KIT REVIEW No. 136

By Bill Burkinshaw

REV-OLUTION

RIGID ROTOR R/C HELICOPTER FOR 0.60 cu in MOTORS

EVEN taking into account the rapid rate of development of good ideas into reality in the modern world, few people would have thought ten years ago that R/C helicopters would have developed from an almost practical curiosity to the current state of practical perfection. It almost defeats my understanding even now that anyone having spent the time and money to build then learn to fly an R/C helicopter should risk all and attempt aerobatics with it. But people did and very soon all manner of reports of the helicopter that did a loop or a stall turn started to arrive and experimenters started to festoon their models with elevators and other devices aimed at improving the aerobatic performance.

Perhaps *American R/C Helicopters,* the manufacturers of the Revolution read Bob Agnew's prophetic words in May 1973 RCM&E where he commented appropos of the Rigid Rotor system 'potentially this is the most suitable of all for models', — for their system certainly works and presented to an astounded public the first helicopter capable of axial rolls. Rolls had been seen before, but axial they certainly were not.

Experts will say that the rigid rotor is not new and point out that Dieter Schluter's Cobra of 1971 had rigid rotors, but the Revolution system of rigid head and no flybar is certainly new.

In more conventional helicopters, if any can at present be said to be conventional since there are so many hybrid systems around, the control inputs to the rotor blades are via servo paddles and the R/C servos are thus coupled via appropriate linkage indirectly to the main rotors. The Revolution system however couples the servos directly to the rotors. Early experiments with this system indicated that whilst control was extremely positive, stability, and thus controllability, was not good. To overcome this instability, American R/C Helicopters hit upon the idea of weighting the blades to increase the gyroscopic stability of the rotating blades and thus damp out the instability, the greater mass of the heavier gyro requiring more force to upset the stable condition.

Of course now that the servo effect of the paddles driving the main rotor to the desired position is removed, very careful design of the linkages between R/C servo and blades is necessary otherwise unduly high loads will be fed back to the servos. A combination of carefully designed linkages, carefully selected rotor speed and just the right amount of weight finally produced the successful Revolution system. It should be noted that an alternative conventional flybar head version the Revolution 60 is available. A conversion kit for this type of head is available and also a .40 power version.

Assembly

Before commenting on the assembly of the model it is only fair to point out that the kit received for review was a very early sample and subsequent kits that I have examined do not contain the one or two annoying faults that were present in mine. It is also reasonable to stress that the Revolution Rigid Rotor is not to be recommended as a first R/C helicopter for whilst the machine is most certainly capable of good hover performance, its real strength is in aerobatics and the two requirements i.e. fast response to control inputs for aerobatics or ultra stable for precision hovering manoeuvres do not necessarily go hand in hand and the newcomer to R/C helicopter could well find that this model is too much of a handful.

The basic structure of blue anodised alloy sideplates, tail boom and engine mounting are very quickly assembled and all parts fit nicely. A *Meteor* 60 engine was fitted which necessitated the elongation of the mounting holes with a Swiss file. Had I chosen to fit a *K&B* there would have been no re-working necessary and in any case only 10 minutes work was required. The cabin which houses and conceals the R/C equipment and the majority of the mixing linkages is very simple, an epoxy glass fibre laminate lower section is retained by a combination of wood screws and socket cap screws to the plywood bulkhead and lower mainframe extension respectively. Before fitting the bulkhead and lower cockpit parts I finish painted both items.

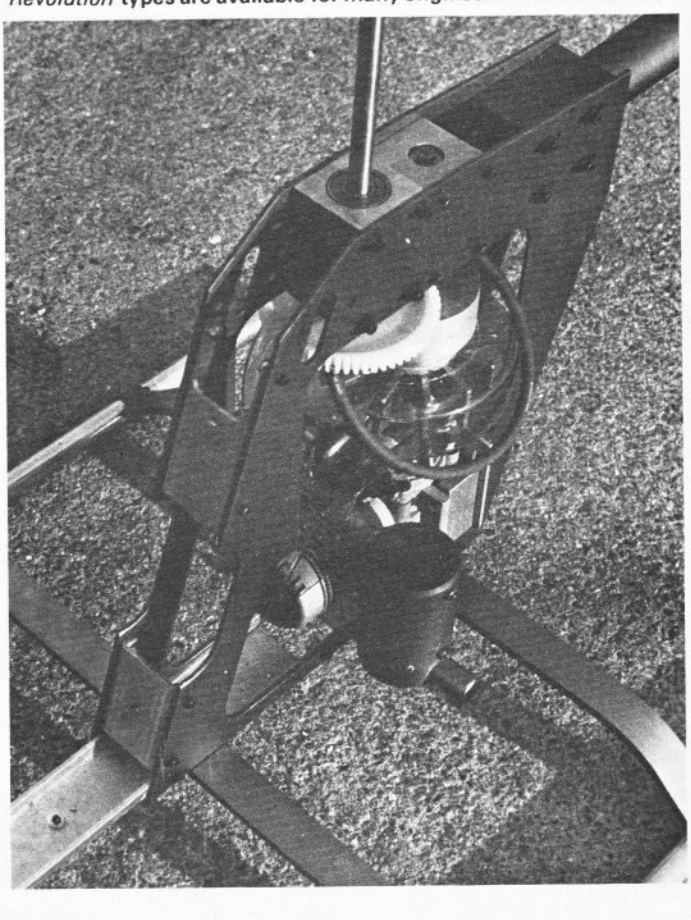
Four servos are fitted to rails glued to the bulkhead — I also added woodscrews at this point to reinforce the servo rail fixing. These servos control collective pitch, cyclic pitch (one servo for fore and aft, one for lateral) and the tailrotor. All four servos are coupled to a mixing unit which is necessary to avoid changes in cyclic pitch (the 'steering') when collective pitch changes (the 'up and down') are made. Additionally the mixer system is arranged so that tail rotor pitch is increased with collective to help control torque reaction changes which occur as collective pitch changes are made.

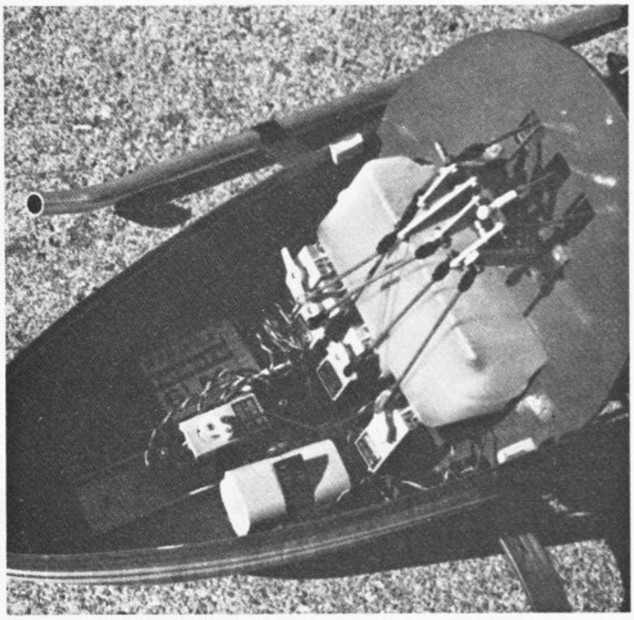
A separate servo controls the throttle and is coupled to the collective pitch, servo with a 'Y' lead from the throttle output on the receiver. Thus opening the throttle also increases the main rotor and tail rotor pitch simultaneously. The mixer unit is not difficult to set up providing the instructions are followed implicitly. As previously stated the kit I assembled was an early one and the instructions for this conflicted with the importers' advice sheet. However a letter, and later a chat with the designer, confirmed that the importers' instructions were correct and once re-set my initial misgivings over the poor mechanical design of the mixer were all removed.

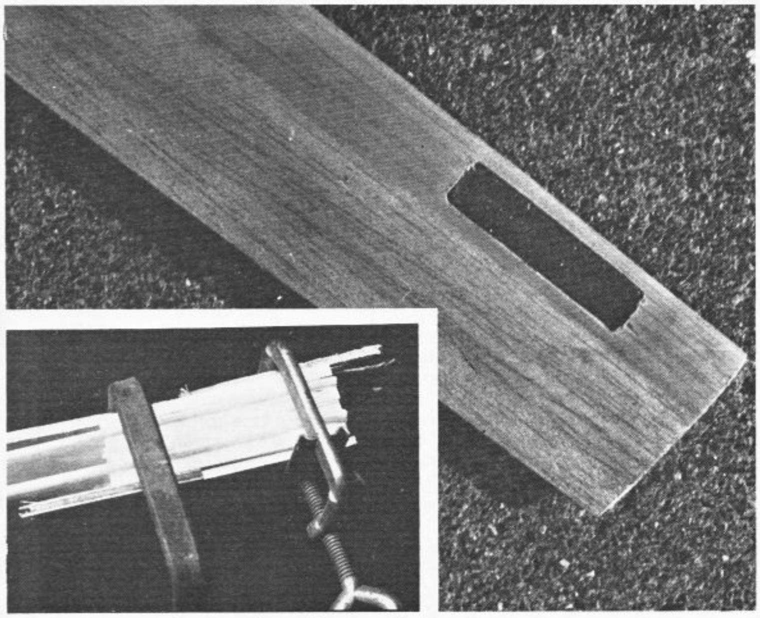
I chose to replace the material supplied for the pushrods — a small diameter studding, as I felt that the one or two bends I was forced to make in the pushrods could well cause fatigue failure, as any bend would be completely covered in the s'vees' of the thread, any of which could be a potential fracture point.

Tail rotor assembly was very straightforward, the drive belt and shaft drive pulley etc., are already in position and only needed care in twisting the belt the correct way round. The tail rotor blades are finished moulded items and only require 'de-flashing' before installation but the main rotor blades are another kettle of fish altogether. In the preamble I indicated

Below: simple robust basic structure is quickly assembled. A *Powermax* dustbin silencer was fitted although purpose-made *Revolution* types are available for many engines.







Above left: R/C equipment is hidden by the seat removed here for photography. Careful spacing out of the servos necessary to allow adequate clearances between pushrods. Note 5th (throttle) servo fitted between Rx and Ni-Cad. Above right: tip weights inset in blade before fixing and fairing. Inset: re-inforcement pieces clamped firmly whilst glue is drying.

that the blades are weighted — they could of course just be 'heavy' but it is far simpler to resort to weighted ordinary (obechi — balsa laminated) blades.

The blades are of symmetrical section with tongue and groove joint between the hardwood leading edge and balsa trailing edge. After joining these two portions an additional spindle-moulded section is glued top and bottom at the root to provide a square and parallel section to fit the blade holders. A 50gm lead weight is let into the hardwood section of the blade near the tip. It is important to fit this very carefully not taking any more material than necessary out of the blade, I used epoxy to fit the weight then faired the weight into the blades with a mixture of micro-baloons and epoxy. The blades were then finished with epoxy resin and a *Fablon* type self-adhesive plastic.

Balancing the blades is made much easier if a really accurate pair of scales is available — I used a pair of automatic laboratory scales capable of measuring down to 1/10th of a milligram! The method in the instruction of simply bolting the blades together is not accurate enough — my model vibrated far too much and a further effort was made as described.

Last item to be tackled was the fin and tailplane. Various types have been tried on the Revolution, since the first prototype which tended to 'balloon' on application of fore and aft cyclic when flying forward. The type shown in the accompanying photograph is a modified version of that supplied shown in the accompanying photograph in later models. I found the 6mm plywood used for the fin shaped easily with a razor plane. The tailplane is covered with heat shrink film and the fin sprayed and fuel proofed.

Test flying

Before venturing out to the flying field my confidence started to wane and I finally decided to enlist the help of an experienced Helicopter pilot. I knew that Vago Nordigian of Watford Model Centre had flown a *Revolution* so enlisted his help. He insisted that I ran in the engine well before he made any attempt to lift off the machine so I proceeded to run several tanks of fuel through the motor. Unfortunately not enough, for it soon became apparent that the power was sagging-off considerably by the time the engine was at lift off RPM for more than a few seconds.

An increase in main motor pitch (via the links from swash-plate to rotors) brought down the lift-off RPM sufficiently to keep the motor running and initial trimming and familiarisation consumed a further couple of tanks of fuel. A second trip out with the model to take airborne photographs saw the motor freeing up and consequently it was possible to gradually decrease the main rotor pitch.

With every decrease in rotor pitch the main and tail rotor speed for lift-off of course went up, thus increasing the power of the tail rotor and the gyroscopic stability of the whole model. It was very noticeable that with this gradual increase of RPM the model was becoming more steady in the hover. It would seem that even though the engine develops enough power at half throttle to lift-off better control will most certainly be developed if the engine is allowed to rev quite a lot higher. In fact for my own attempts I reduced the pitch even further to take advantage of maximum possible gyroscopic stability and tail rotor control.

The engine seemed by this time free enough to fly circuits and these were accomplished with ease. At the time of going to press the engine is still not felt to be sufficiently reliable to venture to the altitude necessary to perform aerobatics. It should be remembered also that as the blades are able to swing fore and aft (lead/lag) that any sagging off in power input can cause the blades to lag excessively and can cause violent oscillations and total loss of control during a roll or loop — not a risk we were prepared to take.

It should be pointed out that the rotors on this model are relatively slow revving and overall performance will suffer if they are allowed to rotate at too high an r.p.m. As a guide the rail rotor r.p.m. at lift-off should be approximately 7,500 r.p.m. The main rotor blades should be locked up firmly but not totally rigid.

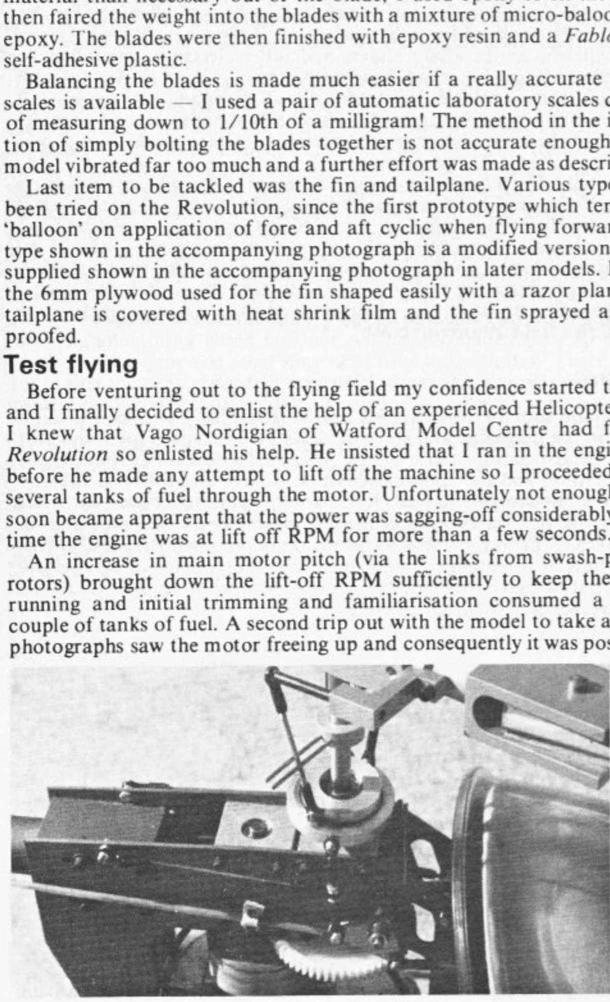
Conclusions

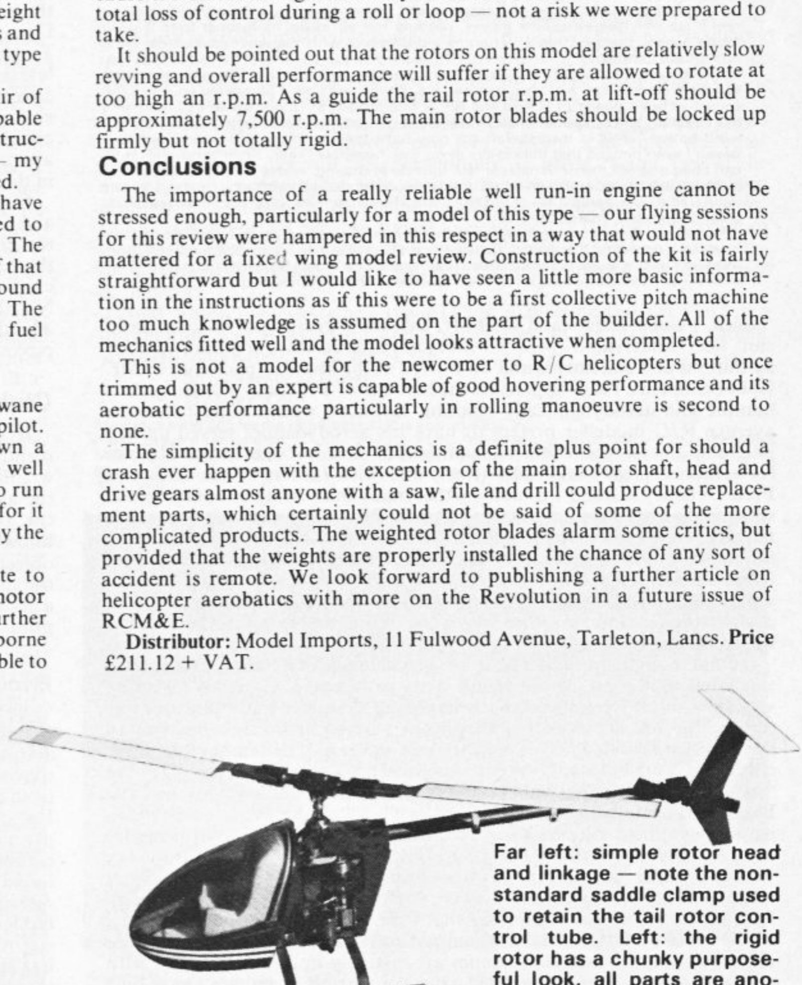
The importance of a really reliable well run-in engine cannot be stressed enough, particularly for a model of this type — our flying sessions for this review were hampered in this respect in a way that would not have mattered for a fixed wing model review. Construction of the kit is fairly straightforward but I would like to have seen a little more basic information in the instructions as if this were to be a first collective pitch machine too much knowledge is assumed on the part of the builder. All of the mechanics fitted well and the model looks attractive when completed.

This is not a model for the newcomer to R/C helicopters but once trimmed out by an expert is capable of good hovering performance and its aerobatic performance particularly in rolling manoeuvre is second to none.

The simplicity of the mechanics is a definite plus point for should a crash ever happen with the exception of the main rotor shaft, head and drive gears almost anyone with a saw, file and drill could produce replacement parts, which certainly could not be said of some of the more complicated products. The weighted rotor blades alarm some critics, but provided that the weights are properly installed the chance of any sort of accident is remote. We look forward to publishing a further article on helicopter aerobatics with more on the Revolution in a future issue of RCM&E.

Distributor: Model Imports, 11 Fulwood Avenue, Tarleton, Lancs. **Price** £211.12 + VAT.





Far left: simple rotor head and linkage — note the non-standard saddle clamp used to retain the tail rotor control tube. Left: the rigid rotor has a chunky purposeful look, all parts are anodised blue or gold.