(SIXTH PAPER)

The CHAIRMAN Our next speaker is Mr MORRIS, who has been concerned with the manufacture of wooden helicopter blades since 1937, and whose contributions embrace the supply of blades for the Cierva W 9 and W 11 Mr Morris will not read his paper but will give us a talk and illustrate his remarks with a number of slides Mr Morris would like his talk to be in the form of a " quiz " and he will welcome Members' interruptions when amplification is required of any of the points which he will make

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THE MANUFACTURE OF WOODEN HELICOPTER BLADES

By N B MORRIS

Our Company has been making wooden helicopter blades of different types since 1937 I want to tell you something of their materials and manufacture and would welcome questions in the course of my talk

Fig 1 shows a cross-section of the big Cierva blade as used on the W 11 This is monocoque construction Notice the centre of gravity of the blade and the incidence of the tip superimposed on that at its widest section

The main spar is built up at one-inch thick blocks of compressed wood laminated of 1/32 inch Canadian birch veneers bonded with resin film and pressed to about 2,000 lbs per square inch at 300°F The density is about 1 2

As a matter of interest, by laminated wood we mean that the grain in all the laminations runs parallel, whereas in plywood the grain of adjoining laminations is at right angles

In the first of these blades, which were 12 ft 6 in long, the spars were made in one piece, but it was later discovered that by using smaller pieces and building up blocks with scarfed joints, like brickwork, a better weight distribution was achieved and it was possible to localise weaknesses (Fig 2)

Once all these pieces are individually scarfed they are bonded together with a resin of the phenolic group Each of these sections is then weighed and you can get acumulative total balance which can be corrected by any of these individual sections, so that by having a batch of 24 blades you can get an accurate control of weight

After this the pieces are planed to a uniform thickness and then glued together on a very large surface table made specially for the job

There are essentially three types of root end fittings The screw type (W 11) the inverse taper cone (Fig 3) and the large laminated metal fitting of Mr Hafner's type (Fig 4)

At this point a number of questions were put to Mr Morris

Question Which do you prefer from a manufacturing point of view ?

Answer We thought the W 11 type for ease of construction Balance and stiffness are compared after checking length and incidence

The reason is that after you have made up the main spar you can then put on the root end fitting and you have a separate component One of the biggest advantages, if there are any advantages in wooden blades, is the fact that you can break it down into quite a number of separate components like the sectioned main spar and all these can be manufactured in separate places

Question Have you any tests on these root end fittings ?

Answer We have not made any ourselves, but I understand that Ciervas have

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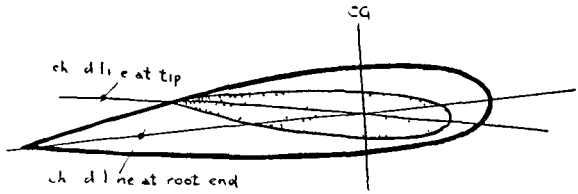

Fig 1
W 11 Section

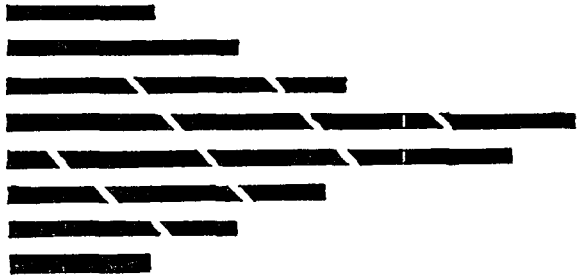

Fig 2
Bonding of laminated spar

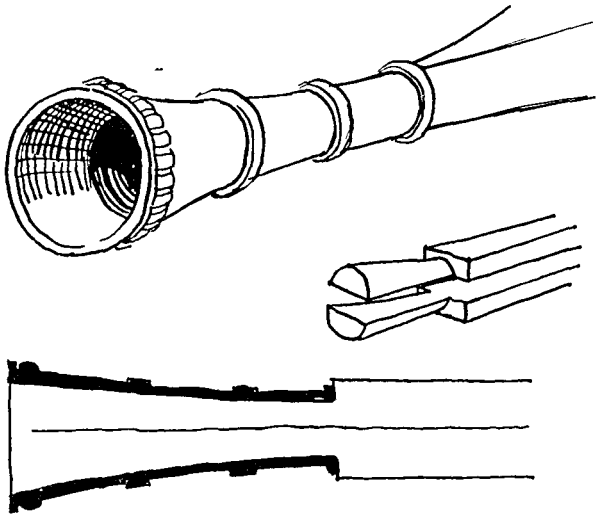

Fig 3
Taper cone type, root fitting

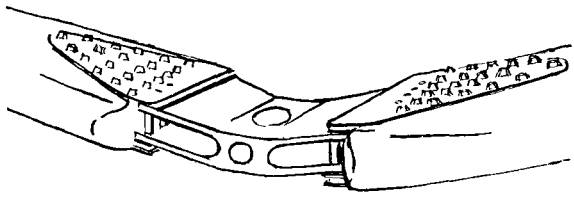

Fig 4
R 46 root fitting

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Question Can you tell us what sort of adhesive is used?

Answer One of the new resins, but aeroplane varnish is very suitable to use in the workshop It is all very well talking about high grade chemical adhesive but it is a different story when you have to use it in production on the workshop floor

The R 46 blade, had a laminated ash root, was 24 feet long, had spruce ribs and a typical aeroplane skin Fittings are steel plates—three at the top and three at the bottom—inserted in between the ash laminations at the root end

The flexibility of wooden construction is borne out by this case Pulling tests were carried out at Glasgow University The first test failed at 45 tons, and by the introduction between the laminations of a piece of Canadian birch veneer across the grain we secured the additional strength of 15 tons

In the W 11 blade, the outer skin laminations are 1/32 to 1/45 Canadian birch veneer running chord-wise The centre is eighth African Gaboon veneer running lengthwise These skins are made up in steam-heated moulds with phenolic resins

Question Have you tried the autoclave method of moulding them?

Answer We have very definite objections to the autoclave method It is less expensive for experimental work, but then you have proved something by a method which cannot be put into production

Question But it can be put into production

Answer We have an autoclave 40 ft long and 12 ft diameter which we scrapped about ten years ago I think there is very little that steam dies cannot do

Question It is the cost that I am thinking of

Answer I think it may be very misleading

As a production possibility the pure monocoque blade is definitely very suitable for quantity production

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(SEVENTH PAPER)

The CHAIRMAN, introducing the next speaker, said Mr KING has a very wide background of aeronautical experience ranging from lecturing to design and its practical applications He was with the de Havilland Co for some 21 years, employed in such capacities if Chief Propeller Designer, Chief Aircraft Stressman, and Chief Technician In more recent years Mr King has been devoting his energies to the development of plywood and composite structures using new synthetic resins His original contributions in this field are well known , also his activities as Technical Consultant to the Wood Development Co

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