Building the GRAUPNER BELL 212 'TWIN JET' HELICOPTER

By JACK BARNARD

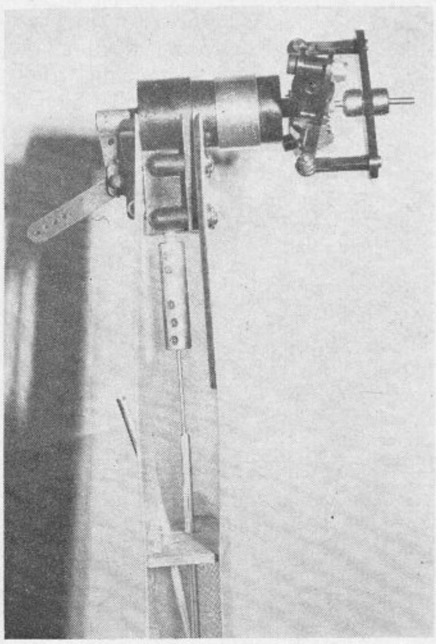
Foreword

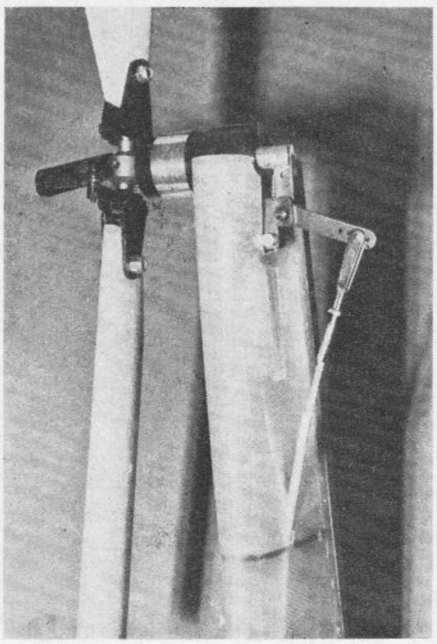
I read my review on the building of the mechanics and realised that it will be difficult to follow unless one fully understands what happens to the various parts when the engine is running and during flight. Let us assume that the tank is full of fuel, an acc. is connected to the glow plug and we have an electric starter in our hand.

The pulley of the starter is placed in the starter belt on the motor, and the model engine is started. Due to the action of the automatic clutch the model engine R.P.M. has to rise above a certain figure before it is connected automatically to the drive shaft. A gear on the drive shaft turns a large nylon gear which transfers the drive vertically to the main rotor. The horizontal drive at the end of the main drive shaft continues via a flexible drive to the rear rotor, the flexible drive is turned at engine R.P.M., and is changed to right angle drive via a gearbox incorporated in the rear rotor assembly. The blade angle of the rear rotor can be adjusted to increase or decrease thrust as required to overcome the torque of the main rotor and maintain directional control of the fuselage in flight.

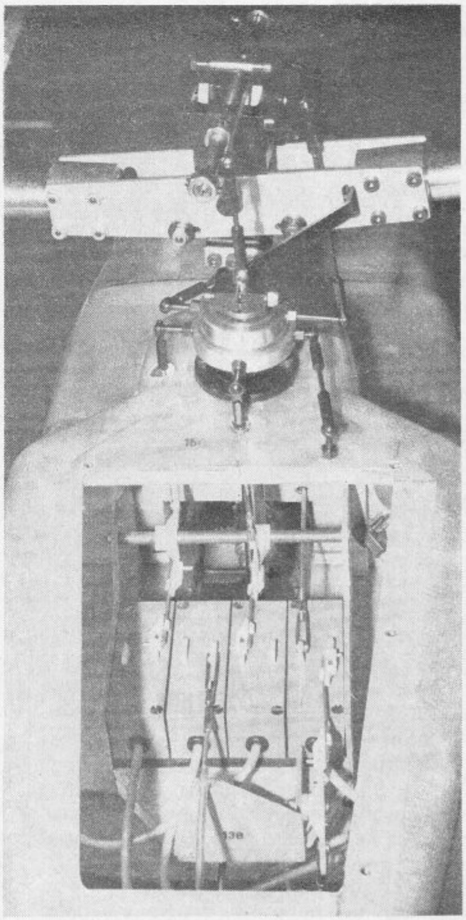
The main rotor, driven from the large gear via the vertical drive shaft, has three controls connected to it. One, the collective pitch control, adjusts the blade angle for lift changes, and is operated in conjunction with the throttle control, in fact, both are operated by one servo. Imagine the engine turning at low R.P.M. and the rotor blade angle at the minimum lift angle. At this setting there is not enough lift to raise the model from the ground, but if we increase the power and at the same time increase the angle of the rotor blade to give positive lift, we reach a point where the lift produced overcomes the weight and the model rises from the ground. The two other controls are connected to the swashplate, and if you look at the photo of this you will see it is in two parts, an upper and a lower bearing. Both of these bearings can tilt, together, in any direction, but whereas the lower one remains stationary, the top bearing turns with the shaft. It can be seen then that if we tilt the lower bearing either fore and aft, or sideways, the upper bearing will tilt with it.

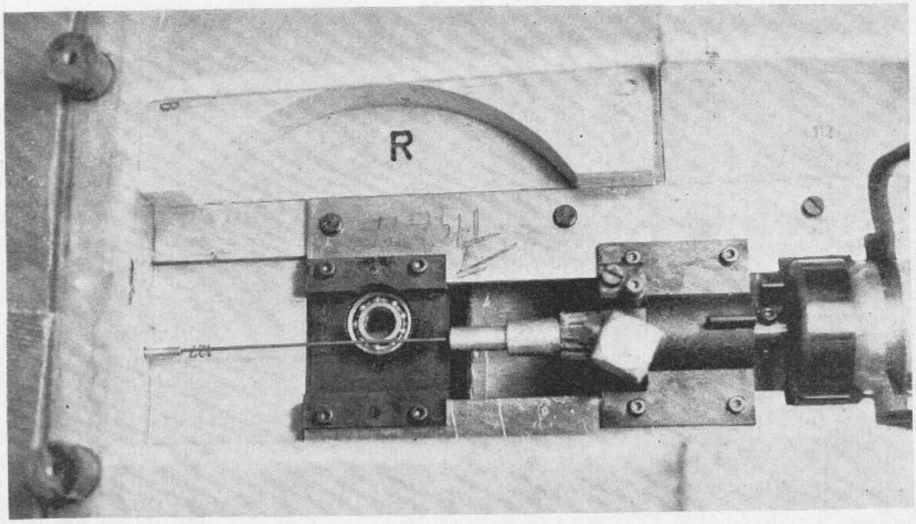
The upper bearing is connected to the pitch control in the rotor head (not direct to the main rotor blades, but via the small stabilising blades, however, the final result is to control the angle of attack to the airflow, or pitch, of the main rotor blades). The effect of tilting the swashplate as the rotor turns, is that the blade angle, or pitch, or angle of attack, whichever your prefer, is periodically varied during the cycle of rotation. The blade angle is increased during one half of a complete rotation and decreased during the other half, moving the point of maximum lift to that side which is producing the increased blade angle. Imagine now the helicopter hovering at about six feet above the ground, and the forces acting upon it. As the model is not moving in any direction these are only the LIFT and WEIGHT, and in order that the model remains hover-

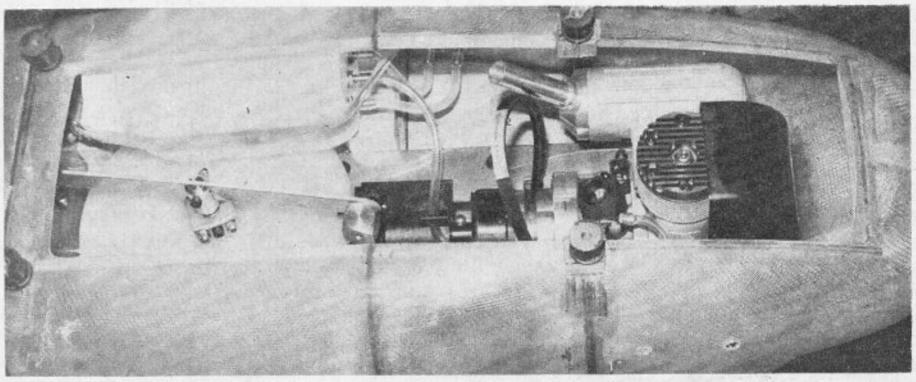


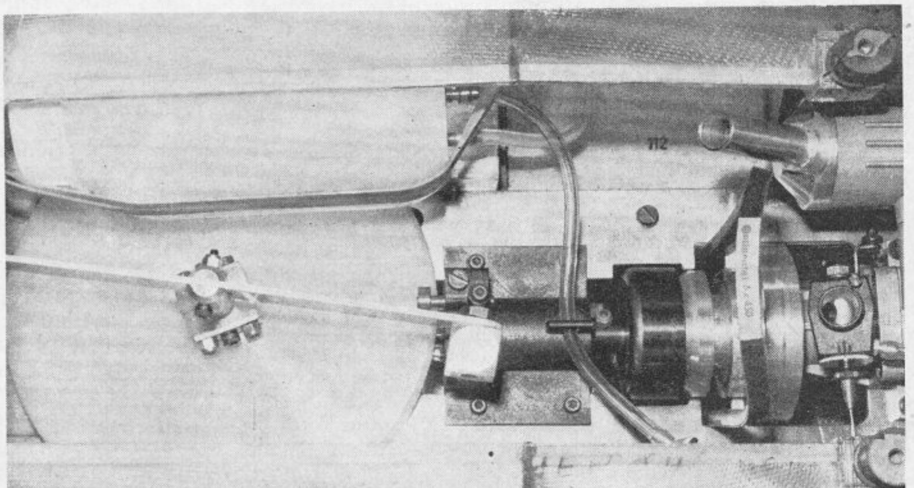


Far left: rear rotor assembly in place before building in the wooden components of the fin. Our author recommends leaving assembly in place during this operation to ensure correct alignment. Note drive to rotor unit. Left: the rotor unit completely installed on fin. Slot in fin side permits disconnection of unit from drive shaft.









Above: view through top hatch showing four Graupner Varioprop servos and attendant linkages to main rotor head. Top right: view through fuselage bottom reveals power pack in place, with large nylon gear wheel removed to show the flexible wire drive to the tail rotor. Centre right: view of the whole engine and drive compartment, which remains open as shown for access and cooling. Right: close-up of engine and drive bay showing the fuel tank installation, retained in place by rubber band.

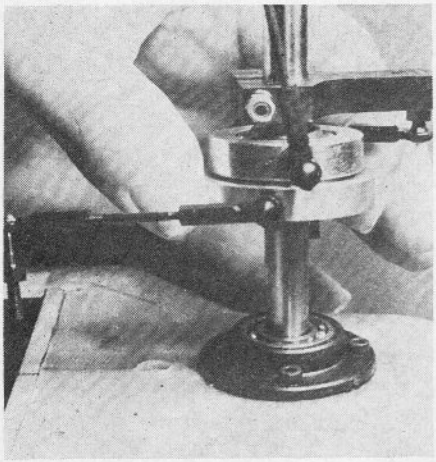
ing at one point these forces have to be equal and the lift must be exactly above the weight. The blade angle under these conditions will have to remain constant during the cycle of rotation. The effect now of tilting the swashplate will be to provide a diametrically opposite and simultaneous change of blade angle which tilts the plane of rotation, thereby tilting the lift force and producing a resultant thrust force in the direction of the tilt, moving the model in the direction we have chosen. This particular control, the variance of blade angle, is called, the Cyclic Pitch Control.

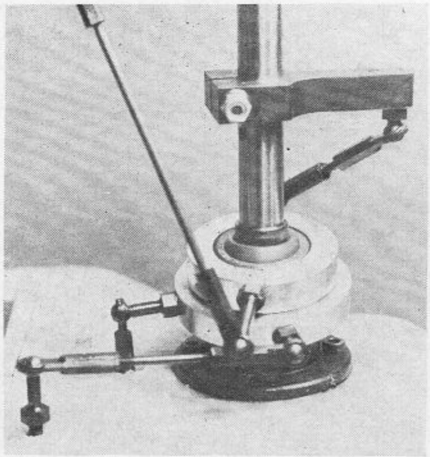
That is basically the function of the mechanics. There are, of course, many problems which have to be taken into account in the designing of the helicopter – ground effect, fuselage effects, gusts, anything which could cause sudden changes of blade angle to airflow. The experts will have to bear with me, I have merely attempted to describe the basic reasons for having each particular part where it is and its basic function. (Beginners to the R/C 'Copter game should perhaps read Bob Agnew's three-part introductory series in R.C.M.&E. April, May and June '73 editions).

Bell 212 Mechanics

After removal of the large nylon gear, and the engine silencer, the power assembly is placed in its correct position, i.e., the front of the power pack in line with the front of the sub-assembly, and a sharp pointed pencil is used to mark the point where the holes have to be drilled in the bearers for the retainer bolts. A long shanked bit is provided for this job, and this allows the drill to be kept well clear of the fuselage. The blind nuts for the retainer bolts are now epoxied in the holes beneath the bearers. A steady hand is needed here, as there is really only room in those holes at the side of the sub-assembly to get one finger through. I was just becoming expert at this when I reached the last nut!

With the power pack bolted tightly in position, we turn the model upright again and position the upper bearing of the vertical drive. But check first that the Allen screws holding the lower bearing assembly are tight. Mine were quite





Far left: main rotor shaft assembly upper bearing is retained by four Allen head bolts which are accessible by moving the swash plate up the shaft. Left: the main rotor shaft bearing in place on seat of epoxy glue, together with swash plate and linkages.

loose and the hole bearing assembly was free to move, not much, but enough to make the positioning of the upper bearing a little tricky. The vertical drive shaft is used to line up the two bearings. I would point out here that the instructions for the fitting of the mechanics cover 50 pages with approx. 400 words per page, the fitting and the lining up of the bearings for the vertical drive covers two pages. The bearings must be lined up extremely accurately, and the step-by-step procedure is very detailed.

As I could not possibly hope to cover all details I will confine my remarks to points of importance and possible help to would-be builders. The upper bearing is bedded in epoxy on the top of the fuselage, and in the absence of the suggested material for use as a gasket between the bearing assembly and the epoxy I used *Solarfilm*. When the epoxy seat for the bearing assembly is quite hard, we can mark the positions for the four Allen screws and blind nuts which hold this assembly secure.

The rear rotor assembly and its drive are the next parts to be fitted. A ply former is epoxied to the inside of the right-hand side of the fin, the tail rotor assembly is fixed in position by four self-tapping screws which pass through the fin and former and screw into lugs on the rotor assembly. The solid wire rear drive is now passed through the brass tube and checked for correct positioning to its fixing points at front and rear. The brass tube, when fitted, was not glued at the ends, but now, with the final drive lined up, the tube can be fixed with epoxy.

No less than six Allen screws at each end hold the rear rotor drive wire in position, a cut-out in the port side of the fin at the rear allows access to the Allen screws at the base of the rear rotor gearbox.

The instructions now advise the removal of the rear rotor assembly during the fitting of the wooden parts of the fin, and I have to confess that I did not do so. The rear rotor shaft has to be fixed at exactly right angles to the fuselage centre-line, and as the sides of the fin are flexible until the solid wood-work is fitted I felt it was advisable to leave the rotor in position to ensure the correct angle of the shaft. I can see no reason why not, as the epoxy used to glue the wood to the fin does not get near the rotor assembly, I do see, however, a risk that a twist to the fin could be built in without the rotor shaft as a reference. If the rotor assembly is left in, it should be wrapped to keep dust, etc., out of the bearings.

Forward again now to the main drive, note that the rear drive is now about to be covered at the front end by the large nylon gear and as the front of the inner wire of the drive has to be oiled every five hours flying we must either cut the brass tube off flush with the bulkhead, or do as I did, drill a small hole in it at this point in order to be able to get the oil onto the wire.

Now we fit the large gear to the vertical shaft. Only an idiot would do this before insertion of the shaft into its bearings, as the gear is much too large to go through the opening in the base of the fuselage without being tilted. So I removed the large gear from the shaft and started again inserting the shaft through its bearings the correct way up. Use the position of the holes drilled through the shaft to determine which end is which – top or bottom. The large gear is now pushed onto the shaft and clamped into position. The bolts which clamp the gear to the shaft have to be checked for tightness before each flying session. The small-bearing which holds the gear firmly in mesh is now repositioned and the gear is turned to check for smoothness and backlash. That small bearing holding the gears in mesh is adjustable to take up excess movement in the gears or to free the gear if found to be too tight.

The main drive shaft is hollow and through its centre passes the control rod of the collective pitch control. A large lever connected to a servo moves this rod up or down as required to give control changes. The lever can be seen in the photograph crossing the base of the large gear. The lever is pivoted at the end nearest the engine and connected with a bushed bearing to the base of the collective pitch control rod. The end of the lever furthest from the engine passes through the nylon moulding in the rear bulkhead into the rear compartment below the servo tray, and is connected by a short push-rod to the rearmost crank on the servo tray. The other end of the crank connects to the throttle servo.

The final adjustments to the collective pitch control linkage are made when the main rotor head has been fitted, and bearing this fact in mind I had left the bolts holding the control lever in position finger tight only, and just as well as it turned out, because when I turned my attention to the fuel tank, I found that I had to remove the lever and operating rod in order to get the tank into position. It is just possible I suppose to squeeze the tank in without damage, and no doubt someone will prove me wrong, but if you try it, I suggest having a spare tank handy, just in case. The Graupner tank sits very snugly in the corner, I have held it with one large rubber band only and think this will be enough. If it does break free it is not going anywhere, and can't get mixed up with the controls sufficiently to stop anything operating. The Graupner tank comes in kit form and holes have to be drilled

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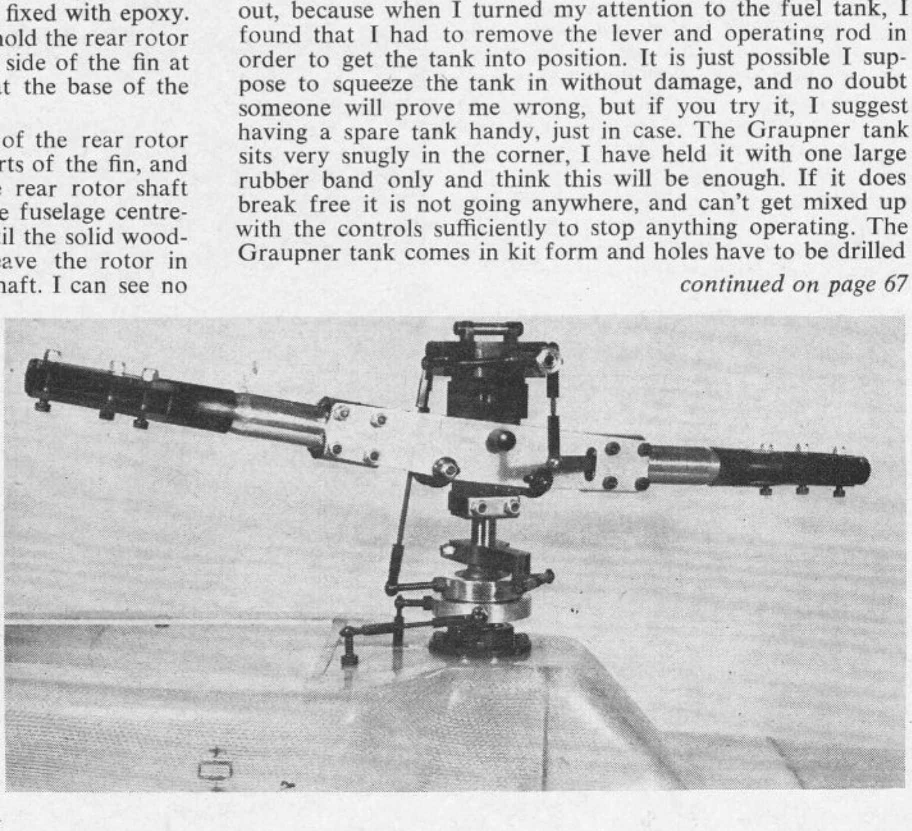

The main rotor assembly, less rotors, showing head and control linkages. An alternative set of bridge plates for the rotor head are available for training. These restrict control movement.

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in the base of the various outlets. I find it very difficult to ensure that all the drillings are removed from such tanks. A piece always seems to find its way to the jet at the wrong moment, for me anyway, so just as a bit of insurance I put a filter in the fuel line to the engine. The fuel line from the tank to the engine passes neatly through its own guide on the bottom of the drive shaft casing, across the engine and through a hole in the former to the throttle, the filler and vent tubes go to nipples fitted to the side of the fuselage just in front of the tank itself.

The engine silencer has now to be refitted (you won't get the power assembly into the fuselage with it in position by the way, so it has to be removed) and two holes have to be drilled in the fuselage sides in order to get at the bolts which hold the silencer in position. I had a bit of trouble getting one bolt in. I couldn't get my fingers round the corner, so used the old trick of holding the bolt to the screwdriver with a short length of fuel tube and pushed it through the side of the fuselage. The trick works very well, but have you ever had the tube stick to the bolt and not come away with the screwdriver? There is a first time for everything I suppose!

An extension is fitted to the carburettor needle, passing through the fuselage. A small brass nipple is supplied which is soldered to the needle, and a length of thin wire is then soldered into the nipple to complete the extension.

We have now finished at the base of the fuselage for the moment, and the next part to be fitted is the swashplate assembly which is slipped onto the top of the vertical drive shaft and positioned just touching the top of the upper bearing. The small push-rods which connect the swashplate control points to the servo tray cranks are now made up using the dimensions given on the plan, and all controls are connected in their approximately correct position. Final positioning can only be done with the radio gear connected and the rotor head and rotors in position.

I placed the main rotor head in position at this time for a photograph of the assembly but did not clamp it tight and removed it immediately after the photo was taken as it has to be balanced with the rotor blades after the blades have been covered and finished, before final positioning.

Care has to be taken when easing the main rotor head onto the shaft as a tilting plate in the head has to be correctly positioned to fit onto the top of the collective pitch control rod, the plate is secured in position with a bolt which passes through the rod.

The control for the rear rotor can now be fitted, the quicklink at the front of the Bowden cable has been fitted and the cable is now cut to the correct length and the rear quicklink added. The correct angle of the rear rotor blades with the servo centralised is shown on the plan, I resisted the temptation to give the editor a shock as the model left the ground on its test flight and connected the control as per the plan! The main parts of the mechanics are now in place, the rotors will be fitted after the blades are ready and balanced, and there are one or two small trimming pieces to be glued on. A plastic template is included in the kit to ensure that the rotor blades are set to the correct angle. The position of the swashplate can be adjusted by the push-rod adjustable quicklinks. I have oiled the rear rotor drive and replaced the undercarriage assembly and my part of this review is complete, apart from summing up as follows:-

I feel a little lost at this point. Is the model suitable for a beginner? Such is a very difficult question to answer. It's the first I've built, and I have not tried to fly one yet, so I will stay with the kit assembly. One need know absolutely nothing about radio control flying to build this model. The instructions are so complete and the plan so accurate, the parts so accurately cut, one would have great difficulty in making mistakes in the building. Even if you have no intentions of building one, do pop into the local model shop and have a look at the mechanics – the machining and accuracy really took me by surprise, I had genuinely not realised that progress with the model helicopter had reached this level. My last word is to the Editor, I accept your invitation to the test flights and as a sign of good faith will bring with me this small vital piece of metal I have removed from . . . (Could he be talking about the transmitter . . . Ed!)