DISCUSSION.

MR. OSWALD: Permit me to express my appreciation of the trouble Mr. Simmonds has taken in writing this paper, and especially to thank him for such a useful appendix.

Under the heading of Structure Percentage Weight, in considering future all-metal seaplanes, Mr. Simmonds gives the figures 38 to 40 per cent. I think we are justified, even from present experience of such metal machines, to put the figures at 37 to 39 per cent. This will give you an extra passenger in a 13,000 lbs. machine.

With regard to the choice between twin outboard and tandem engines, admitting Mr. Simmonds's arguments, there is one more point in favour of the former, namely, the superior water manœuvrability.

I agree with the lecturer in giving the palm for seaworthiness to the flying boat with wing tip floats. Continental designers, in my opinion, have sacrificed some of the important quality of seaworthiness in an endeavour to approach to the semi-monoplane wing structure.

The number of variables governing porpoising in a machine taxying at sea are such that, if any machine lays claim not to porpoise under any circumstances, then in my opinion it has been more good luck than good judgment.

As regards secondary buoyancy, in the case of the rigid metal hull, cross bulkheads are the simplest and cheapest method of obtaining the buoyancy.

Under airworthiness, Mr. Simmonds gives a volume co-efficient for fin and rudder. If the divisor 2 had been omitted, the co-efficient .05 would have been obtained, agreeing with that recently recommended by Professor Melvill Jones, of the Advisory Committee for Aeronautics.

An adjustable tail plane is very necessary. The Chairman now has a patent mechanism under test, which will prove a great boon to flying boats.

The thanks of the flying boat industry are due to Mr. Simmonds for clearing up the apparent poor efficiency of the flying boat, as judged by figures given by Sir Sefton Brancker.

The examples showing the improvement obtained in paying load per H.P. and percentage of total weight by the use of air-cooled engines are very illuminative, and emphasise the value of the lecturer's paper.

The liability of the engine mounting to vibration while the engine is running all out during taxying, is a very difficult matter to cope with. Fittings with a factor of safety of from 10 to 20 sometimes fail. The only

plausible reason for such failure is vibration.

CAPTAIN F. J. BAILEY: As a pilot engaged since its inception on the only civil marine air route in the United Kingdom, I should like to say how cheering and encouraging it has been to find someone with such faith in seagoing aircraft, and who possesses such an intimate knowledge of what one imagined to be the secret trials and tribulations of the crews of sea-going aircraft.

Mr. Simmonds has quite rightly placed seaworthiness as the first essential of a civil seagoing machine. I should like to point out, however, that there never was a more misused term. The boatmen on Bournemouth beach assure one that their row boats are "seaworthy" craft, and this, I regret to say, is the type of seaworthiness of many marine aircraft. In my way of thinking, an aircraft is not seaworthy if it cannot be sat down on and continue to float and taxy, right side up for several days, in any sea produced by weather conditions in which it can safely fly.

I have known aircraft fly between Southampton and Guernsey with such a sea running in the Channel, that had a forced landing occurred, no motor boat—unless it be a motor lifeboat—could have attempted a rescue. Only a few marine aircraft within my knowledge would have been seaworthy under such circumstances, and I am glad to be able to say that those few are flying boats of British manufacture. I know of none of foreign make that would have stood a chance. In our idea of a seaworthy aircraft we are, I think, supreme, and this should be all the more encouraging when we remember the point brought to light by our lecturer, that our flying boats are really amphibians, and that we have yet to see the first purely commercial flying boat built in this country.

Another point which I think needs stressing has regard to our civil marine route. I refer, of course, to the ridiculed Southampton-Guernsey line. Owing to the irregular service maintained and the poor traffic returns, the idea has sprung up that a flying boat route is a farce. The facts need considering. Firstly, Guernsey is not an ideal place to operate to—a small island with no large and densely populated hinterland to draw traffic from, situated in a gulf open to the prevailing wind, which is deflected by the high land of the French coast, causing fog, precipitation and unstable weather conditions. Secondly, the aerodrome consists of a small harbour (half dry at low tide) which offers poor shelter and a rock strewn tract of water perpetually surging in unison with the Atlantic swell, across which—at times—an 8-knot tide rushes. It needs little wind to beat this area up into a state to be dreaded by airmen.

There have been many days when the flying boat left the harbour unescorted, as no motor boat would go outside, when onlookers on the quays lost sight of the machine in the trough of a sea, and when passengers soon realised that flying was not all gliding sensation, and never repeated the experiment.

I can assure anyone who doubts the sea-going aircraft's ability to succeed, that the Southampton-Guernsey service would be as popular a service as any run by Imperial Airways, if the aerodrome conditions were

similar at Guernsey to those at Southampton. If a service must be run to such a place I submit that the aircraft must be much bigger than the seas it is expected to take off in. One could not run a regular Dover-Calais steamer service with a steam pinnace, and I am convinced that the secret of commercial success with sea-going aircraft is in the use of bigger machines.

For this reason it will be interesting to watch the Swan's behaviour, when she is operated on the Guernsey route.

Finally, I suggest that the future of our commercial aviation lies in overseas routes, on which, as the machines grow bigger, it will be more economical to use boats which float at a mooring when idle, and need no special aerodrome, instead of aeroplanes which require special aerodromes, and will probably be limited in size by undercarriage difficulties. In fact, it is just possible that our children's children will think it funny that in grandfather's time the air liners had wheels.

CAPTAIN SAYERS: I am very glad that Mr. Simmonds has dealt so fully and so soundly with the much neglected subject of seaplanes and their transport possibilities.

There are one or two points on which I should like information. Mr. Simmonds seems satisfied that the all-metal seaplane is now proved satisfactory, and is ready to supersede the wooden type for all purposes. The seaplane of the future undoubtedly must have a metal hull, but is any metal hull yet produced proved to be a practical proposition?

The one difficulty is corrosion. I have been told on good authority that any reasonable duralumin hull can be relied upon for eight to ten months without any sign of corrosion worth mentioning. But after this comparatively short period corrosion begins to appear at a rapidly increasing rate, and when this state of affairs has begun, the maintenance of such a hull becomes prohibitive.

It is well known that the products of corrosion are invariably excitants of further corrosion. Duralumin in the clean state corrodes very slowly, but apparently as soon as corrosion in any appreciable degree has occurred the process is greatly accelerated. This, if it is the fact, means that in a duralumin hull corrosion must be prevented almost completely. Paint and varnish are to some extent protections, but no paint or varnish is completely impermeable or free from the liability to scratching or other mechanical damage. And it is very difficult indeed to ensure the maintenance of such a protection across joints in the hull plating, etc. It is in such places that the initial signs of corrosion can usually be first seen.

If my information as to this experience with present hulls is accurate, the present type of hull is not a practical proposition for any purpose. A hull is far too costly to be scrapped after a year or so of life, and methods which will more effectively protect the light alloys must be found before the metal hull can supersede wooden ones—great as the defects of wood hulls are.

Corrosion of a type which is thus accelerated by the presence of corrosion products must, I fancy, be mainly of an electrolytic nature. Protection

against such corrosion can be attained by keeping out any possible electrolyte. All the protective coatings in use are, I believe, to some appreciable extent permeable by water, and hence fail in this respect. They are also usually fairly easily damaged by scratching.

It seems possible that if a thin uniform coat of a suitable metal could be applied over the whole hull after construction, which was in intimate contact with the hull itself throughout, and was unbroken across any of the joints in the hull, a very considerable degree of protection could be obtained. Aluminium alloys are difficult to electroplate, and in any case a complete hull could scarcely be subject to electrical deposition. The possibility, however, of applying a metal-spraying process seems worthy of investigation. The process is carried out with a spray-pistol, using an oxy-acetylene flame, and produces a coat of .001in. or less, which apparently makes perfect contact and adheres most tenaciously to the metal to which it is applied. Such a coat would be electrically continuous, and could easily be renewed at frequent intervals. Scratches, etc., would penetrate it, but re-spraying damaged parts of the surface would present no difficulty, and, unlike any method of painting, will apparently ensure complete cleanness of the surface sprayed.

I would most strongly support Mr. Simmonds in his protest against the neglect of the seaplane for transport services. When in the future the history of the earliest efforts to develop air transport comes to be written, it will appear almost incredible that this country, surrounded by water as it is, should have attempted to operate land machines of singularly small reliability over densely populated districts with a filthy climate and microscopic facilities for landing, in competition with highly developed railroads, when we might have run seaplanes over continuous landing surfaces in competition with slow steamers. The explanation is, of course, that aviation is completely in Government control, and that Governments of the type now in existence are constitutionally incapable of any but the wrong action.

MR. F. L. WILLS: I did not come here with the intention of making any remarks, as I am little concerned with the technicalities of construction. Mr. Simmonds, in dealing with the Commercial Development of Marine Aircraft, has, in my opinion, omitted to mention the future of Aerial Survey Photography. In Canada, a considerable amount of survey work has been undertaken, for which flying boats and seaplanes are used. In connection with the Irrawaddy and British Guiana surveys, here again the seaplane had to be adopted, as rivers provided the only means of landing, the country itself being chiefly covered by dense forests.

There is little doubt that where air survey is concerned with the mapping of unexplored territories, marine aircraft must be used. Constructors, I think, can in the near future expect to be building aircraft specially designed for air survey work, and eventually the proportion of such machines built should be even higher than passenger craft—of course, as regards the marine side of civil aviation only.

MR C. G. COLEBROOK: I have been very interested in the paper, but one statement has particularly caught my attention. This is with reference

to the time when a flying boat of 50,000 lbs. will be in existence. I have worked this out at about 22 tons gross weight, and if it is assumed that the engines used would carry 16 lbs. per horse power, it means that something like 3,000 horse power would be required. I do not quite see how that total horse power is to be realised. There is a Beardmore engine now in existence which develops 1,300 h.p., and if three of these were used the total horse power would be 3,900, which would be in excess of requirements. If Mr. Simmonds has any information as to the possibility of building an aircraft of that weight with any commercial prospect before it I should be glad to hear more about it. Is it practical at present to develop the flying boat to anything like that point?

MR. LANKESTER PARKER: I should like to thank Mr. Simmonds for his reference to my firm, and I feel glad that the flying boat has not been neglected.

Re criticisms on porpoising, I believe it was said that the passengers would get more fore and aft movement in the twin float seaplane than in the flying boat, but this should not be so if the passengers were seated about the centre of gravity. It is often said that, due to porpoising, a machine is liable to leap into the air before flying speed has been attained. I have flown many seaplanes, and some have done this at a speed dangerously near stalling point; otherwise I cannot see how this condition could possibly arise. With regard to the stability of the seaplane and flying boat, no really large twin seaplanes have been made—making comparison very difficult. Take the case of the old 320 h.p. Sunbeam Short Seaplane. This machine was loaded to 22 lbs. per h.p., and was at least as seaworthy as an equivalent size and loaded flying boat. Why should not the comparison hold good in larger sizes?

MR. MANNING (*Chairman*): There are one or two general comments I would like to make on the paper.

I quite agree with metal hulls. With regard to the large hulls, whether they are in metal or in wood they give trouble—the joints are not satisfactory. Although boat building has been going on for thousands of years, yet no solution has been found. With regard to duralumin, one can make a very satisfactory joint with riveting. Duralumin is a ductile material, and a small blow would only make a dent, and, of course, a dent would be of very little importance.

I notice with some little surprise the differences in weight of a biplane and a monoplane. I think that the lecturer will find that the biplane is lighter. It is very difficult to cut down the weight of a monoplane wing to equal that of a similar biplane.

There is one other point I would like to make, and that is, I would like a definition of what he actually means by "paying load." He mentions this many times without an actual definition. If petrol is included in the paying load, then the range must be taken into consideration.

MR. SIMMONDS'S REPLY TO THE DISCUSSION.

I must say it has been a great source of pleasure to me to see so many eminent people here to-night expressing their faith in marine aircraft.

I do think that from the civil point of view the flying boat has been greatly maligned, and if this paper and the information in the Tables does anything to counteract this misrepresentation, I shall feel well satisfied.

Perhaps I may now reply to the various gentlemen as they have spoken.

Mr. Oswald mentions a 37 to 39 per cent. Structure Weight for an all-metal flying boat. If he will refer to my Table he will find that the structure weight of the Rohrbach is 38.8. Does he definitely know of a lighter structure weight than that?

MR. OSWALD: Well, at present we have a hull that has a weight of 38, and we think also that we could get it lighter, therefore I have put 38 as the top figure.

MR. SIMMONDS: I am very pleased to hear that already in this country we have got so low as 38 per cent.

I think, however, that there has been a surfeit of unwarrantable optimism in this matter. Our experience in wooden hulls and structures has enabled us to effect progressive reductions in structure weight and in the same manner we shall be able to reduce the per cent. structure weight of all-metal aircraft. But this will take time, and we shall do best by not exaggerating the immediate gains in weight which will accompany the replacement of wood by metal.

With regard to the fin and rudder volume, I might well have omitted the 2, but I am in the habit of dividing by the span, and hence in writing this in the conventional manner " 2s " I retain the 2 in the denominator. I feel, however, that this is preferable to halving a co-efficient which is already in fairly general use.

This paper was already in print before I read Professor Jones' recommendations on this matter, and I was thus gratified to know my suggestions here had his approval. There is one possible line of argument arising from Professor Jones' recommendation which I should like to forestall. It may be argued that because seaplanes in the past have carried more fin area than landplanes, that for the former a higher co-efficient than .05 should be insisted upon. This is, however, quite fallacious. Because the landplane has in the past been under-finned there is no reason for applying a similar corrective in the case of the seaplane, which in this respect has not greatly

sinned. As a general rule seaplane designers do not have fin and rudder co-efficients less than .025 (my definition), and it is sincerely to be hoped that a higher co-efficient for seaplanes will not be inflicted upon us.

I am very pleased to see Captain Bailey here to-night; the present deplorable state of British civil marine aviation which his first hand account reveals becomes the more unsatisfactory when considered in conjunction with his reasoned and practical faith in the flying boat as a commercial craft.

I was much interested in Captain Sayers's remarks on corrosion. It is quite true that there are aluminium alloys which corrode at an alarming rate, but duralumin is not one of these by any means. With a number of Captain Sayers's opinions I cannot agree. He is incorrect in thinking that the products of corrosion are invariably excitants of further corrosion. The only product of the corrosion of duralumin is aluminium oxide, and this is inert. Nor do I think he is right in stating that corrosion accelerates.

With regard to paints and varnishes, it is true that none is yet perfect, but to state that no paint or varnish is completely impermeable seems too sweeping, for several of them do give very good service.

At least one protective coating is completely impermeable, and that is aluminium oxide anodically deposited on the surface.

The spraying of a metallic coating is unfortunately unsuitable because all metals resistant to corrosion are electro positive to aluminium, and hence would accelerate corrosion.

I am happy that corrosion is not nearly so serious in practice as theory might indicate, and there are duralumin hulls still in use which have given several years' good service, and are likely to give many more. It must be admitted, however, that we still have much to learn with regard to the corrosion of duralumin, and it is to be hoped that scientific research in the problem will continue.

With regard to Mr. Wills' observations, I am sure we all agree with him that aerial survey offers a most important sphere of utility to the seaplane. In order to deal adequately with transport seaplanes I have been compelled in this paper to avoid reference to all other special civil types. Seaplanes, however, have already done very good survey work in many parts of the world, and will continue to do so.

I have no hesitation in saying, in reply to Mr. Colebrook, that were there available to-morrow an order for a 50,000 lb. flying boat, there would be no dearth of designers or constructors both competent and willing to carry the work through.

With reference to the question of power units for such a boat, this could be solved in several ways. Two possible arrangements come to my mind, either four Rolls-Royce Condor or six Bristol Jupiter engines.

Captain Bailey's experience has shown that we must have bigger flying boats before we can tackle the sea under its worst conditions, and thus it should be one of the aims of designers to effect progressive increases in the size of their marine aircraft.

When Mr. Lankester Parker states that no really large twin float seaplanes have been built, he is almost admitting the comparative inefficiency

of this type in large sizes. The Junkers G.23W. weighs about 12,000 lbs., the Farman Goliath 12,800 lbs., and I shall be very surprised if much larger float seaplanes than these are ever built. Compared with flying boats of the same size they have poor seaworthiness, and, in addition, large structure weights.

The question of the behaviour of a float seaplane whilst porpoising is a very interesting one. Mr. Lankester Parker assumes the centre of gravity to have a steady forward velocity, but I think he will find that actually it suffers severe accelerations and retardations. The nearer the passengers are to the planing bottom the happier they are likely to be. There they suffer only the linear accelerations and avoid those due to pitching.

So far as wooden construction is concerned, Mr. Manning is probably right that the biplane is lighter than the monoplane. But for monoplanes wood is not an efficient material, and I do not consider such a comparison fair or useful. The metal wing monoplane, however, can hold its own against any biplane of equal aspect ratio.

Paying load is revenue load, and thus cannot contain fuel. Nor for the purposes of the Tables does disposable load contain fuel—the disposable load for a given flight includes crew, equipment and paying load, which are literally at the disposition of the operator. With regard to the quantity of fuel, however, he has no option. It is a function of the aircraft. (See also " Notes on the Tables (5)," page 25.)

Perhaps I may repeat that the basic feature of the Tables is that an endeavour has been made to put all the aircraft on a truly comparative footing by selecting a given range, 300 miles, and evaluating the disposable and paying loads. In addition the decrease in these loads is indicated for each 100 miles increase of range.

I feel there are many who will disagree with our Chairman in his statement that the joints in large hulls are unsatisfactory. Possibly he is hard to satisfy, but from my own experience the joints in the larger hulls have not caused more trouble than those in the smaller, and in neither case, with modern methods, do serious difficulties arise.

In conclusion, I should like to thank you all very much for your presence here to-night. We are agreed that the flying boat has a vast future before it. To many a nation it will become a valuable asset; to us, as an island and as an Empire, it is already a positive necessity.

A hearty vote of thanks to Mr. Simmonds for his extremely interesting and valuable paper was passed unanimously, and the meeting closed.