

## DISCUSSION.

COLONEL MOORE-BRABAZON: This has been a most extraordinarily interesting address. Commander Burney is going to give us other lectures on airships on future occasions, for I feel that an hour is much too short a time in which to deal with all his problems.

Commander Burney, being an old sailor, looks at his airship with salt spray in his eyes, but I look upon it as divorced from war and as a commercial proposition. I grant that at times it should come into co-operation with the Fleet or Army as a carrier of squadrons, but I think it wiser to look upon it from the commercial point of view.

There are one or two points I should like to mention.

Firstly, what is the reason for the very low breadth to length ratio?

I congratulate Commander Burney very much on having so clearly demonstrated the advantages of using hydrogen for fuel.

He dealt for some time with the question of mooring mast design, and, I think, rightly, because if it were not for mooring masts in general, rigid airship flying would not be possible at all.

I am not a technical man, and consequently cannot argue, but there was one thing he did not mention which struck me as a difficulty. If (as I think very necessary) one must at times moor or mast the airship, it seems to me that with a weight of 15 tons on the top of the mast you are going to get rolling of the ship. From the design which he put before us to-night it seems to me that in any rolling of the actual ship you impose a movement of the ship on a horizontal axis for an hour. That seems to me very serious, and I should think could be eliminated by an attachment to the nose.

There is only one other thing that seems to me difficult. Commander Burney said he was having a duplicate set of bridles; but when you are mooring to your mast on landing, or at sea, it seems to me that there is and always will be a danger of fouling the mast, and if the most vital part of the ship is going to be situated in the one place which will be likely to foul the mast, it does not seem the right place to put it. As a potential passenger I look on this with some apprehension.

LIEUT. OLECHNOVITCH: I should like to ask whether the perfectly streamline shape would affect controllability?

How can this kind of mast be used on the sea when heavy weather is expected?

Is it possible to make a flexible attachment of the airship to the mast by making three points of suspension slightly flexible by means of buffers?

COLONEL LOCKWOOD MARSH: Commander Burney referred to mooring experiments at Barrow, and the results of those are distinctly interesting.

There were two types of mooring tried—one proposed by Mr. Wallis—mooring by the extreme nose, and the other proposed by Commodore Masterman, which was the type of which pictures have been shown on the screen. These experiments were with non-rigids, and the chief difficulty of mooring by the extreme nose was that they could not get the nose stiffeners to stand up. They constantly broke, and therefore for the purpose of non-rigid mooring Commodore Masterman produced the forked type.

It is, of course, quite true to say that as far as it went that type was successful, but the trouble was that the rings which were used for attachment on each side of the nose constantly doubled up, and it was for that reason that that type of mooring was abandoned, and that the experiments were stopped and the work transferred to Pulham. The nose mooring was introduced again because by that time permission had been obtained to use a rigid airship for experimental work. The rigid airship had rigidity in the nose, and therefore there was not the difficulty of stiffeners breaking.

From the point of view of aerodynamics it does not seem that the best position for mooring would be by the extreme nose, and it would be interesting to know whether Commander Burney has had any results from the N.P.L. as to the comparative advantages of mooring by the extreme nose or by the two points further off. It would seem that mooring on each side of the nose would set up great stresses, and there would be a tendency for the nose of the airship to be twisted off, so one would have thought the nose system was better because it left the airship more free to move.

There are also difficulties with regard to putting the control car in the extreme nose. I should have thought that from the constructional point of view it would have introduced difficulties in the design to put a heavy weight like the control car in a position where there is no gas-bag to support it. There is also another difficulty with regard to putting the control car in that

position. Supposing an accident happens at the mast, such as the accident to the Shenandoah and the R.33 the other day, the control car might get carried away, and would almost certainly be damaged; therefore it is a dangerous position for it. I think also that from the pilot's point of view there is some advantage in being able to see aft and to see how the engines are working, etc. Also when landing to a shed and possibly also on a ship there is an advantage in being able to see aft and to see the other cars and the landing party.

Commander Burney said that the single point mooring had failed on practically every occasion in a high wind. I cannot recollect any occasion on which the single point mooring has failed except in the cases of the Shenandoah and the R.33, but certainly airships have been moored out at Pulham in as high a wind as the R.33, and I think it is hardly true to say that on every single occasion in a high wind the single point mooring has failed.

Commander Burney mentioned a proposed route to Australia, and I would just like to ask him why he selects Colombo as the best point for a site. One would have thought that it would obviously be more convenient for passengers and freight to be landed in India, which would presumably be their destination.

I thank Commander Burney for his very interesting paper, and for the splendid fight that he has put up during the last two years to keep the airship flag flying. It is very largely due to Commander Burney that the airship position has again been taken up by the Government.

COMMANDER BOOTHBY: I would like to remark as follows, taking Lieut.-Commander Burney's points in turn :—

(1) *Streamline Design.*—The ultimate object to be aimed at is to include engines and passenger cars inside a streamline hull. In 1915 Messrs. Vickers worked out a design for including engines and controls inside an external keel, which was a step in the right direction, and something of the sort may be adopted again.

As regards placing the pilot's car in the nose, the stern is probably a better position, as it shortens the control leads and facilitates the taking of back bearings. A look-out position in the bow, with a voice pipe for the control position aft, should meet the situation.

(2) *New Type of Anchoring, involving new Mooring Mast.*—An International Conference was held at Australia House some three years ago, to

standardise airship fittings, including mooring masts. Practical experts from Germany, U.S.A., France, Great Britain, and other countries attended.

The type of mast advanced by Lieut.-Commander Burney was considered, and rejected as impracticable—chiefly on account of the weight of material to be moved as the airship swung.

There can be little doubt that they were right, and that this type of mast is unsuitable for practical purposes—but not for political! It is only fair to state that a mast of this species has proved quite good for small ships, once they were secured to it, but there is little reason to doubt that they would ride equally well to the International Standard mast.

(3) *Hydrogen—Heavy Oil Engine.*—The lecturer's remarks are concurred in. It is difficult to see the object the Air Ministry have in view in developing a semi-Deisel type, unless they wish to use it in helium-filled airships—if and when we obtain helium! I believe the engineer officers who worked on this fuel system during the war are still in the country, and it might be worth while the Air Ministry consulting them on the question. Even with helium-filled ships it is possible to use the hydrogen-heavy oil system, at any rate for cruising purposes.

MAJOR C. C. TURNER: I should like to ask the lecturer what are the dimensions of the mast?

Also I should think that Bagdad is not a very useful point, for surely there is not a great deal of traffic there, and it is rather off the line.

MR. COLEBROOK: I should think that with the single mooring mast it is hardly necessary to have side guys.

I gather from Commander Burney that the two mooring points on the airship will be roughly 50 feet apart. Has he any data which enables him to predict that a space of 50 feet will be sufficient to correct instability as the airship is drawn downwards towards the land?

DR. THURSTON: It seems to me that Commander Burney has made out a very good case indeed for the airship. He has shown very clearly the difficulties, even the disadvantages, and therein lies development.

With regard to the use of two fuels in an internal combustion engine, I feel that the development of this idea will be of use to the whole world in the

future, and the extension of that idea alone will make the airship worth while.

Regarding the mooring question, it always struck me in going through the Panama Canal that we might get some tips from the Americans in getting liners through those locks at great speed, and I think that great use could be made of electric motors running on rails. When the airship comes in, cables are attached to four of these motors, which are arranged so as to move together. If we had some such arrangement as that on a platform which could be made to turn into the wind, we could drop our cables in such a way that they would form a bracing structure for the airship, which would enable us to haul it in or move it to the position that we wished. It struck me that there was the possibility there of dealing with these great floating structures.

#### COMMANDER BURNEY'S REPLY TO THE DISCUSSION.

I venture to disagree with the Chairman on one point, as he said I always had the salt sea in my eyes. What he appears to forget is that when anyone is endeavouring to put through any large scheme the question of finance is of major importance, and unless it had been possible to prove to the Admiralty that there was a very great use for these vessels as Naval auxiliaries, it would have been quite impossible to get a commercial scheme through on any other grounds whatsoever. That position has not altered very materially, because until commercial vessels can be operated on a self-supporting basis they will require a subsidy, and that subsidy will not be paid unless the powers that be consider that they are getting sufficient value in return. The call for economy imposed by conditions in this country necessitated that any money available for aerial development should be given to heavier-than-air craft.

Replying to the Chairman's question regarding low length to breadth ratio, the results of model tests show that for a given volume we get less resistance with a low ratio than with a high one. As a matter of fact, to get the best design we should have to go to under  $4\frac{1}{2}$  to 1.

He then asked a question in regard to the weight of 15 tons at the head of the mast causing roll; we worked out the stability of the monitor with a weight of 30 tons at the mast head, and by putting the weight of 30 tons at the head of the mast, but at the same time removing the 14 inch turret guns, armour, etc., which together weighed 650 tons, we found that the metacentric height of the monitor had been increased by 1 ft. 6 in. Now that the weight of the revolving portion at the head of the mast has been reduced to 18 tons,

it is evident that the metacentric height will be still further increased. We are now considering further modifications which will, if adopted, result in a still further reduction of weight. Eighteen tons sounds alarming from the aeronautical point of view, but to the naval mind is unimportant. When one is dealing with sea conditions one must leave one's idea of weights in connection with aeronautics behind.

Now as regards the further point raised by the Chairman, in which he suggested that owing to the monitor rolling in a sea way that the monitor might impose stress in the airship due to horizontal motion. I think there is some misconception here. I have never suggested that either with this two-point system, or with any other that is known, it will be possible for an airship to moor to a monitor in the open sea. The proposal is that the monitor should be in a land locked harbour, and in that case the roll should not exceed 2 in. to 3 in. Under these circumstances, I do not think the Chairman need have any qualms as a potential passenger.

With regard to the position of the control car and possible damage to the nose, I think there are some misconceptions in reference to my suggestions. When one is operating a battleship or cruiser one has the "monkey's island," which is the place from which the officers in charge operate the ship. In that position there is no telegraph, and the control is carried out from the fore bridge, the "monkey's island" and fore bridge being connected by voice pipe. What we propose to do with regard to airships is to bring them into line with naval vessels, and the position in the nose will take the place of monkey's island in the battleship. As I have already said, our secondary position will be in a sense a movable position. That is to say, when we are navigating away from land, what is termed the normal control car will be within the streamline hull, and we shall save by this method the head resistance of the normal control car during the whole of our flight. At the same time, when the actual operation of mooring takes place, the phenomena of kiting or sailing of the airship will be largely eliminated by the employment of the bridle system.

Commander Boothby suggested the stern for the control. That is not really a new idea; most vessels have a subsidiary position for control in the stern. The Z.R.3 had such a position in the fins.

Regarding the International Conference, to which he referred as having taken place three years ago, we also have had an International Conference, but ours was only three months ago, at which Dr. Eckener, of the Zeppelin Company of Germany, and Mr. Lehman, of the Goodyear Company of America considered this question, and as a result of that discussion they decided to adopt the two point method as standard for International Airship lines, subject to satisfactory results on trial. It may be that in the intervening

three years more knowledge has been acquired which now makes possible such a development.

Replying to Colonel Lockwood Marsh's question in regard to mooring by two points and the possible twisting of the nose, I think he should consider two factors. First of all, one is able to hold the airship at two points, one on either side, where the diameter of the ship is fifty feet, and distanced from the nose about twenty feet; when one considers the forces that produce rolling, I think he will find on going into it mathematically that the stresses produced by preventing a rolling motion being set up are well within the strength of the hull structure at the point of attachment, especially when the broad base available is considered.

Colonel Lockwood Marsh also suggested that as the weight of the control car was about 4 tons, the addition of this weight in the nose of the vessel would rather overbalance her. There again, there is a misconception, because there is very little extra weight added in order to obtain the forward control position. To transmit the mooring stresses from one side of the ship to the other, our hull at that point has to be very strong, and whether the airship is moored actually by the nose or by two points further aft, the fact remains that that weight in the bow is there not for the control position but for the mooring of the ship. The additional weight required for the control position will be little more than that required for the flooring and windows.

He also asked: What would be the position of the control car if the nose was torn out as was the case with the Shenandoah and the R.33? Our very object in redesigning the bow and altering the method of mooring is to prevent the nose being torn out, because the strength of the two point system will be so much in excess of the single nose position that the strength of our mooring points will be sufficient to prevent an accident similar to that of the R.33. There is, however, a secondary steering position for either approaching the mast or going to a shed. We are not at present able to say which will be the best; some pilots have one opinion and others another, and I think it would be unwise to impose upon the captain of the ship a position which had not been tried, without giving him an alternative in case of getting into difficulties. I expect myself that with further experiments it will be found that the secondary position will not be utilised to any extent. I think it will be found that the experience with surface ships will apply to airships, and that the officers will prefer the "monkey island" position.

Colonel Marsh went on to ask why I said that although the single point mooring had been tried, it had failed upon every occasion, and queried the correctness of that statement. I think I was justified, because if you take the R.36, the reason that she has no nose at present is because it was crashed, while the Shenandoah and the R.33 have both suffered in a similar way. It

is not accurate to say that the system is infallible because by good luck rather than by good management you sometimes get a high wind that the vessel can stand without breaking away. I think it is fair to say that under conditions which are natural to this country and America, at some time or another, every vessel fitted with the single point system has had an accident of a serious character due to this defective design.

In reply to Mr. Colebrook I would say that with the single point system kiting must necessarily occur in a gusty wind. This is due to the fact that the mooring rope has very little effect in damping out oscillations. The lateral forces causing, and at other times restraining, the motion are entirely due to the angle made by the axis of the ship with the instantaneous direction of the wind. Owing to the long distance between the centre of gravity of the ship from the point of attachment of the mooring rope at the masthead, the ship has to move considerable distances laterally to alter the angle of inclination of the axis to any appreciable extent. The mass of the ship is considerable, and a considerable momentum is worked up in the oscillations, and with the single-point mooring system, side guys are essential.

With the two-point mooring system, even if the two ropes are enclosed by only a small angle one with the other, a small lateral movement results in a relatively big couple acting on the ship through the medium of one or other of the ropes and the thrust of the propeller astern. This couple tends to turn the bow of the ship back into the wind and oscillations are quickly damped out. If an actual example is taken and the forces and moments examined for different portions of the ship relative to the mast, it will be seen that quite a small distance between the mooring points is sufficient to give this effect. Moreover, the effect becomes more and more intense as the ship is drawn nearer to the mast.

Replying to Lieutenant Olechnovitch regarding controllability and more perfect streamline : as a matter of fact, the position of the fins and the rudder is dependent to a large extent upon the shape of the vessel, but so far as we know, so long as the fins and rudders are suitably placed and of suitable size, the controllability of the perfect streamline is just as good as the other.

With regard to Major Turner's question as to the dimensions of the mast, for the naval position we find the height works out at 150 feet, but on land where height is easier to obtain, we go to about 200 feet. As a matter of fact, the higher the mast the better.

Major Turner also asked why Bagdad should be one of the points on the route. There, again, it is a matter of financial policy. The only countries we are advised as likely to assist a commercial line are Australia and New Zealand, therefore we have to make Australia and New Zealand our main



objective. The route has been planned as the closest approach to the arc of a great circle to Australia, and Colombo was chosen because it has railway connections with the whole of India, and we shall therefore secure the Indian traffic, whilst at the same time no stations will be constructed on Indian soil until such time as India is prepared to assist financially on the same lines as Australia and New Zealand. Bagdad and Columbo follow the arc as nearly as possible. The selection of Columbo necessitated Bagdad, as otherwise Ishmalia would be too far from Columbo without an intermediate station. Thereafter, Australia and New Zealand are reached with the greatest despatch.

CHAIRMAN : I feel very greatly indebted to our lecturer to-night, and for that reason I thank him from the bottom of my heart. I also thank him very much on behalf of the Institution for what he has told us, and should very much like to know on what dates he can lecture to us again.

Commander Burney having briefly responded, the meeting closed.

