Multi Blade Rotor Systems

Mark Powelson

The Multi Blade Rotor System was developed by observation of all known model helicopter parameters while every solution found was thoroughly flight tested. Several examples out of the preseries production were flight tested over a one year period. After all, you as an experienced helicopter modeler will not experience any difficulties in installing and adjusting it properly. Just a little care and observing of the instructions will do.
Since the rotor head comes completely assembled, the blades are exactly balanced and matched to form a harmonizing set, you need not expect any problems or require any particular skills.
The instructions are mainly meant for application of the Multi Blade Rotor in combination with the drive train system made by Heim Helicopters. Adaption to other systems is possible. Because of the washout of the rotor blades it is necessary to specify your order for *clockwise* or *counter-clockwise* spinning drive train systems. The swashplate must be setup for up and down movement in order to change collective pitch settings.
As an additional part you will need the swashplate driver (pickup link) similar to the one made by Schluter Helicopters.

General

Do not disassemble the rotor head unnecessarily. We understand your curiosity and we will tell you what is inside the blade holder; two radial ball bearings care for a bind-free and playless pitch change, an additional axial bearing takes the centrifugal loads, thus easing the radial bearings workload.
If any disassembly of the rotor head should ever become necessary, notice the following: the axial (compression) bearing is to be inserted with the printed side towards the rotor hub, the washer is inserted with its groove facing the rotor hub (if done in reverse, the bearing will bind). The rotor hub has two mounting bolt holes, one for the common 3mm bolt and, located on a 90° off set, a second one for a 4mm bolt. From the technical point of view, we feel the latter to be the better choice. The mounting hole in the rotor shaft has to be enlarged for it. Because of the extremely hard steel sometimes used, a particular drill bit for hard metals has to be used for that purpose. Generally, the 3mm bolt will suffice if you take care only to expose the unthreaded part of the bolt to any shear loads.

Installation

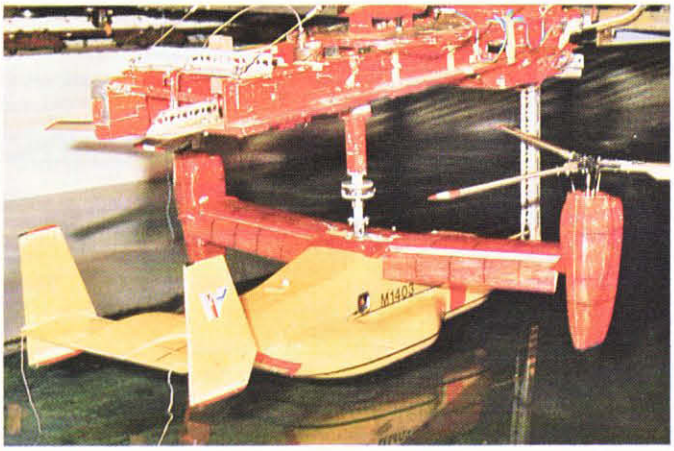
Let us discuss the installation process to the standard helicopter control layout such as an unmodified Heim (two bell cranks care for left and right cyclic as well as up and down sliding movements of the swashplate for collective control, and a third bellcrank moves it back and forth for longitudinal cyclic). The rotor blade pitch levers, being integral parts of the blade holders must always face into the direction of rotation.

Swashplate Preparation

If you decide not to take advantage of the Peka swashplate which is of very high precision and quality while being fully prepared for ▷

Morley's 3-blade rotor head for the Hughes 300.

Perfectly controllable and stable, the 3-blade rotor head gives added realism to Morley's Hughes 300.



Scale model 'Osprey' under test using Morley's 3-blade rotor heads at the Commercial Hydrodynamics Facilities.
(Photo acknowledgement to Westland Aerospace Newsletter).

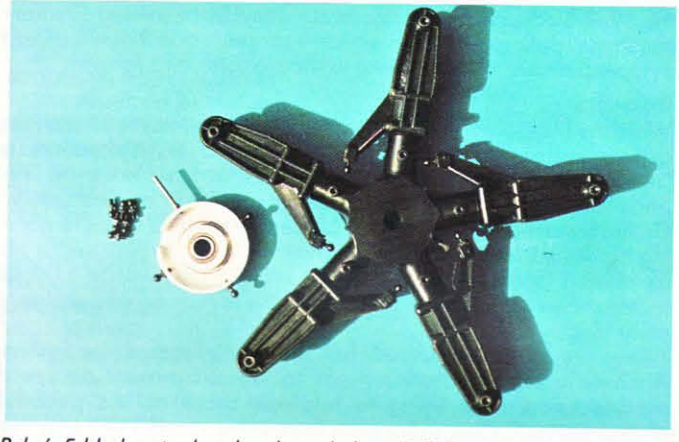
Morley's 4-blade rotor head for the Agusta 109.

Wolfgang Simon's lovely Bell Twin 400 with the Peka 4-blade rotor system on both main and tail. Model is pictured in front of Castle Ashby, England.

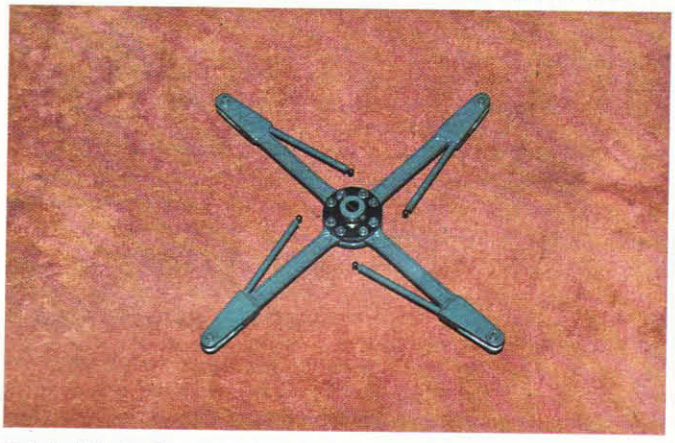
The Twin 400 with the 4-blade elastomeric non bearing rotor head. With either the multi system or elastomeric system the model flies fabulously.

Peka's 5-blade multi rotor head on the Peka Kevlar Hughes 500D. Superb model, superb performance.

Peka's 5-blade multi rotor head and 4-blade tail rotor on Mark Powelson's Champion which was used as the test bed for testing purposes.

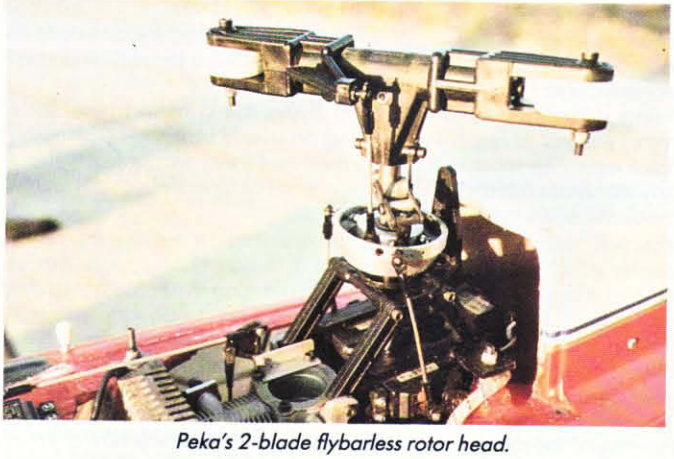


Peka's 5-blade rotor head and swashplate. (Full details of setting up all the heads on different models in part 2 of this in-depth article in next issue).



Peka's 4-blade elastomeric non bearing rotor system. Simple but very, very effective.

Mark Powelson demonstrating his Champion which shows the multiblade rotor system is quite stable and flies like any other – even inverted.



Peka's 2-blade flybarless rotor head.

◁the Multi Blade Rotor, you will have to alter the existing one. Two additional mounting positions at the inner swashplate ring are needed, a drill bit 1.5 to 1.6mm is required and a tapping tool 2mm. Remove the existing two blade rotor and the Bell/Hiller mixer (pitch compensator of the Heim Helicopter) and the swashplate. Only the latter will be further used.

Three Blade Rotor

Two of the existing mounting holes at the inner swashplate ring, situated opposite to each other, will be utilized. A ball link is bolted to each of them. One of them serves for pitch control of one of the blades, while the opposite one picks up the swashplate drive. In an angular distance of 60° right and left of the swashplate driver, a hole 1.5 to 1.6mm is drilled, tapped to 2mm, and equipped with ball links. Check this arrangement referring to the sketch. You may find it convenient to make youself a template.

Four Blade Rotor

All four tapped holes with ball links, as provided, are further needed. Drill a fifth hole, spaced exactly 45° between two of the existing balls. Tap and install a fifth ball link which will pick up the swashplate driver. Compare with the sketch.

Rotor Installation and Swashplate Driver Adjustment

Slide the swashplate and swashplate driver onto the rotor shaft (set screw is situated opposite the scissor arm). Bolt the rotor head on the shaft. Bolt the rotor blades into the blade holders (watch direction of rotation). Tighten the self securing nuts only so far, so that the blades can be swivelled back and forth with just a little force. They must not swivel by their own weight. Balancing of the rotor is not necessary.

Screw ball link ends to the 3, 4 or 5 pitch control rods. Prepare control rods in exact equal lengths that establish a minimum blade pitch angle of −3° up to a maximum of +6° to +8°. These are average values from which variations might be required in order to meet the model's weight, power and RPM. The maximum pitch can be enlarged up to +12° if necessary. Measure the blade pitch with a blade incidence meter at the blade tip.

Rotate the rotor so that one of the blades is exacty in line with its blade holder and centered over the tail boom. Rotate the swashplate driver on the shaft to the left perpendicularly to the fuselage center line, in case of the four bladed head 45° (see sketch). Reverse this to the right hand side in case of the clockwise spinning rotor. Of course, its ball link was connected to its ball at the inner swashplate ring. Hold it in that position and advance the rotor in the direction of its rotation so that the rear rotor blade, mentioned before, is displaced approximately 7° right, resp, left of the tail boom centerline. Tighten the swashplate driver set screw. Re-check this adjustment.

Blade Tracking and Operation

Upon having used a little care on these simple basic adjustments, you will find no large deficiency when checking the track of the rotor blades. Generally, half a revolution of one of the pushrod ball links should suffice as a corrective measure.

It is always difficult to apply contrasting colours to more than two rotor blades. This becomes particularly true with the four-bladed rotor. Depending on the daylight conditions, it could be helpful to apply brightly coloured tape to the blade tips. *These, however, serve only for the first tracking inspection and have to be removed after that. They de-balance the exactly matched rotor blades!* Normally, no re-adjustments will be required later.

In order to reach its full potential the Multi Blade Rotor needs at least 1600 RPM. Higher values even improve its stability and control response. Fine tune your system as required.

Being skilled and experienced in flying the common two-blade rotor, you will at first feel as having an overly sensitive responding rotor now. This is because of the neat and tru cyclic control without any stabilizer interactions. Reduce your control deflections either mechanically or electrically (Dual Rate).

You will feel as though you are possessing an entirely new helicopter now, having responsiveness and aerobatic capabilities as never before. Do not be too quick in blaming the rotor system for any side effects you seem to recognize. This is only because you have got used to the truly existing side effects of the stabilized two-blader and now there are none. The Multi-Blade-Rotor only follows your control inputs in a very true manner.

You will however notice an ever lasting requirement of a slight leaning of the cyclic control stick into the desired direction of rotor thrust. By the way, you never expected the behaviour of a powered glider from your stabilizerless, direct controlled rotor system with its high and true control response (which happens to be much alike to a full scale hingeless rotor system). This is particularly valid for high speed flying at high altitudes. You soon will notice the minor stick reflections required for that, and you will become acquainted to it. The rotor itself behaves fully balanced.

After you become familiar in flying and observing your helicopter, you may wish to rotate the swashplate driver a few degrees to the left or right in order to make the helicopter track even more exactly in correspondence with your cyclic control. Do so, if you want. The position of the driver is not that critical.

Handling Epoxy/Glass Rotor Blades

The hints given here are not restricted to the Multi-Blade-Rotor-System because of their validity for all blades made in similar fashion.

The PEKA-Rotor-Blades were carefully designed to withstand all operational loads, with a good safety margin. They are hollow bodies with a stress bearing skin. *Respect them as those.*

Their hard and seemingly invulnerable surface might lead to careless handling. Avoid, however, excessive tightly bundled rotor blades to unnecessary bending, torsion, or compression loads while storing and transporting.

By exposing to high temperatures, epoxy resin can temporarily lose much of its rigidity, might plasticize and become a victim of slight deformations, that will not always return to its original shape after cooling off. The enclosed air will expand by heating and can develop "ballooning" of sections of the blade. Thus, do not heat the rotor blade in order to speed the drying process after possible repainting, avoid exposing them for hours to bright sunshine, do not place behind your car's windows, etc.

While these rotor blades withstand extreme tearing stress, they are on the other hand programmed for controlled fracture upon an accident. This could result in a possible danger in an event of one of the blades going into the full pitch position suddenly while operating RPM due to a linkage failure. Therefore check your linkages, push rods and ball bearings regularly. Make sure to replace questionable parts on time. Check for stiff, playfree connections and actuations. This is also true for the conventional, stabilized two-blades. It should be mentioned here again. You will never consider the Multi-Blade-Rotor as a toss-around toy. By observing all safety recommendations you will maintain it properly and thus will keep it in top condition, while ensuring its top performance forever.

Repairs

While the Multi-Blade-Rotor provides a greater potential, it requires quite a bit more care in handling. Whenever a landing becomes a "noisy arrival" with damage of the rotor system, do not try to "rebend" anything. Only part replacement regains its original safety. Do not try to replace single rotor blades. Better send all the remaining blades including the broken one(s) to the manufacturer or his distributors (see addresses at end of article). They will be quick to match a new set for you, consisting of the remaining and replacement blades.

There are rights protected for the Multi-Blade-Rotor-System Aachen. In some cases this might not always prevent backyard manufacturers from trying to fabricate more or less doubtful copies. Distrust in any spare parts from other sources and only use genuine parts. They shall always try hard to provide needed parts by return mail.

Safety

On considering yourself as an old "pro" we need not give you advice on how to handle your model. Make sure by regular inspection and maintenance that every technical component remains in a first class condition.

Operate the model helicopter and its subsystems only in accordance with its manufacturers' instructions. Never be tempted by the heliciopter's now increased capabilities to have it fly towards or over persons and property. Stay away from others and fly safely! Have lots of fun and happy landings with your Multi-Blade-Rotor System.

Further info from:

Peka-Lufttechnik Knipprath, Junkerstratte 91, D-5100 Aachen, W. Germany. Tel: 0241-86498/163217.

Capstone Rotors, 4720 Robinhood Park, Columbus, Ohio 43227, U.S.A. Tel: (614) 866-4360.

Yorkshire Helimod, 37 Easterly Avenue, Leeds 8, England, U.K. Tel: 0532-488568.