

In order to be in the fashion, suitable Oleo Compression Rubber Under-carriages have also been designed. One of these is a very simple adaptation of the standard undercarriage, and the other is an entirely new design (see Fig. 30).

In conclusion, I desire to thank you for listening so patiently to me, and I sincerely hope that my paper has been of some interest. If any members of the audience would like to ask any questions I shall be very happy to answer them to the best of my ability.

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### DISCUSSION.

MR. A. V. ROE:—I think that speaking is one of the most unpleasant things to do. I did, however, jot down one or two points which I wished to mention.

Mr. Parrott did not explain why we adopted the rather unique under-carriage, which was one of the special features of the Avro.

The principal object of the long, single skid was to assist the machine when landing on rough ground, and it also provided an anchorage for the diagonal towing cables to the axle, which prevented long grass from lapping round the axle and tending to turn the machine on its back; a type of accident which was often experienced with the light machines in the early days of flying. These wires acted as a sort of guard or plough and enabled landing to be made in very long grass or standing corn without unpleasant consequences.

It may interest you to know how the number 504 was arrived at. We built twenty-two aeroplanes and seaplanes before commencing to number each different type. When we produced our military two-seater we decided to call this Type 500. The selection of this high number was really a piece of drawing-office "swank." The 504 was the fourth of this series. The machine was not given a name, as is usual in these days, but was merely referred to as the 80 h.p. Avro Biplane, and, later on, when it became necessary to have a more exact identification, the drawing office type number 504 was adopted.

During the time when this machine was being designed and produced, I lived in diggings close to our works at Manchester, and this enabled me to amuse myself in the evenings over the drawing boards. It gave me an opportunity of looking very closely into things, etc.

I was very fortunate in finding Mr. Parrott and Mr. Chadwick, both of whom very materially assisted me in the production and design of the Avro Training Machine. Mr. Parrott came along as the result of an advertisement in "The Engineer," in 1909, for an aeroplane draughtsman, with no salary to commence. About this time my brother joined us and assisted in financing the undertaking, and Mr. Parrott soon had a salary.

Mr. Parrott has dealt very fully with the history of the machine and has really left me nothing further to say.

MR. MANNING :—I am sure we have all found it of very great interest to have such a complete and well-illustrated account of the Avro Training Machine. It is remarkable to think that many of these machines, which were built in 1912 and 1913—12 years ago—are still in good condition. One wonders how many aeroplanes of modern design would last so long as that.

There is a point that keeps occurring to me, and that is, how very modern some of the earlier machines were. Probably the aeroplane of to-day is better in some respects, but then, of course, we had the monoplane, which shows to a large extent how little we have advanced in aeroplane design. If you consider the advance in the motor-car, or motor-bicycle, or other mechanical means, you will find that the advance in the aeroplane seems to be slight.

It is of very great importance to have had this lecture, because the evolution of this type is really the only method which has produced a really satisfactory aeroplane. We are all very much indebted to Mr. Parrott for this very interesting paper, covering a most important section in the history of the aeroplane.

MR. H. V. ROE :—I have nothing much to say, except with reference to Mr. Manning's remark that we have not advanced very much in design since the war, and I think that a great deal of this is due to lack of competition. We made our progress at the beginning because we had a very hard tussle, and we had to work very strenuously to get any recognition at all. I think we have now reached the stage when we are satisfied with what we have done. I am out of the business now, so I am speaking without personal bias, and may be allowed to say that I do think the industry is suffering from the fact of looking to the Government for subsidies, instead of standing on our own feet, as we did in the early days of the pioneering struggle.

It may be interesting as an example of the opposition one had to meet in the good old days, to recall that at the beginning of the war we were instructed that we should have to give up making Avros as they were now out of date, and to make B.E.s instead. Pending arrangements we could continue making Avros to existing orders until instructed to make B.E.s. Finally, however, we were told to complete the orders then in hand, and, as you know, ultimately we never made B.E.s at all, but made thousands more Avros; in fact, the demand for this "condemned" machine was so great, that, as Mr. Parrott has mentioned, we had 18 other firms making for us.

CAPTAIN SAYERS :—I have been extremely interested in hearing about the Avro 504. For some reason I was late in arriving, and so missed the early part of the lecture, which I feel sure was of special interest.

I should like to dwell to some extent on the fact as to the relatively slow progress of design which is shown by this particular lecture. This slowness extends to well over twelve years; because in essentials, the 504 of to-day differs about as much from the original 504 as that type did from the 1911

60 h.p. E.N.V. biplane. The 504 Avro was always extraordinarily good, and there is no machine to equal it in its own field.

To design an aeroplane of a distinctly novel type is a very dangerous proceeding. I think that so far as the war period and four or five years after is concerned, our problem was not so much that of taking an enormous step forward, as to consolidate the position already won, and not to take undue risks with hazardous, experimental machines. I do think that we have now arrived at a time when we have got once more to take risks in designing novel types of machines. If we do not, we may find in another 12 years, that the 504 Avro still represents the best of training and light commercial machines. I think that we may probably look to Mr. A. V. Roe, whose experimental ardour did so much to develop our present type of aircraft, to again start experimental work with really novel types.

Mr. Low :—It is rather interesting to hear the remarks regarding the slight development in design recently, and also the suggestion that the industry in general is looking to the Government. I think that that is really responsible for a good many of our troubles. The old spirit that used to be so marked at Brooklands seems to have died nowadays, and it is very rarely that one meets anybody with any desire to bring something new out, for the sake of aviation alone. I am afraid the Light Aeroplane Club Movement will not help us much; its present trend of development will place it out of reach of the very type of members for which it was inaugurated. If only we could get back to some of the old Brooklands days, with its whole-hearted, though independent enthusiasm and rivalry, we should learn very much more in a short space of time. We have not gone very far in design and construction since 1918. The progress made has only resulted in more expensive structures and costly power-plants.

Another thing is the great tendency to clap on power. We are not now getting anything like the performance we had before the war. There, again, more or less slight efforts would develop a light aeroplane, larger than spending a great amount of money on large machines and engines. We are only following a blind alley in clapping in these large engines.

∴ I should like to ask the lecturer why the 100 Mono is considered the best type for training purposes. I do not like the Mono; it is more costly in fuel consumption than many others.

FLIGHT LIEUT. WHITWORTH-JONES :—I have had the honour of belonging to this Institution for four years, but this is the very first meeting I have been able to attend.

Mr. Roe said he would like to hear some remarks from dissatisfied pilots. I don't think there are any such people, as far as the Avro is concerned. Most machines have some little snag that pilots love to grumble about, but I have never heard anyone say a word against the Avro, which has always been known by pet names, such as "The Avroid," presumably because it is the best of flying tonics.

A few little peculiarities of this machine, which I have noticed, may be of interest :

In Egypt, where I have been for some time, the wheels of the undercarriage are always put on the wrong way round ; this has the effect of widening the undercarriage somewhat.

Another point is the question of the fuselage cover. The bottom of the fuselage gets very oily and soon accumulates a considerable amount of sand, which rots the fabric in a short time. As the fuselage cover is made in one piece, this involves the replacement of a complete cover. I would like to suggest that it might be more convenient to make the bottom panel of the cover separate from the rest.

Another point of interest is the development of a violent vibration in some machines, particularly those machines used by inexpert pilots. The vibration was noticeable after several bad landings had been made. The machines did not seem to be damaged by the rough treatment, except that a broken tank strap was always found to be associated with the vibration.

On replacing the broken strap and tightening up, the vibration disappeared, but as the straps were continually breaking, we tried replacing them with slings made up of two lengths of 20-cwt. cable, placed inside a piece of old, petrol-resisting rubber tubing. Cable was used to give extra flexibility to the slings, the double width of heavy cable giving a wide bearing surface. The rubber tubing was used to prevent the cable cutting into the tank. At first we only replaced the bottom straps in this way, as they were the ones that always broke. We then found the top straps breaking, so we replaced the whole lot with cable. We found that this effectively stopped the vibration and kept the tank rigid in the fuselage.

I would like to thank the lecturer very much for his very interesting paper on a machine which all pilots love.

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#### MR. PARROTT'S REPLIES TO THE DISCUSSION.

MR. H. V. ROE :—I cannot agree that there is insufficient competition in the Aircraft Industry. There are a considerable number of aircraft establishments and there is sufficient competition among them to give a healthy stimulus to design.

I will agree that very few machines are designed and built speculatively now, and I think this is due to the cost of the modern methods of construction and the difficult regulations covering the approval of new designs by the Airworthiness Section of the Air Ministry.

CAPTAIN SAYERS mentioned that the 504 K. may still be a Service machine in twelve years' time. We sincerely hope it will be.

MR. LOW asked why the 100 Mono should be considered a better engine for training purposes. Our experience with various rotary engines is that the 100 Mono is more satisfactory because it has only one control—one lever

to push forward, like turning on a tap. It is possible to so arrange the needle valve controlling the petrol supply, that it is impossible to choke the engine. With the 110 h.p. Le Rhone and 130 h.p. Clerget, there are two controls, one a throttle and the other a mixture regulator.

We find that new pilots show a tendency to choke the engine by giving it too much petrol, and so get into difficulties when taking off. We feel that, so far as a training machine is concerned, the engine should be as fool-proof as possible, and the pilot should not be saddled with the problem of actually regulating the engine, but that it should be possible for him to devote his whole attention to the control of the aeroplane. Another objection to the 110 h.p. Le Rhone and 130 h.p. Clerget engines, is that that larger size engine increases the torque reaction and gyroscopic effects on turns, and it tends to stiffen the controls up too much.

LIEUT. WHITWORTH-JONES' point with regard to the fuselage was interesting. On most of our machines we now dope a strip of material over the lacing under the fuselage, and this prevents sand, dust, and oil, etc., being blown into the inside.

With regard to engine vibration, I cannot quite see how the failure of the tank's straps should be the cause of this, but should rather have thought that the tank's straps failed as a result of vibration. I suppose the true reason is slackness in the rear support of the engine. In the 504 K., in order to deal with a range of rotary engines, we devised a system of adaptors to bring the attachment points up to the same dimensions for each different engine. The adaptor on the rear support takes the form of a collar screwed on the crankshaft. In course of time a certain degree of slackness eventually creeps in, and this will cause vibration.

Another frequent cause of vibration is lack of balance in the engine itself. Where old engines are employed various parts will have been changed from time to time, and unless the greatest care has always been exercised in selection of new parts of the same weight as the parts being replaced, the engine will quickly develop roughness.

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A very hearty vote of thanks to Mr. Parrott for his interesting lecture brought the meeting to a close.

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#### CAMBRIDGE UNIVERSITY—BUSK STUDENTSHIP.

The attention of members is drawn to the fact that there is a vacancy in the Busk Studentship in Aeronautics, and particulars may be obtained from Professor B. M. Jones, Engineering Laboratory, Cambridge. Final application must be made before May 12th, 1925.