The latter has some advantages in staggered machines, as it tends to reduce the torsion offset.

Spar joints to fuselage and top centre section are either plain butt joints or socketted, and present no difficulty except perhaps in providing sufficient bearing area for the bolts taking tension through the joint.

FOLDING WING JOINTS.—The design of joints for folding wings presents any amount of scope for ingenuity in order to keep the weight down. Compared to a non-folding job, the joints come out very heavy, owing to the whole weight of the machine having to be carried over the joint, and tensions and compressions of great magnitude also pass through, necessitating a good hold on the spar and an all-round robustness which is not called for when the inner lift wires are attached to the fuselage direct.

Ingenuity can be displayed in making the upper and lower joint parts as nearly similar as possible for economy in production, without wasting weight, and this is not simple, as the character of the forces present is quite dissimilar.

Joint fittings complete will weigh about 0.02 of the total weight of the machine per set, unless the interplane struts can be arranged to seat on the hinge pin, when a considerable saving can be effected, as then there is practically no bending moment to be taken over the hinge fittings.

It is difficult in a folder to arrange the inner end ribs to butt, and they must usually be placed clear of the main wiring lugs on the joint fittings, and the intervening gap covered by aluminium.

DISCUSSION.

The Paper was discussed by MR. W. O. MANNING, who touched upon the following points :—

Location of ribs, and attachment of fabric; deflection of ribs under unit load; wing hinge bending moment; possibility of fouling of elevator rudder; loading on bottom of hull; water absorption; invertion of empennage.

MR. TINSON'S reply to Mr. Manning :

I am afraid that my remarks re the location of ribs on one side of one spar were dictated more by practical than theoretical considerations. Some

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years ago I patented a method of attachment of the rib to the spar which enabled a good shear joint to be made each side of both spars in much the way that Mr. Manning has described. I had a piece of three-ply forming an angle between the web member and the spar, dovetailed into the web. Good shear joints were made between the rib and the spar. I found that the additional load which a rib would carry with that provision was enormous, compared with a rib fixed in the more usual way, but later I concluded that in a machine of moderate size (up to, say, 3,000 lbs. weight), the usual method of attaching the rib was quite sufficient, and by locating the rib on one side only, a lot of time was saved.

I am interested to know that it is necessary to attach the fabric to the flanges on the top and bottom members of the rib, in the case of big machines.

With regard to deflection of ribs under unit load, I am afraid that in order to get through in the time I have missed out much of the information I had down here, but amongst the things I have collated there is some data on the deflection of ribs under unit load, and, as Mr. Manning says, it is remarkable to what extent the rib does deflect in this condition, and that the change of section which this causes is a matter for consideration.

With regard to the wing hinge bending moment, I am afraid I failed to make myself clear. What I should have said was, that by placing the interplane strut on the hinge pin itself, the hinge fittings were relieved from considerable bending moment, and did not have to take the full weight of the machine across the hinge. Of course, the bending moment due to the continuity of the spar still has to be provided for in the design of the hinge, but by comparing a hinge in which the interplane strut is on one side of the hinge pin with a hinge in which it is on the top, it will be seen that much weight can be saved by adopting the latter method.

I am glad Mr. Manning has mentioned watching the point that the elevator rudder may foul. I had that point in my paper, but missed it out as I thought it too simple for a learned institution.

With regard to the loading on the bottom of the hull, I should like to explain that I believe the figures which I quoted were taken from a paper which Mr. Manning read before the Institution some time ago. I am almost sure that the figures which I give were extracted from a copy of that paper.

I should also like to expand a little on the question of pressures and the design of floats generally. The points regarding steps need very special consideration.

The step is usually built up as in flying-boat practice, that is, as a sort of wedge piece, fixed to the float bottom but separate from it in so far as carrying tension along the keels is concerned.

Buckling at the sides is a common fault, and I think is generally the result of inadequate bearing area at the strut ends in the frame, combined with perhaps a certain amount of permanent expansion due to the water absorbed.

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A small machine (say 2,500 lbs.) will absorb anything from 50 to 100 lbs. of water and oil the first time it goes out, irrespective of the water which gets into the hull or floats and can be pumped out again.

With regard to an inverted empennage, the idea at the bottom of this design was to make a clear line of fire for the guns, but it also has the advantage of lowering the tail float, and thereby increasing the stability of the machine on the water.

In proposing a hearty vote of thanks to Mr. Tinson for his concluding paper, the Chairman remarked that the lecturer had given the Institution quite a good testimonial when he said that he had quoted from a paper read before them, in order to find information for a paper on which he himself was an expert. The vote of thanks was seconded by Mr. Manning.

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