

## DISCUSSION.

MR. MANNING (Chairman) : I think we have seldom listened to a more interesting paper, and I am sure everyone must be anxious to discuss it. Will some gentleman, therefore, please open the discussion?

COLONEL BELAIEW : I have been very interested in this paper, and would like to say a few words regarding the first portion.

With regard to welding, of course, I do not know whether I am voicing the general opinion, but so far as I personally am concerned, I am very much in sympathy with the lecturer's remarks as to specifications. I would like to draw attention to some of the points that seem to be of particular interest.

Just before the War I had that experience with some particular kind of material which was not very much in favour, and, as I was able to discover afterwards, it was not because that particular kind of material was entirely unsuitable, but simply because it was not one of the standard products of the home market.

I am of the same opinion as Mr. Fokker, that once you have secured a good material, the welding itself can be done by ordinary and not necessarily skilled work-people; and I understand that the work-people become skilled very easily under guidance, so I quite realise that the thing of first importance is to get the right kind of material.

I am not quite sure whether we are unanimous as to what the right kind of material is, and whether we agree as to the specifications, but I quite see that once we have agreed upon and tested a certain material, the result, as proved by the lecturer, has been, and must be, a great success.

A most important question, of course, is to make the material in welding as homogeneous as possible, and this is more or less easy because there are certain processes of crystallisation which occur after the welding has been finished, so that, if we make quite sure that the crystals are more or less one into the other, then we can be certain that the material is at least as good as the other parts. The most important question, therefore, is to secure as far as possible that the crystals merge one into the other. If you know that trick, then, of course, you are quite all right. That trick is acquired by long experience, and I am not quite sure that it is so easy as has been stated by Mr. Fokker.

MR. S. G. WILLIAMS : To prevent our all going home to-night feeling that welding is re-established as the right thing in aircraft design, and looking at some of the diagrams which we saw, it surely must have been evident to one or two of us that welding as applied to those designs presents certain characteristics which we do not consider desirable in an efficient weld,

and which are largely due to the microscopic structure of steel. We also saw what appeared to be a much lower kind of material showing considerable crystalline formation.

Re tubing, Mr. Fokker refers to "the proof of the pudding being in the eating," of course, sometimes "necessity is the mother of invention," and though you may maintain the establishment of a particular material, yet it is often the design that permits it, and the design we have been shown this evening is a design which has permitted a particular type of construction that will not always be available to all designers. That is the point we must keep in mind.

DR. THURSTON: I have been very greatly interested in hearing this valuable lecture of Mr. Fokker's.

It is a happy augury for the future that our relations are now of a saner nature, and that it is possible for us to meet Mr. Fokker and admire his many British qualities of perseverance and grit.

He has demonstrated in a very clear way the importance of metal construction, and the value of welding if used with discretion and sure knowledge. I should like to ask Mr. Fokker the following questions:—

- (1) How much cold working was left in the steel tubes?
- (2) Did he use a low grade carbon steel for his tubes?
- (3) Was there a large amount of impurities, such as phosphorus or sulphur, in the steel used for the tubes?

I am a strong believer in the possibilities of metal construction, not only for the bodies of aeroplanes, but also for the wings. By a suitable use of tubes or sections of tubes built into a scientific structure it appears to be possible to make metal wings quite as light as wooden ones, with the added advantage that they will be more durable.

Although there is a considerable prejudice in England against the use of girders built up from welded tubes, the practice was adopted quite early in this country. Sir Hiram Maxim, for instance, in his first flying machine, built between 1891 and 1894, used such girders for carrying the platform of his machine. When this machine crashed in 1894 it behaved precisely as shown in Mr. Fokker's photographs, namely, the sections doubled up but remained intact and capable of carrying load. That is a most important and valuable property of metal construction.

MR. FOKKER, in reply, said: Re material, our experience was that the materials which were from specifications which were of high quality were usually not very good for welding, the ordinary material giving much better results. After I came to Holland our Dutch Government gave me some special English specifications. We used them for tubes and found we got many difficulties with this very good material. We therefore gave the matter our careful attention, and found that the German materials we got were very much better, and we had no difficulties.

During the war it was very difficult to get enough tubes which were cold-

drawn and seamless, so after numerous tests we were permitted to use welded tubes with a seam, though at first in Holland, all these tubes with welded seam were absolutely forbidden, as they were considered dangerous. After successful tests they were used for two years, and employed on 8,000 machines during the war. It was finally proved that tubes with a welded seam were much better than the other kind.

Regarding skilled labour, as you say, in a few days they become skilled, that is, if they have the ability to learn welding; but if they have not learned it in three or four days, then they cannot learn it at all, for it can really be learned in a few hours, and you can soon tell whether they have any feeling for it. During the war we had no difficulty at all with welders.

Regarding crystals, that was specially the result of tests which were made by the Dutch Research Department of our Government, and it has been proved by numerous welded joints that they show up in new joints.

We found some joints which were not welded without mistake, but the mistakes were so small that it could not be of any influence on the strength of the whole joint. In good welded spots particularly you always find spots which are not absolutely clear, but after microscopical research it is found that generally the material goes in very well.

With regard to Mr. Williams' remarks. I should like to say that a point I mentioned in my lecture was that the main thing is for a constructor to use good construction, for without good construction, the system of welding cannot be employed.

With regard to Dr. Thurston's remarks, I would only like to say that this composition was determined in America from a D.VII machine which was built in Germany, where we had no better material, and had to use this. From this material we have built 8,000 machines. We used it during the war and we got our difficulties, but our Military Committee had given a special specification, and we were forbidden to use this and that.

MR. MANNING (Chairman): It is my very pleasant duty to propose a very hearty vote of thanks to Mr. Fokker. I do not think we have ever had in England papers of greater interest, and of especially great interest because they deal with methods of construction which are completely taboo here. If one showed designs of the sort we have seen to-night to Government departments in England, I am sure they would be shown out of the building.

We have seen, however, that machines can be constructed in this way, and whether we use that construction or not, we shall leave this hall considerably wiser than when we entered it, and this is entirely due to Mr. Fokker. It is a sign of the times that Mr. Fokker can come over here and read a paper of this type, and we owe him more than we can adequately express in the way of thanks for his kindness in doing so.

The vote of thanks was passed with prolonged applause, and after Mr. Fokker had briefly responded the meeting closed.