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VARIO'S LARGE-SCALE TURBINE 'SQUIRREL' IS BIGGER THAN EXPECTED

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REVIEW

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VARIO'S LARGE TURBINE ECUREUIL

BUILDING AND FLYING VARIO'S LARGE TURBINE MODEL

The Eurocopter AS350 Ecureuil (Squirrel) is a single-engined light helicopter originally manufactured by Aérospatiale, which is now part of the Eurocopter Group. The AS350 is marketed in North America as the A-Star and there is a twin engined variant known as the Twin Star. Development of this helicopter began in the early 197's to replace the Alouette II and the first flights took place on 27th June 1974. Thanks to its versatile flat-floored cabin, the AS350 B3e can be quickly and easily reconfigured for all types of missions, from utility and heavy load transportation, to medical evacuation, 'Search and Rescue', law enforcement and passenger transportation.

This is a high-performance member of the Ecureuil family as the AS350 B3 outclasses all other single engine helicopters for performance, versatility, safety and competitive acquisition and maintenance costs. It excels in hot conditions and very high altitudes, and broke records when a standard production aircraft landed on the top of Mount Everest in 2005 (altitude: 29,029 ft/8,848 m). It is no wonder this machine is often seen in the sky in many different parts of the world. Thus with so many examples to be readily seen, it would make an ideal candidate for a scale project and that is exactly what I thought, as I ordered the Vario Ecureuil, along with the Jakadofsky Pro 5000 turbine.

Absolutely stunning the first time in the air

The Mechanics

Within a few weeks, there came a knock on the door and a courier was standing outside with some extremely large boxes. The Ecureuil had arrived, followed closely by the Jakadofsky turbine. The mechanics are the same as those that I have now fitted in my Huey; the only difference being with these is that they are set up for the opposite rotation (right hand rotation for the Squirrel).

I decided to start proceedings by getting the mechanics built, as they would be required to position everything in the fuselage. To do this, I first had to decide upon what servos I would be using for the eCCPM operation of the swashplate. I decided to use Futaba S9206 servos, so four were acquired as Vario use a 4 servo 90º swashplate and two servos are fitted into each sideframe.

The first stage of the mechanics build is to attach a number of roller bearings to some of the cross members. These will act as supports for the main gears ensuring the teeth stay fully engaged in the bevel gears that drive them. In addition, the autorotation unit is attached to one of the main gears and a bearing carrier is fitted to the other.

What you need to know about these mechanics is that they are capable of running in either direction, anti-clockwise in the case of my Huey and clockwise in the case of Ecureuil. This is achieved by positioning the gear fitted with the autorotation unit, either above or below the bevel gear driving it.

In the case of the Ecureuil, the gear is placed above the bevel gear. The second main gear is there to share the load between the front and rear bevel gears, and so in effect free wheels.

quote quote quote quote quote quote quote quote quote quote???????????

The mechanics parts are packed in numbered bags to coincide with the pages in the assembly manual

Here is the autorotation unit; it depends on which way this is assembled in the mechanics that dictates the rotation of the rotor head

Both main gears are held in mesh with the bevel gears by four bearings and stop the gears moving out of mesh under load. The main shaft is supported in three bearings and stopped from moving up and down by no fewer than four collars. The centre of the autorotation unit is attached to a flat on the main shaft by grub screws. It is necessary to position the bevel gears between the main gears, as you fit the main shaft and position it along with the bearings onto the side frame.

Next the intermediate drive gear is fitted onto a shaft that drives the rear bevel gear and also carries the tail coupling. It is important that both the gears and the tail coupling are positioned on the shaft correctly, so the grub screws that hold them in position are located correctly on the flats ground into the shaft that carries them.

Once this has been done, additional plates and supports are added to one of the side frames, along with two of the servos. At this stage, none of the bolts holding the bearing blocks, or cross members, are fully tightened. This is done once the frames are finally assembled with the second frame added.

Next you prepare the second side frame by fitting the remaining servos and additional plates that support the turbine. Before this second plate is fitted, you need to install the turbine, which is supplied with the required clutch bell pinion already fitted. The Jakadofsky Pro5000 has an integral reduction gearbox, which is guaranteed for life and reduces the turbine 98,000 rpm to 19,300 rpm at the clutch bell, which will drive the rotor head at around 875 rpm.

The turbine is supplied with a front mounting bracket and a small rear bracket is supplied with the mechanics and fits to the rear of the turbine. It is possible to adjust the turbine vertically, which will allow you to later set the correct gear mesh. With the turbine roughly positioned and two of the four front mounting screws in place, you are now ready to fit the second side frame. Once this is in position, the necessary fixing screws are added, but not fully tightened, as all the gear meshes and the pinch rollers that run on the main gears need to be adjusted.

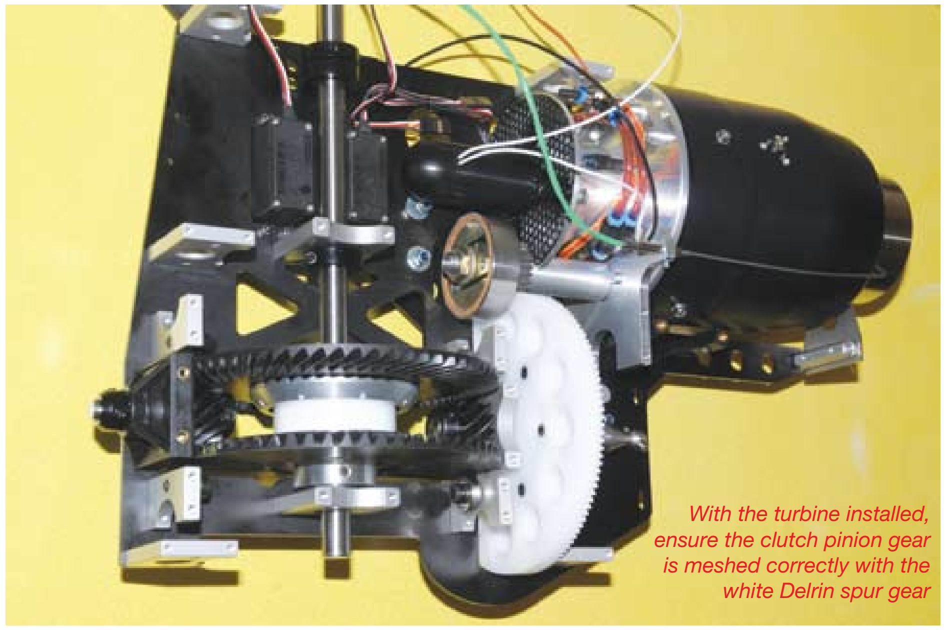
I started this process by securing all the spacers, which do not support any gears or pinch bearings. This way I have a rigid frame within which I can adjust the gear meshes. At this point in time, do not fully tighten the topmast bearing block, as this will be changed for the extended mast support. Also do not use any thread lock, as you will need to remove some of the screws to attach the mechanics to their mounting framework.

With the main frames fixed together, I could start getting the gear meshes sorted out. First, I adjusted the mesh between the turbine and the large white Delrin gear, taking care to get the mesh parallel, as it is all too easy to end up meshing deeper on one edge of the gear than the other. Once I was happy with this mesh, I fully tightened the turbine mounts, using thread lock. I also fitted the rear turbine mount, but did not thread lock this, as the exhaust would need to be fitted later.

The mesh between the main gears and their bevel gear drivers is not adjustable, so all that remained is the adjustment of the bearings that run on the main gears and hold them in mesh. I set these, using a 0.02 mm feeler gauge between main gear and bearing, making sure that the bearing was parallel to the back of the main gear and not contacting on the corner. The next hour

The drive gears installed on one of the side frames ready for the turbine

The tail gearbox components, notice the gearbox casing extension for the long output shaft



With the turbine installed, ensure the clutch pinion gear is meshed correctly with the white Delrin spur gear or so was spent carefully removing one screw at a time and applying thread lock, making sure to omit those which I needed to remove at a later stage.

Having gone as far as I could with the main mechanics I built the tail rotor gearbox, which is the standard Vario unit we are all familiar with, apart from it being fitted with an extended output shaft support and additional bearings that came already fitted. The output shaft on this particular tail gearbox is extended to clear the rear of the Ecureuil fuselage. As one would expect, the casings are all anodized aluminium.

With the majority of the mechanics now built, I was ready to turn my attention to the fuselage and started by assembling the cradle that carries the mechanics and is anchored to the undercarriage. This is a simple framework consisting of two aluminium plates and aluminium spacers. The top of this frame is attached to the mechanics by a series of screws and spacers. It is to this structure that the fuselage is attached.

Fitting The Mechanics

The fuselage itself consists of two major components, namely the tail boom and the front body of the helicopter. The tail is removable and is located onto the front fuselage on a cone, while being fixed at four points, but more about this later.

As with all Vario fuselages, the first job was to cut out all the windows and doors, being careful to leave enough material for fitting the windows later. Then with the mechanics fitted into their cradle, I was ready to get them in position in the fuselage and onto the undercarriage. The undercarriage is a one piece, welded, aluminium structure and is positioned in two recesses in the fuselage. You will need to make sure that it is positioned centrally in the fuselage and equally about the centreline of the fuselage. This takes time and it is essential that you get this bit right.

Once I was happy that I had it positioned correctly I decided to fix the undercarriage to the fuselage with some small self-tapping screws. This allowed me the freedom to position the mechanics centrally in the fuselage making sure that the main shaft was in the correct position and also taking great care to get the mechanics running parallel to the centreline of the fuselage and thus that the output to the tail is straight. Once you are happy that everything is positioned correctly, four holes are drilled through the fuselage and the skids and the mechanics are bolted into position.

While you have the front section of the fuselage attached to the skids, you can fashion the two covers that fit over the undercarriage cross members and fit these in position with two self-tapping screws.

Fitting The Tail

Once this has been done, the mechanics are removed and you are ready to fit four cam-type posts that secure the tail boom. The rear of the fuselage has a cone moulded onto it and this cone has four slots, into which the four posts are fixed. Four threaded inserts are glued and screwed into the bottom of the fours slots and the posts then screw into these inserts.

A female version of this cone is moulded into the tail boom with tenons that locate in the slots in the front of the fuselage. You will need to drill holes into these to take the four posts that you have fixed into the front fuselage section. These holes need to break out into four recessed diameters, which coincide with the tenons. The cam type posts will protrude into these recessed diameters when the tail boom is fitted, then the four cam locks can be inserted and locked onto the cam posts to hold the tail in place.

This is possibly the most difficult part of the whole build and took quite some time to get right, but it is important to get it right, as you need to be able to remove the tail boom to do any maintenance on the tail drive at a later date.

Here we have the screw insert cam bolt and cam lock nut, four of these hold the tail boom in place

The four cam bolts are installed in the cutouts in the rear of the front half of the fuselage

Here you can see the head of the cam bolt showing in the recess in the tail boom before the cam nut is fitted, plugs are provided to hide the recess

The Tail Drive

Once I had the tail boom location and fixing sorted out, I glued the two wooden formers into the rear of the fuselage and continued with the rest of the build. There is an intermediate gearbox that sits behind the mechanics in the rear of the fuselage and it was this that I built next before moving back on to the tail boom itself.

As with the full size, so it is with the model, the tail drive sits on top of the tail boom. The tail boom is in fact completely empty, with both the tail pitch servo, pitch change mechanism and the tube drive mounted on top of the boom and shielded with a cover.

I turned my attention to the tail pitch mechanism and fitted my tail servo into the recess provided. The tail pitch pushrod is a carbon tube with ball joints attached at both ends and supported in two guides that have to be fixed to the boom. Take care to ensure that the tail pushrod and guide are fitted within the area that will eventually be covered over. One half of the tail gearbox mount needs a crank to be mounted to it, so you will need to drill this and mount the crank, ready for the rest of the tail boom to be assembled.

The tail drive is supported in two bearings along its length, with an additional two bearing support close to where the tail boom fixes to the front of the fuselage. The tail gearbox is mounted in a metal ferrule, which is bonded into a moulded fixing at the rear of the tail boom and in front of the moulded in vertical fin. Before bonding the metal ferrule in place, I decided to position the tail tube drive in position, so as to be sure everything was perfectly in line, before fixing anything permanently.

Drive to the tail is carried by a steel tube coupled to the tail gearbox by a claw coupling and a rubber cruciform. I made up the two single bearing supports and positioned them onto the tube drive along with the coupling for the tail gearbox. Next I located and fixed the tail gearbox into its mount and positioned this into the rear of the tail boom. I then positioned the tube drive, along with the two support bearings and attached the tube to the tail gearbox. With this pressed fully home I could ensure that both the bearing supports and the tail gearbox were positioned correctly, before bonding them in position.

I also bonded in place the sidepiece of the gearbox mount, onto which I had earlier fitted the crank for the tail pitch change mechanism. Once the glue had set, I was ready to position and glue the double bearing at the front end of the tail boom. The front bearing is carried on two pieces of wood and again I used the tail tube drive to get this bearing in position ready for gluing.

The Intermediate Gearbox

Now I could turn my attention to the front part of the fuselage and fitting the bulkhead that will help to support the mechanics. To the front of the mechanics is fitted a large aluminium bracket that attaches to the fuselage bulkhead. I fitted the mechanics back into the fuselage with this right-angled bracket attached and then positioned the bulkhead in front of the mechanics. A further piece of wood is fitted to the aluminium bracket and glued to the bulkhead. The bulkhead was then glued into the fuselage and allowed to completely set before the next stage. This was to fit the tail boom, cut the tail drive tube to length and finally fit the intermediate tail drive gearbox that I had built earlier.

The intermediate tail drive gearbox is connected to the tail tube drive by another claw coupling and rubber cruciform. As I had not permanently fitted any couplings to the tail tube drive, I removed the tail gearbox and the coupling at that end, which allowed me to slide the tube drive forward and backwards as required to position the intermediate gearbox. As the tube drive is supported in its bearings, this would position the intermediate gearbox in line with the tail drive tube and only leaving me to position it far enough back in the front fuselage section. Vario give no dimensions for positioning this gearbox, which left me with the dilemma of where to fix it.

This gearbox is connected to the main mechanics with articulated joints so, bearing this in mind, I positioned the intermediate gearbox as far back from the mechanics as I thought feasible. Too far forward and the angle of the articulated joints could become too acute, which would prevent the tail running smoothly. I ended up with the split in the claw joint that connects the gearbox to the tail tube drive, coinciding with the split line of the tail boom to the front of the fuselage.

With the intermediate gearbox now fixed in place, I could cut the tail tube drive to its final length and permanently fit the claw couplings before turning my attention to making the coupling between mechanics and intermediate gearbox.

Once this had been done, I was ready to fit and hang the doors, hinge the cover on the fuselage side and fit all the covers ready for the fuselage to go off to be painted.

Finishing Touches

The paint scheme I had chosen did take Andy Meakin quite some time to complete but the wait, as I am sure you will agree, was worth it. While the fuselage was away I spent my time checking over the mechanics and fitting the swashplate, pushrods and rotor head ready for its final installation. Once the helicopter was back with me, I set about fitting everything back into it.

Firstly, the mechanics were fitted, which is a two-person job, especially locating the driveshaft to the intermediate gearbox. Once this was done, the fuselage stands on its undercarriage, making it much easier to work on. Next came the tail, taking care to engage the claw coupling properly before adding the cam locks to hold it in place. I have to admit that I did have some reservations about the rotating cam locks and so decided to add some silicon rubber that should stop them moving, yet will be easy to remove should the need arise.

With the mechanics in and the tail on, I was ready to consider the fuel tank and although there is no mention of this, there is really only one place to fit it and that is under the mechanics between the frames that hold the mechanics in place. The tank is right under the main shaft here, so there should be little or no change in trim as the fuel load decreases.

Up until this stage in the build, I had not really given the radio installation much consideration. There is a hatch on the side of the model and beneath this was the ideal place to install all the switches. That of course was until I laid things in the model to try and achieve the correct balance point. I have always, wherever possible, preferred to use batteries as ballast, carrying additional weight to me does not make any sense, but in the case of this machine, I had little choice.

As you can appreciate, this is a large model with the turbine behind the main shaft. Even placing the batteries right in the nose I still required nose weight. Putting the batteries right in the nose required very long wires to the switches, which would mean a chance of voltage drop, so a compromise had to be reached. My switches were installed in front of the fuel tank. A tube just big enough to hold the gas bottle, was installed at an angle of approximately 45 degrees beneath the side hatch and the batteries for the radio and turbine were installed as far forward as possible, using standard wires.

Now the moment of truth! With the cockpit floor installed along with a pilot, seats and the instrument binnacle, what would the balance be like? Well 2 kg of weight was added to get the centre of gravity on to the centre of the main mast. Of course my concern was now the overall weight of the model. With a Vario's target weight of around 18 kg, how did my model measure

Component parts of the intermediate gearbox before assembly

The intermediate gearbox positioned prior to finally being fixed in place

Intermediate gearbox assembled prior to fitting in the fuselage

Tail boom with the covers fitted, it's almost complete

Here is the hatch where I had intended to fit the switches but where the gas is housed instead

Looking into the front of the fuselage you can see the front former that the mechanics are anchored to and the rear formers that stiffen the rear section of the fuselage

The Ecureuil certainly looks the part

up? With the blades fitted and no fuel in the tank, the weight turned out at 22 kg, quite a shock! A quick call to Vario soon confirmed that this was in fact about right and their demonstration model was about 21 kg.

Flying

Some people may not be aware that to fly any model weighing 20 kg or more 'dry' weight here in the United Kingdom, requires a CAA exemption certificate! Having decided that I could not lighten the model, I was confronted with the task of getting a CAA exemption cert. to operate this model.

My first port of call was the Large Model Association (LMA), who operates the exemption scheme for the Civil Aviation Authority (CAA). I got in contact with Tony Hooper, the chief examiner for the LMA, who explained exactly what would be involved in getting a full exemption that would allow me to operate the model. In very basic terms the model would have to be fitted with a redundant receiver system and pass an examination to confirm that it meets an acceptable standard of construction and design. When the required criteria have been satisfied, a Certificate of

The very first few seconds in the air the look of concentration on my face says it all!

Construction and Design is issued, which would then allow me to apply to the CAA for an Exemption to Test Fly the model. I was also supplied with a Log Book, which would need to be signed off as the test flying procedure was completed.

Obviously, that is a simplified description of what is required, but you can learn more by looking at their website: http://www.largemodelassociation.com. So far, I have been granted the Exemption to Test Fly and the initial testing of the model will count towards the flying time that I will need to complete before the full Exemption is issued. Jon Tanner and I have discussed this subject at length and believe that the subject of operating large and heavy models, including obtaining a CAA Exemption Certificate, needs to be looked at in more detail. Watch these pages!

I arrived at the flying site where I met up with Jon Tanner with his camera and Tony Hooper, who would be witnessing the flights. Armed with my Exemption to Test Fly, my Log Book and, of course the model I was ready to fly.

Conditions, for a test flight, were almost perfect, although a little less wind might have been better but, after all, this model is over 20 kg, so a little breeze should not make any difference. The blades were bolted on and the controls were once again checked, both by Jon Tanner and myself, just to be sure that I had not missed anything. Once satisfied, the fuel tank was filled and the model carried out to the patch. A range check was carried out and all was well, so there were no excuses left, it was time to start the turbine!

The Jakadofsky started and ran on the second time of asking – I had not bled the fuel tubing. All that was now left for me to do was select flying speed on the turbine and wait for the blades to achieve the target flying speed, which would be indicated to me when the red LED indicator in the cockpit went out.

What seemed like an eternity passed before the LED went out and the blades were at their 875 rpm target speed. I gently raised the collective pitch a little, checked the controls once again and eventually lifted into the air. The blade tracking was spot on and the model had no vibration, although some right and back cyclic trim was required to hold the model in a stationary hover. I landed and made the trim changes before lifting off once more and hovered for a while, as Jon took the all-important pictures.

Once Jon had finished, I moved the model around a little, trying to get a feel for the controls, but no sooner had I started to relax just a little, it was time to land and check the fuel level, which, as it turned out, was a little low. Tony informed us that we had been flying for about 7 minutes, so I probably had a further minute or so left in the tank, but the turbine had been shut down and the blades were slowing. The first flight had been a success, so it was now time to do some post-flight checks and look to see how the photos had turned out.

Checking the model over revealed no problems so, after a cup of coffee, we decided to go for a second test flight. I dialled a small amount of exponential in on the cyclic controls, and increased the gyro gain. The tank was once again filled and the model carried back out to the flying area. This time the turbine started and ran at the first time of asking and it seemed no time at all before I was ready to lift back up into the hover. Jon was moving around, getting a few more pictures and I lifted the model into a hover at just above head height. Once the area was clear, I started to move the model around in the air a little, just to get a feel for the controls and see if the tail was holding better than it had on the first flight.

At about 6 minutes into this second flight, a strange noise seemed to start from the tail, at which point I quickly landed and switched the turbine back to idle. A sharp vibration was then apparent, so I immediately shut the turbine off, by which time the vibration had all but stopped and the blades were slowing down. We had managed a total of 13 minutes test flying and I now needed to find out what had gone wrong. Nothing obvious had come loose or broken, however I did see that the swashplate had started to separate, which would lead to blade tracking problems. However, a full examination would be needed so it was back to the workshop to see where the noise and vibration had come from.

Conclusions

Firstly, I need to point out that as far as I got with the flying of this model, I am very pleased

VARIO ECUREUIL

About 6 minutes into the first flight and I was getting to grips with it

A bit of back trim required!

Yep the other side looks just as good

with the way it feels in the air. I have flown the three blade rotor head on other models and it has always proved to be quite manageable without any additional stabilization. The extra weight of this model does not seem to have made any noticeable difference to the way it feels in the air.

Building the model is reasonably straightforward but, having said that, the positioning of the intermediate gearbox should really be specified for the less experienced. This gearbox is only glued in place and although this seems to be adequate, perhaps some additional braces might be a good idea. The tail boom is located on a cone and held in place with four cam posts. As mentioned I added a small amount of silicon when fitting the cam locks on the final assembly. This was just to be sure they did not come undone, although there is probably little chance of this happening.

The turbine and the mechanics themselves are the same as those used in my Huey and having completed several hours flying without a hitch, I have every confidence in them. As for the target weight, it came as a great surprise that this model tipped the scales at over 20 kg, but I do not see how I could lose any weight in the build, so I think Vario were very optimistic with their estimate.

Verdict

Once the teething problem with the vibration has been put to bed, I am confident that this machine will live up to all expectations. The colour scheme, courtesy of Native Air/Omniflight Helicopters is absolutely stunning and certainly makes this machine stand out from others. I look forward to completing the test flying schedule and must thank Tony Hooper and the Large Model Association (LMA) for their help in guiding me through the process of getting this, my first model over 20 kg, into the air.

Was it worth all the effort? Of course it was… as soon as the skids cleared the ground it was all worthwhile! ***MHW***

We Used

JR 11 X Zero transmitter, two JR RD1222 twelve channel receivers, eight EA101 satellites, two Spektrum VR6007 Voltage Regulators, Futaba S9206 servos Futaba GY401 Tail Gyro, Powerbox RRS, two Power Box, 4000 mAh Lithium Polymer Batteries and Jakadofsky Pro 5000 Turbine

Spec

PRODUCT Eurocopter Ecureuil AS 350 B3
MARKETPLACE Serious scale model builder
MANUFACTURE VARIO Helicopter
GmbH & Co. KG. Seewiesenstr. 7, Grafendorf, D-97782 Germany
UK IMPORTER Vario UK Sales. First Floor, 229-231, Church Lane, Lowton, Warrington, Cheshire, WA3 2RZ. Tel: 01924 273888 Fax: 01924 273886.
www.vario-helicopter.co.uk
MAIN ROTOR DIAMETER 2360 mm
OVERALL LENGTH 2500 mm
ALL UP WEIGHT 23 kg
CONTROL REQUIREMENTS 7 servo heli radio (4 servo eCCPM) and gyro
POWER REQUIREMENT TURBINE