BUILDING AND FLYING INSTRUCTIONS
for
REMOTE CONTROLLED HELICOPTER
D-S 22

The instructions will seem different and unfamiliar to you because a helicopter is an all new aircraft, and most of you in general will have no experience with this type of machine. Therefore the instructions are more than building instructions, including a general picture of the helicopter technique and special building- and flying instructions for the "D-S 22". This will enable mainly the beginner to gain a certain basic knowledge of this branch of model flying.

Those who are already experienced in this area may concentrate mainly on the mere building instructions.

HISTORY OF THE "D-S 22"

The remote controlled helicopter "D-S 22" is another creation of Dieter Schlüter, designer of the BELL HUEY COBRA, which is the world's first full controlled model helicopter. The development of this model began in 1967, and at the time it seemed impossible to build a model of a full sized helicopter and control it the same as the full scale conterpart. As there was no knowledge about the drive, the control system, and the flight characteristics, many experiments had to be made to find the problems involved in the development of a model helicopter.

After many, many attempts, in 1969 the control system which is now used on the BELL HUEY COBRA was developed. In January 1970, the first real controlled flights took place. In March 1970 the first BELL HUEY COBRA was ready for take off. Only a few months later, on June 2o, 197o, Dieter Schlüter made a world record of 11,5 kilometers, flying in a closed circle for a total time of 27 minutes and 51 seconds. Both were recognized as official world records.

After this achievement, Schlüter, a successful automotive engineer, received many requests for complete helicopter kits. A fibreglass fuselage and special gears were developed, the rotor head improved and the steering modified etc. Dieter Schlüter began to sell home-made complete helicopter kits and by the end of 1971 some hundred kits were sold all over the world and they were flying!

The increasing demand on one end, and the problems of mass production and distributing on the other, lead to the relationship between engineer Dieter Schlüter and the Hegi model building firm of Nürnberg, Germany. The kit for the BELL HUEY COBRA was accepted by the world of modellers with enthusiasm. It was obvious for the many interested that with its robust, plain system the flying of a remote controlled helicopter was possible as well financially as technically. The flying success also proved that the steering of a tested model helicopter can be learned without difficulty.

The high demand brought certain problems inasmuch as the basically planned production capacities were not always sufficient to meet the high demand. Besides this, transportation of the BELL HUEY COBRA created some problems, due to its relatively long fuselage, for it does not fit in the trunk of a medium-sized car. Also, many modellers asked for a more "civilized" model.
Thus the "D-S 22" was designed, a scale model of the American "Enstrom F 28 A". This model has a relatively wide fuselage and the large cabin makes it possible to place all mechanical equipment in such a way that it can be easily reached after removal of the canopy. This also makes it possible to remove the aggregates like engine, clutch, transmission, cooling fan etc. individually. Development of this model was made in late Summer 1972 and, with a few exceptions, the well-proven parts of the BELL HUEY COBRA were maintained. Therefore, testing could be concentrated on the new form of fuselage and development of the new rotor head with tetering hinges.
In February 1973, at the Toy Fair at Nürnberg, the model was first officially shown to the public. At the same time, the production capacity was increased and the complete production was done by Schlüter's new firm "Schlüter Modelltechnik", Mühlheim/Main, Germany. Here, the complete kit for the "D-S 22" called "Komplettbaukasten" is being produced, assembled and packed with all additional parts. The mechanical kit for the BELL HUEY COBRA is also produced by "Schlüter Modelltechnik". Distribution of this item is done by Schuco Hegi, Nürnberg.
The spare parts service - which in the helicopter field is of special importance - is also done by Schuco-Hegi, Nürnberg, but at the same time by "Helicopter Spare Parts Service", Ing. Dieter Schlüter, Mühlheim/Main.

TECHNICAL INFORMATION

The technical equipment of the "D-S 22" is similar to the mechanical kit of the BELL HUEY COBRA. Its drive system is well proven in thousands of models but, when starting production of the mechanical parts for the "D-S 22", a few minor modifications have been made. Due to the size of the new model, the length of the main rotor shaft and tail rotor shaft has been changed. The transmission case was changed by adding some reinforcements and an axial fixation of the individual bearings. The connection of the main rotor blades was also modified. The blades are no longer rigid, but each one is equipped with a tetering hinge for smoother flight.
For a better understanding of the mechanical drive and the control system some information is now given.

Motor

For power, any modern .6o engine is qualified. Peferably, engines with a crankshaft diameter of 8 mm (1/4 "), as the cooling fan is made to fit this most standard size motor.
Of course it is possible to use an engine with another size crankshaft, without the necessity of reworking the engine.

You may use rear valve and front intake motors. To get a good flying model, it is only necessary that your engine be equipped with one of the new throttles. In the original, a Veco 61 with a Perry throttle (Hegi No. 215 15o) was used.

Cooling

As a helicopter engine does not use a propeller, and the motor is housed inside the fuselage, a special cooling system is necessary. In hovering flight, where there is no forward speed and therefore no air cooling, the cooling system must be very effective. On the other hand, the cooling system should not take too much power away from the motor. The radial cooling fan of the BELL HUEY COBRA, with its special housing, has proved the best. With this new housing, and if you are taking a front intake engine, it is possible to remove the engine without removing the housing.

Starting

To start the engine, a V-belt which fits into the flywheel of the cooling fan is used. We recommend you use an electric starter, however, it is possible to use a longer V-belt and start the motor by hand.

Clutch

The motor and main gear are connected by a centrifugal clutch. This clutch allows easier starting because the main gear and clutch are not engaged while starting the motor. Since clutch and gear are not engaged at this point, the drive shafts are also disengaged from motor power. The totally new developed clutch is self enclosed, and requires no servicing. It begins a "soft" engagement of motor and main gear at 35oo rpm's and continues its functioning without slipping at about 5ooo rpm's.

Main Gear

The high rpm's of the motor must be reduced for driving of the main rotor and tail rotor. This is the function of the main gear, especially developed for the helicopter. Important for a main gear is its degree of effectiveness, which is necessary for little loss of power. This is accomplished with the use of special cog wheels, and the placing of all gear shafts in high precision ball bearings. The main gear runs service free in an oil bath. Having the gear housed is necessary, as the dust produced by the rotor in hovering flight would harm an open gear.

Tail Rotor Drive Shaft

The flexible shaft which drives the tail rotor may also be installed in other fuselage forms. The guide for the drive shaft is a thin brass tube which has proved to be very functional. The drive shaft is greased with normal car grease before installing. Further greasing is not necessary.

Tail Rotor

The tail rotor gear serves as the drive for the tail rotor which corrects the torque of the main rotor and allows movement of the model around the vertical exis. The tail rotor gear is capsule enclosed and contains special, lightweight ball bearing angle gears and cog wheels. The connecting mounts of the tail rotor blades move very easily because of the miniature ball bearings, and allow easy movement even at high rpm's and corresponding centrifugal force. Changing the pitch in the tail rotor blades is done by a pushrod which slides in a shaft and is guided through a control guide slip free. By modifying the control guide, the tail rotor controls may be used in other model forms.

Main Rotor Shaft

The main rotor shaft (mast) couples the main gear to the main rotor, and is made of high quality steel which is tested for precision roundness. There are special ball bearings at the top of the fuselage, but for service or repair, the shaft can be removed without disturbing the other components.

Swashplate

The swashplate is at the fuselage top and transfers controls for the forward and backward, left and right movement from the servos (which are mounted in the fuselage), to the turning counterparts of the main rotor. The swashplate is contained slip free in a special ball and socket joint, and fitted with an additional ball bearing.

Main Rotor

The main rotor consists of a hub, which connects the main rotor shaft with the rotor head, the upper cardan unit, the control system, and the blade mounting. All moving parts in the rotor head are assisted by ball bearings. All the materials used have been carefully selected so they provide the necessary strength. This refers particularly to the so-called rotorhead see-saw with the tetering hinges, the blade mountings and the connection screws. (Function of main rotor will be explained in detail later when talking about steering of the model).

Main Rotor Blades

The main rotor blades have a special, tested airfoil (Clark-Y). Very important in the selection of the airfoil was the simple production, due to its flat bottom, and also the strong possibility of eventual warping, and the incidence. Two blades are necessary for each model. The blades are already glued and shaped, and the mounting holes are drilled. The foil, when applied, makes for a very fine finished surface of the wood. The blade itself has a hardwood leading edge, and a balsa trailing edge. This makes possible an exact mounting on the rotor head and a good laying for the center of gravity in the airfoil. The additional effort of applying weights in the nose of blade for obtaining a more forward center of gravity is not necessary with this airfoil.

Fuselage

The fuselage of the "D-S 22" is made of fibreglass, and it is already finished. For the installation of the various mechanical parts, the fuselage is reinforced with formers and longerons. This frame is made from pre-cut wooden parts, which are glued together outside of the fuselage. Insert the complete unit into the fuselage and glue it in with epoxy and the fibreglass strips, provided with the kit. Details see building instructions.

Training Landing Gear

A special training landing gear with a wider spread is recommended for trimming the helicopter. By losening four screws, this landing gear can easily be replaced by the normal, smaller skids or by a landing gear with pontoons.

Landing Gear with Pontoons

The landing gear with pontoons consists of a frame, mounted to the same screws as the normal landing gear or the wider spread training gear. The two pontoons consist of inflatable plastic hoses. With these, the helicopter can not only start and land on water, but it can also be used on land without problems. The landing gear with pontoons proved to be an excellent training landing gear, for the airfilled pontoons have a shock absorbing effect. Being relatively wide-spread, they will also prevent a tipping over of the helicopter (especially over the edges).

Fuel Tank

A 5oo-ccm fuel tank is installed in the front fuselage formers. The tank is installed in such a way that its contents can easily be controlled by looking into the cabin (Hegi No. 217.961).

RC-Gear

Any good, modern proportional RC system with four channels is okay. Exceptionally powerful servos are not necessary because only a small amount of force is required to move the controls. After removing the canopy, the RC gear is installed in forward section of the fuselage, mostly under the control panel. After re-installing the canopy, the RC-gear is practically out of view, but most of the interior cabin can be seen, allowing true-scale cockpit configuration.

Control System

Before the control system of the "D-S 22" is explained in detail we will now explain the system in general. By turning the positive angled main rotor blades, the air is absorbed and pressed down. Depending on the size of the rotor, the rpm's of rotor blades, the blade incidence, and the airfoil, a certain lift is produced. If there is more lift than the weight of the helicopter, the helicopter moves upward. If the lift is the same as the weight, it keeps the height it has. If the lift is less than the weight of the helicopter, the helicopter sinks. In each case, the needed lift is regulated by changing the incidence (collective blade adjusting), or by changing the engine rpm's.
For changing the rotor blade incidence (collective pitch adjusting), push rods and linkage are necessary. When the lift is controlled by changing the engine rpm's, these parts are not used. With every change in the blade incidence, a change in the engine rpm!s is also necessary due to different air resistance. When the lift is regulated by the engine rpm's this procedure happens automatically when you give the engine more power or when you reduce the power.

To drive the main rotor, power from the motor is necessary.This motor power leans itself on the fuselage of the helicopter.This makes the fuselage want to turn in the opposite direction that the main rotor is turning. If for instance the main rotor is turning to the right (clockwise as seen from above), the fuselage will turn to the left. This rotation around the vertical axis is prevented by the tail rotor. The tail rotor works similar to a normal aircraft propeller in that it pulls the tail of the fuselage and therefore balances the torque of the main rotor. Because this turning is always changing, depending on the incidence of the main rotor blades, the thrust of the tail rotor must be changeable as well. So, the incidence of the tail rotor blades is also adjustable. When adjusting the pitch of the tail rotor, this side thrust also serves for turning the entire fuselage around the vertical axis. (Direction changing of the fuselage).

When using the collective blade adjusting, any change in the lift will cause a change of the torque. This means the fuselage has a different pull around its vertical axis, and requires exact regulation or adjusting in the pitch of the tail rotor.

In addition, any adjusting of the main rotor incidence will require adjustment of the motor power.

On the other hand, if the lift is not controlled by changing the blade incidence, but by varying the motor rpm's, you don't have all these problems. When you open the throttle, the motor rpm's increase, and with it, the motor power. The increasing torque is balanced out automatically by the tail rotor, because it gets more rpm's, and this produces more side thrust.

Applied to a model, and especially to the D-S 22, this means: Vertical movement is controlled by only one channel, and that's the motor throttle. By opening the motor throttle, the motor power and the motor rpm's increase. At the same time, the tail rotor rpm's increase as well, and that provides the harmony of a constant balance in the increasing "fuselage torque".

All of this is dependent on an exact aerodynamic turning of the main and tail rotor, which to develop, took much time. For this reason, it is not good to make any change in the airfoil or the incidence. You only trim the tail rotor one time so that the proper direction of the machine is kept, thus preventing it from turning around the vertical axis.

If now you open or close the throttle steadily, the torque is balanced automatically. This means that the fuselage will not, or only slightly, tend to turn around the vertical axis. Now, if you want to change the fuselage direction by turning it on its vertical axis, this is done by changing the tail rotor incidence. You do the same thing if you have to adjust to wind, etc.

The <u>motor throttle control</u> is done by channel 1, the best longitudinal movement on the left transmitter stick. The tail rotor controlling is done by channel 2, the cross movement of the left transmitter stick. The stick, when moving to the left, will reduce the tail rotor incidence and turn the fuselage nose to the left. Move the stick to the right, and the fuselage nose goes to the right. The neutral position must be trimmmed so that with a steady throttle opening, the fuselage does not move around vertical axis. (Wind,however, will affect this). Consequently, channel 1 (motor throttle) steers the vertical movement of the model, while channel 2 (tail rotor) steers the turn around the vertical axis or fuselage direction.

Do not confuse fuselage direction with flight direction! The flight direction of the helicopter is not controlled by the tail rotor, but nearly exclusively by the main rotor.

For a better understanding of the main rotor control, read on: The turning rotor blades produce a certain lift which must be equal to the helicopter's weight for hovering. The area of the turning rotor blades is called "rotor circle area". If this circle area is exactly horizontal in the air, an exact vertical thrust is produced and the helicopter will hover over one certain point. If the circle area is dipped in another direction, (by an outer influence, or by a control movement) an additional thrust takes effect in this direction, producing a corresponding acceleration in the direction the rotor axis is dipped. Here it is important you remember that there is no prefered direction for the main rotor system. The main rotor may be dipped in all 36o degrees!

The dipping of the main rotor is done by cyclical blade adjusting. This control movement is transferred to a so-called swashplate in the rotor head. The swashplate is connected to two servos. One causes the swashplate to dip forwards or backwards (flight direction), and the other to the right or to the left. By moving both servos, a dipping of the swashplate in any 36o degree direction can of course be accomplished. The control of the main rotor is obtained by a certain connection between the upper turning part of the swashplate, and the pushrods that lead to the blades of the main rotor.

This control mechanism is built so that the rotor area keeps the exact same plane as the swashplate. In other words, if the swashplate is dipped 3 degrees forward, the rotor area also dips 3 degrees forward. The swashplate moves in all directions. The servos for the swashplate are controlled by channels 3 and 4 on the right stick of the transmitter. When the stick is neutral, the swashplate is exactly horizontal at a 9o degrees angle to the main rotor shaft. If the right stick is moved forward the swashplate dips forward. When the stick is moved backwards, the swashplate dips backwards. If the stick is moved right or left, the swashplate does the same. The point is, the swashplate moves in any 36o degrees direction.

In every case, the movement of the stick (and with it the swashplate) causes an acceleration in the direction the stick is moved.

The D-S 22 has a rotor head with cyclical "over controlable" gyroscope stabilizing. This is described as follows:

A dipping of the main rotor area in a certain direction is not accomplished by dipping the entire rotor head, but by so-called cyclic blade adjusting. This cyclic blade adjusting is not to be confused with collective blade adjusting, by which the incidence of the two rotor blades is adjusted in a positive or negative direction. (and also the before-mentioned torque changes). With this control system, the two rotor blades of the main rotor are rigidly connected to the tetering hinges and the see-saw. Each rotor blade has a measured positive incidence to the stabilizer bar of 4 degrees. If the hub is dipped to the side, the incidence is increased on one rotor blade, while the incidence is decreased

on the other, the same amount. For example, one blade has an incidence of only 3 degrees while the other now has 5 degrees, however, the sum of the two is still 8 degrees and therefore, the sum of blade resistance and the resulting torque is constant. Only, the blade with the least incidence will of course have less lift, than the blade with the most. This means a corresponding dipping of the entire rotor system, because the blade with the most lift will go more upward, while the blade with the least will go down. This cyclic blade adjusting of the main rotor blades is done by the stabilizer bar where two small, but relatively heavy, stabilizers are mounted.
When the swashplate is on a horizontal bearing, the stabilizers run in a neutral plane and have the effect of a stabilizing gyroscope. The stabilizer bar is therefore kept on a certain horizontal plane by the weights. Because the rotor blades are angled (4 degrees incidence) to the stabilizer bar, they run on the same plane as the stabilizing bar. If now the swashplate is dipped forward, then the pushrod on the stabilizer bar causes the bar to twist. This causes one stab blade to have positive incidence and the other to have negative. Before, the stabs were only used as weights, but now, they have a control function. The stab with the positive incidence will go up, the one with negative indidence down. This means a change in the running plane of the stabilizing bar until it runs parallel to the dip of the swashplate. The stabilizing bar now controls the main rotor blades until they reach the same dip as the swashplate. If the swashplate is now moved in a rectangular position to the main rotor shaft, the cyclical adjusting of the stabilizer-control keeps its plane, and at the same time, the main rotor system stays on the same plane as the stabilizers. A change is made only with a new control movement of the swashplate.

A special feature with the "D-S 22" is the so-called "S-Rotor" which has the following advantages in comparison to the rigid rotor system of the BELL HUEY COBRA:
By the centrifugal forces, the main rotor blades of a helicopter are put into a horizontal position, or to be more exact they are positioned into a 9o degree angle to the main rotor shaft. These centrifugal forces at the rpm when hovering are about 5o - 6o kp. Under these forces, the rotor blades would be exactly in one straight line. But besides this, the lift is also effecting the rotor blades. Suppose the total weight of a helicopter is about 5 kp, a lift of 2,5 kp per blade is created. Consequently, each rotor blade is being pulled into a horizontal position by the centrifugal forces with about 5o - 6o kp, and being lifted with 2,5 kp (using the forementioned example). This results in a certain slanted position of the blades of about 2 - 4 degrees, and this dihedral is called "cone-angle". Naturally, this "cone-angle" is larger at a stronger lift and smaller at a weaker lift. The turbulence has also an effect on this.
Under the rigid rotor system, the see-saw which connects the two blades is bent to a normal dihedral. However, should the lift be different, the blades have the tendency to change their cone-angle. Now the so-called tetering hinges come into function, allowing each blade individually to be positioned in its own and best position, resp. in the cone angle required for this certain flight position and load. This permits the blades to

run extremely smooth, at the same time maintaining nearly the same stability of the main rotor, as in the rigid rotor system. Thus the S-rotor incorporates the stability of the rigid rotor system and guarantees smooth run by individual steering of the blades.

BUILDING INSTRUCTIONS FOR FUSELAGE

Be sure to follow the instructions exactly, as sequence of the individual tasks will guarantee an assembly without problems. Take the building plan and compare the text with the plan. The wooden parts for building the fuselage are pre-cut.
Put the building plan with drawing of fuselage on a straight board. Following this plan, drill a hole of 6,5 mm diameter in the marked position in former 6, and drill one each hole of 3,5 mm diameter in the marked positions of the inner side walls 5. Later on, the 9o degree control lever for steering of the swash-plate will be put there. Fit and glue fuselage bottom construction parts per photo No. 1 out of wooden parts 1 to 8 inclusive. Make sure all parts - except parts 6 and 7 - are precisely located flat on the building board. Cut out door openings on the fuselage (with small circular file). Make sure to leave a 3 mm wide strip on which the doors will be glued later.
Following photo No. 2, install cured lower framework through the front of the fuselage. Pull the framework forward until the front curved formers engage with the fuselage shape and make sure it is exactly aligned to center line of the fuselage. Put frame in a tightly fit position by placing some support formers vertically into the fuselage. Laminate framework to the fuselage with the fibreglass tape provided in the positions marked on the plan. Make sure that strip overlaps onto both the wood and the fuselage. It is recommended to put a layer of epoxy on the wooden parts, for fuel-proving purposes.
Per photo No. 3, insert former No. 1o through the rear of the fuselage. Put your finger into the large opening in former 1o and position it straight, adjusting hole to fuselage center line on top. Epoxy former 1o with "Stabilit Express". Mark off position of slots for elevator fin on fuselage, drill and file to shape. Slide longeron 12 through fuselage, having rounded off trailing and leading edges. Align fin symmetrically on the fuselage and epoxy from inside and outside with Stabilit Express. Apply epoxy on seems between fuselage and fin so that filleted corner is created.
Bend tube 837 for guide of tail rotor drive shaft slightly to a s-shape. Slide tube through former 6 from the front and then over the fin. Locate it centrally in the fuselage with the rear end protruding through the hole in former No. 1o. The front end of the tube should only be about 5 mm to the front of former No. 6. It should rest on the fuselage bottom as shown on the plan.
Using Stabilit Express glue pipe to former No. 6 and with pieces of fibreglass tape as shown on the plan, glue and reinforce to the fuselage and the fin. Take care that no glue enters the tube. Install support formers no. 9 with Stabilit Express using fibre-glass tape reinforcing to the shell.
Acc. to photo No. 5, make unit for the tail rotor arm from

former 11, tube 834 and the partly pre-bent 3 mm diameter steel wire. Bend wire in final form of strut as shown in photo No. 5, connect steel wire with wire 836 to former 11. Acc. to fuselage side view on plan, make sure that wire binding will not interfere with later installation of the tail rotor gear box screws. Epoxy binding wire carefully with Stabilit Express.
Acc. to photo No. 6, insert this assembly in fuselage from the rear, fit former 11, watch for exact horizontal position of tail rotor arm to axis over total length of fuselage and glue carefully in former 1o resp. fuselage tail. Watch that no glue will get into guide tube for tail rotor gear! The tail rotor arm should extend 15o mm from the back of the fuselage. For control, measure a distance of 965 mm (± 2 mm) from center of dome on top of fuselage (later position of main rotor shaft) to rear end of tail rotor arm.
Acc. to photo No. 7, make canopy frame from parts 14, 15 and 16, clamp with pins and glue together. Fit in and epoxy reinforcement edges 17. Acc. to building plan, glue with Stabilit Express reinforcements 22 and 23 behind edges of canopy opening in the fibreglass fuselage. After cured, take out canopy, drill holes for dowels in upper canopy former 15, transfer these holes to upper rim of canopy opening and drill there 5 mm diameter for the dowels. Epoxy dowels 21 in former 15 and at the same time, line up with holes in fuselage. Drill 3 mm diameter hole in center of lower rim of canopy opening in fibreglass fuselage, insert screw M 3x1o with washer from below and fasten from top with washer and nut. File off protruding threaded section so that only a threadless pin remains. Acc. to detailed drawing in building plan, assemble canopy latch from parts 18, 19 and 2o with two screws M 2x12,4, washers 2 mm diameter and two nuts M2, and slide into slot of canopy former 14. Clip this assembly into position over the previously mounted pin for the time being by tightening the M2 screws.
Epoxy pilot seat from parts 27, 28 and 29 and 3o acc. to photo No. 8. Sand and paint seat. After later installation of the engine, a piece has to be cut out on position marked A, so that the glow plug of the engine can be reached. Fasten seat with two screws 2,9 diameter x 9 and washer 4 diameter to longerons 8 of base frame, as shown on photo No. 9. By untightening both screws and turning seat by 9o degrees, seat can be removed from front fuselage, even after doors have been glued in. This permits perfect working in the area behind the back of the seat.
The instrument housing is made from parts 24, 25 and 26 acc. to photo No. 9 and is glued together and fitted to canopy former 14 acc. to building plan. However, this part will only be glued in after the frame of the cabin has been sealed with sealer, re-sanded and painted acc. to your own choice, and after the windows have been glued in with Acetone glue. Final adjustment of the canopy latch is made to ensure a neat fitting framework in the fuselage. Now epoxy these pieces and then glue in the painted and completely equipped instrument panel.
Finally, glue rudder fins 13 to the ends of stabilizer fin acc. to plan. Cover with Japan silk or at least with foil, varnish several times and then paint. Also paint tail former 11 and tail rotor arm. Painting of complete base frame is recommended.
Now the fuselage is ready for installation of the mechanic. The canopy doors can already be cut from the material provided with the kit, but it is advisable to glue these only in after mechanical

installation and after installation of RC control and steering etc. have been completed. It is recommended to roughen edges of fuselage with sand paper before applying Acetone glue.

Use of Decorating Foil

The attached decorating foil is made of special, self-adhesive material and to be used as follows:

a) equally wide red strip with black side strip is for nose of fuselage from door to door,
b) red strip with black sides, getting smaller, for sides of fuselage
c) curved black and white strip with straight pieces is for canopy doors,
d) four black strips for outer rim of canopy, to cover gluing surface,
e) black and red strip to mark tips of rotor blades,
f) others acc. to plan or your own choice.

Before applying foil, be sure fuselage is clean and without grease spots. Pull foil around nose of fuselage very tight and stretch so that black side strips fall into place automatically.

BUILDING INSTRUCTIONS FOR MECHANICAL PARTS

When assembling the mechanical parts, be sure to follow the given sequence. Take the pictured spare parts list and compare the 3-digit part numbers, thus getting acquainted with the looks and names of the individual parts. The small parts are assorted acc. to individual building groups and it is easier for you to open the referring small parts box only then, when actually using these parts for assembly.
The plastic boxes on top of the kit contain from left to right:

1) Box A: Small parts for transmission, engine, cooling system, and base plate,
2) Box B: Small parts for rotor shaft, upper bearing, swashplate
3) Box C: Small parts for tail rotor shaft and tail rotor drive
4) Box D: Small parts for main rotor head.

Main Gear Box Assembly

The outer ring of the ball bearings on gearblocks (21o, 22o, 23o) must be cleaned thoroughly with a rag, so they are free of grease. Do not use a cleaning solution, which could cause damage to seals. Following photo No. 1o, put gearblocks in one of the transmission cases (2o2 or 2o3), cover with second transmission case and check for proper functioning of the gears. Take apart again. From small parts box A take six screws M 3x1o and one screw M 3x3o with nuts. Mis Stabilit Express (middle groove of attached package). Take one transmission case and apply a thin layer of Stabilit Express in the six half-round grooves made to accept the ball bearing rings. Press gearblocks into the grooves. Take other transmission case and apply Stabilit Express on the six grooves and the facing. Attach the two halfes acc. to photo No.11, using the bolts and nuts set aside before. Important! Depending on the temperature, Stabilit Express will cure within ten to fifteen minutes. The main gear box has to be assembled within this time so that the

Stabilit Express does not cure ahead of time, causing an imperfect securing of the two housings. After the Stabilit Express has cured, fill gear housing with hypoid transmission oil SAE 9o through hole in bottom of gear box, until oil level reaches rim of filler hole. Close filler hole with screw M 5x6 from parts box A. For a later control in the model, put it on its nose and proceed same way as described here for the first filling. An oil change is done the same way (first oil change after about 2 hours running time, then about every 1o hours).
Important! Use only the attached special oil! Other oils may react with the material of the housing as well as with the seals of the bearings.

Modification of Engine and Mounting of Radial Cooling Fan

For power, any 1o ccm engine can be used. However, the engine has to have a crankshaft of 8 mm diameter. Most of the 1o ccm engines on the market have this crankshaft diameter, in some cases special crankshafts may be obtained from the engine producers. Make sure that the fan is not mounted to the crankshaft end which normally holds the propeller. In any case, the hub has to be removed from the engine and the fan has to be mounted directly to the front crankshaft bearing. Only this guarantees perfect run. The Veco 61 engine has been well-proven in use of helicopters, and the following mounting instructions are meant for this type of engine.
Remove hub and cone from Veco 61. Careful! If you try to do this with force, the crankshaft could be pressed back into the engine housing, where it could hit the back part of the engine housing. It is therefore recommended to remove the front part of the bearing housing from the engine and then remove hub and cone. Take cone (1o4) from small parts box A and slip on free 8 mm crankshaft (Do not use old engine cone). Put fan (1o5) on cone and tighten firmly by using crankshaft screw with allen wrench, acc. to photo No. 12. When doing this, hold blades of cooling fan with your hand, in no case tighten in c-clamp! Check cooling fan with crankshaft for smooth run. This is important, for occassionally when tightening the crankshaft screw, the bearings on the engine could be restricted. A slight tap on the cooling fan with a plastic hammer in axial direction will help. It is easy to check out the smoothness of run with your hand.

Mounting of Clutch

Insert centrifugal clutch (1o6) with already installed needle bearing (1o7) into fan opposite the engine, and fasten with two socket head screws M 4x15 from small parts box A, acc. to photo No. 13. CAution! Do not test-run engine when centrifugal clutch is connected. Without clutch bell, the clutch shoes will bend to the outside and fly off.

Power Unit Assembly

Mount assembled gear box to base plates (1oo and 1o1) with four bolts M 3x1o and nuts from small parts box No. A. (See photo No.14) The proper position of the right and left base plate can also be seen on photo no. 14.
The fan housing (1o8) is fastened with four screws M 3x8 and washers 3 diameter from small parts box A from below to the base plates.
Slip starting belt (11o) over the clutch and pulley on the fan!
Install power unit with cooling fan and clutch in base plate

(see photo No. 16). Lay supports (1o2) from small parts box A underneath motor flange, align motor and pull back again about 3 mm so that frontside of clutch does not start in clutch bell. Now mark in base plate position of mounting holes for engine, remove engine and drill four holes (3,5 diameter) through supports and base plate. Mount engine and supports with four socket head bolts M3x15 and four lock nuts from parts box A. Be sure exact width of base plate (11o mm) is maintained and that the engine is aligned exactly to the clutch, so that it is working freely. (The washer in box A might have to be put under the cone of the cooling fan in case the distance between transmission and engine is too big).
Fasten main rotor shaft (42o) with socket head bolt M 3x15 and lock nut M3 from small parts box B to upper gear connection. Finally, file off protruding ends of the two bolts used for mounting the fan housing. The plate has to have a level surface for the now following installation into the fuselage.

Installing Drive Unit into Fuselage

Drill a hole in the center of the fuselage top for the main rotor shaft (15 mm diameter). The wooden parts of the fuselage should now already be varnished, for oil-proofing purposes, for the drive aggregate needs not to be removed again from the fuselage. Place fuselage on its back so that base plate is face-up. To do so, place tail of fuselage on workbench and put canopy opening on the back of a chair. Now install the completely mounted drive unit with main rotor shaft head-on into the fuselage and push the rotor shaft through the 15 diameter hole in the fuselage dome. For exact alignment, the drive unit should now be moved forward and backward on the longerons of the fuselage frame, until the main rotor shaft is centered exactly in the 15 mm diameter hole in the fuselage dome. If necessary, thin plywood pieces should be put between base plate and fuselage frame. There is also the possibility to apply Stabilit Express on the longerons 7 and to press the drive unit into the glue and adjust it. The holes are already drilled in the base plate, now drill the eight mounting holes 3 mm diameter in the longerons and fasten base plate with screws M 3x2o and large washers and eight nuts M3 from parts box A. Very important! Mounting of the base plate has to be done with extreme care and always be sure that drive unit remains centered in the 15 mm hole in the fuselage dome. In any case, be sure not to bend the base plate or the main rotor shaft, in order to achieve more exact positioning! Exact alignment between engine, clutch and transmission and exact position of the main rotor shaft have to be maintained. The base plate is only installed once. Should removal of individual aggregates be necessary at a later time, this is done through the interior of the fuselage.

Mounting of Training Landing Gear

Before continuing to install the mechanic into the fuselage, it is recommended to assemble the training landing gear and fasten it to the base plate acc. to photo No. 19.
You will find the following parts for assembly of the training gear in a small box at the right-hand side of the kit:
Four mounting clamps already bent and drilled,
eight screws M 3x1o for clamps,
eight nuts M 3 for clamps,
four screws M 3x3o for mounting of skids to base plate,

four nuts M 3 for these screws.

Connect struts with skids by using the clamps. Positioning of struts and skids can be seen on building plan.
Locate 15x15 mm wood block in the wooden pieces kit and cut into four 2o mm lengths. Drill a 3,5 mm hole centrally through the side of the blocks and use these as spacers between the struts and the base plate. Attach with four screws M 3x3o and allen-head screws. Now the fuselage can be stood upright, which makes further installation easier.

Upper Main Rotor Shaft Bearing

Acc. to Photo No. 2o, slip gear ring (421) together with bearing (422) over top of the main drive shaft.(You can see in the photo that the rotor shaft is centered exactly in the 15 mm diameter hole). Cover the support area on the fuselage dome with Stabilit Express and press bearing ring in place. By applying the Stabilit Express any unevenness of the fuselage dome will be corrected. Caution: Do not use too much glue, for it could get into the ball bearing. After the Stabilit Express has cured, drill four holes (3,1 mm diameter) through top of fuselage and fasten bearing ring with four bolts M 3x15, four washers and four nuts M 3x15 from parts box B.

Swash Plate Installation

Take two control arms with ball joints (4o4) from parts box B. Following photo No. 21, screw these control arms in outer ring of the assembled swashplate (417). The control arms must be screwed in all the way and must be secured with lock nuts from parts box B. The third control arm (4o4) also has a nut M3 and is screwed 5 mm into the hole of the top bearing ring of the swashplate. Secure with nut. The ball of a ball joint (o5o) from parts box B will now be slipped over bolt and is screwed into the M2 hole in the large outer ring of the swashplate. Now with the swashplate in this position, place the ring (418) over the main rotor shaft, then the swashplate (with collector pin upwards) and then the second ring (418). The collector fork is now fitted on the shaft so that the collector pin extends through the collector fork opening. The collector fork will be fastened temporarily with a socket head bolt M 3x15 and a lock nut M3. Proper alignment will be done later.

The holding rod for the lower rigid ring of the swashplate is made by using rod (4o5) and a ball joint with ball. Acc. to photo No.21, screw on back of fuselage with a screw M 2 with washer and nut M 2. Exact position of holding rod and 7 degree off-center position of swashplate can be seen at the right hand bottom corner of the plan. Be sure that holding rod is bent slightly so that control rod will not hit when swashplate has extreme steering position. Temporarily fasten an allen head screw M 3x15 in upper hole of main rotor shaft with lock nuts from parts box B. Mounting of main rotor head will be done later.

Tail Rotor Gear Assembly

Required small parts for tail rotor gear assembly are assorted in small parts box C. Insert the gearblock with hub (321) into the gear housing (31o) opening which is opposite the opening of the square part of housing. The gear block without hub (32o) is inserted into the other end of housing. By sliding the gear

blocks back and forth, a remarkable tolerance can be obtained. The hypoid gears must function exactly. Fill the gear box through the opening with car grease by using your finger, and then press cover (311) into place. Now push control rod (312) through center hole of cover (311) and through the hole in the shaft of the gear block (321). Be sure that rod moves freely. Should the hole in the black plastic cover be too tight, widen it slightly. Acc. to photo No.22, slip control rod (312) through the control guide (313) and fasten to the side of the gear box. Before doing so, it might be necessary to work on the slot of the guide (313) so that the rod has free movement without play. As seen on photo No. 22, screw the forementioned parts with two screws 2,2 diamter x 6,5 in the holes on the square part of the gear box. Tighten cover on top with two screws 2,2 diameter x 6,5. Now fasten flexible tail rotor drive shaft (3o2) with the couplings (3oo) and four socket head set screws M 3x3 to the gear shaft. Push this assembly from the rear into the tube of the tail rotor arm and at the same time into the guide tube in the fuselage, and then push forward until the tail rotor gear can be pressed into the tube of the tail rotor arm. The tail rotor gear should be totally pushed in with a slightly turning motion.
Check on main rotor gear that tail rotor drive shaft has a distance of 1 to appr. 5 mm. Should shaft be a little bit too long, it can be shortened by filing off excess length. The end of the tail rotor drive shaft are welded. When adjusting length of shaft, be sure that it will not be re-installed under pressure or tension, otherwise it will not fit smoothly into the guide tube.
After fitting the shaft,pull it out again together with the tail rotor gear. On the guide tube drill positions for mounting holes for the tail rotor gear and for later tightening of the screws for the shaft coupling. Positions can be seen on side view of plan. Note that fastening of gear housing in the guide tube for tail rotor shaft is done with three each screws 2,2 diameter x 6,5 in a 9o degree angle. Drill 2 mm diameter holes for screws and 3 mm diameter holes for tightening the clutch screws. Now grease complete drive shaft well and thoroughly, thus giving the guarantee that total length of the tube in the tail is greased perfectly. Also press some grease into the guide tube. Finally, push the drive shaft with tail rotor gear housing in right position. Be sure that drive shaft is exactly in horizontal position.
Now drill 2 mm diameter through the mounting holes in the tail tube and fasten tail rotor gear with two screws 2,2 diameter x 6,5. These same screws will also have to fasten the gear box and the plastic ring between the ball bearings on the shaft with the tail-rotor hub (see photo No. 23).
Important! The clutch pieces (3oo) are only pushed on the shafts of the main- and tailrotor so far that the socket head screws are fully laying on the shaft. It is more important that the opposite screws, laying on the shaft, are fastened away from the end of the shaft, thus preventing that the shaft will be pushed aside and torn when tightening the screws.
Per photo No. 23, now fasten the two ball bearings (316) to the hub with two socket head screws M 3x3. Attention! Before doing so, tighten socket head screws M 3x3 in hub on gear with 1,5 mm wrench! Also tighten screws for bearings. Acc. to photo No. 24, fasten one each ball of the ball links (o5o) to the arms of the two Nylon blade mounts (317) by using screws M 2x1o and nuts M2. Slip one blade mount with ball and one blade mount with arm but without ball over ball bearing of blade mount and screw together

with 2 each screws M 2x1o and nuts M2. Tighten well without damaging Nylon parts. Put a drop of varnish or Stabilit Express on thread tips protruding from nut, thus preventing a possible later loosening. With 2 screws M 2x1o and 1 each washer 2 mm diameter fasten control plate (315) to the shafts of the ball points (o5o). The balls of these ball points have been earlier screwed to the arms of the blade mounts. Push a collar (314) with screw M 2,6 x 3 on control rod protruding from rotor shaft. Then push control plate with ball bearings on balls of the blade mounts. Positioning may be seen on photo No. 24 and side view on plan. Fasten another collar (314) with screw M 2,6 x 3 at the end of control rod (312). Temporarily fasten the two collars left and right of the control plate (315) to the control rod. When the rod is in center positions of the guide, the pitch of the blade mount should be appr. plus 8 degrees. Exact adjustment will be made later after installing the RC equipment.

Installation of Tail Rotor Blades

Sand tail rotor blades slightly so their profile is exactly as shown on the plan. Then round off one end of each tail rotor blade and drill a 3 mm diameter hole.
Important! This hole has to be drilled exactly in the position as shown on the building plan so that the tail rotor blade - after mounting between the two tongues of the Nylon blade mounts - can swing aside in the event of impact.
Cover blades with foil, and per photo No. 25, fasten with one each screw M 3 x15, two washers 3mm diameter and one each lock nut M3. Tighten this just sufficiently so that the blade can be moved with light finger pressure and is not held rigidly. Centrifugal forces will keep these in a completely radial position in flight, but the pivot allows them to swing aside in the event of impact, thus preventing damage to the tail rotor gear.

Main Rotor Assembly

All parts for assembly of the main rotor are found in small parts box D.
With 2 socket head screws M 4x1o mount 2 ball bearings (5o3) to main rotor hub (5oo), putting a 4 mm diameter washer between ball bearing and rotor hub. Tighten screws for ball bearings well with socket head wrench from kit (see photo No. 26). Acc. to photo No. 27, press this unit from the top in a cardan shell (5o2) in the referring space. Now fit two ball bearings (5o3) to the stabilizer rod (5o5) and insert into place in the cardan shell. Acc. to photo No. 28, slip on one side of the stabilizer bar the angled control link (5o7) with socket head screw M 3x3 and temporarily fasten in center of stabilizer bar. On opposite side of stabilizer bar slip on collar (5o6) and also fasten temporarily with socket head screw M 3x3. Press second cardan shell (5o2) on ball bearings and insert four socket head screws M 3x35 from the top through the holes of both shells. Acc. to photo No. 29, with four lock nuts M3 mount the pre-assembled see-saw with tetering hinges (51o) directly under the cardan shells. When mounting the see-saw, be sure that the slanted, flattened side of the hinges point downwards, away from the cardan shells. Tighten mounting screws well but not too hard, so that plastic cardan shells will not get squashed. Acc. to photo No. 29, fasten parts 5o9 with four screws M 3x2o and with lock nuts M 3 to see-saw. If done correctly, the tetering hinges must have a larger way upwards, than downwards.

Mount stabilizers (5o8) on outer thread of stabilizer bar. It is correct that the thread in the stabilizers begins only deeper in the hole. Thus a longer part of the stabilizer bar without thread is put into the stabilizers so that the screws M 3x3, which are now put into each stabilizer, will press on the unthreaded part of the stabilizer bar. Before tightening these screws, adjust stabilizers parallel,acc. to photo No. 3o.
Now untighten the temporarily fastened screws for the angled control link and the collar on the stabilizer bar, put the complete rotor, as shown on photo No. 3o, on the rotor hub and push stabilizer bar backwards and forward until it is absolutely balanced. The angled control link and the collar have to be adjusted accordingly. Tighten these two parts in their final position with screws and be sure that the control link is also aligned to the stabilizer blades. The easiest control is, to put the ball of the control rod exactly in the center of the head of the mounting screw for the ball bearing on the main rotor hub. Both stabilizers must then be exactly in horizontal position. This position can also be seen on the drawing of the rotor head (on plan).

Covering of Main Rotor Blades

Lightly sand down the full length of the already prepared rotor blades until a smooth surface is obtained. Check profile of rotor blades. Exact profile can be seen on building plan, center. Also lightly sand off edges on blade tips, but watch that you do not round off the edges. If desired, rotor blade tips can be varnished, but it is important that no paint or varnish will be put on the remaining rotor blade surface. The attached foil which is especially made for covering of rotor blades, can only stick perfectly when applied on the sanded, but otherwise untreated wood.

For covering rotor blades with foil, it is advisable to proceed as follows:
Peel the backing off the foil and place it, sticky side up, on a flat surface. Place rotor blade with curved side up on foil, so that about 1 cm of foil extends past trailing edge. Press blade on foil in this position (see photo No. 31). Pull extending 1 cm foil flap over trailing edge. Any wrinkle on the upper side can then be smoothed out with finger pressure (see photo No. 32). Following photo No. 33, pull remaining foil over rotor blade and make sure foil sticks on blade smoothly and firm.

Rotor Blade Installation

As can be seen on plan, use rotor blade mounts (5o4) and socket head screws M 3x15 with lock nuts from small parts box D, and fasten main rotor blades to tetering hinges of main rotor. Lock nuts M 3 should be on top, for later tightening will be necessary. Attention! Centrifugal forces on the rotating rotor blades are extremely high (5o - 6o kp), therefore use only original socket head screws and original mounts. Otherwise there is danger that the rotor blade tears off under strong load and may cause bad damage and injuries. The two rotor blades have to be aligned towards each other in an absolutely exact horizontal line. Should it be necessary to loosen mounting screws for blade mounts, be sure to tighten them again.

Now control pitch of the main rotor blades. Transfer degree scale from plan to gauge and fasten gauge with rubber band under a rotor blade (see photo No. 34). Do not fasten at the extreme end of the blade, but about 15 cm to the center. The gauge has already a pitch difference of 4 degrees to the stabilizer bar. This 4 degrees difference between the bottom of the rotor blade and the stabilizer bar is now checked by placing the complete unit on a smooth table and by making sure that the stabilizer bar is in an exact horizontal position. Should this not be so, bend mounting blades acc. to photo No. 35 until gauge and stabilizer rod are aligned, resp. both are exactly parallel to the table surface. Check second rotor blade in same way.
Finally, make sure that the two rotor blades are in axact horizontal position towards each other.
Now the rotor blades have to be balanced. Acc. to photo No. 36, place completely mounted rotor head with stabilizer rod on two blocks of same height (or between an open vise). Now put a match under the upper part 509 of each hinge. By pressing the main rotor blade down, the match is pressed together until the rotor blade is in exact horizontal position resp. in one line with the main rotor see-saw. Use same procedure for opposite rotor blade. After alignment, both rotor blades are in one line with the see-saw. Now it will show that one blade is heavier than the other. To balance, cut a piece of foil of estimated size, peel off backing and place, with the adhesive side up, on the tip of the lighter blade. Check exact horizontal position of both blades with measuring stick on a smooth surface (see photo No. 37). When you have the right amount of foil, stick it on the tip of the blade. <u>Important!</u> We suggest that you use foil of a different color than the tip of the other blade so that you have a distinct contrast between the two. Later on, it will be easy to identify a blade that is not turning in a proper pattern. For marking of the blade tips you will find in the kit one each black and red strip of foil, 3 cm wide. The exact balancing of the rotor head is very important for having a quiet run of the rotor. The work in aligning and balancing the rotor head must be done with extreme care, which in the beginning requires some attention, but later on becomes routine.

Installation of Muffler

You will see installation of muffler on photos No. 38 and No. 19. It is a special helicopter silencer, with its exhaust pipe going downward. File a 16 mm diameter hole in the fuselage. Attach the special hose provided with the kit to extract the exhaust fumes through the 16 mm hole, cut in the fuselage. Proceed similarly when using different types of engines or silencers. It is recommended in all cases to use silencers with the exhaust pipe on the bottom, pointing downward.

Needle Valve

When later having the model in action, the engine can only be reached after untightening the mounting bolts of the pilot seats. It is therefore recommended to extend the needle valve ot the engine to the outside. Photos No. 19 and 38 show a Veco 61 where a 1,5 mm diameter steel wire has been welded to the brass connection lathe for the engine. The wire is then guided through the fuselage side wall and then bent to an ear. The cooling housing has to be provided with an opening for the needle valve.

Installation of Tank

The installation of tank and fuel line can be seen on the plan and also on photo No. 38. Insert the 5oo ccm rectangular tank from the top into the provided opening in the base frame. Be sure that fuel line does not touch engine housing. For better installing of the hose to the side of the carburator, loosen the four mounting screws of the cooling housing and push it back until it touches the gear. This makes it easier to get to the carburator and this is also of advantage when the control rod for the motor throttle is installed.

Installation of RC Equipment

Any good, modern proportional RC system with 4 channels is okay (4 Servos). The plan shows installation of a system with 4 relatively large Servos. Glue two plywood pieces, 3 mm thick, in the bottom of the front fuselage. Screw Servos with special clamps to these wooden pieces. Size and position of plywood pieces can be seen in plan. There you will also find the function of the individual Servo and the direction of movement.
Basically, installation of the RC equipment should be done acc. to instructions of the manufacturer. There are no special requirements for high force, so the so-called "mini-servos" can also be used.
To transfer the control functions to the individual mechanical aggregates, it is recommended to use a control rod kit, which can be ordered under No. 2o3.77o. This kit contains all parts you need.
When using the normal control rods, remember that these have only a length of 1 m, and in such case the rod for steering the tail rotor has to be extended between former 1 and 9. All rods have to run smoothly, but without play.

Arrangement of Steering Functions on Transmitter

The functions of the main rotor are transferred to the right-hand stick, which neutralizes in all directions. This is done in the following order:
Transmission control stick forward = swash plate goes forward (forward flight)
transmission control stick back = swash plate goes back (backward flight)
transmission control stick to the right = swash plate goes to right (sideway flight to right)
transmission stick to the left = swash plate goes to left (sideway flight to left).
In addition to these four main directions, all directions in between can be steered by combining stick movements. The maximum movements are given in the plan in degrees as well as in mm-rodway.
Be sure that holding rod which runs on the back of the fuselage from the swashplate up to the front is slightly bent (as shown on plan) so that the outside ball bearings will not get in contact with the holding rod at an extreme steering of the swashplate 45 degrees to the right forward.
The tail rotor will be connected to the sideway movement (left-right) of the left transmitter stick. The tail rotor takes over the function of the rudder of a fixed wing plane. Moving the stick to the left means a turn of the helicopter around the rotor shaft to the left resp. flying of a left curve. (Decrease of pitch on tail rotor). Moving stick to the right means turning of the fuselage to the right resp. flying of a right curve (Increase of tail rotor

pitch). The fourth function is the motor throttle which is also put on the left stick on the "backward" and "forward" movement. Here opinions about the best application are different, but each of the arrangements has certain advantages. Acc. to the method of motor throttle of a fixed wing model, known to many model flyers, the motor throttle can be connected so that movement of the stick to front means full speed, movements of the stick to the back means idle. There is also the contrary, i.e. stick to front = idle, stick to back = full speed. There is a further difference insofar, as the motor throttle can be flown with or without neutralizing stick. A non-neutralizing stick brings the advantage, that mainly the beginner will be able - through steady, slow acceleration - to get carefully to the point where the model is hovering steadily. Is this point achieved and the weather is not too turbulent, the stick can be left in this position and one can concentrate on the other steering functions. A very good recommendation for the advanced helicopter pilot is an arrangement of the stick, where the first half of the stick movement from idle (stick completely forward) to about 5o % carburator opening (stick in center) does not neutralize. At this point, the engine can be throttled down so far that the fly-wheel clutch disengages perfectly, or up to the center position one can accelerate so much that the clutch has engaged perfectly, yet the rotor has not enough power for lift-off. The lifting and later flying is then done in the neutralized area, i.e. between center position of stick and maximum way to the back (pull). The advantage of this arrangement is that you always have the helicopter "on the stick" and that you can react better, mainly during difficult landing maneuvers or during turbulent weather.

ADJUSTING AND TESTING

Before flying the helicopter, the following basic adjustments must be checked again:

a) Center of Gravity
The center of gravity should be exactly under the main rotor. The easiest way to check the CG is by inserting a thin screw driver through the top hole of the main rotor shaft and lift up the fuselage. After the main rotor is mounted, the model can also be lifted up at the stabilizer bar (directly at the rotor shaft so that the rod does not bend. See photo No. 39). When the tank is empty the model should balance out exactly horizontal, resp. the main rotor shaft should be vertical. When the tank is filled, the model should balance out slightly nose-heavy.

b) Swashplate
With the transmitter control stick in neutral and trim levers in center position, the swashplate should be in an exact 9o degrees angle to the main rotor shaft. Crosswise to flight direction a slight dip to the right (1 degree) is advised. It is also important that the swashplate is mounted at 7 degrees as mentioned in the plan, and that both steering rods run perfectly through the holes in the fuselage. The ball bearings must not touch the edges of the holes, this also has to be controlled at maximum steering in both directions.

c) Main Rotor
The balanced and assembled main rotor is now put in place on the

shaft and fastened with a 3x15 socket head bolt and lock nut M3. Acc. to photo No. 4o, the stabilizer rod with stabilizers should be placed so that the stabilizers point in the proper running direction (the rotor turns clockwise as seen from top). Connect the angled control arm of the stabilizer rod to the control arm on the top turning part of swashplate by using rod (424). The top of teh swashplate is adjusted by moving the collector fork so the rod goes exactly straight through the opening in the main rotor see-saw. In this position the control arm on the upperring to swashplate is exactly in a 9o degree angle to the stabilizer rod. To determine exact length of rod (424), it is important that at an exact horizontal position of the swashplate the two stabilizers have to be in a horizontal position also, i.e. parallel to swashplate. This adjustment is only correct when swashplate is in horizontal position. Should the swashplate be tilted, the stabilizers are tilted more than the swashplate. Exact alignment can therefore only be done in neutral position of the swashplate.

d) Tail Rotor

With tail rotor servos neutral and trim in center position, the tail rotor push rod should be in the center of the slot of guide. Again be sure rod moves freely in the guide, by disconnecting the rod at the ball joint. Now adjust the two rotor blades to a 8 degree pitch by using pitch gauge, with the center line of fuselage as reference. The pitch is adjusted not by changing the length of the pushrod, but by adjusting the collars on the left outer end of the control rod that goes through the tail rotor shaft. The play of the ball bearings on the blade mountings, which can be felt at the tail rotor blade tips, is insignificant. This play will disappear when the tail rotor is turning, due to centrifugal forces. When checking the steering for the tail rotor, be sure that the pitch of tail rotor blades can be reduced to at least 0 degrees when steering to the left (fuselage nose goes to left). For later fast flights the pitch should be reduced to 2 degrees negative! Should you not be able to reduce pitch to 0 degrees, it is not possible to fly a left curve at a relatively low forward speed.

e) Engine Adjustment

Adjusting the engine throttle is done by hand since it can vary with different type engines and carburators. By moving the left stick on the transmitter backward, you should be at full opened throttle. When stick is neutral, the throttle is 1/3 open. The final adjusting will be done with the engine running. The needle valve should be opened about 2 1/2 turns if you use the suggested Veco 61.

f) Fuel

Before starting the engine, there is one suggestion regarding fuel. The great amount of experience with many types of fuel has shown that the best helicopter fuel is normal fuel without nitromethane additives. The best are mixtures with mytanol 18 - 2o % castor oil. Throttle abilities, cooling, and most of all a softer engine run will be accomplished by adding 3 % high test gasoline.

g) Engine Starting

An electric starter with a flywheel is the best way to start the engine. If you intend to make a starter, be sure to use the proper

dimensions on the flywheel. The outer diameter is 28 mm, the thickness about 5 mm, the V-groove some 36 degrees,and 6 mm deep. Pull the drive belt out of fuselage (see photo No.41). It should be slung around the flywheel on the fan and the flywheel on the starter. Press downward on the starter to tighten belt. Now turn switch on, and the motor should be turning. Be sure it's turning in the proper direction (main rotor turns clockwise as seen from top). Connect battery to glow plug, and fuel line to tank. Now choke the engine slightly to draw fuel. The motor should not be on full throttle while starting. The best setting is a slightly increased idle. Hold the rotor head while starting the engine because the clutch will start engaging at higher rpm's. When engine has fired, remove starter and push belt back into fuselage. Should the engine run at high rpm's the first time, don't let go of the rotor blades and set engine to idle as soon as possible. This prevents overheating and unnecessary wear on the clutch. After engine is adjusted to proper idle, the clutch is disengaged and the rotor should not turn. However, it takes a while for the main rotor to stop turning. <u>Do not stop the main rotor suddenly as it could easily change the pitch of the blades.</u>
Should the engine be hard to turn, which happens with a new engine or an engine that has not been run for a long time,lower the compression by loosening the glow plug about 1/2 turn. But don't forget to tighten plug when engine fires. A new engine can be "broken in" installed in the helicopter. This is okay, because the engine almost never reaches its full rpm's and therefore runs cool. At first, we suggest you fasten the model to the ground and let the rotor turn as it will. Now, with a rich setting, adjust the throttle. An exact idleing is not obtained right away.

h) <u>Engine Setting</u>
Assuming the engine is fairly broken in, we will now adjust the engine to the full throttle. Hold the model to the ground by the landing gear, or put the model on a table and let someone else hold it. With the tank half full, full throttle should be given (but slowly, please!). At full throttle, a remarkable amount of smoking occurs. (This means it is over rich). Keep engine at full throttle for a minimum of 3o seconds and notice that engine does not loose rpm's. If it does, the needle valve is set too lean. It is best to follow the engine manufacturers' suggestion. The idle setting does not effect the actual flying, however, it can influence the disengagement of the clutch. The idle should not be too rich so you will have a good change from idle to full throttle. Especially since later on, most of the flying will be on the inbetween area. Full throttle is seldom used. In general, relatively hot glow plugs are best, however this depends on fuel and engine.

At this time an important point must be made for the safe operation of the helicopter. At all tests with the helicopter, one should always remember that turning rotor blades have a momentum that can not be underestimated. While hovering, the rotor turns at about 1ooo rpm's. This means a circular speed on the tips of the blades of over 3oo km per hour. At full performance, the blade speed is close to 4oo km per hour. The centrifugal force on each rotor blade at that speed,weighs 5o to 6o kilograms (more than a sack of cement). Therefore, when operating a helicopter the main rule should be: To use only original parts for rotor connections, rotor head, and blades. Only this way can you be sure that safety is maintained due to proper installations.

All blade connections must be inspected once in a while, nuts and bolts must be inspected, and in case of doubt, change them!

Beginners, in particular, should never fly close to spectators. Get rid of children and curious people. Never, ever, fly over spectators!

i) Checking Alignment

The main rotor blades must, at full speed, turn on the same level. To check this, one tip must be marked with a contrasting colour of foil. (See also: "Balancing of the rotor blades"). To check this alignment, rotor blades must be turning as fast as possible. Tie the model down, or hold down by the tail. From the side, look at the tips of the blades. Now you can see if blades are turning at the same level,as the colored tip will identify the blade that is not proper. A difference of 5 mm can be disregarded. When you see that a level difference is more, it must be corrected, otherwise there is a loss in the steering ability of the helicopter. When you see a level difference, the rotor must be stopped (or, idle motor and let the rotor stop by itself). Use the pitch gauge and check if the pitch of the lower running blade is below 4 degrees in reference to the stabilizer rod. If below 4 degrees, the pitch must be increased. If more than 4 degrees, it must be decreased (see photo No. 35).

In almost every case, any level difference is caused by rotor blade pitch. It is of course assumed that the blades are balanced. When both blades have been adjusted to proper 4 degree pitch, it is still possible the level varies. The centrifugal force can cause a small, but remarkable easy change in the level alignment. And added to this, a small possible difference in the airfoil of the blades. Besides, due to the centrifugal forces the blade mounts on the rotor are "setting". The rotor blades are made of wood, and even though they appear the same on the outside, they may not have the same elasticity or take the same amount of strain. It can also happen that the pitch gauge shows that pitch is different, even though blades run on the same level. This is not important. It is important that the blades run level when turning at high rpm's.

Trim of the Tail Rotor

Now we are at the point of the test flying where the tail rotor must be trimmed. The model should be placed on ground as even as possible, and slowly but evenly, accelerate the motor, but be careful the model does'nt lift suddenly. This is especially important when there is wind, at the time first flights are made.

A certain amount of headwind will increase the lift capability of the main rotors and cause an unwanted lift-off. This will later be explained more fully. To adjust the tail rotor, only enough throttle should be given, so model becomes light, and starts to "swim" on its landing gear. The nose of the model must always be pointed into the wind. At this point, you can tell whether the model has a tendency to turn right or left. In other words, changing its course. If you have followed instructions, and the tail rotor is porperly aligned, the trim on the transmitter should be sufficient to counteract any turning tendency. Whereas, hereby and therefore, the following basic rules must be adhered to.

If the model turns its nose to the left, the pitch of the tail rotor has to be increased. Do this by adjusting the trim lever on transmitter to the right. If the model turns its nose to the right, adjust the trim to the left. The trimming of the tail rotor should be continued until the model has no tendency to turn when you open the throttle slowly and evenly. However, you should always be aware of the possible change in wind direction. The model will always tend to face the wind because of the influence of vertical fin. Should the trimming on the transmitter lever not be enough to adjust the tail rotor, then make corrections by adjusting the collars on the pushrod. Do not alter the rod between servo and tail rotor! The first few hovering flights are only to trim the tail rotor and get the feel of the model. Before you start the real test flying, please study the following basic rules.

BASIC RULES

Basic Rule No. 1

Never tether the model to the ground. The model should never be fastened to the ground with strings or similar devices. The model must have its freedom, only then the stabilization of the main rotor can work. Tethering the model would hinder the natural flying movement of the model, and totally unbalance the helicopter. Furthermore, this would require the pilot to maintain the most difficult of all flight positions, flying over an exact fixed point. This is asking too much!

Basic Rule No. 2

Keep nose of model into the wind! Always be sure, especially in the beginning, that the nose of the model is pointed into wind direction. Never try to take off with a crosswind, even if it seems easier or there is only a slight breeze. Even with correct tail rotor trim a light breeze will cause the model to turn after lift-off and an untrained pilot will find it difficult to correct this sudden turn. A lift-off with tailwind is worse because the model will almost always turn around 18o degrees and really confuse the pilot!

Basic Rule No. 3

Walk with the model. Especially in the beginning, always walk with the model. It is best to have the 'copter at two or three meters distance, (nose into wind) then slowly lift the machine and let it pick the direction it wants to go. Don't stand in one spot, instead, walk with the model always keeping your distance. You can observe the model if it is not too far away, furthermore, you can be sure you are looking the same direction as the model.

Basic Rule No. 4

Forget the tail rotor. That's right! Overlook the tail rotor completely during practical flight. Instead, keep your eyes on the middle of fuselage, and the nose of the fuselage. Just like a fixed wing plane, a left turn will be controlled by automatic reflex with the transmitter stick so the model goes to the right. An amazing number of pilots make the mistake of not controlling the model according to its flight direction, thus watching the tail rotor instead of the nose. If the tail turns to the left, a correction to the right would counteract. No! This incorrect steering should be overcome while hovering, until you master the model. No later than your first fly a round, and if the model is at a distance, this incorrect practice will lead almost certainly to a crash. Principally, the tail rotor has to be thought of as the rudder of a fixed wing model.

Basic Rule No. 5

Operate engine throttle slowly and evenly. Open and close the engine slowly and evenly because any change of rpm's will result in a change of torque. At a slow and even opening of the throttle, the rpm's increase on the main rotor and tail rotor at the same time, therefore, an automatic torque balance is obtained. (See explanation for control). A sudden acceleration will create a sudden,heavy torque change that cannot be balanced out by the tail rotor immediately. This could cause the model to turn around its vertical axis.

Basic Rule No. 6

Don't be afraid of attitude.
A certain attitude, or tilt, is much safer than a model which is without ground relation, it has no turning tendencies. However, one should always keep in mind that a helicopter will take the direction of the attitude and immediately accelerate. This acceleration in the direction of attitude, (attitude of the main rotor) can be very fast, which does not mean the model will turn completely on this attitude, but it's important that the landing gear does not catch on an obstacle on the ground.

Basic Rule No. 7

Practice hovering first.
This rule is importantbecause it will save a lot of disappointment. Hovering must be practiced until the pilot is completely sure of himself, because, hovering is the start and finish of every flight manoeuvre. Furthermore, when hovering at a low altitude, any mistake you make can be corrected by simply setting the model back

on the ground. If the landing gear ever catches on something and the model turns over, the worst that can happen is damage of a rotor blade.

Basic Rule No. 8

On touch-down at wrong attitude, cut throttle.
Especially while practicing hovering. In the beginning, control mistakes will happen, when it does, let the model down from low altitude. Cut the throttle slowly until the main landing gear reaches the ground. Even if the touch-down is made with model at wrong attitude, the model will fall back on its three landing pods if you cut the motor immediately (a good engine idle will now be appreciated). The reason for a sudden engine cut can be explained the following way: The model has a total flight weight of 45oo grams. Now you decrease the throttle and the rotor rpm's have a lift of only 44oo grams. The model lowers itself now 1oo grams overweight. If the helicopter touches the ground with only one landing gear, the part of the models weight will rest on this one landing gear, for example, 3oo grams. If the same rotor rpm's are kept, the main rotor then has an overlift of 2oo grams. At a tilted position of the model, this would lead to the main rotor lifting the helicopter again and would pull it to one side. Added to this, comes the additional lift caused by it's being closer to the ground. (Ground effect). Again the suggestion: After a tilted touch-down, in case of emergency, cut the throttle so the helicopter will fall on its landing gear and not tip over.

Basic Rule No. 9

Watch the attitude of fuselage and main rotor.
The main rotor of a helicopter is controlled by the swashplate. This means the main rotor orients itself acc. to the position of the swashplate. It is unimportant whether the swashplate is tilted by the control stick, or inclined because of a fuselage inclination. Consequently, the main rotor does not know the difference between a movement of the swashplate as a result of control, or by the fuselage attitude. This means: If the fuselage is level (horizontal), and the swashplate is dipped 3 degrees to the nose, the main rotor will also dip 3 degrees to the nose. This will lead to a remarkable acceleration forward. As a result of this forward acceleration, the fuselage will dip its nose. This dip can, as example, be 2 degrees. If you leave the original swashplate front dip, the 2 degrees dip of the fuselage nose is added to this causing the swashplate now to dip 5 degrees to the front. (When you think of the original level before the control command was given). Therefore the rotor will follow the original swashplate movement, and from the original 3 degrees, will reach a dip of 5 degrees, which again would lead to a more, and normally undesired acceleration. To stop the forward movement now, it is not enough to bring the swashplate back to its original position. (Transmitter stick back to middle position.) With the 2 degree forward dip of the fuselage, the swashplate also has a 2 degree forward dip. The main rotor will set itself now to the 2 degrees dip, and the model will keep a slower, but forward, acceleration. In order to bring the model back into a neutral flying position, the swashplate must now overcome the 2 degree dip of the fuselage. To neutralize, it has to be moved 2 backwards. Not until now do you move the swashplate

back to its original horizontal position. The main rotor will also be horizontal now, and not create further acceleration. To stop the forward movement, the main rotor must be moved backwards also. Let's assume the necessary move backwards is 3 degrees, and the fuselage has a forward dip of 2 degrees, the swashplate must be moved back 5 degrees by the transmitter stick.

Basic Rule No. 1o

Do not be afraid.
Do not let the previous explanations confuse you. To control a model helicopter is a little complicated, but it sounds worse than it actually is. Hardly anybody today has a serious thought about the different forces working on a normal fixed wing model. When, for example, up elevator is given. The difference is only that today, in general, not much is known about the flying technique of a model helicopter and sometimes imagination exists which is altogether wrong. These detailed explanations are purposely made to make you very familiar with your helicopter.

PRACTICING

The training landing gear is installed. The rotors etc. are properly checked and adjusted, the engine runs, the main rotor level is correct. The tail rotor is already roughly trimmed.

It is suggested to make the first flying tests on a large obstacle free area, a flat surface is desirable. The wind should not be too gusty, but an easy steady breeze is of advantage. The models nose points into the wind and you yourself are positioned 3 meters behind the model. Now accelerate the engine very, very slowly until the clutch engages properly and rpm's of the main rotor increase steadily. After a short stop at the reached rpm's, slowly accelerate again until the model starts to "swim". Now the first thing to check, is any turning around vertical axis (flight direction), and if necessary correct the trim of the tail rotor. After the model keeps the direction with the nose against the wind, slowly accelerate a little bit, but only a little, since the main rotor rpm's take awhile to increase, after which it builds up rather fast because of ground effect. Now observe the model (the middle part of the fuselage, and not the tail) and try to find out, whether the model wants to dip to one particular side (in most cases it tries to move diagonally forward to the left side). Such a movement should now be corrected by moving the trim lever for the main rotor on the transmitter until a rough vertical lift is obtained. If you have the feeling that the model does not move into this direction anymore, (observe dip of the fuselage) slowly accelerate again until the model hovers at an altitude of about 2o to 5o cm. In this altitude, the model will sit on an aircushion, however it may try to go in any direction. This direction must be remembered and you must try to counteract by controlling the main rotor to neutralize this movement. Do not remain on one spot, follow the model by trying to hold the same position in regards to the wind. It is also not important to move the model back to its starting point, instead it is important to try to stop movement of the model in any kind of unwanted direction. Remember, that a stop does not happen suddenly, instead it will have a necessary delay, the same as experienced while accelerating. Repeat this first lift and counteract the flight movement for awhile. Do not be tempted to accelerate more to bring the model into higher altitude. The flying outside of ground effect is easier, however, if a control mistake is made, it is better to make the mistake at an altitude of 5o cm, then you can bring the 'ship' down without damage. A control mistake at a two meter altitude is already a much bigger problem. A correction of the main rotor should not be too timid, instead, slow but prominent, short countermotion should be made. Always observe the fuselage position. If a not too drastic control mistake is made, do not bring the model down suddenly, instead try to correct your mistake. Always walk with the model and keep it in front of you with the nose into the wind.

As soon as you stop making the basic control mistakes, leave your safety altitude of 5o cm, and try to fly at a 2 to 3 m altitude. Under no circumstances in the beginning, try circular flights or turn the model too much around its vertical axis and reach a position in crosswind, or even worse, in tailwind. This would lead, at the beginning, to a complete malcontrol. At the previously mentioned altitude of 2 to 3 m, try not only to prevent unwanted flight movements, also try to stay in one place. At the beginning it is absolutely unimportant whether you hover over an exact certain point. Important is only that you do not loose your model.The hovering position should be tried again and again. Do not be tempted to start flying around. Even so, at this stage there would be no difficulty, since the model is very stable when flying forward.However the landing will be very difficult since one has to go out of forward movement into hovering. It would be better now to try to move the model crosswise to the right and left side and always the nose has to be kept into the wind. Later on, you can even cross your airfield side ways, but do not forget to walk with your model and keep it in front of you at a couple of meter altitude. After you reach the point where you are sure that you have a tight control over your model, there is no reason why you cannot, by slowly accelerating your engine, climb to 8 or 1o m altitude. This additional acceleration has to be done carefully so the helicopter does not gain altitude too fast. The same way when lowering your model, the throttle has to be cut very slowly to prevent a fast drop in altitude. On one side you need relatively high motor efficiency to stop the drop which could cause a strong acceleration, and a turning of the fuselage. On the other side the danger exists that at fast descend,the model hits his own rotor turbulence and then you lose all the lift.

When making these flights, please remember to make prominent, but relatively short corrective movements on your stick, observe the position of the model and wait for the reaction of the movement.You should always be aware that the model needs time for stopping after a certain movement. Example: Model hovers at 2 m altitude. The fuselage starts, hardly noticeable, to dip tailwards. Later on you will realize that this movement will lead to backwards flight and therefore you would,by making a forward correction, not let this movement start. At the beginning however,this reaction will be made too late, and the model will start a backwards flight. Immediately dip the main rotor forward. (By pushing the stick for the swashplate forward), until the fuselage is not on the leveled horizontal pattern, but shows a slight forward dip. This way, you not only stop the backwards acceleration, you also stop the backwards movement. At a standstill of the model, the nose has to be lifted again, and the fuselage leveled horizontally. Probably, the model now hovers two meters behind its previous point, but it hovers. Now you can move forward those 2 m by lowering the nose with a short movement of

your stick forward. The model moves slowly forward now. Before you reach the point where you want to stop the model, again lift up the nose, wait for the model to stand still, and immediately put it in horizontal position again.
All possible flight directions will be controlled by following the rules

a: stop movement
b: initiate corrective move
c: stop corrective move
d: hold new position

This corresponds exactly with the control of any full scale craft.

ADVANCED TRAINING

If you master hovering as previously explained in practicing, and if you hav not made a flight around by mistake, now it is time to start the advanced training, and this includes controlled flying around.
Lift the model (naturally with the training landing gear) to a hover at 2 m altitude. In this hovering position, trim your model again and get used to hovering by moving crosswise. If you have done that for 2 or 3 minutes without failure, bring the model to a standstill and start flying forward by dipping the nose slightly. This you have done many times already while hovering, however, you stop this motion immediately in order to prevent flying away. You leave your acceleration in this position (at the slow start of forward flight, additional acceleration is not necessary). The model will now accelerate forward and you will observe if the helicopter is trying to fly at a wide right turn. At a slow speed this right turn is very wide. If you want to be really sure, then let the model fly in this manner and it will return automatically after a perfect circle back to the starting point with the nose against the wind. Condition for this is, that there is only a light breeze so the 'ship' will not drift away. If you want however fly straight out, you must be sure, the model does not get too fast. Should this be the case, lift up the nose of the model by pulling on your main rotor stick and the model will come to a stop not too far away from you, since you are forced now to make anexact hovering position again. This hovering at a bigger distance will be very unusual for you and will not be easy. Therefore, try to keep moderate forward speed with an appropriate dip of the main rotor. The tendency to turn to the right will be counteracted by

a: left control of tail rotor and
b: left control of the main rotor.

At the beginning the model will swing back and forth. This plays no important role, since you have a lot of time for corrections. The following reasons require correction in a proper straight out flight: The main rotor and the tail rotor have been trimmed for hovering position. The tail rotor for example has to balance the total torque of the main rotor and is not assisted by the fin. This will change at a forward flight, since now the stabilizing effect of the fin will be added. Consequently with the help of the fin, the tail rotor oversteers causing a right turn of the fuselage around the vertical axis. Therefore the pull of the tail rotor has to be decreased by changing the pitch on the tail rotor with the appropriate stickmovement to the left.
The main rotor system will now have a certain amount of aileron effect to the right side. The reason for this is that the clockwise turn of the rotor will find the rotor blade on the left side being against the wind and the rotor blade on the right side will

practically turn with tailwind. Therefore the blade on the left side will have more lift than the blade on the right side. In order to balance the aileron effect on the right, the main rotor must be also tilted toward the left side to correct this (this effect you will find exactly in the same typical manner on a full scale craft). It is quite obvious that as faster forward movement exists, the bigger the correction on the tail rotor, as well as the main rotor has to be made. Now you reached already a distance of 2o to 3o meters away and you wish to start turning around. If this should be a righthand turn you only have to neutralize the tail rotor as well as the crossposition of the main rotor. The model will then fly almost by itself a righthand turn.

Should you wish a lefthand turn, decrease the tail rotor pitch and at the same time increase the aileron pitch on the main rotor to the left.

Now you should be capable of reaching at least a 0 degree pitch on the tail rotor, otherwise a lefthand turn cannot be made. While flying a turn, the helicopter, the same as a fixed wing model, has a tendency to lose altitude. To balance this you pull up the nose, the same as you would do with an elevator, by changing the main rotor. These control operations can be done without problems since they happen very slowly and there is enough time for thinking.

At this time it is necessary to make the following remarks:

It is not easy to judge the exact flying position of a helicopter if you look at it from the side, since the helicopter has no wings. Orientation on the tilted wings of a conventional model does not exist, and it will be hard to judge from the sideview whether the helicopter is turning towards you or away from you. In case of doubt, a very heavy steer, preferrable to the left, will identify the position of the craft.

After the first turn is made, the model now will be flying at a rather high level if you have not cut the throttle somewhat. This altitude must be maintained by adjusting the throttle. The deceleration of the engine on the helicopter will surprise you at the beginning since, from hovering you are used to flying with relatively high engine performance. While flying forward however, you reduce the engine performance remarkably. One flies the normal forward flight speed, on the average, with half open throttle.

Preparing for the touch-down, the throttle will be further reduced. One would hardly believe that the helicopter is capable of staying airborne with such a small engine performance.At the beginning,one is normally hesitant to try such an extreme cut of the throttle, causing the craft to be too high on the final approach. It will be necessary to try for another touch-down, or lower the helicopter vertically from the high altitude. Attention must be given again, that when you lower the craft it is not done too fast,and hits its own rotor turbulence, while coming down. Should it happen,you can only get out of the turbulence with a heavy dive and acceleration. While on the touch-down approach, your craft should not be moving forward too fast. The course of approach will be controlled by the side rotor and main rotor stabilizers. One lets the helicopter approach for a touch-down almost like a conventional model, and shortly before the final touch-down, like one does with the elevator on a normal model, you pull on the main rotor stick and lift the nose up. Be sure, the craft starts to lift immediately. Furthermore, you must realize that with decreasing forward motion, the lift will also decrease and force the pilot to slowly open the throttle and hold the craft in a hovering position before the touch-down. It is important to do the touch-down in such a way, that when hovering, the pilot is in the same position as before, when he was practicing hovering.

The touch-down approaches should be tried again and again. It is also important that you don't neglect the hovering training. After one is familiar with the flying around techniques,you will notice that these manoeuvres are much easier than hovering, and can lead to fast flights across the field, with bad touch-downs. There is another advantage to hover practice, because eventual malefunctions will appear, and are not dangerous at the low hovering altitude. For example, if the engine is too lean it will show when hovering, since the highest possible engine performance is required.

It is definitely more dangerous when making a fast flight with an improperly adjusted engine, when a touch-down fails, because the engine is too lean.

MAINTENANCE TIPS

The parts of the drive mechanism of the helicopter are in general maintenance free. Only in the main gearbox, the oil must be checked and the breatherhole on top of the main gearbox must remain open.

Regreasing the tail rotor shaft after the first grease is applied, is normally unnecessary, however, it would not hurt. In the beginning, the set screws that fasten the tail rotor shaft to the clutch have to be checked and most of the time tightened one or two turns.

The tail rotor gearbox, which is filled with grease, is practically set for a lifetime. An overfilling of the gearbox with grease is improbable, however, it is suggested to often apply small drops of oil into the slot of the tail rotor controlplate, the joints of the tail rotor, and the small ball bearings of the pitchcontrol.

The top ball bearing for the main rotor shaft, the ball bearing of the swashplate, and the ball in the middle of the swashplate would also appreciate small drops of oil occasionally. The same should be done for the four ball bearings of the main rotor. Also the slot in the swashplate key could use oil once in awhile. We don't have to mention that the fuel system should be kept clean. To prevent flooding the engine after stopping, the fuel line must be disconnected from the tanks!

To protect the engine, it is suggested that you not stop the engine immediately after hovering. As explained previously, while hovering a relatively high engine performance is necessary. If the engine is stopped too soon after hovering, it does not have a chance to cool and therefore, a sudden overheating exists, since the engine inside the model receives very little cooling air. After hovering, the engine should be left running at idle for a short time, so it cools before it is stopped.

For repairs, use only original spare parts!

The helicopter has to meet high demands and it took many tests to find the best and most proper material to meet these demands. When using the pictured spare parts list, it is no problem to order spares. Each spare parts has its special number and it suffices to quote this number with the prefix 2o3. Safe functioning of the helicopter depends on the use of the original parts.

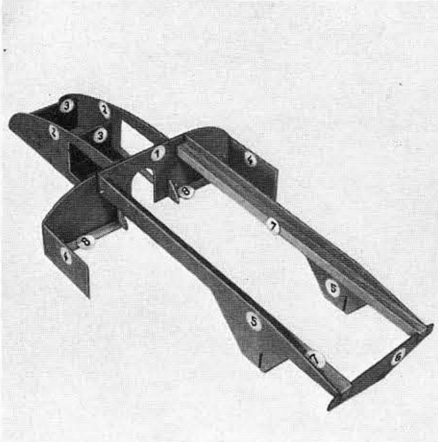
At this place one suggestion:

Be careful when close to main rotor blades! Remember always: Blade speed at full performance close to 4oo km per hour and centrifugal force on each rotor blade at that speed up to 6o kp!! And another thing: A helicopter is a technically fascinating machine but it can only function when assembled with care and technical understanding and proper maintenance. If you keep this in mind and act accordingly, you certainly shall have a lot of fun with the D-S 22.

This wishes for you

Yours

Dieter Schlüter



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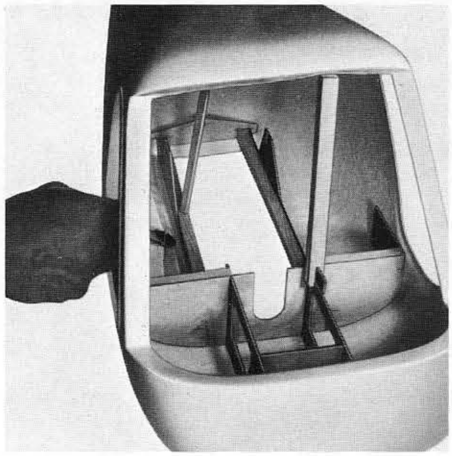

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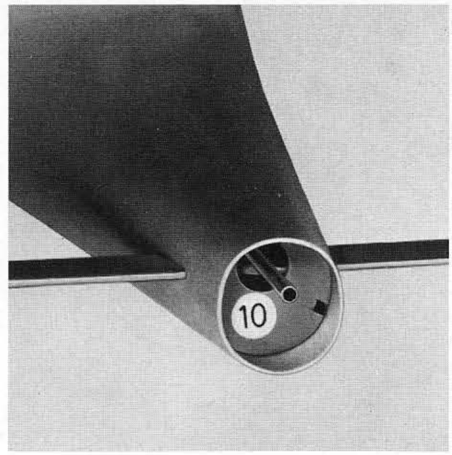

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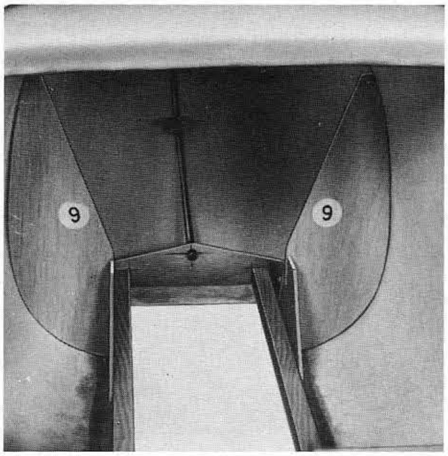

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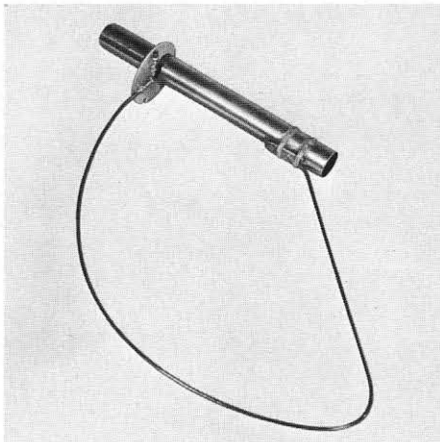

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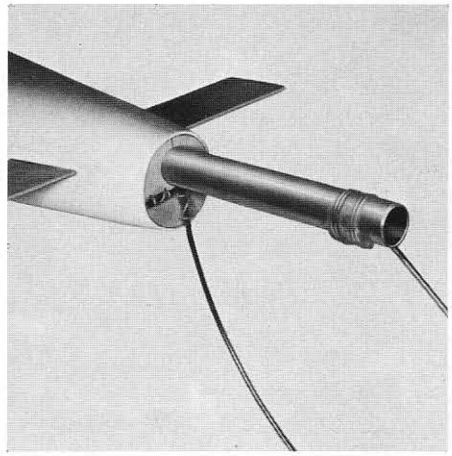

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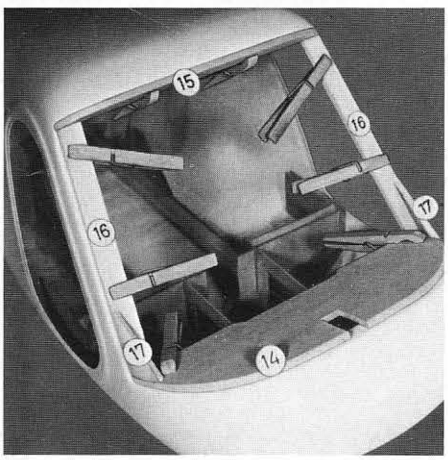

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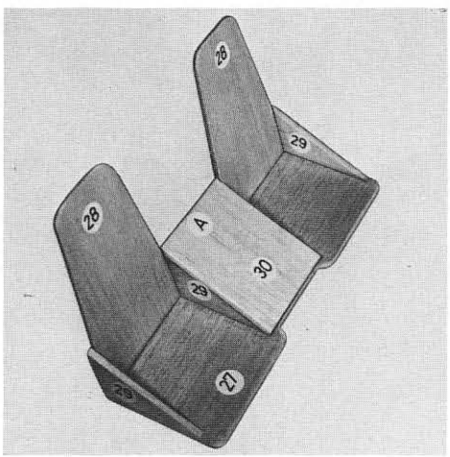

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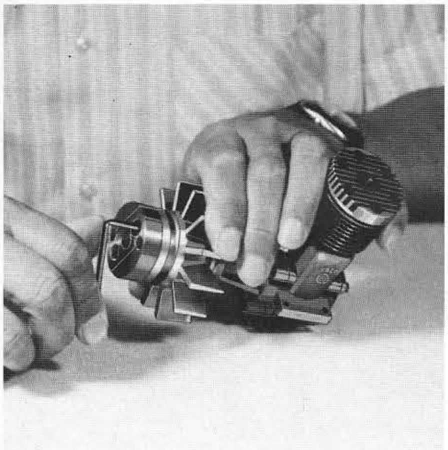
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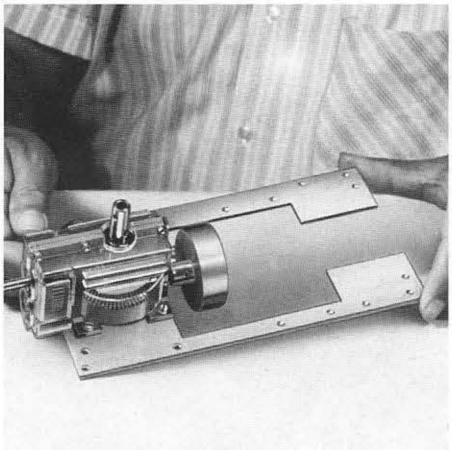
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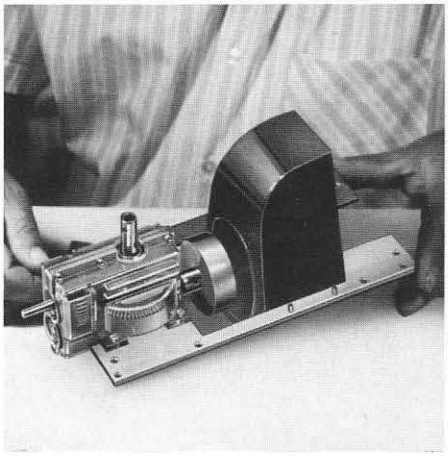
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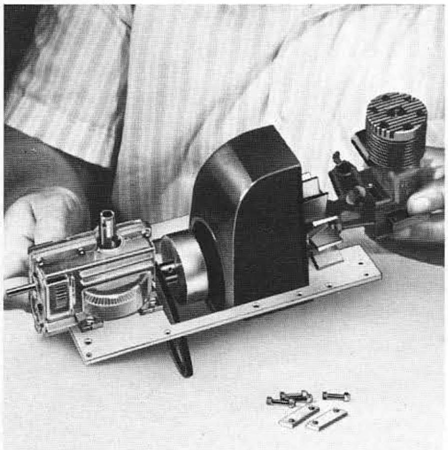
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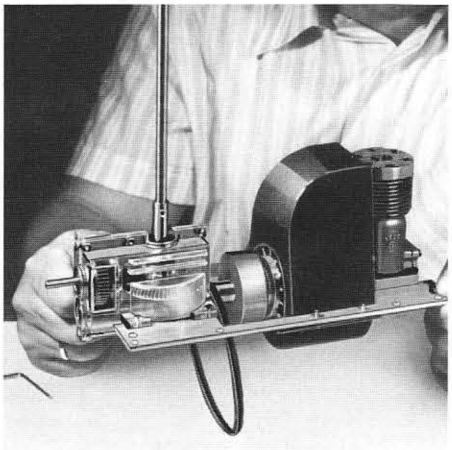
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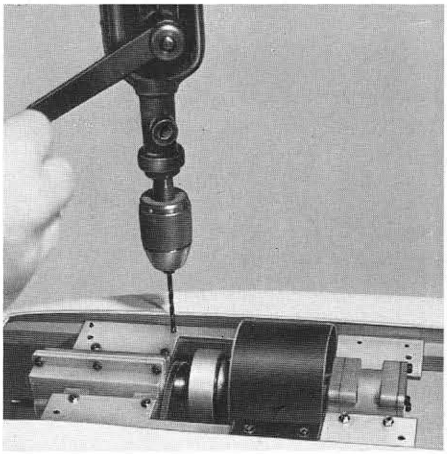
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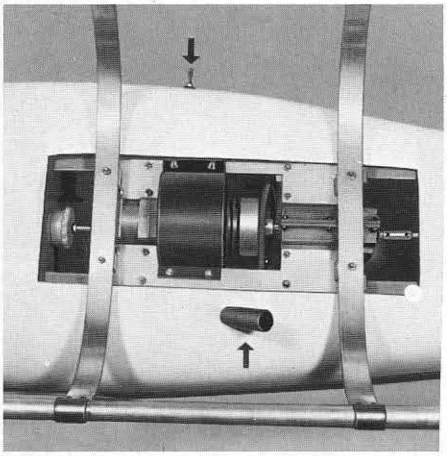
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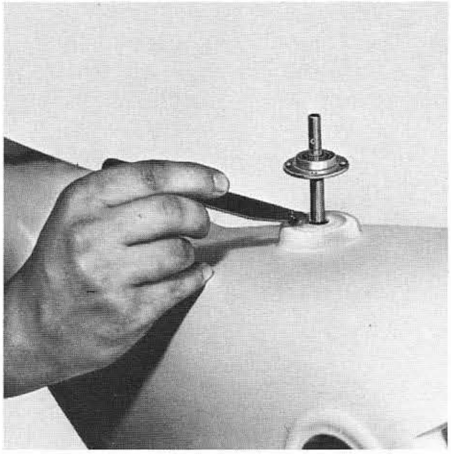
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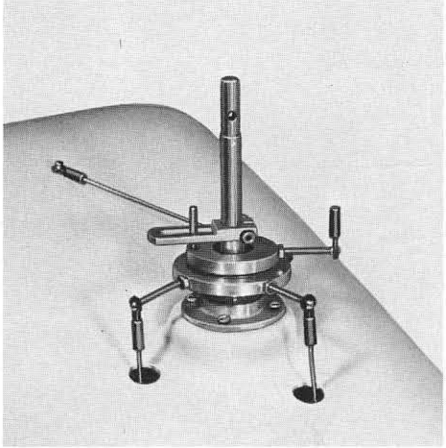
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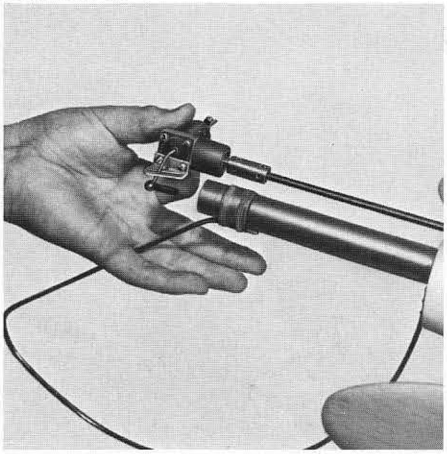
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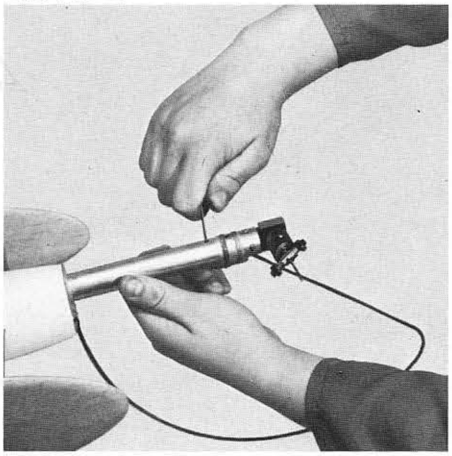
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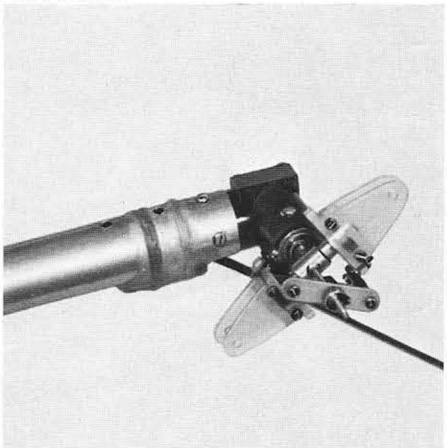
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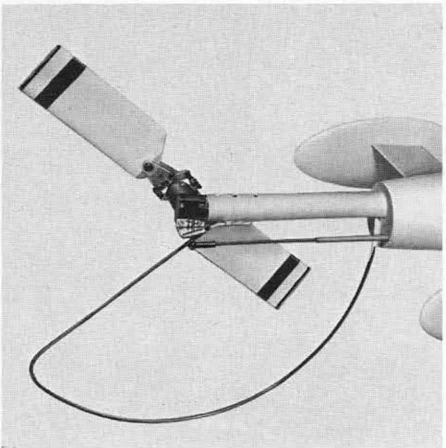
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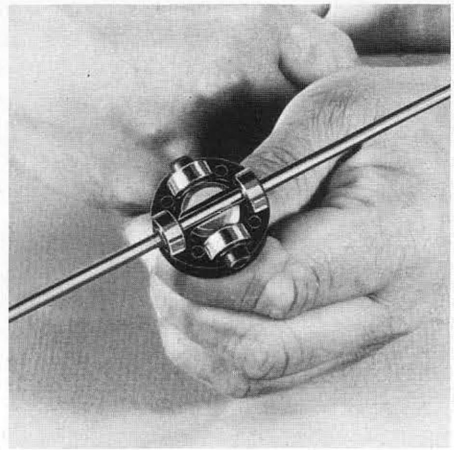
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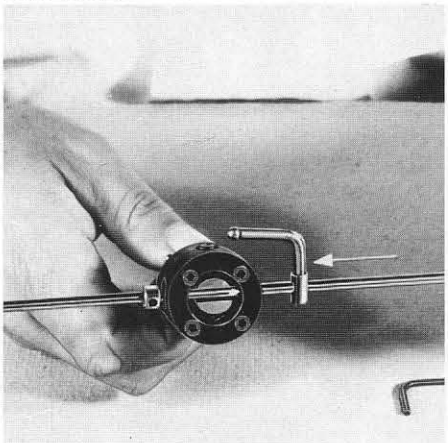
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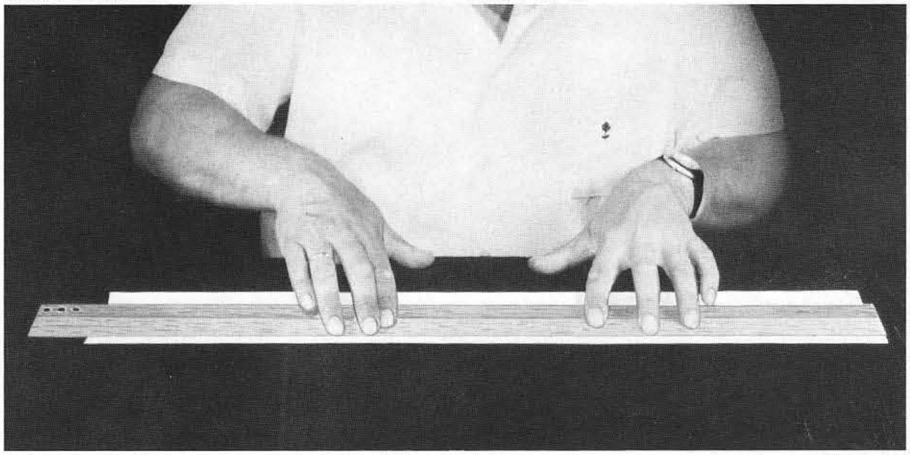
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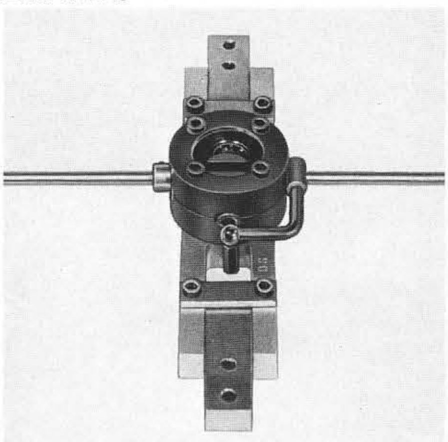
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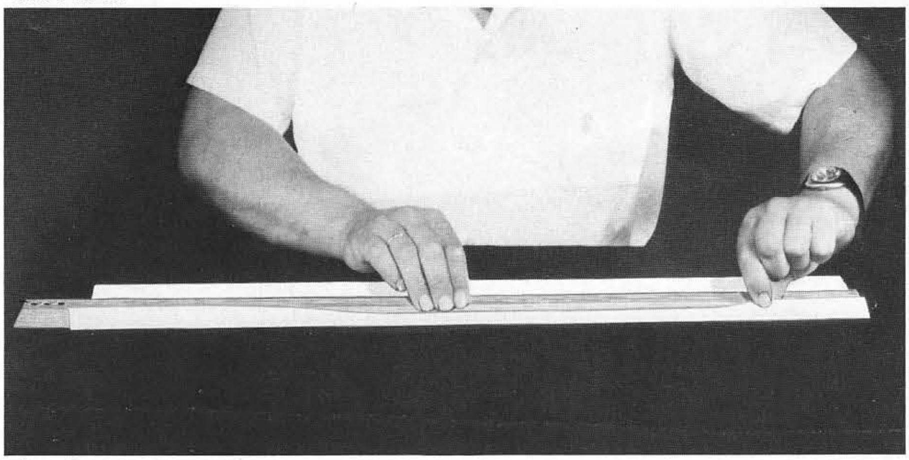
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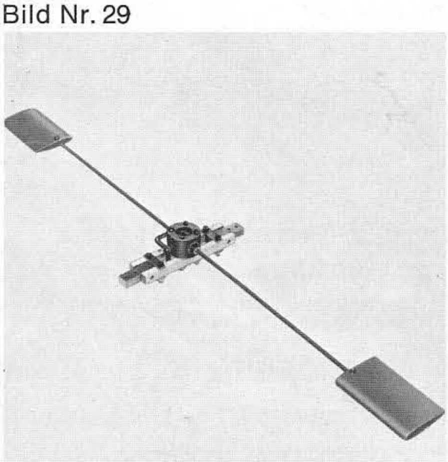
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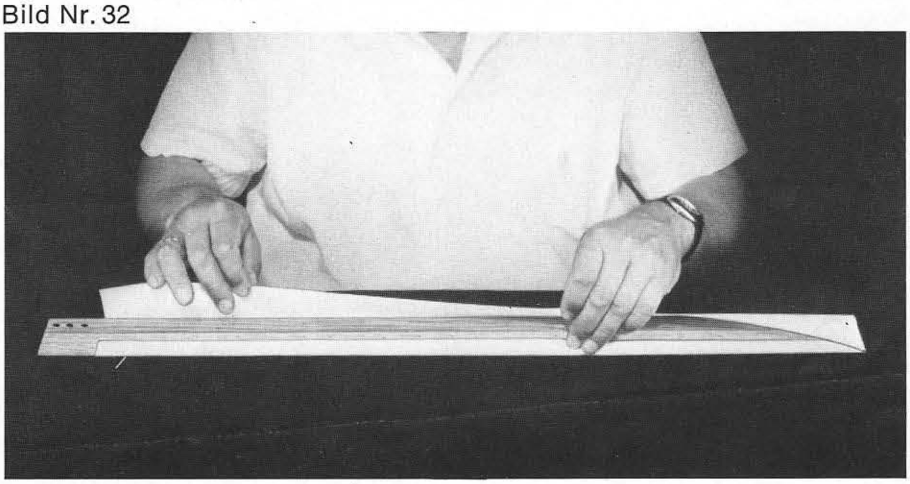
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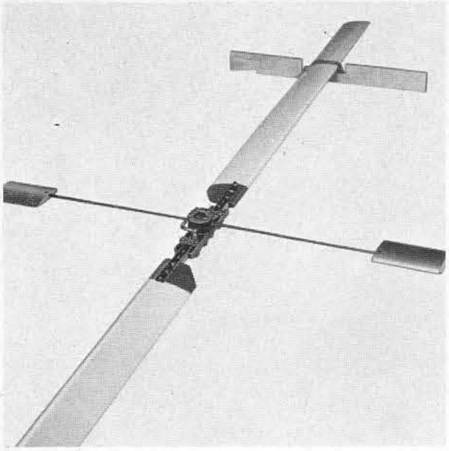
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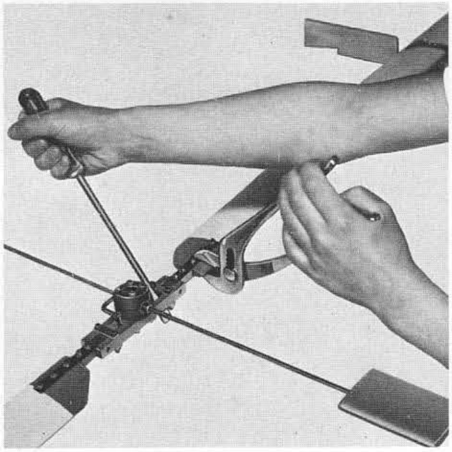
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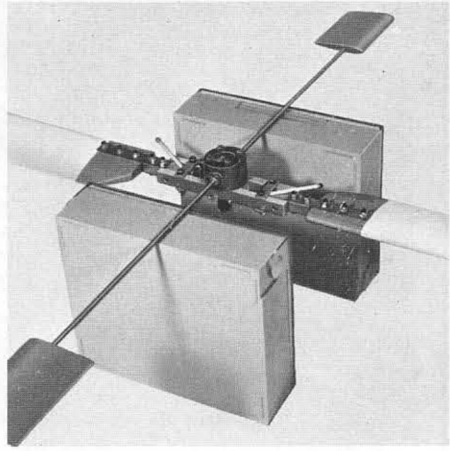
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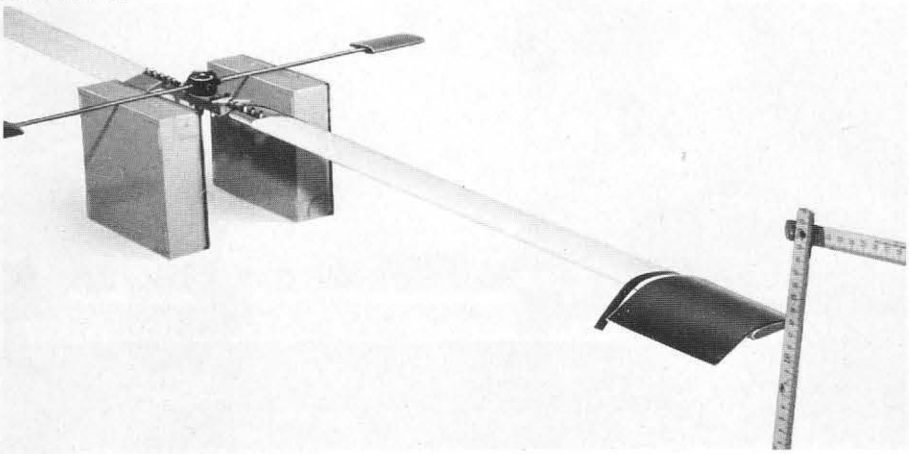
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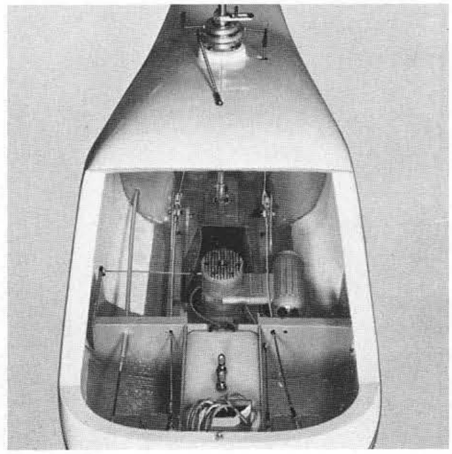
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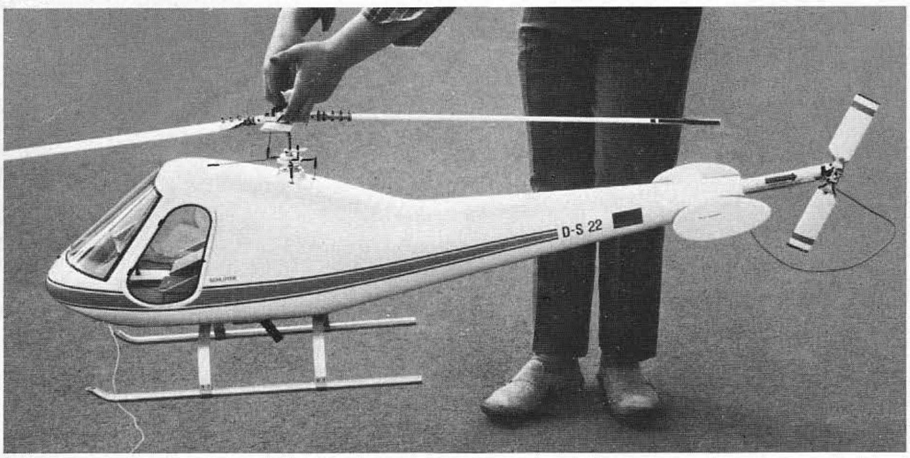

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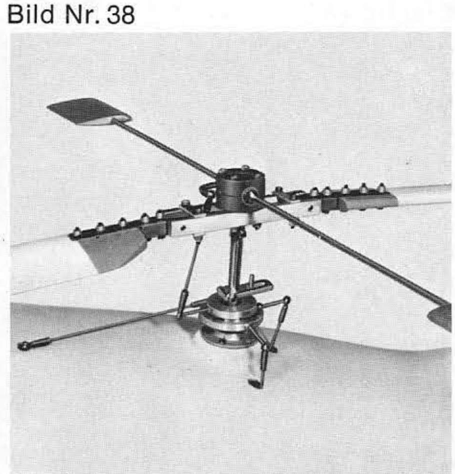
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Bild Nr. 41

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