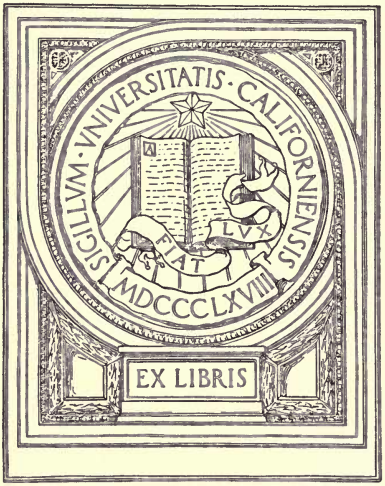

AIR MINISTRY.

Air confere

PROCEEDINGS

OF THE

SECOND AIR CONFERENCE,

HELD ON

7th and 8th February, 1922.

Presented to Parliament by Command of His Majesty.

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AIR CONFERENCE, 1922.

MINUTES OF PROCEEDINGS of the SECOND AIR CONFERENCE, held on the 7th and 8th February, 1922, in the Council Chamber of the City of London at the Guildhall, by kind permission of the Lord Mayor and Corporation.

TUESDAY, 7th FEBRUARY.

MORNING SESSION.

The Conference was opened by the Rt. Hon. the LORD MAYOR OF LONDON, SIR JOHN BADDELEY, who spoke as follows :—

The LORD MAYOR : My Lords and Gentlemen; it gives me great pleasure to be here this morning to welcome the delegates to the second Air Conference, who, these next two days, are to discuss matters of high and vital interest in connection with aerial transport from various points of view. In this historic—this almost prehistoric—Guildhall you are assembled to advance the ultra-modern science of aviation, an event which lends itself to most earnest reflection. People tell one that aviation is only in its infancy; but may I say that great strides have been made during the last 15 years. I mention that because I remember well—I was Sheriff of London at the time—that the aviator, Blériot, was acclaimed by the then Lord Mayor as having performed a most wonderful feat in flying the Channel. I remember soon after that a great meeting in the Guildhall, at which Lord Montagu of Beaulieu and others very strongly enforced the necessity of studying and pursuing the science that had so recently been started. It was a great meeting, and I have no doubt that it had an important effect upon that which not very long afterwards came about, namely, the great War, in which aviation took such a great part. At all events, aviation has now come to stay. It has made great strides, and the British Empire must see that it does not lag behind its contemporaries in a science of this nature. By patient research our air services, military, naval and civil, must be so perfected and so encouraged as to challenge comparison with those in every other nation in the world.

I hope that the two days' Conference will be interesting, attractive and useful, and that its effect may be seen in the course of time in the advance which aviation makes in every direction.

I will now resign my seat to Captain Guest, who will, I understand, conduct the morning session of your Conference.

The Chair was, accordingly, taken by Captain The Right Hon. F. E. GUEST, C.B.E., D.S.O., M.P., Secretary of State for Air.

The CHAIRMAN : My Lords and Gentlemen; I think our first duty is to place on record our thanks to the Lord Mayor for having placed at our disposal this magnificent Hall, and to thank him also for the words which he has delivered from this Chair—words of encouragement and words of support.

The business of the next two days is, I think, of the greatest importance, and I will from the Chair indicate the procedure. The first day will be occupied, as can be seen from the Agenda, by papers which will be read. To-morrow will be devoted to discussion upon the subjects raised by the papers, and I would like to invite those who are anxious to take part in the discussion to send up their names and the organisations they represent, if it is convenient, before the session arrives at which the particular discussion will take place. Those of you who have already prepared your minds for this Conference will quite simply send up your names to-day; but to-morrow will not be too late as long as the names come up to the Chair before the subject comes on for discussion.

The object of the Conference, as it appears to me, is mainly to encourage civil aviation. It affords an opportunity to review the past, both at home and abroad. It enables us to compare notes on the various problems involved, and to make our plans for the future. It is now eighteen months since you held a Conference of this nature, and on that occasion it will be remembered certain resolutions were passed. This affords me an opportunity of pointing out that, although at the time the then Secretary of State for Air was not able to give any definite promise that the resolutions would be carried into effect by the Government, yet the substance of them has already been made effective. At that time the Secretary of State said, what I think most of you will still admit to be true, that sooner or later civil aviation must fly by itself, and that the Government's duty should be limited to facilitating, stimulating and liberating.

During the interval of eighteen months the Government has not been inactive. By its research programme certain landmarks have been placed on record, which, although developed primarily under the Service side of the Ministry, will be of permanent and lasting value to civil aviation as well. I will only mention two or three of these landmarks—the development of fireproof measures, safety fuel tanks, navigation instruments, gyro-turn indicator, terms which will be more familiar to many in this room than they are to the outside world. Then there is the development of directional wireless, of the high-lift wing section, and the amphibian, which is a completely new development of this great undertaking. Besides that, considerable successful experiments in high-power water-cooled engines have been made. This I mention purely to indicate that, although the Government have not exceeded or have not been able to go beyond the functions indicated by the Secretary of State for Air two years ago, yet in research they have not been inactive.

However, the public is impatient and is always looking for the reasons for what they describe as our slow development. I think that in that connection we must face the facts. The slowness of the development, in the first place, must be admittedly due to the general depression of trade. There is not the capital free and available for experimental development in private hands. There is besides that, I think you will admit, a very difficult obstacle to be overcome before flying becomes popular. It has to overcome the dangers of aerial navigation, and, although in this country our development has been slow, yet in that respect we are ahead of any other country. The best test of that is that our safety line, if I may describe it in that way, is the highest in Europe. My conviction is that the measure of progress in civil aviation is dependent to a great extent upon the

standard of safety. There are a number of figures to prove the high level of our safety line, which will be laid before you by other speakers as the Conference develops. It is sufficient for me to point this out to you that, in the whole of the year we have just gone through, nearly 50,000 people have been carried in the air in flights of different lengths, nearly 25,000 flights of one kind and another have taken place, and only two fatal accidents are recorded. I submit that the safety line shows a very high quality.

I think you will consider it my duty from the Chair on this occasion to offer one word to those who are interested in airships. I must admit that from what I can see the outlook is not hopeful. Some of the same conditions, such as depression of trade, undoubtedly operate upon this class of enterprise, but you will be aware that one of our great Dominions has shown a desire to join in the Imperial scheme. I regret that I have to announce to you or to any of you who may not know it that the other Dominions of New Zealand and South Africa, owing to the stringency from which the world is suffering, do not see their way to co-operate. However, in order, if possible, even yet not to extinguish the hopes which lie in some of our breasts, the date of the final throwing up for disposal of the material that we have held on charge since the Colonial Premiers' Conference in July last will, I hope, on our recommendation to the Colonial Office, be extended to 1st June.

There are two complaints made by enthusiasts on this subject, which I wish to meet before they are expressed. The first one is that we are losing our premiership in this connection and surrendering our lead to other countries. I submit, with I think the certainty which is acquired from living in the midst of a machine to which all available information automatically comes, that the developments in other countries have been largely exaggerated and that we need not have fears on that score. The other complaint, however, is that the complete closing down of this branch of aerial navigation will have the effect of dissipating, and, perhaps, permanently losing, all those staffs of designers, without whom it never could have been created. I think that is true, if your outlook in this connection is limited to a few years, in fact if you think it is only a matter of a year or two before we shall be back into such normal times, or such abnormal times, that there will be money available in great quantities for what must still be considered as a speculative enterprise. My belief is that the period of depression will be longer and that it may be many more years than two or three before there is sufficient spare cash to undertake this commercial enterprize. If the period of say, ten years is considered, and if the recommendation from some of you is that during that period a very heavy subsidy should be found from the Government first to put it on its legs and then to keep it going, I submit that you could start it all again *de novo* at the end of that period of depression without it costing any more money.

Meanwhile, the world is busy repairing the breaks in the proved methods of transport. Railways and ships and such like which have borne us so far have got to be put into a perfect state of condition before we can find or obtain money for airship development from any of the ordinary natural sources.

One more word only before I call upon the Under-Secretary to read his paper. It is this: The bogey of foreign competition must be investigated and must be faced. I am not afraid of saying that

in my belief, taking a long view of aircraft traffic in general, there is little or no prospect of a real commercial success being obtained in Europe. England in the last few years has shown itself to be so well rail-roaded as to render it unattractive and certainly unprofitable to develop aircraft lines from a commercial point of view. I am almost of opinion that it is true of Europe generally and that the prospects of an aerial commercial success in Europe are not very great and will not be for many, many long years to come. I believe that to be true to a lesser extent in America also.

I couple with that a *caveat* to you, asking you not to expect too much even of the cross-Channel service from a commercial point of view. You must remember that you are taking on there a most difficult enterprise in so much as you are competing with a most highly developed system of both rail and boat services, and that it may be defeated owing to the punctuality and regularity of the older forms of service. But, although from the home point of view that is a somewhat depressing outlook, yet to counter-balance it there is an extremely bright outlook as far as the British Empire is concerned abroad. We are the one great Empire which has spaces and distances which are unbridgeable except by air, and, surely, it should be to those definite opportunities that a great deal of our future attention should be turned. I can see now in my mind's eye the possibilities of Imperial air communication on lines which may have struck many of you already. The transportation of both mail and passenger services from London to India is, in a way, when accomplished, going to be of far greater value to the Empire and probably a greater commercial success to those who engage in it than competing between Paris and London.

The present communications from London to Aleppo are already established by air. A small gap enables you to link up with Baghdad, which, under our Service control, is already organised into a great flying system. From there you have but a link remaining which has already been reconnoitred between Bassoura and Karachi and the line between London and India is accomplished.

Then I go on to the question where I think our opportunities are greatest and where our prospects of a material and valuable return are highest. It is in this connection that I am rather hoping that the far-flung Dominions will perceive that money of, say, a sum such as 250,000*l.*, which it was suggested in the Australian Parliament might be available to join in an Imperial airship system, might be four times as reproductive if linked with the last portion of the route, say, from Singapore to Australia in a heavier-than-air service.

In conclusion, I would suggest to you that the tone for us to adopt during this period is surely one of simple but not extravagant optimism; that the time should be spent, as I think it has been spent in the last two years, in strengthening the *liaison* and the co-operation which exists between the Air Ministry and the aircraft industry; that we should take as our motto for the next year or for the next period: "Sit tight and work hard, but do not stunt, and be ready for better times."

The first paper appears under the head of "Civil Aviation" and will be read by the Right Hon. Lord Gorell, Under-Secretary of State for Air. In this connection I should like to remind you that Lord Gorell was appointed a few months ago to fill the vacancy

created by Lord Londonderry. Lord Gorell will now be the Parliamentary and administrative link between Civil Aviation and the Air Ministry. He has been asked in that capacity to give us to-day the views of the Ministry, and he is in a position to do so from the months of very close study that he has specifically devoted to this subject. I will ask him to read his paper.

CIVIL AVIATION.

The Rt. Hon. LORD GORELL, C.B.E., M.C., Under-Secretary of State for Air: Captain Guest, my Lords and Gentlemen; at the Air Conference held in this hall in October 1920, the first of the papers read was one dealing with "Civil Aviation and Air Services," by Major-General Sir Frederick Sykes, Controller-General of Civil Aviation, and I think it is right that we should again devote the first portion of our attention during the present Conference to the very important but difficult subject of Civil Aviation. It is, perhaps, also a desirable thing that this first paper should be the product of a different brain from that which dealt with it at the last Conference. In his paper, I remember, the Controller-General of Civil Aviation laid before his audience a full and detailed exposition of facts relating to the progress of Civil Aviation in this and in other countries of the world. It has now become perhaps more important still to approach this question as a matter of broad policy with which the Government are concerned, and since my connection with the Air Ministry it has fallen to me to interest myself rather specially in the civil side of flying and to endeavour, by as careful a study of the problem as possible, to ascertain the directions in which development can be best assisted by the Government.

FACTORS OF SUCCESSFUL DEVELOPMENT.

One of the first points which must, I think, strike anyone coming fresh to a study of Civil Aviation is the decided increase in the interest taken by the public in the air. It is rare to have a single day without an article, or at any rate a communication, whether relating to matters of fact or individual opinion, being set out in one or more of our important newspapers: and I know of no better guide than this to the relative interest in public matters. It is gradually, very gradually, being brought home to the public that flying is a great deal more than a third arm of warfare, an impression naturally predominant in view of the marvellous achievements and extraordinary growth of the Royal Air Force in the war. But as the events of the war recede from being matters of daily comment into the serener atmosphere of history, gradually the general public are beginning to realize that aerial transport has come to stay as an additional means of communication in peace, and attention is swinging away from the exploits of famous battle-fighters and from the great bombing raids to a sober consideration of the practicabilities of transport by air as applied to civilian travel and commercial transport.

There are many indications of this more durable public interest; one is the desire of greater numbers, than was the case in October 1920, to attend this second Air Conference; another is the active criticism which is now directed to everything done—or, it may be, left undone—by the Air Ministry in relation to the development of Civil Aviation. No one need complain of that; for my own part,

I welcome all criticism which is based upon the desire to help on the object which we have in view, and I am hopeful that from our discussions to-day and to-morrow, the Air Ministry may be furnished with many criticisms and suggestions which it may carefully consider and by which it may be actively assisted. There is no disguising the fact, however, that its task in this respect is not an easy one. Increased though this interest of the British public in aerial matters undoubtedly is, it yet falls far short of the interest which this country ought to take. Just as it has always been our boast that we have, as a people, a natural genius for the successful navigation of the seas, so I think it has been shown in the last five or six years that we have a natural genius for flying; and more than that, from our position as an island Empire, we have not only unusual opportunities, but also a special need to give that genius free play, and by utilizing to the full the means of communication by air—far speedier than any can ever be by sea or by land—to overcome the great distances across which the Empire is stretched. But it needs to be frankly stated that we have not as a people yet shown that general interest in this new element which is being shown to-day by some other countries, notably by France. I will refer in a moment in more detail to the effort which France is making, but I wish to emphasize the fact that, though, no doubt, a great deal can be done by a Government to assist the development of Civil Aviation—and, possibly, a great deal more can be done by a Government to hinder it—still in the long run the real factor of successful development must be the amount of public interest and private enterprise put into it, and until there comes to the British public a real and substantial realization of the potentialities of aerial transport and the opportunities afforded by it—a realization not in the mind only but in the pocket also—I do not see how it will be possible for this new industry to develop on the broad basis on which all who have considered it realize that it should, and could, be developed.

THE SERVICE AND CIVIL SIDES.

I am not now speaking of war, but of peace. There is no doubt that from the point of view of war our national situation has already been greatly changed, and in the future will be still more changed, by the growth of aerial activity, and that it is a simple truism that we have now ceased to be an island. But to-day I am thinking only of consequences to ourselves in relation to peace and commerce. I may, however, perhaps be permitted briefly to refer to the intimate connection which, in my view, must always subsist between the Service and Civil sides of flying. They have sometimes been represented as conflicting; I do not agree with that view. I think that they should more truly be regarded as complementary one to the other, and that, if we are to seek for a parallel, the closest we can probably find is that of the relation of the Mercantile Marine to the Navy. The *rôle* of the Navy is to maintain peace and order on the seas; the *rôle* of the Mercantile Marine is to bear passengers, goods, and mails across those seas; and it has also, as was shown so gloriously during the war, the *rôle*, in case of need, of supplementing and assisting the activities of the Navy. Such are the respective *rôles*, substituting "air" for "seas" of the Royal Air Force and the Civil Aviation industry. The parallel may be regarded as holding good

in another respect also; the development of the Mercantile Marine was not brought about by direct Government action; it did not depend for its expansion upon subsidies, but upon fundamentally sound commercial principles. Such, I believe, is the true view also in respect of Civil Aviation. I do not wish to press the parallel too far, and I think one difference, possibly a difference in degree rather than in kind, must be noticed, namely, that for many years to come at any rate and probably for all time, success in the air, whether Service or Civil, must depend primarily upon constant scientific research. I believe research to be the essential link between Service and Civil flying.

I do not speak in the least degree as a technical expert; probably in the position which I happen to hold, it would be a disadvantage to pretend to any degree of technical qualifications, but speaking as a layman, it seems to me that the requirements of the Service fall into two main categories. The first is for the actual purposes of war, with three sub-heads: battle-fighting, bombing, and reconnaissance; the second, those ancillary but essential services connected with movement and supply. I mean something of the same distinction which, in the war, lay between the *rôle* of the tank and the *rôle* of the motor lorry. I cannot help thinking that all improvement in Service machines utilized under the second category will be of direct service to Civil Aviation. It requires no great flight of imagination to believe that in the future we shall see aeroplanes used for the movement not only of stores but also of platoons, or even possibly of companies, and the experience gained by the use of machines designed for such purposes must be taken into direct account by designers of aeroplanes to be used for the transport of commercial goods or passengers. I referred a moment ago to the *rôle* played by the Mercantile Marine in time of need, in supplementing and assisting the work of the Navy. That *rôle*, too, will fall, if the need should ever arise, to those trained in Civil Flying. I believe, myself, that the suggested organisation of an Auxiliary Air Force will make a further and valuable link between the Royal Air Force and Civil Aviation. Apart altogether from the arguments relating to it from the Service side, it seems to me that some such system would have the effect of diffusing amongst the general population the sense of the air as a present and practicable means of communication, which sense, as I said just now, I deem to be of paramount importance in the development of all aerial activity.

I want to pass away now from such general considerations as I have attempted to indicate and to deal more specifically with the present state of Civil Aviation in this and in other countries, to try and outline the policy of the Government towards it, and to make some suggestions with regard to its future.

THE FUTURE OF AIRSHIPS.

Before, however, dealing with the problems connected with heavier-than-air craft, I think I should refer to the important question of the future of airships. You will all doubtless remember that for reasons of economy the Government came last year to a decision to close down the Airship Service, a decision which was immediately greeted by exclamations of dismay from many quarters, more especially in the Press. Now, a newspaper has one great advantage over a Government. It has on each of its pages a number of columns, and, so long

as each of these columns is consistent within itself, it need not trouble greatly to ensure that they are consistent taken as a whole. So that, throughout last summer, we had examples of conflicting columns side by side, in the one voicing the national demand for the strictest economy, and in the other denouncing the Government for its short-sighted policy in deciding to close down the Airship Service. The Government, however, which has to endeavour to view policy as a whole, had come with reluctance to the conclusion that the maintenance of this Service was a burden that this country could not at the present time afford. There are certain items of expenditure which a man cannot afford to undertake when he is poor; there are others which he can afford not to undertake even if he is poor. The whole question of the development of Airship Services depends upon whether expenditure upon them should rightly come under the first category or under the second, for few deny the probability, and many are convinced of the certainty, of the world being connected up by such Services at some date in the future.

So much public interest was aroused by the Government decision, that the question was brought to the notice of the Dominion Premiers assembled in London for the Imperial Conference, and, accordingly, a special Committee, presided over by the Secretary of State for Air, of which I had the honour to be a member, was set up to investigate and report specifically upon the expenditure involved by the maintenance of an Airship Service. The enquiry conducted by this Committee was, I think, the first which had ever thoroughly examined this question. Its report has been published* and I need not refer to its findings in detail, but I may remind you that the Committee reported that, if the Airship Service were maintained for a minimum period of inauguration of one year, the establishment of the route from this country to Egypt could be definitely begun and tentative flights made beyond Egypt in the direction of India and South Africa at an estimated cost of 540,000*l*. If the Service were to be maintained for a two-year period of inauguration, a regular monthly service to Egypt could be established, the definite extension to India begun, and demonstration flights carried out towards South Africa; the estimated cost is 1,339,000*l*. This is all that could conceivably be done with the existing fleet. If it were decided to establish an Imperial service on a definite basis, the construction of new airships and of fully equipped permanent bases in South Africa and Australia would be necessitated. It was considered that this establishment could not be completed under five years and the estimated cost, given with the greatest reserve, is in the neighbourhood of 8,000,000*l*. These are big figures, but to go on dabbling with an Airship Service is merely to spend money to little purpose; to be of real value now experiments must be full scale. We no longer require to know whether an airship can fly the distances, what we need to find out is whether a service can successfully be run—and that with the bases and ships necessitated must be very costly.

The foregoing figures are estimates based upon development being undertaken by direct Government action. There were also under consideration three proposals for development by private enterprise, and it may be recalled that the Committee expressed the view that "the best hope of the successful development of Imperial air communications lies in private enterprise conducting the service for profit,

like the Mercantile Marine, on business lines." Each of the three proposals analysed in the report, however, involved definite financial assistance from the Imperial Government, and had, therefore, like the analysis of development by direct Government action, to be submitted to the Imperial Conference.

The decision of the Dominion Premiers, when the report of the Committee was before them, was that the airships themselves should not be disposed of until each Premier had had an opportunity of consulting his Parliament to discover whether in his Dominion there would be financial support to the establishment of such an Imperial Service. There the matter rests; so far, final replies have only been received from New Zealand and South Africa, who have decided not to participate in any scheme.

The comment has been made, on one or two occasions, that the Government has shown in this matter either hostility to airships or an indifference to their development. Yet the decision to close down the service was taken purely on financial considerations, and certainly I can speak from my own knowledge when I say that on entering the Air Ministry in July last, I was impressed by the eagerness, nay, even the anxiety on the part of those concerned with the matter, to discover, if it were possible, some means financially practicable by which the service could be maintained.

Since the decision of the Dominion Premiers was taken, the conquest of the air has suffered one of the greatest disasters of its history in the terrible accident to the R.38. It ought to be decisively said that this disaster has not affected, and will not affect, the belief in the future of airships. We are not so faint-hearted a race as to allow ourselves to be deterred even by such an event; it is the toll that nature inevitably exacts from those who seek to prove her secrets —and it has been paid. Moreover, it should be borne in mind that the R.38 was based on an experimental design for service purposes and was, therefore, not intended for purposes of commerce or civil communications. Speaking for myself, I am perfectly certain that the time will come when the airship of the future will be an essential link in the unification of the Empire, though that time may be more distant than some of the greatest enthusiasts would have us believe. I regard it as certain that, whatever developments we may see, or our children may see, in heavier-than-air craft, it will be the airship which will ultimately be employed for aerial transport over the great distances of seas. In this connexion, I think, it well to point out that it is possible that the development of aerial transport has been a little hindered by what one may, perhaps, term the exclusive enthusiasm of advocates of aeroplanes and airships respectively. I mean, that it is surely a mistake to concentrate regard wholly upon the one or upon the other; the functions of both, though rather different, are concerned with transport through the air, and the capabilities of each should supplement those of the other. It seems obvious that the airship can be employed most economically over long distances, and the aeroplane most economically over distances which, though of considerable length, are yet much shorter, and that the true view is to regard the airship with its much greater air endurance as the long-distance steamer and the aeroplane as, what might be termed, the local express.

[A knowledge of what is being done and what it is proposed to do in other countries is necessary for a comprehensive survey of the airship question.

Lord Gorell.

Considering the results of airship activity in Germany, both before and during the war, it is probable that as soon as the peace terms permit she will begin to establish this form of transport on a commercial basis. In accordance with the Peace Treaty, and the Ultimatum of the London Conference of 1921, construction of aircraft, which includes airships of all kinds, is at present forbidden, but Germany is, nevertheless, fostering airship development by the means left at her disposal, and the Council of Ambassadors have recently agreed to allow an airship for the United States to be built in Germany. Her scientists are probing the constructional problems connected with large airships, while every effort is being made, by financial and other assistance, to maintain her technical staffs and airship bases in existence. At the same time German commercial interests, especially the Hamburg–Amerika line, are negotiating with foreign countries with a view to the development of airships and airship services abroad, and plans are being discussed for an airship service between Spain and Argentine.

France has decided to provide six airship stations, two in France and four in North Africa, and it is possible that the Norstern may be operated this spring between Marseilles and Algiers.

America is interesting herself in airships; it is stated that an airship service between Chicago and San Francisco is under consideration and that, if this proves successful, a Trans-Atlantic line from New York to England will be started. America expects to secure great advantages through possessing the main sources of supply of helium which appears likely to supersede hydrogen for inflating airships.

Italy has for many years devoted herself to the scientific development of the semi-rigid airship. One of her latest semi-rigids, the "Roma," was sold in 1920 to the American Army, and is now in course of being re-erected in America.* The Italians are also discussing plans for maintaining an airship service between Rome and Tripoli, first for mails and later for passengers also.

These are the facts and intentions of other countries. In the ultimate future I feel convinced that the main air lines of the British Empire will be primarily airship lines with branch aeroplane connections running off from them. In any event, suspension of activity by this country in the direction of airship services, being based solely upon financial considerations at the present time, can have no finality about it.

THE PROGRESS OF CIVIL AVIATION.

I now turn to the general progress of civil aviation. In the printed report of this paper there will be found set out the principal facts and figures relating to this progress in the United States, the chief continental powers, the Dominions and this country. Many of them have been included in the recent †Half-Yearly Report on Civil Aviation, and time does not permit me to give them all now; I propose therefore to confine my attention to-day to some of the

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* Since this was written the "Roma" has been destroyed during flight on 21st February.

† Half-Yearly Report on the Progress of Civil Aviation, April 1st to September 30th 1921, Cmd. 1559, 1921.

principal facts and figures relating to France and to this country, merely recording here that many other countries, and America especially, are showing an interest and activity much greater than our own, and then to pass on to deal with the Government policy and certain specific aspects of the general problem.

[*United States.*

The development of Civil Aviation in the United States has, particularly in the absence of any central controlling authority, depended to a great extent on the Post Office air mail services, in which it is noteworthy that in the three years during which these have been in operation there has been on the average only one fatal accident for each 94,000 miles covered, although there have been daily services, winter and summer, across three bad mountain ranges and over a great western desert. One and a quarter million dollars were voted in 1921, after being first rejected by the House of Representatives, for the operation and maintenance of a service across the continent, and it is on this route that efforts are being concentrated, as the Post Office service between New York and Washington was suspended at the end of last summer. During the year ended 30th June 1921, 1,770,658 miles were flown and 44,834,080 pieces of mail carried with an efficiency of service of just under 86 per cent. A number of privately-owned services, including a daily one across the Strait between Florida and Cuba, are in operation. It was estimated last autumn that 1,200 machines were then engaged in commercial flying in the United States. One company, the Aeromarine Airways, carried last year 6,814 passengers a distance of 95,020 miles without a single accident or mishap, and in addition transported nearly 30,000 lbs. of mail and freight. During the first six months of 1921 there were 40 serious accidents in the United States (not including accidents to Government-owned machines) resulting in death to 14 persons and injuries more or less serious to 52.

A bill is now before Congress for the creation of a Bureau of Aeronautics within the Department of Commerce, with a view to the Federal regulation and licensing of air navigation and assisting generally the development of commercial avitation.

Belgium.

About 10,000,000 francs was voted last year for Civil Aviation, including 1,600,000 francs for subsidies, which are allocated on a similar basis to the French and in the case of international traffic are on a liberal scale, being equivalent to a 200 per cent. addition to the receipts from passenger fares. The greater part, if not the whole of the subsidy, goes to the Société Nationale pour l'Etude des Transports Aériens, which has a capital of 4 million francs and operates daily services from Brussels to London, Paris and Amsterdam, *viâ* Rotterdam.

The increase in traffic in Belgian machines flying between this country and the continent illustrates the progress made; in the period from April 1920–September 1920, only 49 passengers were carried in Belgian machines which made 38 journeys; for the corresponding period last year the figures were 597 and 339. The following figures indicate the work carried out by Belgian aircraft during the periods indicated :—

	1920, 1st July to 30th September (3 months).	1921, 1st January to 30th June (6 months).	1921, 1st July to 30th September (3 months).
Number of flights	435	579	645
Number of machine-hours flown	409	1,127	1,062
Average duration of each flight	56 min.	1 hr. 57 mins.	1 hr. 39 mins.
Approximate machine mileage	30,500	85,000	76,800
Number of passengers carried	944	1,017	1,182
Weight of goods carried (in tons)	5·4	7	6·9

Germany.

The German Government has been restricted in its activities by the terms of the Peace Treaty, but has done much to develop internal air lines by granting subsidies amounting to 11,000,000 marks, besides 10,000,000 marks allocated to constructional firms for the encouragement of design and manufacture. During the summer months daily services were in operation between Berlin and Munster (*viâ* Bremen), Wangeroog, Hamburg, Dortmund, Dresden, Augsburg (*viâ* Leipzig and Munich) and to Riga (*viâ* Danzig, Konigsberg and Kovno) as well as between Hamburg and Dresden and between Munich and Constance.

The Minister of Transport, after consultation with the State Postal Authorities and the Air Transport Companies, decided to suspend the subsidy to regular air traffic on all lines from 31st October and reserved the right to fix the date of resumption of regular subsidised air traffic and to determine beforehand the lines to be flown over next year. The Deutsche Luftreederei reports that from 1st January to 31st August 1921, the various air transport companies which it embraces made 3,714 flights and covered 381,370 kilometres.

Holland.

The budget for 1922 includes 1,315,000 florins for civil aviation, of which 370,000 florins was set aside for subsidies for air transport companies. Regular daily services were operated in 1921 by the K.L.M. (Koninklijke Luchtvaart Maatschappij) between Amsterdam and London, *viâ* Rotterdam, and between Rotterdam and Hamburg. In conjunction with French and Belgian companies, it also carried out regular daily services between Amsterdam and Paris. During the summer of 1921, 289 flights were carried out between Amsterdam and London, 278 between Rotterdam and Hamburg, and 433 between Amsterdam and Paris, transporting in all 1,511 passengers, 30,856 kg. of various articles and 1,395 kg. of mails. It is interesting to observe that whereas the passenger traffic from Amsterdam to London was in excess of that in the opposite direction, the weight of goods carried from London to Amsterdam was 3½ times as great as that from Amsterdam to London.

Switzerland.

The value of civil aircraft and pilots as a reserve for the military air force is made the basis of Swiss official policy; aircraft is leased

temporarily to private aviation companies for training purposes and the Budget for 1922 included grants to Swiss companies to assist them to purchase modern machines; the companies further receive subsidies based on the number of pilots which they keep in training. In 1920 the amount was 200 francs per month for each pilot, in 1921, 300 francs, and now in 1922 the grant is increased to 400 francs.

An aerodrome is to be established at Constance for international air traffic between Germany and Switzerland.

Sweden.

During part of the summer of 1921 a service, operated jointly by a Swedish and an Esthonian company, was maintained between Stockholm, Revel and Riga. Thirty-one trips were made in each direction and 17 passengers, 575 lbs. of goods, as well as 1,480 lbs. of mail, were carried. The average time taken from Stockholm to Reval was 2¾ hours whereas the journey by boat takes 24 hours.

The Swedish Waterfalls Board opened in the summer of 1921 an air service between Porjus and Suorva, thus effecting a great saving in time as the journey by land is difficult; Suorva has hitherto been almost isolated, although in the midst of beautiful scenery, but the journey by air only takes about an hour. The first flight over the route was made by a British pilot, Colonel Henderson, but afterwards the service was maintained by two Swedish pilots. Up to September 1921, in the course of 270 flights, 21,330 kilometres had been covered and 327 passengers, besides 5,951 kg. of goods, carried. The service has been used for transporting mails and foodstuffs from the railway station at Porjus to Suorva where large works employing several hundred workmen are being carried out in connection with the water power installation.

The International Air Traffic Association, at its conference at Stockholm on 10th and 11th August, decided to discontinue traffic on the international air lines during the winter, in view of the absence of arrangements for wireless and meteorological reports, the lighting of air routes, &c., and of government assistance in general.

Czecho-Slovakia.

The vote for civil aviation in 1922 is 9,080,000 kroner as compared with 6,850,000 kroner voted for the preceding year. The Compagnie Franco-Roumaine will receive a grant of 6,000,000 kroner (nearly double the 1921 subsidy) in connection with the Paris-Prague air service, to which I shall refer later.

Australia.

Until the autumn of last year the funds available for the development of Civil Aviation in Australia were devoted to the provision of aerodromes and emergency landing grounds, assistance being rendered by the military Air Force in connection with surveying, map making, and the necessary pioneer work on air routes. The Federal Government then decided, however, that for the development of air services some form of direct assistance to private enterprise was necessary and allocated a maximum sum of 54,000*l.* to be spread over three routes :— Geraldton–Derby (Western Australia), 1,195 miles (maximum subsidy, 25,500*l.*); Sydney to Adelaide, 795 miles (maximum subsidy, 17,500*l.*); and Sydney to Brisbane, 590 miles (maximum subsidy, 11,500*l.*). Transport companies were invited to quote the subsidy which they would require for the operation of the services weekly in both directions

on the basis that time table and fares would be subject to approval and that all space other than that required for mails would be at their disposal; the personnel employed must be members of the Australian Air Force reserve. The actual saving in time to passengers from Sydney travelling by air to Brisbane and Adelaide is 18 hours and 14 hours respectively. It still remains the policy of the Government to provide aerodromes in all the capital cities and at junctions of the aerial routes, and to provide emergency landing grounds at frequent intervals along such routes, as well as to prepare and issue aerial maps. The municipal authorities are establishing aerodromes under their control in many towns, particularly in New South Wales.

Canada.

The policy in Canada is in some respects similar to that which prevailed until recently in Australia, but the Air Board has on its civil side a definite programme of rendering assistance with civil aircraft to the Government and Provincial Departments. Direct subsidies for commercial air services have not been given but the $700,000 voted for 1921–2 have been used for the survey of air routes, regulation of flying, including issue of licences for pilots and machines, acquisition and maintenance of civil air stations, other than terminal aerodromes, and, in addition, work has been carried out for provincial governments in connection with forest patrolling, fisheries protection, surveying, anti-smuggling operations, &c. The Air Board also lends airships and aeroplanes to commercial companies free of charge under certain conditions, and in particular, an Ontario Lumber Company is proposing to borrow lighter-than-air craft for use in connection with fire protection, forestry reconnaissance, and other survey work.

Between April and July 1921, 518 flights on civil Government aircraft were made and nearly 73,000 miles covered.]

France.

The total civil aviation vote for 1921—administered by the Under Secretary of State for Aeronautics and Aerial Transport under the Minister of Public Works—was about 184½ million francs, or about 55 million francs more than in the previous year, and was about half the vote for service aviation. Thirty-three million francs was allocated for subsidies to air transport companies and about 25½ millions to the construction of two rigid airships, airship bases and supplementary equipment. Although the total Civil Aviation Vote for 1922 has been reduced from 184½ to about 152 million francs the subsidy part has been increased to 46 million francs. Moreover, it is not possible to arrive correctly at a comparison between the French effort and our own merely by dividing francs into pounds; in France rates of pay are lower and materials are cheaper; francs go further than the pounds for which they can be exchanged. Besides the grant of subsidies to companies engaged on regular transport services, a grant of half the value of machines purchased, provided that they are of specified types constructed after 1st July 1921, is made by the State, and an interesting special grant is one to the Compagnie Aérienne Française of 100 per cent. on its receipts for air photography, "joy-rides," helps to fishermen, &c. As a further encouragement to civil aviation, the fees for medical examinations, licences, &c., have been abolished.

Considerable progress has been made regarding regular services; in 1919 there were only three companies operating on three routes, but in 1921 regular and frequent services, worked by seven different

companies, were in operation from Paris to London (three services each way daily), Amsterdam *viâ* Brussels (once each way daily in addition to direct services three times a week to Amsterdam), Warsaw *viâ* Strassburg and Prague (once daily), and from Toulouse to Casablanca (four services each way weekly), Bordeaux to Toulouse and to Montpelier (once daily), from Montpelier to Nice (twice a week each way), from Bayonne to Santander (daily), and there was also a service from Paris to Le Havre to connect with Trans-Atlantic steamships, operated by the Compagnie des Messageries Aériennes, which is also responsible for the greater part of the journeys between Paris and London. The services between Paris, Prague and Warsaw are carried out by the Cie Franco-Roumaine de Navigation Aérienne, which is subsidised by the Czecho-Slovak Government as well as by the French, and also receives important privileges from the Roumanian and Polish Governments. In a period of about 12 months ending last September, the Company's machines covered 156,520 miles and carried 500 passengers, 80 tons of goods and 300 mail bags. An extension of the service in the spring from Prague to Constantinople is proposed.

Arrangements have been made by the Government for civil pilots liable to mobilisation to have opportunity for one hour's flying a month free of charge at any one of five training centres for reserve pilots, which are organised under the control of the Service de la Navigation Aérienne.

[The following statistics illustrate the total work carried out by French civil aircraft :—

	1st January to 30th September 1921.
Number of flights - - - - -	5,115
Number of machine-hours flown - - -	14,100
Average duration of each flight - - -	2 hrs. 45 mins.
Approximate machine mileage - - -	1,145,500
Number of passengers carried - - -	8,761
Weight of goods carried in tons - - -	126]

The French air traffic between Paris and London showed a considerable increase last year. Between April and September the number of departures and arrivals of French machines to and from the Continent amounted to 1,058, compared with 408 for the corresponding period in 1920, while the number of passengers carried in French machines was 3,449, as against 312.

The development of aviation in French colonies must also be noticed. A mail service is operated in Syria three times a week, which covers the 75 miles between Aleppo and Alexandretta in one hour, whereas the only alternative means of transport—a combination of rail and steamer—occupies between 8 and 10 days.

A proposal is also on foot for linking up Paris, Marseilles and Algiers by an airship service, and to establish aeroplane services between Algiers and Biskra and between Algiers and Casablanca. For subsidising these routes one million francs was included in the Algerian budget for 1922.

United Kingdom.

I turn to the United Kingdom and here, in view of the relatively small scope which exists for the establishment of internal air lines,

the attention of the Government and of transport companies has been largely concentrated on the maintenance of regular services to and from the Continent, although British flying is by no means confined to those services, to which I will refer in more detail later. I will not attempt to give figures for the aggregate number of flights or the total mileage covered, in view of the disparity between the length and purposes of the flights which tends to make such aggregate figures misleading. The greatest activity, as might be expected, was shown in the summer months; in August, 155 flights between this country and the Continent were made by British machines which carried 920 passengers. During the summer months (April–September 1921 inclusive) two daily services have been operated between London and Paris; and although the number of flights last summer was only about one-third of those during the summer of 1920, the number of passengers does not show any serious diminution, the numbers being 4,006 and 4,336 respectively, while about 500 more passengers were carried in British machines than in French. French companies, on the other hand, captured the largest portion of goods traffic, carrying between April and October 1921 inclusive, 53 tons as opposed to 11 tons carried in British machines. The efficiency of the British services showed considerable improvement—about 93 per cent. of flights being completed within four hours during April–September 1921, compared with about 82 per cent. for the previous year.

The number of accidents has been encouragingly small; for each flying accident during the 29 months from May 1919 to September 1921 the average number of machine-miles flown was 33,000; of the 142,241 passengers carried, 12 were killed and 17 injured. The rate for the six months ended 30th September 1921, was less, and only one passenger was killed and one injured during that period. In this connection I should state that regulations have recently been framed under the Air Navigation Act, providing for the notification and investigation of accidents. The Regulations, which have not yet been signed, will apply, not only to accidents in the United Kingdom, but to any accident to British Aircraft registered in the British islands wherever it occurs, and they will require a notification to be sent immediately to the Air Ministry which will then take steps to examine the cause, and, if necessary, to carry out a formal investigation, assisted by assessors having aeronautical or other special knowledge. The Court of Investigation will have the power to summon such witnesses as may be necessary and to require them to furnish any information or documents which may be relevant. Up to the present investigation has been made through the courtesy of the companies and owners concerned.

During the 12 months ending 30th September 1921 imports into the United Kingdom were carried by air to the value of 512,060*l.*, and the value of exports (including re-exports) was 278,131*l.*; the bulk of the goods were carried between this country and France, but the major portion of them on other than British machines. I may mention here that arrangements have been made for the Civil Aviation Traffic Officer at Lympne to act on behalf of the Customs Officer when the latter is off duty, and the Civil Aviation Traffic Officers at Croydon and Lympne have also been appointed Immigration Officers and carry out the inspection of alien passengers.

The developments in wireless telegraphy and other signal work are worthy of mention; direction-finding stations, working in conjunc-

tion, have been established at Croydon and Pulham, and the combination of bearings from the two stations enables pilots to ascertain their exact position; improvements have been made in the system of ground signals at Biggin Hill and Croydon for indicating weather conditions, and the names of a considerable number of additional places have been marked in white chalk letters for the assistance of aviators; important steps have also been taken to facilitate night flying, and although regular night services have not been maintained, night flying has not been uncommon.

Before concluding this summary, I should also mention two definite attempts on the part of the Air Ministry to encourage research. The risk of fire after an aeroplane crash would be almost entirely eliminated if a safety petrol tank were so designed as to stand such a shock without either bursting or leaking, and for this prizes amounting to 2,000*l.* have been offered; substantial progress has also been made towards the successful solution of one of the chief problems of aeronautics, that of vertical flight by means of a helicopter.

[Although I am unable in this paper to devote much space to the work of the Meteorological Office, it is not because I in any way depreciate its value; the study of weather conditions must always remain a matter of the greatest importance to the airman, and it is, in fact, largely due to the research undertaken and the organisation set up by the Meteorological Office that adverse weather conditions are becoming less and less a hindrance to flying. Without attempting any thorough survey of the work (which is more fully reviewed in the Annual Report of the Meteorological Committee for 1921) I should like to refer to the great developments in weather telegraphy; before the war there was no National distribution or International exchange of meteorological information by wireless telegraphy and practically the only method was by telegram or in rare cases by telephone; now reports are collected from about eight stations in Great Britain by wireless telegraph and, supplemented by reports obtained in other ways, are distributed hourly by broadcast wireless from the Air Ministry. General inferences indicating the meteorological distribution for the British Isles are issued twice daily, and collective messages giving the results of observation at about twenty British stations, four times a day. Special forecasts are issued for the cross-Channel Services. Nearly every European country now issues reports, at least once a day, giving the results of observations at a selection of stations; when the number of available wireless stations is increased, it should be by no means impossible to put into operation the scheme prepared by the International Convention for Aerial Navigation whereby a selection of all these reports in collective form would be issued from the Central National Office within 1½ hours of the time of observation. The study of magnetic disturbances is an important one; as an interesting instance of the difficulties in connection with the selection of suitable observatories, I may mention the serious effect which the electrification of the London railways has had on the records at Kew, rendering them unsuitable for the more important investigations.]

THE FOUNDATION OF A PROSPEROUS INDUSTRY.

These are some of the most material facts and figures relating to the progress of civil aviation. It would be idle to pretend that on a comparison the respective positions of this country and such others,

as France, the United States, and Germany can be considered as satisfactory. The disparity of effort is obvious. So much must be frankly admitted, and yet I do not think that a true estimate of the position can at this stage of development be reached merely by a comparison of facts and figures. It is necessary to look a little deeper and to endeavour to ascertain the foundations upon which they rest. Comparison has chiefly been made between the respective positions in France and in this country, and the question has been bluntly asked, whether, when the figures of the two are set side by side, the French nation or ourselves are right in the policy which each is pursuing; and that is not a question which can be usefully answered in a very few words. Many factors must be taken into account, and it is even possible that wisdom, or lack of wisdom, would not be held to lie wholly on one side or on the other. Each may be right in certain respects, but the question has been asked in that direct form, and it is to be hoped that the discussions at this Conference may help to elucidate the answer.

I said just now that the mere comparison of facts and figures is by no means as decisive as it may at first sight appear. It is true that more flying, indeed, much more flying, is being done in France at the present time than in this country; but that is not enough in itself to show that the French policy is right and ours is wrong. I cannot help believing that the great Aero Show at Paris last autumn must have given those responsible for aviation in France serious cause for consideration. The French have spent 33, and are about to spend 46, million francs on the subsidisation of civil aviation, and yet I find a fairly general agreement that in matters of design and construction, the French have not advanced to the extent that might have been expected. Both in some of the published comments upon the Paris Aero Show and in some of the private opinions of experienced visitors to it, one finds a recognition of this failure to advance, which is at least of much significance; and I was interested to observe that lessons have been drawn by outside commentators to the effect that we in this country, though our actual achievements in the air are smaller, are nevertheless proceeding upon lines which are sound in themselves and will ultimately produce the greatest commercial development. Certain, at any rate, it is that a lavish policy of subsidies, though it must produce immediate and even striking results in the way of miles flown and lines opened, may not really be successful in producing the permanent results which those who believe in the development of aerial transport wish to see firmly established. I will refer to this again before I conclude.

It must not be supposed that in what I have said above I have the least intention of criticising the policy which the French have adopted for themselves; I am only questioning whether it is one which should be applied to this country. What may suit the needs of one nation does not at all necessarily suit the needs of another. It may even be that the ends desired are not the same, or it may be that one nation, having an immediate object in view, thinks it well to take measures to achieve that, even though these measures may not greatly assist an ultimate object. We in this country, I am satisfied, should not be diverted by comparisons with other countries from what we conceive to be the best means to secure the object which best suits the interests of this country, and there is always a further difference with which we must reckon, namely, that national

characteristics are by no means the same, and that throughout our whole history it has been our characteristic to progress, perhaps, slowly, but at any rate surely. It does not suit our temperament to advance far in any commercial enterprise until we are satisfied as to the foundations. It seems to me, looking at it, therefore, from the British point of view, that of all the necessary factors in the successful development of the civil aircraft industry, the first and greatest must be the bringing about in the public mind of a sense of safety; in other words, the first requisite of civil aeroplanes must be their trustworthiness, and though I cannot claim to be able to pronounce technical judgments, nevertheless from all the information which comes to me, I personally feel no doubt whatever that in this respect British machines at the present time lead the field.

The importance of this side of the question cannot be over-emphasised when one considers the public mind. It seems to me to be very much the same necessity as made itself felt with regard to both the steam-engine and the motor. It is not so very long since it was quite possible to find people who were afraid to go in a railway train for fear of accidents; it is even now possible to find people—I had an amusing experience of this only the other day—who are terrified of going in a motor car. It is an everyday occurrence still to find people who regard a journey by aeroplane as, if not risky, at any rate, adventurous. That attitude must be changed if aerial transport is widely to develop. It must be borne in upon the public consciousness that travel by air is, in this twentieth century, a normal means of journeying, and that can only be done by ensuring before all else the trustworthiness of transport machines and maintaining this assurance over a long period of time. And in this connection there will inevitably be, as competition grows, a tendency to get the most possible out of the pilots employed; it must never be forgotten that the human factor has always to be reckoned with, and that an overworked pilot may reduce the factor of trustworthiness to which I have referred as the first essential of commercial prosperity.

THE CROSS-CHANNEL SERVICES.

Before I pass to the general question of the policy of this country, I think I should deal specially with the question of subsidies for the cross-Channel Services. To some extent they are the principal subject with which the Government are in this respect concerned, and, as I am the Chairman of the Committee which has investigated them and framed the conditions concerning them, I bear a direct responsibility for the policy adopted.

I need not go over back history to this audience, except by the briefest summary. You will remember that in March of last year it became evident that the largely increased subsidies being given to the French companies by the French Government were rendering it impossible, unless fresh measures were at once taken, for British firms to compete at all successfully. A temporary scheme, details of which were published in Command Paper 1521 of October, 1921, was drawn up which enabled Messrs. Handley Page and the Instone Air Line, who were then in a position to carry on a service, to continue throughout the summer. During the time that this was in operation, seven months in all, it is satisfactory to recall that the two British firms carried from London to Paris 2,356 passengers, and from Paris

to London 2,140, making a total of 4,496, whilst the French companies carried from London to Paris 1,861 passengers and from Paris to London, 2,081, making a total of 3,942. It is also interesting to note that the rough average of passengers carried by each British machine was six, and the average carried by each French machine, in the one case from London to Paris, was 1·5, and in the other from Paris to London, was 2·4; also that throughout the whole of this period there was no casualty on any British machine. The temporary scheme may, therefore, I think, be said to have been justified in achieving the object it had in view, namely, the maintenance of the cross-Channel services on an equality at least with the work of the French.

This scheme was in its essence temporary, and the Committee directed their attention beyond it to the formation of a scheme of a more permanent character. I do not think that I need trouble you by narrating the necessarily numerous details which make up this more permanent arrangement. They were made public at some length by me in a statement made in reply to questions in the House of Lords on the 27th of October last, and I need, I think, mention to-day three points only: the first, that it was found necessary to renew the temporary agreements with the two firms I have mentioned until the end of this present month, partly because the negotiations were unavoidably lengthy and it was obviously impossible for the Air Ministry to order the new machines that would be required until they had reached a satisfactory stage, and partly because the Government were anxious to meet the views of the firms as far as possible, and felt the reasonableness of their contention that it was disadvantageous to the success of a more permanent arrangement that it should come into operation at the beginning of the winter, more especially following on such a summer of unusually fine weather as we had last year.

The second point is that after the end of this month there will be operating on the London–Paris route three firms. The decision to approve one additional firm for the London–Paris route has been criticised in some quarters on grounds which I cannot think substantial, namely, that it will diminish the chances of commercial success for all three, and those who have made this criticism have at the same time put forward the view that it was a mistake to concentrate on the cross-Channel services alone the money available for subsidies. I think that these two criticisms are, to some extent, contradictory. The Committee based their approval of three firms upon a careful consideration of the volume of traffic which might reasonably be expected between London and Paris in the near future. They had to steer, of course, between limiting approval unduly and extending it too widely, and, after having all the facts and estimates in front of them, came to the conclusion that the traffic on this route might reasonably be expected to be sufficient to make the operation of three firms successful. The approval of this additional firm has, at any rate, the advantage that it has called into being one more aerial transport firm; I say the advantage because, whilst all three firms will have an equal chance of profiting by the subsidy, one of our needs to-day is to increase experience and promote the expansion of the civil aviation industry.

The Committee—to refer to the other line of criticism—took the view that it would be a mistake to spread the subsidy widely at present over other routes and that in order to ensure progress we

must concentrate, we must learn how to make one service a commercial success. I think it is apparent that the moment this has been done every other route lies open for development; and we chose the cross-Channel route because it is unquestionably the most important. It suffers admittedly under the disadvantage from a commercial point of view of competing with the subsidised French companies, but the traffic upon it is much heavier than upon any other which may at the present time be imagined; and, further, it leads to the continent and links up with the trans-continental lines. I think two things will be generally admitted, the first, that the preservation of this service was an absolute necessity, and the second, that we must look to routes across the sea for the adequate development of aerial transport. This country suffers under certain disadvantages. It lies on the north-west of Europe, so that—unless and until aeroplanes can safely negotiate the Atlantic—expansion of transit by aeroplane is restricted to the south and east. It is small; it is covered with an admirable railway system, and, finally, the English weather has been too often a matter for jocularity for further reference to it to be necessary: in spite of last summer, it is usually easy enough to appreciate the remark that worshippers of the sun come to England for the purpose of taking a holiday from their religious exercises. The maintenance of the cross-Channel services provides a daily demonstration of the practicability of regular aerial transport in such a manner as to bring it home continually and pointedly to the public in this country, and that, I must insist, is the fundamental necessity in the development of a healthy industry. For anything commercial to be adjudged successful by the British its practicability must be impressed upon them by actual demonstration over a considerable period of time. If it has done nothing else since March last, the maintenance of regular cross-Channel services has, at least, done this: it has converted many people, previously sceptical, or at least indifferent, to a belief in the future of the air, and it has caused many, who have not yet themselves taken advantage of it, to hear of the rapidity and success of aerial transport from relatives and friends who have.

The third point with regard to the more permanent scheme for these services which I think I should mention is the consideration which was given to the question of the return to the Air Ministry of machines used by the firms. It has always been charged against any policy of subsidisation that it might result in the maintenance in the air of obsolete or obsolescent machines. That is a real danger, with regard to which the interests of the firms and the interest of the Government were identical, the object of the former being to have the use of the best machines available, and our object being to expedite the evolution of the ideal type of civil aeroplane. It has not been an easy matter to arrange. It is obvious that it involves financial considerations which had to be closely watched, but the Government has now been able to agree, for the present year at any rate, that machines, if returned in an airworthy condition, will be taken back after only nine monthly payments of 2½ per cent. of their value, in order that they may be replaced by the latest types of machines, if the Air Ministry is satisfied that the change is desirable from the point of view of forwarding design and construction.

I do not wish to pretend that the arrangements entered into are beyond the reach of criticism; I am not so much concerned to-day

with the task of defending them as with that of explaining them. Their wisdom, therefore, is open to discussion during this Conference. At the same time I should feel that I had ill discharged my duties as Chairman of the Committee which framed them if I did not say that in view of all three members of the Committee, namely, myself, Sir James Stevenson, and the Controller-General of Civil Aviation, the arrangements come to, whether ideal or not, are, at any rate, the only ones which in actual practice could achieve their object at the present time; in other words, the Committee took a great deal of evidence, both from the firms interested, and from others of experience in the civil aviation industry, and as a result thrashed out with considerable care the only conditions which would be adjudged satisfactory, not only from the point of view of the firms approved, but also from that of Government finance. I have seen it stated that it would have been possible to have come to arrangements by which, with half the sum involved, these cross-Channel services could be maintained. That is not in accordance with the facts; the figures produced by the firms were sufficient to show that if we had offered less they would not have been in a position to carry on successfully. I ought, perhaps, in view of the statement to which I have referred, to remind you that of the 200,000*l.* allocated to these services, approximately one-half will be spent in the purchase of new machines.

So much, then, for the moment, in respect to these subsidies. They are necessary because we are asking firms to compete with the French subsidies, and because we deem it essential that the British cross-Channel services shall be maintained. It is to be expected that under the arrangements to come into force at the beginning of this next month the firms will be able to develop successfully, but, of course, it must be admitted that though the service across the English Channel is of the first importance, it is not the only service which one would like to see. Personally, if it were in any way financially possible, I should like to see established also a service across the Irish Channel: it is, perhaps, of no less importance from a psychological point of view, to do away with the idea of the sea lying between England and Ireland. That that will come in due course I have no doubt, and I should like to see it come soon; at the same time it would be misleading to suggest that I see any definite hope of its establishment in the immediate future.

IMPERIAL AIR SERVICES.

I want to pass now to broader aspects. It is inevitable that a great deal of public attention should have been directed to the question of the establishment of Imperial Air Services, whether these be by airship or aeroplane. I have already referred to the position as regards airships; I must now say something with regard to aeroplanes. One difference between the two kinds of service must strike everyone, namely, that the stages of a route flown by aeroplanes must be a good deal shorter than those on a route flown by airships. This is a necessary consequence of the difference in the capabilities of each to which I drew attention earlier in this paper. I suppose that the distance which can be covered by an aeroplane most satisfactorily in a single commercial flight, having regard to all the factors and to the very important question of the endurance of the pilot, will be variously estimated. I have seen it stated that a stage of 250 miles was a length which might be taken as a general average; perhaps this is

too low an estimate to-day; but at any rate it is clear that in the establishment of any Imperial service by aeroplane we are confronted at the outset by the necessity for a large number of relay stations, to say nothing of emergency landing-grounds. The establishment and upkeep of such stations, if established and maintained solely for the purposes of an imperial route, must inevitably impose overhead charges of such magnitude that it is hardly possible to visualise commercial success; and it is obvious that in the least civilised parts of the Empire the necessary stations would have to be *ad hoc* stations. It is for this reason that the view has been expressed that for a considerable time, until at least the volume of traffic, by which I mean the carriage of goods as well as of passengers, has increased to a much greater extent than could be expected in the immediate future, the establishment of these routes must be primarily undertaken by the Royal Air Force; in other words that, however valuable they may be from the point of view of imperial inter-communications, they are not yet a commercial proposition. I feel I must confess, considerable sympathy with that view. From the point of view of the Government, although the desirability of opening the routes to commercial services should be constantly borne in mind, the first necessity is to effect the linking up of the different areas of Royal Air Force squadrons and, when that has been effected, we shall have stations established at convenient stages, in connection with which, or it may be beside which, civilian stations can be successfully established and economically protected. The process of linking up the stations established for service purposes is steadily continuing, and it may be, therefore, that the time is not far distant when an imperial route for civilian and commercial purposes can be established with a prospect of commercial success. At the present time, however, it would inevitably have to depend on substantial assistance from the Government, and I question whether, in the present state of public finances, there would be, apart from a comparatively small body of air enthusiasts, any general support for the expenditure of public money in this direction.

AIR MAILS.

I have not, so far, referred to the subject of air mails, as I feel that it makes for a clearer survey to deal with that separately. It forms, however, of course a very important, perhaps even a fundamental, part of the problem. Perhaps I had better begin by a reference to the development of regular air services in various parts of the world. The United States Government was for some time the only state which itself operated an air mail service, and the extent to which the trans-continental service was used bears testimony to the possibilities in this direction, as applied to traversing great land distances; nearly 45 million pieces of mail were carried in the year ended 30th June, 1921, and this was in addition to large quantities carried on other routes by non-subsidised commercial companies, as, for example, across the Florida Strait between Cuba and the mainland.

Australia recently entered into important contracts with commercial companies involving the carriage of mails by air on a large scale; the companies were to receive a subsidy in consideration of their maintaining regular services.

The Newfoundland Post Office authorities at St. Johns are, I understand, contemplating the operation of a service in the northern

part of the island, although nothing has come of it as yet, and the Maltese Government have also expressed themselves willing to consider tenders for an air mail service between Malta and Syracuse as an alternative to the steamer service. Mails are in some cases carried on routes operated by service aircraft, as between Cairo and Baghdad, where a fee of 6*d*. per oz. is charged. The special fees for letters posted in the United Kingdom vary from 2*d*. per oz. for the London to Paris service to 5*d*. for ½ oz. (and higher charges for heavier packets) for those intended for transmission to Morocco by air from Toulouse.

In considering the utility of air mails I think it should be pointed out that probably a fairer indication would be given if the question asked were to be, not "how much earlier will a letter posted for transmission by air mail reach its destination," but rather "how much earlier would it have been necessary for me to post a letter for transmission by the ordinary services in order to reach its destination at the same time as the letter which I am now sending by air"; judged in this way the saving in time is often not so striking. During the 12 months ended 30th September last, 102,240 letters were posted for outward transmission by the cross-Channel air services, and of these 63,340 were for Paris. The numbers carried in the opposite direction were rather less. The use of the air services for the carriage of parcel post packets is an important development; it is now possible greatly to accelerate the delivery of parcels to Paris by paying the special additional fee of 9*d*. a lb.; the parcels are normally delivered by the transport company's agent on the day of despatch from London.

It will be seen from the above brief statement of activities that the world is waking up to the potentialities of the transit of mails by air. The first necessity in any system of such transit must, it seems to me, be regularity of service; this is a necessity emphasised by the General Post Office, and I am sure that in this they are right. To a great extent this has been gained in that 95 per cent. of the flights on the London–Paris mail service between 1st April and 30th September, 1921, were completed in less than 4 hours from the scheduled time of starting. At the same time it will be seen that no very substantial advantage, though advantage to a certain extent there must naturally be, is gained from the point of view of the General Post Office by the more speedy transit of mails across the Channel by day flights. Mails so sent could not reach their destination until the close of business, and if despatched by the ordinary method, they would still arrive at their destination in time to be dealt with together with the air mails on the re-opening of business next morning. For the cross-Channel air mails, therefore, the development of night flying is necessary. If a business man could post his letters in the evening and be assured that they would reach his French correspondent early next morning, then, indeed, he would see the advantages of the cross-Channel air mails service. One must not, of course, confine the expression "mail" to letters alone; by it should rightly be understood postal packets generally in addition. And I think I should in this connection refer to one factor of considerable importance in the development of the aerial transport of goods generally, and that is that the advantage of the much speedier carriage is to a great extent lost if the goods in question are delayed at their destination by Customs House requirements. To promote an increase of goods carried by air there must be some arrangements made by which such

goods, on their arrival, are quickly passed through the Customs and forwarded to their respective destinations.

On the general question of mails I have not found that the General Post Office deserves some of the more harsh criticisms which have been passed upon its officials. Their interest in this matter and the interest of the believers in the air are one and the same. It is obvious that if there can be secured a regularity of service, they will desire to take advantage of it in just the same way as in time past they changed from sending mails by road when the coming of the railways opened up a sure and much speedier method. It seems to me that there are two sides to be considered. As long as it costs more to send a letter by air, the General Post Office must, in addition to the question of regularity of service, be assured that there are a sufficient number of people who are willing to pay that extra sum in order to obtain more rapid communication.

But the further question, which is really the other side of the attitude towards aerial transport, which may reasonably be expected of the General Post Office, is the question of charges. At present more is charged for mails travelling by air than by land and sea. If once it can be shown that mails can be borne by air at approximately the same charges as they can be borne by land and sea and a good deal quicker, then there is no possible reason to doubt that, always provided the essential requisite of regularity of service is secured, that will be the method the General Post Office will normally adopt. If, in the future, a man can send a letter to India and receive his answer in, say, a third of the time that is now required, and at approximately the same cost, it is perfectly certain that there will be many more letters going, and that the revenue of the General Post Office will be proportionately increased. So that I put these two requirements, regularity and cheapness, as the twin pillars of any real development of the transit of mails by air. The first underlies all civil aviation and every effort must be made to secure it; the second is a matter which, I feel, now deserves full examination; I will indicate in a moment one manner in which it will receive it.

CIVIL AVIATION AND COMMERCE.

But before I do so I think that I should for a few moments turn to the consideration of the general relations between civil aviation and commerce. At present it is hardly too much to say that they are distinctly poor; there is no real sign that business brains in this country have yet taken into serious consideration the degree to which the air may be utilised for the purposes of their businesses. I hope that in our discussions here consideration will be given to this. What we need more than anything else is a review by each great industry of the possibilities of assistance which the air can bring to it. It is not possible for me to take the different industries and make suggestions; I have not the requisite knowledge of the particular needs and problems connected with each, with one possible exception, namely, the great industry comprised by the word journalism. Some time ago, before the war, I did have the experience of several years' practical work on a great newspaper, and I should like to give from that some illustration of what I have in mind in suggesting consideration of air possibilities by each industry. In some, no doubt, the factor of time is relatively unimportant, though in all it must be

taken into account. In others it is of prime importance; certainly it is in the work of a newspaper. One remembers so well the great rush in the early hours of the morning to complete the various editions in time to catch the various trains; a missed train meant, of course, a direct and immediate loss. It seems to me, looking back upon that time, that here we have, as soon as any regularity can be guaranteed in night flying, a very good illustration of the way in which the aeroplane can be employed in industry, and even to-day I am a little surprised that some of the great newspapers, whose keen interest in the future of the air we gratefully recognise, have not, if only as a matter of advertisement, regularly employed the aeroplane to some extent, at any rate, in connection with their early editions. The advantages are so obvious that I need not elaborate them; by air and by air alone, we could, if we happened to be readers of that paper, have "The Times" to read at breakfast, even if we happened to be in the north of Scotland.

[We had one tentative example of what can be achieved during the railway strike of 1920, and investigations into further possibilities have from time to time been made when for any reason recently the railway services have been temporarily curtailed. But the cost of any scheme brought temporarily into operation must always be far higher than the cost of one established on a basis intended to be permanent, and no indication of what could be achieved can, therefore, be gathered from such sporadic attempts. We shall really only begin to make decided progress when the business community as a whole begins to go seriously into the cost and practicabilities of meeting their constant need of the speediest means of transport by making use of the air.]

THE POLICY OF SUBSIDIZATION.

On the general question of aerial development I notice that some critics of the attitude adopted by the Government have endeavoured to draw a distinction between promise and performance. They have for the most part freely admitted that the objects of the Air Ministry are to promote the establishment of a prosperous civil aviation industry at as early a date as possible; but they have not been so satisfied that the means taken to that end have been all that could be desired. Probably the action of any Ministry in any Government falls short of what enthusiasts consider desirable; but in this particular connection it is noteworthy that in nearly every case I have been able to examine the critics, consciously or unconsciously, have based their comments upon an illusory view of the present situation; I mean, they have wished the Government to do a great deal more in ways that would cost the taxpayer a great deal more money. It is always possible for any enthusiast to take what I might call a telescopic view; that is to say, he can bring a distant object nearer by a concentration of vision which excludes consideration of the situation which immediately surrounds him. I need hardly dwell to-day upon the extreme necessity for public economy, and I was much heartened when I found that, on the assumption that it was idle to expect that at the present time more money could be devoted to the subsidization of civil aviation, a keen and experienced critic admitted to me that he found it difficult to see what further action the Air Ministry could take. I think that this is an assumption which must be made. It is

hardly fair to contrast the greater amount of flying which is being done by the French to-day with that which is being done by this country, unless one is prepared to support the allocation by the British Government of sums similar to those which are being allocated by the French Government; I am sure that no degree of public support would be given to such a proposal. This country is endeavouring to pay its way and must, if it is to achieve that, postpone expenditure on many things in themselves highly desirable. This, which is a simple truism, receives additional emphasis in respect of civil aviation when we remember, first, that a comparison with the French effort is a comparison of two things fundamentally different in their purpose, and, secondly, that it is by no means certain that subsidization on a wide scale would achieve the establishment of a prosperous industry.

I was interested to observe that a French writer, in a recent article written in defence of the results of the Paris Aero Show against some of the criticisms which had been passed upon it, especially upon its comparative failure as evidence of new design, made some striking admissions of the errors into which the earlier policy of subsidization had led the French Government. For example, he said, "it has been found that in 1920 several companies had made no efforts to attract business and more frequently than not carried out flights with empty machines," whilst of the whole of what he describes as "this delicate problem," that is to say, of subsidies, he says, "it opens up a vast field for discussion, controversy, and incidentally intrigue." The French have shown themselves conscious of some of the pitfalls inherent in any policy of subsidization and have made considerable alterations in the conditions since their subsidies were first instituted; but even of the present regulations this French writer has some significant things to say. For example, of the petrol subsidy he says, "the new subsidy stifles initiative in the firms concerned since they are free from all anxiety in regard to the price of petrol." And he further states that "the present regulations have been drawn up more with an eye to existing machines than to future construction." I think, therefore, that the Government would require much greater justification than a mere comparison between figures of flight for France and this country before they engaged in a similar policy. There would have to be not merely much greater agreement as to the degree to which subsidies can assist the permanent health of the industry, but also a substantial public desire for the expenditure of large sums in this direction.

THE CIVIL AVIATION ADVISORY BOARD.

I am far, however, from wishing to conclude on any such note, necessary as it is to strike it. I stated a little while back that I would indicate one manner in which the present cost and practicability generally of an Imperial air mail service would receive examination. I have the authority of the Secretary of State for Air for giving that indication to-day. It has been decided that on the difficult problems in connection with the development of civil aviation as a whole there is need for a body acting in close relations with the Air Ministry and at the same time representative of the great interests concerned, to advise generally upon such development or to report specifically upon any question which may be referred to it. The Advisory Committee on

Civil Aviation presided over by Lord Weir gave very distinguished help in the past, and it has now been thought well to perpetuate the basic idea underlying the formation of that Committee. There will, therefore, be set up a body which will be known as the Civil Aviation Advisory Board, the Chairman of which will be the Under-Secretary of State for Air and the membership of which will comprise the Controller-General of Civil Aviation, the Director-General of Supply and Research, together with, it is hoped, representatives of the General Post Office, the Associated Chambers of Commerce, Lloyds, the Royal Aeronautical Society, the Air League of the British Empire, the Royal Aero Club, and the Society of British Aircraft Constructors; in addition, the most convenient way of securing representation of the Dominions and Crown Colonies is being considered, and they will in any event be consulted whenever the interests of any are concerned. I am further authorised to say that the Secretary of State has decided to refer to this Advisory Board, as the first subject upon which he desires its recommendations, the question of the cost and practicability of an Imperial air mail service.

There will be many other questions upon which it is believed that the recommendations of such a Board, which it is intended shall meet with some regularity, will be of the utmost value to the Air Ministry. Possibly one direction in which it can give general assistance will be that to which I have referred more than once in this paper and upon which I lay the greatest emphasis of all. I cannot express it better than by quoting the words used by Mr. Holt Thomas in a letter published in "The Times" on the 25th November last, immediately after his experience of the first International Congress on the navigation of the air in Paris. He wrote: "Convinced as I have been for the last fifteen years of the importance of aviation to this country, I return from France with a still stronger conviction that this country must, by hook or by crook, be led to appreciate the enormous importance of aviation, and especially, at this time, of civil aviation, to the British Empire." With that conviction I express myself in entire agreement; but the creation of this conviction, I must repeat, is a task in which a Government Ministry can to some extent assist but which it cannot successfully itself undertake. That must be done by the recognition of the possibilities of the air by the business community. I am certain that passenger traffic, important as it is, is not so essential to the health of civil aviation as an industry as the transport of goods, and if we are to take advantage of the great exploits performed by British airmen in the war and of our needs and opportunities as an island Empire, we do require first and foremost the establishment in the public mind of the realization of aerial commercial possibilities. Whether we look forward with M. Louis Bréguet to a day when an aeroplane will be able to travel at a rate of 1,200 kilometres an hour—faster, that is, than the movement of the earth—or whether we confine ourselves to the actual, the proved possibilities of aerial transport, in either case, we need above all else as a nation a changed attitude of mind, a general recognition that science has now brought to the race of man two more servants, the airship and the aeroplane—in which word I also include seaplane—and that, in the words which Lord Montagu of Beaulieu has put with graphic poetry into the mouth of the latter:—

"Thus doth He send me for Warfare, for Peace, for the ultimate good

Of the nations willing to woo me and fathom my every mood,
That the end may be won by courage, as it was since the world began,
To give the New Dominion of the wayward air to man."

The CHAIRMAN: The second paper on the Agenda is entitled, "Aerial Transport To-day and To-morrow," and is to be read by Lt.-Col. W. A. BRISTOW, M.I.M.E., M.I.A.E., F.R.Ae.S.

AERIAL TRANSPORT TO-DAY AND TO-MORROW.

Lt.-Col. W. A. BRISTOW, M.I.M.E., M.I.A.E., F.R.Ae.S.: Captain Guest, my Lords and Gentlemen; It is a matter of some little difficulty to write in a practical manner of the future of aerial transport owing to the lack of sufficient data upon which arguments can be based or from which conclusions may safely be drawn. This difficulty exists in every department of the subject, both on the technical and commercial sides and in consequence our ideas of the future must to a very large extent be founded on a mixed basis of theory, practice and imagination.

It is impossible, for example, to give schedules of operating costs that could be taken as a guide to the future, as no company in the world has yet run with a complete fleet of aeroplanes and engines such as are considered to-day to be satisfactory for the purpose, neither can we consider that many other important factors are in a satisfactory condition.

It is probably a fair statement that commercial aviation has up to the present been little more than full scale experiment with apparatus largely of a makeshift and temporary character. In spite of these limitations, however, the results have been of an extremely interesting and valuable character, and this audience will doubtless agree that the very greatest credit is due to those who have in face of serious difficulties carried ever increasing loads with factors of regularity and safety of a high order.

CHAPTER I.

Before attempting to deal with the subject in detail it may be as well to examine briefly some of the main outstanding features of the present situation.

In the first place we have to recognise that at present it is not possible to carry on the business without a subsidy in some form or other, and therefore the character, allocation, and working of the subsidy system will have a most important effect on development.

As you are all aware, there has been considerable discussion as to the merits and demerits of the present system, although after hearing much of the criticisms you might be excused for wondering whether there were any merits in it at all.

In the first place it has been said that it is a mistake to confine the operations of subsidised services to the London-Paris route and that there are many other routes which are capable of yielding equally good results.

As a result, however, of close practical acquaintanceship with the working of several of the present air lines, I am convinced that a better route could not have been chosen, and that it possesses inherent advantages not to be found elsewhere. In the first place it is about

the right length for severity of test, the wide strip of water necessitates a high standard of reliability and the rapidly fluctuating weather conditions along the whole route absolutely compel the rapid development of the two great guardian services of aviation, namely, meteorology and wireless telegraphy and telephony. In addition the two termini and the general operations on the route are controlled by different countries with different ideas and methods, and no doubt much of the progress that has been made is due to the mutually instructive effect obtained by such an arrangement. Regarded as an experimental laboratory for the instruction of designers, constructors and operators, an international route is almost bound to be of far greater value than any purely national one.

From a commercial standpoint also the London–Paris route has very great advantages. The actual journey by land and water with its changes, delays and vexatious examinations, is rendered far more troublesome than its mere length would indicate, and very few people who have experienced the convenience and speed that can be obtained on this route in any reasonably suitable aeroplane will feel inclined to revert to the old means of travel.

Further, the number of potential passengers is enormous and in addition to the subjects of the two countries there are the scores of thousands of travellers and visitors from every country in the world who yearly pass between the two capitals. Many of these gain their first experience of air travel between London and Paris and it is highly probable that they would not have the opportunity of obtaining it elsewhere. Consequently, but for this route being open we should lose the services of a great number of important and unpaid missionaries, who, if satisfied, will secure for us an ever increasing number of passengers apart from the value of their propaganda work to the general cause of British aviation abroad.

There are, of course, hundreds of routes within the Empire that could be opened up to air traffic with advantage, but it is considered that success in these will best be assured by first hammering out the many technical and commercial difficulties on our own doorstep, and the Paris–London route for the various reasons given is in the author's opinion specially suitable for this purpose.

The question that next arises is as to whom the subsidy should be given, and the decision to increase the number of firms on the London–Paris route from two to three has been somewhat criticised. This audience does not need to be told of the remarkable success of the British companies in 1921, and they and their supporters can be excused for feeling a little unhappy at the addition to their number bearing in mind the total number of passengers likely to be available next year. Such feeling of uneasiness will, however, in my opinion be completely dissipated if the question is regarded in its wider aspect.

What are the objects in view for which the subsidy is granted? As I see them, their order is: firstly, to promote and encourage British aerial transport undertakings and particularly in order that they shall be enabled to put up a fight against the very powerful and heavily subsidised competition of the French; and, secondly, to help us keep in existence some of the very valuable designing and constructional staffs we had in 1918. But, behind all this, is the real and vital question of the value of a commercial aviation industry in connection with the defence of the country. Progress in flying generally and especially in connection with the design of machines

and engines, depends largely upon actual flying experience and already we see most of the flying all over the world being done by commercial aircraft. Progress in designing military aircraft is, therefore, to an important extent directly dependent upon the rate of evolution of the commercial side. Further, and this is of vital importance, it is considered that progress can only be continuous if the ranks of aeronautical engineers are constantly replenished with new blood.

Why is it that the design of British ships, turbines, locomotives, internal combustion engines and big electrical plant has progressed with ever increasing vigour during the last few decades and that these products of our shops and yards are to be found in every part of the globe? It is because each of the branches of engineering concerned with the design and manufacture of these things holds out attractive commercial prospects to the brains of the next generation, and thus have come into being the various important professions of naval architects, civil, mechanical, electrical and automobile engineers, whose serried ranks wage ceaseless war for efficiency and progress.

It is hardly possible that the profession of aeronautical engineering can be built up on the requirements of military aircraft alone, so that it may well be that the future superiority of our naval and military air fleets will depend mainly upon the growth of commercial aviation, although the actual difference between civil and military aircraft may be as great as that between a "Hood" and a "Mauretania."

The nation is beginning to realise that our position as a naval and military power is undergoing a radical change, and that without adequate air power we cannot expect to maintain the Empire. France and Germany both realise this, and at the moment the French are actively staking out their claims on every airway of importance on a vast field bounded by Brussels, London, Warsaw, Northern Africa and Constantinople, whilst Germany is concentrating on research and experiment on a most extensive scale. Once the latter is free to establish air fleets for service abroad she will undoubtedly make strenuous efforts to become the greatest air power in Europe, if not in the world. We cannot disguise the fact that technically and geographically Germany is in the strongest possible position for accomplishing this purpose, and we, undoubtedly, must think of the day when German air lines will radiate from Berlin over the whole of Europe and probably a part of Asia in addition. Already one of the largest firms of aircraft manufacturers in Germany has concluded an agreement with the Russian Government whereby they jointly run a very large factory in St. Petersburg and halve the profits.

Germany knows, and France knows, that the future history of Europe will depend, to a very considerable extent, on the distribution of aerial power, and if we are to retain anything like our present position it is absolutely imperative that we develop our commercial air fleets by every means at our disposal. Cutting down our expenditure on the Air Force and commercial aviation may render possible some trifling reduction in the income tax, but that will be of little comfort if, as a result of the next war, the income itself disappears.

This is rather a long digression, but it all relates to the question of the number of firms to be subsidised, and I think this audience will agree that all the objects in view will be furthered by the addition of suitable firms to the list of operating companies. Even looked at from the narrowest standpoint the possible loss of a few pasengers by

the existing companies may be amply compensated for by the additional experience that will be gained.

It is not meant, of course, that such expansion of numbers can be continued indefinitely, or that anybody should receive the subsidy. Much harm can be done and indeed has been done, by firms operating without the necessary skill or a knowledge of even the fundamental axioms upon which successful operation is based. I feel sure, however, and I think this audience will agree with me, that we need have little fear but that British aviation on the London–Paris services will be worthily represented this year by the firms chosen, and that the policy of adding to the number operating is sound and in the best interests of all concerned.

The Air Ministry having provided very largely the ways and means, it now remains with the operating companies to examine carefully the results of past operations with a view to devising means for a more successful solution of the many problems to be solved before commercial aviation can be regarded as a permanent item in our social and industrial life.

CHAPTER II.

The first item that has to be recognised—in fact, it does not wait to be recognised—is the impossibility of at present making anything but a financial loss from the operation of commercial aircraft, although on paper it can be shown with comparative ease that the conveyance of passengers and goods by air can be attended with the happiest financial results even without the assistance of a subsidy. It is so tempting to work out the cost of petrol and oil for four trips per machine per day, deduct it from the gross receipts, calculated upon the assumption that the machines are always full, and out of the handsome balance provide for maintenance and depreciation and a dividend of 200 per cent. per annum.

In practice, however, it works out very differently, and operating companies are usually to be found, pruning-knife in hand, attacking every form of expenditure in order, not that the profit may be increased, but that the losses may be reduced. With the aid of the present subsidy schemes in Europe some air transport companies may be showing a profit, but in analysing the real position it is, of course, necessary to omit the subsidy items from the accounts, justifiable and essential though they will be for the next few years.

What, then, must be accomplished in order that a heavy loss can be converted into a profit, and, moreover, with such a reasonable certainty as will from time to time ensure the supply of such new capital as will allow the industry to be properly maintained and expanded? The whole future of the aircraft industry, the aerial transport companies, our national defence, and even the future of the Empire may depend upon our ability to answer this question correctly, and it may be as well at once to examine the various means proposed as an amelioration of the present position.

Since the first days of air transport it has been apparent that the very heavy interest and depreciation charges in respect to the fleet can only be met by keeping the machines constantly in the air with paying loads. This year it has been reported that we are to see an aeroplane doing three or four London–Paris trips in a single day. It is not seen, however, that this will solve the problem; if, for example, two machines are worked on a schedule that keeps them

going all day, it will only be possible to maintain the necessary regularity, and all the operational advantages that are allied to regularity, by maintaining at least one spare machine on each side. A 100 per cent. reserve fleet would then be necessary, and would, theoretically, always be idle; it would seem, therefore, to be just as economical to work the four machines on half time; and, in any case, in several months of the year, weather and lack of light prevent more than one journey per machine per day, or two at the most.

Designers and constructors of aircraft and aircraft engines approach the subject from another standpoint, and are bending their energies to effect improvements which have for their object an increase of the paying load in relation to the fuel consumed and the cost of maintenance and operation. Such work is of the utmost importance, and progress will be vitally affected by the degree of success that is achieved in these directions.

It is clearly impossible, however, to wipe out all the loss by improvements in thermal and aerodynamic efficiencies. Engines already closely approach the limit of thermal efficiency, and he would be a bold designer who would guarantee actually to produce aeroplanes even 15 per cent. more efficient than the best of those existing to-day. I see no immediate hope, therefore, that the work of the aircraft designer will enable the loss to be turned into a profit. Of course improvements in equipment, organisation and methods of operation are all most valuable, and must on no account be neglected, but the sum of them all will not be sufficient to turn the scale.

If civil aviation, therefore, is to have any future, what *is* required? In the author's opinion there is only one answer: passengers, and yet more passengers. Given even a moderate percentage of the travelling public, civil aviation, it is consi ered, could be made to pay its own way within the next five or six years.

It is true that last year showed a welcome increase, and that this year may see a still further advance in the total number of passengers carried; but as the excess will be shared by some seven or eight companies, it is extremely doubtful if the nett increase per company will be anything material. Furthermore, if the weather is not so good as that of last year, the total number carried may be even less.

The regular and safe transport of passengers by air demands a highly-skilled staff; but in addition to the overhaul and maintenance staff, which will have to be increased as the number of passengers increases, although not in the same proportion, there are those engaged in the management and operation of the commercial side of the business, and also those responsible for superintending the actual working of the fleet.

What other class of transport company could afford to keep a staff of such proportions for less than 50 passengers per week, taken as an average, over a whole year? In some undertakings the total number of persons employed in the working of the fleet is greater than the weekly average of passengers carried. No other form of transport could live for long under such conditions, however efficient their vehicles or methods.

This small number of passengers, in addition to raising inordinately the percentage of overhead and other charges per passeng r, actually hampers the efficient working of the fleet in several important respects; for example, the necessary smallness of the fleet limits the number of departures that can be made during any one day and the consequent

inelasticity as to times of departure and space available, renders the fleet incapable of adequately dealing with traffic out of the normal.

It is very difficult at this early stage to form any exact opinion as to the minimum number of passengers that should be carried per week. Incidentally, the aerial week will probably have to consist of seven days, as in every other transport undertaking. To cease work on Sundays, in addition to inconveniencing the public and delaying the expansion of the business, causes a loss of 14½ per cent. per year on the working time, thus further raising the cost per flying hour.

On the basis of a week of seven days, the author has formed the opinion that the minimum number of passengers necessary weekly for the profitable operation of any one company is not less than about 500, and those must be carried in the most efficient machines, operated by an exceedingly skilled and highly-organised personnel. There are, undoubtedly, many who will consider this figure excessive, but probably few will dispute the statement that the present numbers must be increased several times over before the business of aerial transport can be carried on at a profit without the assistance of subsidies.

CHAPTER III.

By what means, then, are we to attract the far greater number of passengers required? It cannot be said at present that there is any real concerted effort being made by the companies to attract the public. Much of the advertising and propaganda is aimed at securing as large a share as possible of the numbers already travelling, and but little, if any, to encourage the general use of the airway. Before we can answer the question as to how the increase is to be obtained it will be necessary to try and form some idea as to the main reasons that keep the public back.

It is considered that the chief reason lies almost wholly in the fact that insufficient attention has been concentrated upon the problem of making flying really safe, and, secondly, we have not made it look and feel as safe as it is. I am not now speaking of any one company, or even of any one country, but as a result of a close examination of the commercial air fleets of the world as a whole, and after talking with hundreds of passengers and timid enquirers after knowledge, I am forced to the conclusion that the question of safety is the most important, and the one most urgently calling for treatment if even a moderate proportion of the travelling public is to be converted.

We are rather apt to think that the public know little of the factors determining safety in flight, and that to them all aeroplanes are very much alike. Experience has shown this idea to be completely erroneous. The author has heard many conversations that show the contrary to be the case, and on more than one occasion has witnessed passengers refusing to travel on a machine which they did not consider either safe or sufficiently comfortable.

Factors affecting Safety.

Pilots.

The experience of last year has revealed several points that require serious attention, even although the number of fatalities and injuries was low, and in the case of the British cross-Channel services was actually nil. As, however, all companies have to suffer if anything impairs the confidence of the public, it is necessary to survey the

European services generally, and the operations of some have, undoubtedly, given cause for considerable misgiving. Probably the most serious cause of accidents has been lack of skill and judgment on the part of the pilots, although it is necessary at once to except British pilots from this generalisation. Our own pilots have, on the contrary, proved themselves over and over again to be exceptionally skilled and resourceful pilots and navigators, and it is impossible to praise their work too highly. I may be stirring up a hornets' nest with my friends in the Royal Air Force, but I am strongly of opinion that British commercial air pilots as a body are more highly-skilled than any other body of pilots in the world, be they naval, military, or civilian.

In America and other parts of the world, however, there is considerable room for improvement not only in the actual flying methods, but in the qualifications deemed necessary by the operating companies for pilots that are to be entrusted with passengers to be taken on long and difficult routes. It seems almost incredible, but it is a fact, that pilots are sent off with passengers on long routes over which they have never flown before, to land on aerodromes they have never seen. It is considered by many that the question of the training of suitable pilots is one calling for the most serious attention by all those concerned with the control and operation of commercial aerial transport.

Aeroplanes.

It is, of course, highly desirable to design aeroplanes capable of carrying the maximum possible useful load for a given horse-power which will be capable of being operated at a high speed with a minimum consumption of petrol and oil. As many in this audience well know, however, it is impossible to attain these ideals to their fullest extent and at the same time preserve the same factor of general safety, and if passengers, because it is not sufficiently safe, will not come forward in sufficient numbers to make the business pay, then the possession of the most money-saving aeroplane in the world does not place the owner in a very much better position.

Is it too much to ask that all aeroplanes used on, say, the London–Paris service, should be able to land and pull up with absolute safety almost anywhere in the country en route? If this cannot be done, then are we not bound to conclude that aerial transport is inherently much more dangerous than transport by land and sea?

How much is it that would have to be sacrificed in order to render machines capable of taking off quickly and landing safely and providing them with stronger under-carriages, with much greater shock-absorbing capacity, and capable of being brought to rest within 60 yards after touching the ground? There would, of course, have to be some sacrifice both in respect to top speed and percentage of useful load; but would it not be compensated for many times over if the public came in hundreds instead of tens?

It would have an immensely reassuring effect on the public mind if they knew that before a commercial aeroplane could receive a certificate of airworthiness it had to make, say, ten forced landings on a given route immediately upon receiving wireless instructions from the ground, and at moments selected entirely by the wireless operator. I venture to think that there are few who would care to accompany the machines on such a test, but the majority of pilots

in the course of a year will probably have to make some forced landings, and not always under the happiest conditions in regard to weather.

Aerodromes.

Sufficient attention has not yet been given in any country to the perfecting of the aerodromes in use. Even at Croydon and Le Bourget there are obvious improvements called for, but for some reason or another time drags on without the defects being remedied. There are few aerodromes in which it is possible to take-off with equal safety in any direction; it certainly is not the case at the two aerodromes just mentioned, and it appears almost easier nowadays to tear down a dynasty than half-a-dozen poplar trees.

We know that the aerodromes are provided by the various Governments helping civil aviation, and it is not desired to appear ungracious; but one is strongly tempted to wish that the various Governments had to obtain licenses for their aerodromes from some independent body before they could be used. Further, there is not a single public aerodrome properly equipped with apparatus by which loaded aeroplanes can be readily weighed or the position of their centre of gravity determined, and it is nothing short of remarkable that more accidents do not occur as the result of ignorance as to these two vital factors.

Meteorology and Wireless Services.

Experience shows these two services to be the twin guardians of safety in the highest possible degree. Times innumerable machines have been saved from danger by timely warning by wireless telephone of sudden changes in the weather conditions, apart from which, in a very large number of cases, it would not be possible to undertake the journeys at all if it were not for the meteorological information transmitted by wireless beforehand. During the past year the departments responsible for this work have made rapid strides towards perfecting their organisation and in enlarging its ambit, and I think I shall be voicing the views of many in the audience in returning thanks for all the help and friendly co-operation received from these two very important departments.

The services also of the Marconi Company and the constant work of their able staff on the development of wireless telephony has been of the very greatest value, and the improvements that have been made are of a most substantial and gratifying nature.

Any suggestions that have been made for the improvement of these two departments are generally concerned with a possible subdivision of the work in the wireless department. At present there is no wireless operator acting solely as watcher and guide to the machines in the air. At one moment an operator may be talking to a machine, and then for 15 minutes or more he may be engaged on transmitting or receiving weather reports or writing out messages. It is considered that the work should be divided, and one or two operators should do nothing but talk to machines in the air, keeping them posted all the time on weather conditions and other necessary information, giving them a bearing even in fine weather, and, in effect, helping the machines with all the meteorological and other information that becomes available as their journeys proceed. In view of the expected increase in traffic this year this question assumes a very real importance.

In the meteorological department one could sometimes wish for a little greater promptitude in the reports, and especially with the reports from French stations. Delays in these are probably due to some defect in the organisation on the other side, but whatever the cause, the resultant position is often very unsatisfactory.

On many occasions machines have had to leave this side only very scantily informed of the weather conditions existing over long stretches of the route in France, and in some cases with no information except some several hours old. As a result passengers have been landed in all sorts of out-of-the-way places. It is considered by the author that the safest policy is not to send passengers off unless and until complete reports are available, showing a safe route for navigation along its entire length; but this obvious desideratum cannot of course be obtained unless the meteorological and wireless departments on both sides of the Channel are working at 100 per cent. efficiency.

[*Greater apparent Safety.*

At present aeroplanes often do not look and sound as safe as they actually are. Many in this audience are thoroughly familiar with the noise of aeroplane engines; but the average man in the street taking to the air for the first time is often rendered extremely nervous by the unmuffled roar from engines giving hundreds of horse-power. Most passengers complain of deafness after a flight, and also of not being able to talk, except with the greatest difficulty, when en route. Further, the noise adversely affects the safety of the machine by reason of the fact that it prevents the pilot hearing any unusual noise in his engine, and also prevents him making full use of the wireless telephone. There are at least two proved types of efficient silencer available, which are easy to fit and low in cost, and it is hoped that this year may witness their general adoption. In some machines also there is an excessive amount of vibration that is very disconcerting, and which should be eliminated.

Pilots should, as far as possible, avoid any sudden alteration in position of the machine, and should also abstain from unnecessarily sharp turns involving undue banking. Suddenly shutting off the engine and gliding down en route in order to look at, for example, a machine on the ground has been known to have an alarming effect on the uninstructed passengers, and manœuvres of this character should be avoided; but if unavoidable they should be carried out as gradually as possible. A careful and considerate pilot can do much towards establishing the confidence of his passengers.

Many of them also do not like being seated in or near the line of the propellers in twin-engined machines. It may be quite all right, but it does not look safe, and many passengers also do not feel safe when sitting facing the tail of the machine. It is considered that every effort should be made to sit all the passengers facing forward with sufficient leg room, comfortable chairs and a clear outlook. It is fairly obvious that a comfortable, well-stowed passenger must feel infinitely safer than one sitting facing backwards on the edge of a small seat, with a view comprising only two propellers whirling within a few feet of his head.

Comfort.

In addition to the problem of increasing the safety and the apparent safety of flight there is the added difficulty of providing a machine

that can favourably compare with other forms of transport in the matter of comfort. Most passenger cabins are either too hot or too cold, and there does not appear to have been any serious endeavour to arrange for a sufficiency of fresh air without draughts. In some machines there is also a strong smell of hot oil which can have most unpleasant effects.

Lieut.-Colonel C. B. Heald, C.B.E., Medical Adviser, and Wing Commander Beatty, C.B.E., A.F.C., Deputy Controller, Department of Civil Aviation, Air Ministry, have carried out some very valuable experimental work in connection with the ventilation of aircraft, and with the data now available there is little excuse for the continuance of the discomfort and illness that has been caused in the past through inattention to these important questions. In machines fitted with water-cooled engines it should be a comparatively simple matter to fit specially light hot-water radiators in the cabins in parallel with the main engine cooling circuit, and with air-cooled engines a portion of the cooling air flow, not the exhaust, could be passed through light tubes.

Travelling to Paris a few weeks ago, the temperature in the machine was 32° F. for over two hours, in addition to which there were a few draughts of about 500 ft. per minute. After standing about at Le Bourget for ten minutes in a biting east wind and driving to Paris, the whole of the passengers had had enough, and several went back by train, for the sole reason that it was too cold to go by air. In this particular case, as in many others, the journey was made in the middle of the day, and most of the passengers had no food between breakfast and 4 o'clock in the afternoon. It would be an easy matter to provide small, cardboard boxes containing a little food and drink, especially at Croydon, where there is an hotel on the aerodrome.]

Luggage.

The difficulties in dealing with passengers' luggage have also to be surmounted before the travelling public can be diverted from the railways in the necessary numbers. In the past, about 30 lbs. weight has been allowed for free luggage, but as can easily be seen by watching the departure of the boat trains there are only a relatively small proportion of passengers whose luggage does not exceed this weight. In many cases it has been possible to take excess luggage on the aircraft, but this is a very expensive luxury. In some cases passengers' luggage has been put on other machines, which have been forced to land on the way, sometimes the companies have sent it by a special courier by rail, but these expedients cannot be continued indefinitely.

There is also the difficulty with regard to the size of the packages that can be taken. There is sometimes plenty of room in the fuselage but the doorway is too small. All these things may seem very trivial to the makers of the machines, but the inconvenience caused to the public and the operating companies is enormous. There was a pathetic tragedy at Croydon recently—a charming French bride in tears because all her hats had been left in Paris owing to the aeroplane doorway being 3 inches too small to allow the hat box to enter. This unfortunate lady, it is said, actually remained in her room at the Savoy for three days waiting for the box to arrive.

The author is of the opinion that the maximum weight of free luggage allowable must be raised, that the charge for excess luggage

must be reduced and that companies should not part a traveller from his baggage in any circumstances.

Landings en Route.

Another serious source of inconvenience to passengers is the delay that arises if they should be unfortunately landed anywhere else but at an aerodrome at which a Customs Officer is stationed.

First, the pilot must find a constable, who, on arrival, in effect arrests all the passengers and conveys them to the nearest police station, perhaps several miles away. Here they are put through their paces by the Superintendent, who then retires to consult his numerous notices and regulations in order to see the next move. He then proceeds to impound all the passports and send for the nearest Customs Officer, which may involve a hunt through all the hotels for miles around. After he has been found and has conducted his examination, passengers are free to proceed to the nearest main line and catch a train, if there is one left, but without their passports, which remain at the police station, from whence they are sent to some authority in London.

Incidents of this nature are bound to result in loss of business. Of course, the moral is obvious—don't come down on the way; but the weather and other factors are not yet sufficiently subdued to enable this excellent rule to be always observed.

This actual case is recommended to the notice of the authorities in the hope that something can be done to reduce the delay and inconvenience that so often accompanies what is obviously a perfectly *bonâ fide* forced landing of a well-known machine and pilot. Whilst there is to-day, perhaps, some little excuse for occasionally landing passengers at places other than their destination, yet it is certain that a continuance of this practice is bound to prejudice most seriously the future of the business.

The remedy is in the hands of many. Firstly, it is essential that we procure international co-operation with a view to improving the system of reporting the weather en route. It ought to be made impossible for pilots to have to land at all sorts of out-of-the-way places because of unforeseen weather conditions, and if bad weather comes up suddenly they should be warned by wireless in time to enable them to retrace their steps to the nearest aerodrome.

Designers also should sit down deliberately to design a bad weather aeroplane in which the probability of arrival at the proper destination is as great as in the case of, let us say, an Atlantic liner. Much improvement could be made if the principle involved were adopted. In such a machine, for example, amongst other important features great care would be devoted to the position of the compass and the wireless equipment, as a full and proper use of these has a most important bearing on the subject. Too often they have been regarded as of only minor importance, and the various units have been squeezed in after construction in the most unsatisfactory manner, and in which their potential usefulness has been reduced to almost negligible proportions.

Further, the operating companies themselves are divided into two distinct camps. There are those who consider that the public must have reliability and that this means reliability of departure; the other school of thought believes that reliability involves reliability of arrival, even though it may involve gaps in the programme of start. Some

booking agencies prefer the first method, as, if the machine starts, their commission on the tickets is assured, and transport companies who adopt this policy may, therefore, procure a larger percentage of the passengers booked at agencies if they acquire the reputation of being certain starters, no matter what happens afterwards. It will probably be found, however, that the business as a whole will best be encouraged by adopting the alternative policy, as a very considerable risk and inconvenience is involved in departing in really bad weather, when there is only a small chance of getting through.

Cost of travelling by air.

The old price for a ticket to Paris was 10*l.*, and when the fare was reduced to 6*l.* the number of passengers increased very considerably; whether this increase was entirely due to the lowering of the fare we have no means of knowing, but it seems fairly safe to assume that it was so to a fairly considerable extent.

The question that naturally arises is, can the required volume of traffic be obtained whilst the fare is so much higher than that charged by train and boat? The standard reply is the difference between the first class fare and the price charged is only small; but is this a fair way of looking at the question? Considering that much of the aeroplane accommodation has been only fourth class (and that flatters some machines), it would appear to be a wrong basis for comparison, especially if the point be conceded that quite a number of people like to travel comfortably as well as quickly. Although I have never heard it referred to in aeronautical circles, yet it is believed that there are even second class passengers on the boats and trains.

If the companies believe they will obtain their full volume of passengers from the rich, there is nothing more to be said, but if it is agreed that an aggregate of two or three thousand passengers weekly are required, then it seems inevitable that the fare will have to be adjusted to meet competition, and the hitherto despised second class passenger will have to be catered for. A traveller who pays usually second class fare may be willing to pay 70 per cent. above the first class fare once for the sake of the experience, but he almost certainly will not continue to pay a sum that is well over twice the cost of his normal method of travelling.

Very few people seem to know that a return ticket to Paris can be procured for less than 3*l.* The author is of opinion that the single fare from London to Paris by air will have to be reduced to 4*l.* before the necessary increase of passengers can be obtained. The time may not be ripe for this reduction, as it is doutbful if the British machines available this summer will be sufficient to deal with a very large increase of passengers, but it is considered that at least by 1923 the question will have to be very seriously considered.

Educational.

In the foregoing notes it has been assumed that there are already a sufficient number of people willing to travel by air providing it is made perfectly obvious to them that their safety and comfort are assured. This assumption may, however, be incorrect, and it is possible that if the views of the bulk of the cross-Channel travellers were taken it would be found that in the great majority of cases they would refuse to travel by air in any circumstances whatever. It may be, therefore, that at present there would not be sufficient passengers even if the fares were the same, and, if this be the case, some form of

general educational propaganda is a vital necessity if the needs of the future are to be met.

In any case, it is probably a necessity, and if the tube railways of London still find it necessary to spend large sums yearly in order to attract more passengers to the underground system of travel, how much more essential must it be to undertake a similar campaign in respect of travelling at about three thousand feet over ground and without any visible means of support!

A whole paper could be written on this subject, but a few words will suffice to give some idea of what such a policy of education and propaganda might entail:—

(*a*) The history of flying, the development of commercial aerial transport and the engineering and scientific aspect of flight should be part of the curriculum in every school in the country, so that the rising generation may be taught to regard air travel not as a romantic novelty but as one of the sober facts of life.

(*b*) The cinema should be much more extensively employed for the purpose of keeping the public informed of the possibilities of air travel.

(*c*) The Press, who already carry on such excellent work, could render it even more valuable by publishing statistics as to the high standard of safety and reliability already attained, and occasionally affording some of their space to the rather more practical side of commercial aviation. Quite a number of people who read only one or two papers are still under the impression that commercial aviation is carried on by "huge flying projectiles" which are loaded up with passengers and shot to their destinations at incredible speeds, and they naturally recoil from the idea of travelling in this manner.

(*d*) Joy-riding concerns should be encouraged as much as possible, and approved firms might even be given a small subsidy in some form or another. There are other means which are also fairly obvious, but the carrying out of such a programme can only be rendered possible by the co-operation of the various interests.

The author suggests that this is eminently a case for the consideration of the Society of British Aircraft Constructors, who might form a small committee, including representatives of other interested bodies, the object of which would be to devise and actually carry into effect some sort of general educational work.

Life assurance policies.

Last, but by no means least, assurance companies should be persuaded to allow ordinary flying under the terms of their standard life and accident policies. Is it likely that people who have paid premiums for years are going to travel by a route on which their policies would be null and void in the event of their death, especially if they have real dependants? Further, it is a very bad advertisement for civil aviation when almost every life and accident policy in the country places a complete ban on flying. The general removal of this restriction will mark a red-letter day in the history of flying, and it will become certainly an important, if not the most important date in civil aviation, and no effort should be spared in endeavouring to procure this vitally necessary reform.

Col. Bristow.

Conclusion.

This Conference comes at a most critical period, alike for the country and for commercial aviation. In view of the vital importance of commercial aviation and its relation to air power, it is lamentable in the extreme that in this year, the fourth after the Great War, the British Commercial Air Fleet should consist, all told, of less than 20 aeroplanes; in fact, on the day this was written, there were only six or seven, and at the commencement of 1923 there will not be more than about 30. It is especially serious from a national standpoint, because our future depends to a very large extent upon our being able to bring the various parts of the Empire into closer relationship.

The British Empire embraces close upon 13 million square miles of territory and has a population of 440 millions. In the development of the various parts of the Empire and in the interlocking of the whole the question of transport and communication is of fundamental importance, and it is greatly to be regretted that the public here are not more fully aware of the importance with which the matter is regarded in other parts of the Dominions.

For example, take Canada: the latest Canadian Air Board report clearly indicates that much of the work in connection with the development and protection of the country is being completely revolutionised by the use of aircraft and that every day aircraft are engaged in forestry reconnaissance, photography, fire-prevention, exploration, communication, transportation, and for many other purposes, with the most remarkable results.

History shows the vast importance of transport, and how that the manner in which its problems have been dealt with has been a cardinal factor in the making of nations. The greatness of the Roman Empire was, to a very large extent achieved through its wonderful system of roads, which, incidentally, were built by the government regardless of expense, and the remarkable development of the United States is undoubtedly due to an extraordinary well-developed and efficient railway system.

The United States with one-fifth the population of the British Empire and of less than a quarter of the area has a railway mileage of 251,984, as against the 134,131 miles in the British Empire. Not only that, but the narrowness of our tunnels and the weakness of our bridges so hampers the development of our locomotives and rolling stock that we are compelled to operate on a very low level of efficiency, with the result that to-day we see traders being forced on to the roads in their frantic endeavours to save their business from disaster. The neglect of another means of transport in our waterways costs this country millions of pounds yearly.

Is the history of British commercial aviation to proceed along these dismal lines? Are we to see French and German machines all over Europe and running as far out as our interests in the East? Are we going to take a short-sighted view of the technical needs of the situation as the railways have done, so that we are handicapped from the very start?

In these notes stress has been laid upon the fact that commercial aviation should be able to stand by itself financially, and there is no doubt that if we can make it so, our chances of supremacy will be improved, but, profit or no profit, other countries are not going to allow the business to fade away. The London-Paris service has been of the greatest value in showing us what to do and what not to do,

but the situation urgently demands that we ask ourselves to-day what is our real programme and what is the next step. Are we prepared to face the opening of 1923 with a total fleet of about 20 machines, or one for each 600,000 square miles in the British Empire?

The position is serious in the extreme, and what should be a big concerted national effort is left to a small group of enthusiasts in the Air Ministry and in the industry.

What we want are, firstly, funds and a revised policy for research and experiment in connection with the problems associated with the development of civil aviation, and as a temporary measure we want a large number of engines and machines ordered to-morrow of the very latest types.

We also require an establishment for the training or re-training of commercial pilots, and such training must be of a far more comprehensive character than it was possible to give during the war. Our present position with about a dozen first-class pilots in training is almost ridiculous, especially when we consider that four years ago we had about 20,000 pilots, and 35,000 engines were turned over to the Disposal Board.

For months past we have been giving unemployment pay to thousands of skilled workers in the late aircraft industry. Is it impossible to put these men to work on manufacturing machines and engines? I am told that in many grades there is little difference between employment and unemployment pay, and if this is true, it seems absurd to keep on paying away hundreds of thousands of pounds to idle men whilst an industry that is vital to our very existence as a first-class power is allowed for want of orders to languish to the point of extinction.

As business men we do not need reminding that it is imperative that the national expenditure be reduced, but, being business men, we also know that much of the money that has been spent since the war could have been most advantageously expended in other directions, and that a small portion only would have enabled the aircraft industry to be kept alive and civil aviation to be placed upon a much broader and more efficient basis.

During the war we utilised our materials to the fullest possible advantage by establishing a system of priority. Money is the raw material of peace, and if we are to husband our resources and yet achieve the maximum possible progress, we must have a properly thought out system of priority in expenditure. At present, incredible as it may appear, there is no such system.

This is a most critical time. We have it in our hands to make or mar the future, and posterity will judge us accordingly. We can succeed if only the nation will take the trouble to envisage intelligently the real position and then go steadily ahead with all the powers of determination, energy and self-sacrifice that we have exhibited in other directions.

It is the duty of the Government, the Air Ministry, and the aircraft industry mutually to co-operate with goodwill on a bold and militant policy that will secure for the country and the Empire the great and material benefits that most surely will follow upon the establishment of a British aerial transport industry on a wide and sound basis. Neglect of this opportunity will involve us in consequences of the most disastrous description, and although we cannot pretend to see

the full measure of the cost we, at least, can see that our position in Europe and the integrity of the Empire would be most gravely imperilled.

APPENDIX.

[This is not a technical paper, and the author has endeavoured as far as possible to abstain from dealing with matters that may form part of the subject of technical papers. It is desired, however, to draw attention to two matters which, although of a technical nature, have in addition a most important bearing on the commercial side of the business, and which call for most serious attention. I allude, firstly, to the problem of getting aeroplanes into the air and landing them; and, secondly, to the many questions relating to the supply of fuel.

The first calls for very considerable research and experiment, and the second for a clearer vision of the objects in view and more effective co-operation between the various parties concerned.

Getting-off and landing.

An aeroplane in addition to operating in its normal medium must first haul itself up to its operating level, a process which is much more difficult than normal flying, and which necessitates a much less advantageous form of vehicle. Also, of course, on arriving at its destination, or even before, it has to retranslate itself to the earth.

It is as if a locomotive before commencing its journey had to haul the train out of a field and up a stiff gradient before it could get on to the rails and proceed on its journey. Imagine the seriously hampering effect such a state of things would have on train design and operating costs. Engines would have to be unnecessarily powerful, wheel loadings would need cutting down enormously, and the consequent cost per ton mile would be radically increased.

Trains, ships, motor carriages, trams, and all other forms of transport vehicle are in the happy state of being able to start, run and stop in their particular medium and on their special tracks. Even airships have this very great advantage, but heavier-than-air craft are inherently at a great disadvantage in this respect. With the ordinary type of wing in use to-day a loading of about 10 lbs. per sq. ft. is accepted as about the maximum possible, but if this difficulty of getting up and down again did not exist, machines could operate quite safely with a wing loading of 20 lbs. to the sq. ft. or, alternatively, if it were only a question of level flight, the power unit could be cut down to something like half its present output.

These twin operations of getting off and landing also account for nearly all the accidents that occur, and the high cost of insurance is entirely due to the dangers attending these operations. Here, then, is a problem that calls for the most urgent attention; its solution is vital to the progress of commercial aviation and also to the successful development of the two very important classes of naval and military aircraft.

It is possible to help matters to some extent, so far as getting-off is concerned, by so designing the propeller that a greater proportion of the full power of the engine is available on the ground, and which is also more effective in producing thrust at the getting-off speed. During the war it was customary to design propellers such that in

level full speed flight they prevented the engines being overrun, but it is a different matter to-day, and in any case the more important problem of getting-off with full loads of passengers is one that calls for effective treatment even if it does involve a slight disadvantage elsewhere. It is, of course, also better for the engines when on full throttle to run at speeds more closely approximating to the full load speeds for which they were designed.

The petrol position.

Let it be assumed that in the most efficient aeroplane existing a given load can be carried from London to Paris at a cost for petrol of 100 shillings. It will not be a very large load; that is immaterial. By improvements in design of the structure based upon long and painstaking work in the wind-tunnel and full-scale experiments we may succeed in another few years in so cutting down the resistance that our expenditure on petrol may drop to 80 shillings; in addition, we may increase the working thermal efficiency of our engines by as much as 10 per cent. These improvements will reduce the cost of the petrol consumed on our hypothetical journey from 100 shillings to 72 shillings and represents what would be a very considerable over-all gain.

But if the price of petrol were reduced to 1*s.* 9*d.* per gallon, this 28 per cent. saving could be effected to-day, and thus by a stroke of the pen the whole aviation industry could be placed in the same position that otherwise will only be attained after years of effort.

I do not profess to know whether it is possible to make such a reduction in price; there are, of course, many who believe that the present level of petrol prices is artificially maintained, but I am very strongly of opinion that the question of a special price for petrol for commercial aviation should be most seriously considered.

Everybody connected with aerial transport has been making sacrifices of one sort or another in order that the business may be developed: the transport companies, their employees, aircraft and engine constructors, underwriters, the general public through the subsidy—in fact, it is difficult to point to a single interest of importance that has not contributed, and in many cases contributed heavily. As far as I know, however, the petrol companies themselves have made no similar sacrifices, but on the contrary have made a handsome profit out of the very large needs of an industry of supreme national importance struggling for its very existence.

I do not wish to do the companies any injustice; it may be that they make only a fair and reasonable profit on aviation spirit; but I do ask them to consider whether they cannot give a special rebate on petrol for commercial aviation for the next three years, even if it involves giving up their profit on this particular portion of their sales. If commercial aviation ultimately fades away the petrol companies will lose what would have been an exceptionally good market and will have themselves largely to blame for the loss.

It is not suggested for one moment that any such reduction in price is to take the place of improvements in machines and engines. It would be better for the price of petrol to go higher than that designers should slacken their efforts, but with the coal of aerial transport at nearly 40*l.* per ton there is urgent need for improvement and economy in every direction. Even to-day much can be done

with a view to keeping down the consumption, not only that in actual flight, but also on the ground.

As this is a matter of very considerable importance, it is proposed to examine this question in detail. In the first place, it is essential that aircraft shall be fitted with accurate and easily read petrol gauges, or, better still, with flowmeters in addition, by which the consumption can be checked from point to point and at any moment.

A mere examination of the figures of over-all consumption is insufficient: it is essential to know how, when and where the fuel is being consumed at every stage of the operations. Having fitted suitable gauges which incidentally must indicate correctly both in the air and at rest with the tail skid on the ground, the next step is to inaugurate a petrol log book for each machine in which a complete stage to stage record is kept.

The first thing that will probably be observed is that the engines are using more in actual flight than would have been expected from a study of the test bed consumption figures. Some of the causes of this cannot easily be remedied, but some economy can be effected.

It will often be found that the carburettors are at fault. It is easy enough to set a carburettor on a test bench so that the mixture never errs in the slightest degree on the rich side, but the engine is there always at one level, it is not bumped about, and even if it were occasionally starved somewhat on being opened out, it would not matter. But the ground engineer has a totally different proposition before him, and if the regulation of the mixture is in his hands he is always bound in the interests of safety to err on the rich side. It is not possible to tell, especially in daylight, how much the flow can be cut down, some engines give just the same revolutions on the ground with a mixture well on the rich side, and experience has shown that several engines of various nationalities have been consistently run on over-rich mixtures.

This also is partly due to the fact that at some period in the development of aero engines somebody invented the term "altitude control" for the fuel economiser. The result was that commercial pilots formed the idea that it was a device that did not interest them as they never flew at any altitude worth considering. As mechanics also did not look on it with favour owing to the difficulty in maintaining the correct clearance, it was taken off altogether or locked in some position supposed to correspond with full throttle requirements. For commercial machines it should have been termed the petrol economiser, and every effort should have been made to induce pilots to use it to the uttermost capacity, instead of which we have machines getting-off with a mixture naturally on the rich side even on the ground, and wasting at least 10 per cent. to 15 per cent. for the rest of the journey.

In my opinion the carburettor for commercial machines should contain two independent means of regulating the supply to the engine. The flow should be through a fixed jet of such capacity that the maximum requirements for getting-off are never prejudiced, and an economiser under the control of the pilot added to the circuit in order that once safely in the air and well warmed up the petrol could be cut down to the minimum.

Further, the economiser should operate in such a manner that in the event of its becoming at all out of adjustment there would be no chance of the petrol supply becoming strangled. One means of

effecting this would be by making the economiser work on the principle of reducing the pressure in the float chamber, so that if anything went wrong all that could happen would be a loss of economy until the fault was corrected; but with economisers of the needle-valve type is it almost certain that sooner or later trouble will be experienced necessitating a forced landing.

It ought to be possible to-day to carry 10 persons from London to Paris in still air on a single-engine machine in two-and-a-half hours on a consumption of about 50 gallons of good aviation petrol.

Another and a most important factor in the petrol situation is the wide variation in the quality of the petrol supplied by the various companies. This absolutely prevents any company from operating its engines at their maximum efficiency, as in nearly every case they are compelled to work with a compression ratio below that at which their engines could be safely worked, and consequently with a serious loss in efficiency, and, incidentally, without that reserve of power they might otherwise possess. The remedy for this state of affairs is not easy, largely because on the London-Paris route supplies have to be drawn from different countries and the fuel is generally widely different in character.

The first requisite is a drastic revision of the basis on which petrol is sold. At the present time there seems to be a conspiracy of silence on the part of petrol companies as to the real value of their fuel for aero engines, and most of the official specifications for petrol are based on false premises, and are entirely useless for all practical purposes. It would, perhaps, be the simplest course if engine makers published a table showing the maximum compressions that could be used with their engines, according to the different toluene values that could be guaranteed by the petrol supplier.

Thus, supposing a firm were using Lion engines, Messrs. Napier would provide a specification showing the maximum compression ratios possible with fuel of various toluene values giving consumption curves corresponding to the compressions indicated. The chief engineer of the transport company would decide the compression he would wish to adopt after consideration of the special circumstances of his particular service, and then proceed to place a contract for fuel according to the requisite toluene standard.

But, and a very important "but," the petrol companies would have to guarantee and actually maintain the standard agreed upon, otherwise there would be trouble of the most serious description.

It is believed that 10 per cent. to 15 per cent. could be saved immediately by effective co-operation between the various interests on these lines.

There are also minor ways of effecting economy; for instance, petrol can be saved by avoiding as far as possible taxying machines under their own power. It is quite usual to see engines kept running for 15 minutes after a machine arrives before taxying away to the sheds. At Croydon the largest machine can be pushed by hand from the Customs house to the level crossing, although a tractor is necessary when coming in the opposite direction. The petrol that can be saved, however, under this heading is very considerable, and runs into hundreds of gallons per month with large machines.

There is also far too much petrol wasted tuning engines and warming them up before departure. A good ground engineer is worth paying

well; if he thoroughly understands his engines and can test accurately and quickly he will save nearly 10*l.* weekly on petrol alone.

Economies such as are outlined in the foregoing may not appear of prime importance to-day, but it is fairly certain that they will all have to be effected to the utmost farthing before the balance-sheet can show a profit without the subsidy.]

The CHAIRMAN: Gentlemen: We will adjourn now till 2·45; but I would first like to read you a telegram that I have received from the Northern Aviation Club, Liverpool. The telegram is as follows:—

> "Hope successful Conference suggest advertising and booming aerial post as concrete proof economy time commercial world Fazackerley Secretary."

TUESDAY, 7th FEBRUARY.

AFTERNOON SESSION.

The Rt. Hon. LORD WEIR OF EASTWOOD in the Chair.

The CHAIRMAN: My Lords and Gentlemen: In opening the technical session of this Conference I am sure you will agree with me that we should congratulate the Air Ministry on their organising once more this Air Parliament. It performs admirable service in affording an opportunity to bring together those with a common interest in air progress. It enables them to review the achievements of past years, and to indicate the lines for future progress.

While the morning session dealt with the broader question of general aeronautical policy, our technical session treats of the basic problems on which the whole development depends. Let me put it very shortly, as I think I have done before, that security in war and prosperity in peace for this country depend on our being six months technically ahead of all other nations.

Our programme this afternoon is quite a long one, and consequently I will call at once without any further delay on Major F. M. Green to read his paper on "Research from the Designers', Constructors' and Users' points of view." In a meeting like this Major Green requires no introduction from me. You all know him well. You know the wonderful work he did for us at Farnborough, and the still greater progress he made at Coventry. I now call on Major Green.

RESEARCH FROM THE DESIGNERS', CONSTRUCTORS' AND USERS' POINTS OF VIEW.

MAJOR F. M. GREEN, O.B.E., M.I.C.E., F.R.Ae.S.: The development and use of aeroplanes has been of such rapid growth that we cannot but feel that there are possibilities of improvement in everything connected with aeronautics. It is easy to make suggestions for research in every direction, and to state a list of questions that would involve many years of work using all our existing facilities. In the hope of making this paper of some immediate value, I propose to confine myself to suggesting lines of research from which an immediate

and substantial return may be expected. Research of this type is not always of fundamental importance to the science of aeronautics. I wish to say that I am definitely not in favour of abandoning the more abstract research, or, indeed, of relegating it to a second place in our programme, for in the long run it will probably yield results of infinitely greater importance than are likely to be the outcome of the special investigations I shall suggest; but from the designers', constructors' and users' points of view, it is in research of the latter type that the chief interest lies. It is difficult to separate research into such distinct headings as is suggested by the title of the paper. The designer, if he is to be successful, must certainly see things from the users' point of view, and also understand methods of construction that will be used in his design. All sorts of research are, therefore, of interest to him.

RESEARCH FROM THE DESIGNERS' POINT OF VIEW.

Before suggesting what lines of research are likely to yield the greatest advantage to the designer, it will be as well to try to put ourselves into his state of mind when he has to originate a design. By this means we shall be enabled to see what are the governing factors in producing the design, and to gain some idea of their relative importance.

We will imagine that we wish to produce an aeroplane as suitable as we can make it for a definite purpose. We shall, in all probability, start by knowing the load to be carried and the density of that load; the maximum distance in a single flight will be known, and the climate and geographical conditions in which the aeroplane is to be worked will be stated. The speed at which the aeroplane is to be flown is generally the maximum that can be obtained while satisfying other conditions; in any case there is a minimum speed below which the aeroplane will be of little use. With the data given, the problem is to design the safest and most economical aeroplane that we can. Economy and safety may appear to be antagonistic requirements, but I think it will be found that without a high degree of safety economy in operation is impossible, quite apart, of course, from other considerations.

The requirements being known, the first step is to make a rough estimate of the total loaded weight of the aeroplane, which the designer will do from previous experience. He will also know roughly the maximum load per square foot of plane surface that is permissible, and by this means he will be able to fix the area of the planes and the general dimensions of the aeroplane.

The next step is to estimate the amount of engine power required. The answer to this question will possibly be some horse-power for which there is no suitable engine. The designer must consider the available engines, choose the most suitable, and re-estimate the total weight. This can now be done with a fair degree of accuracy, as the weight of the power plant and useful load will be more than two-thirds of the total weight of the loaded aeroplane, and the probable error on the weight of the structure of the aeroplane itself should not be a large proportion of the whole.

The designer is now in a position to know what sort of an aeroplane is produced by the original specification, and it is more than likely that the resulting aeroplane will be commercially impossible. It may be much too big and expensive for the load it carries, or the

fuel consumption may be too high. If this is so, the original specification must be amended by reducing the speed or by decreasing the maximum distance to be flown in a single flight, or by altering other conditions. The aeroplane must then be re-estimated to try to reduce it to the least possible cost and size for the work which it has to do.

Immediate Problems Involved.

Wing surface.

From many points of view it is an advantage to use the least amount of wing surface that will give the results required. Smaller wings mean lower first cost, less weight, and less upkeep.

The load per square foot which governs the size of the wings is generally fixed by the designer's idea of the highest speed at which he thinks landings can be safely made. To some extent, also, it is governed by the length of time that the aeroplane will take in getting clear of the ground. The designer, therefore, wants information as to the characteristics of various wing sections, and also of various shapes and arrangements of planes, and is at once face to face with the question of how to apply wind-channel results on models to full-size aeroplanes. He does not question the accuracy of the work carried out in the wind channels of the National Physical Laboratory and elsewhere, but he must decide whether it is possible to apply them to full-scale machines, and if so, how to do it.

It seems to me—this is a personal opinion only—that this is the burning question of the day, and that until designers can be shown how to use wind-channel results on wings, and until they can be convinced that the results can be used without the chance of serious error, it is of little use suggesting further wind-channel research on new kinds of wings. It will be better to devote all the available energy and talent to clearing up this problem than to amass results the value of which is unknown. The present state of uncertainty is bad from another point of view, as it encourages an expenditure of money on experiments unlikely to be profitable. Until it has been clearly shown how to interpret wind-channel results, it is unwise to spend much time and money making aeroplanes with unusual wings based solely on these results. It must not be forgotten that the certified test of the National Physical Laboratory carries a great deal of weight, and rightly so, and although no guarantee is given that the results can be applied directly to full scale work, the general public is apt to think that some such guarantee is implied.

A great deal of full-scale work has been done in testing aeroplanes at the Royal Aircraft Establishment and at the Royal Air Force Experimental Stations at Martlesham Heath and elsewhere. Unfortunately these tests cannot by their very nature be as clear cut as wind-channel tests, nor have the results the same kind of accuracy. A large number of corrections and allowances for various disturbing factors have to be made. The expense also of the work is very high. At the same time, the results obtained really do apply to wings of a scale in which we are interested, and the figures inspire in the designer more confidence than do wind-channel results, which he does not know how to interpret.

For many years experiments have been made with a view to obtaining the resistance of the aeroplane by measuring the thrust or pull of the airscrew, which seems to be the most obvious and successful

way of doing it, although considerable difficulties were at first found in getting accurate results. It will be of great value if this work is continued, and if full-scale tests on the same aeroplane fitted with different sorts of wings can be made, and the results published as soon as possible after they are obtained. The results can be checked by making gliding experiments, which, indeed, have already been made; but the thrust-meter method is likely to prove the more useful. The aeroplane used for this purpose need not be large or expensive, and it certainly seems that every effort should be made to establish a connection between full-scale and model results for some typical aerofoil such as R.A.F. 15.

Another question in which the designer is concerned in fixing the size of the wings is how much of the maximum available lift the pilot will be able to use; that is to say, at how near the minimum speed will he be able to fly without risk of losing control. Research work on control at low speeds is certainly needed; part of this, I think, can well be carried out in the wind-channel in close co-operation with full-scale experiments. The cause of the most usual form of flying accident, generally known as a spin, is bound up in this question, and it seems not unlikely that one of the greatest dangers of flight may be removed when we have more knowledge of the subject.

Wind-channel experiments are valuable chiefly in indicating lines of research, and in providing generalised data with the aid of which suggestions for improving control may be worked out on paper. But until the vital question of how to apply their results with reasonable certainty to full-scale aeroplanes is cleared up, I think it is essential that full-scale experiments should be carried on with all resources. I should here like to say that obviously it is quite impossible to make as many full-scale tests as one would like; the expense is far too great, and you can do more work in a few days on a wind-channel than you can in years on full scale. At the same time I think the connection between model and full-scale results is not firmly established yet, and that we must use the wind-channel results rather as indicating which of the many full-scale experiments we should like to make, or we can actually carry out. The size of the controlling surfaces, namely, the elevator, tail plane, and wing flaps, are all affected by the characteristics of the planes; but again we must know the relation between model and full-scale in such matters as the travel of the centre of pressure before we can use model results with certainty.

Power required.

In estimating the power required for an aeroplane, it is necessary to add to the drag of the wings the resistance of the body, struts, wires, landing gear, and other parts external to the wings. This is work which can well be done in the wind channel, and there is every reason to believe that the results of such work can be applied to full-scale work without much error. The measurement of resistance is more a matter of direct experiment than of research. Already a sufficient number of results exist to make a rough estimate possible by analogy with some previous aeroplane, but it is always advisable to experiment on a model of any aeroplane of a new design.

Knowing the total resistance of the aeroplane the power required can be settled when we know the efficiency of the propeller. This is a matter on which research is needed, particularly on the efficiency

of the propeller in relation to an aeroplane body. This seems to be an excellent example for comparing wind-channel results with the full-scale results which can be obtained by the use of a thrustmeter on an actual aeroplane.

Another matter which affects the resistance of an aeroplane is the power used in cooling the engine. We are still uncertain whether it takes more power to cool an air or water-cooled engine, and in the case of radiators we are quite at variance as to their most economical arrangement. Research is needed in this matter, and it should probably be carried out in connection with the efficiency of propellers mounted on suitable bodies.

Materials for aeroplanes.

The aeroplane designer is obviously interested in the properties of the materials he uses. The weight of the aeroplane must depend to a large extent on the specific strength of the materials used. A good deal of work has been done on the characteristics of wood, and as this material is subject to such wide natural variations it does not seem that further research will be of much help. So long as wood is used, the making of good aeroplanes will be a matter of art rather than science.

In the covering for aeroplane wings nothing has yet been produced to compete seriously with linen or cotton fabric treated with suitable dope and protective covering. It certainly would be an advantage if this could be replaced by metallic covering, but such covering must not be of greater weight per square foot, and must have reasonable resistance to tearing. Up to the present no such material has been produced. It seems to be more hopeful to spend time on improving the existing fabric dopes in order to make the covering as permanent as possible than to experiment on metallic covering.

Metal construction.

Up to the present nearly all aeroplanes have been made principally of wood, and the technique of construction of this sort has been brought to so high a standard that it is unlikely that we shall be able to make wooden aeroplanes appreciably lighter than they are now made. The substitution of metal for wood may enable us to effect improvements. Using steel of 45 tons per square inch tensile strength it is possible to make aeroplane structures of at least no greater weight than those of wood. The use of steels of higher tensile strength should enable us to make them lighter. The present difficulty is that in order to make parts suitable for aeroplanes, the thickness of the material has to be small, and we have yet to find out the best methods of making and using thin sheet metals. Many of the fundamental principles have been established and the development of this sort of work calls for research of rather a practical nature.

The use of aluminium alloys for aeroplanes has not made much progress, as there is certainly a feeling amongst engineers that aluminium alloys are unreliable, and the use of this material is discouraged by the Air Ministry. The possibilities are considerable, but probably a large amount of research work must be done before the extended use of these alloys is possible.

Calculations of stresses.

Intimately bound up with the use of materials is the knowledge of the stresses at which they can be worked. The more complete is

our knowledge of the loading, the lighter we can make the aeroplane structure for a given strength. It has been customary to apply the results of model tests to full scale wings in order to find out how the planes are loaded in the various conditions of flight. We know that this is not strictly correct, and that the centre of pressure is generally further forward on the full scale than on the model. More exact knowledge of this subject would enable us to proportion the structure of the wings in a more economical way.

The method of calculating the stresses in an aeroplane structure has been gradually developed and improved. The present methods standardised by the Air Ministry more nearly represent the actual case than those used in most other, or possibly all, branches of engineering. At the same time a number of assumptions are made for the purpose of simplifying calculations which are not strictly accurate, particularly in neglecting redundant members. It is generally assumed in the calculations that the incidence bracing takes no load. In actual flight it always does take a share of the load, and the result is generally to make the aeroplane somewhat stronger than calculations show. At the same time it is possible that redundant wires may actually weaken the aeroplane and not strengthen it, and research into the method of calculating the strength of aeroplanes structures will certainly lead to improvement in design. The calculations may appear at first sight to be so complicated that their meaning will be difficult if not impossible to interpret, but it is probable that more work on this subject will lead to methods which are simpler and easier to understand than the strain energy methods generally in use. I may say research of this type is not very expensive; it is mostly calculation work, and it does not in the general way require a great deal of direct experiment, which is work which, as a rule, costs most money.

Problems of the Engine Designer.

The success of an aeroplane depends largely upon the performance and reliability of the motor that drives it. The reliability of the motor is, to a very large extent, bound up with the reliability of the materials that are used in its construction, while the weight per horse-power that can be obtained depends upon the stresses to which the materials can be safely worked. The properties of high tensile steels are fairly well known, but engine designers are forced to reckon on a tensile strength far below that which they know can be obtained. As an example, the usual specification for high tensile steel for aeroplanes engine parts calls for a tensile strength of 55 tons to the square inch combined with certain other properties. It is well known that steels have been produced which give a strength of 50 per cent. in excess of this, combined with the other properties which are necessary, and the value of such a steel is obvious. Unfortunately it is not commercially possible to obtain reliable steels of this sort, and it certainly seems that research is needed to find out how to produce higher quality alloy steels with regularity.

I may say in these remarks that I have dealt merely with tensile strength knowing quite well that that is not the only, nor most important, factor in choosing the steels; generally speaking, however, improvement in other qualities can be obtained to about the same extent by the use of selected and special steels; but on the other hand, it is not always possible to obtain them commercially.

Major Green.

Aluminium alloys enter largely into the construction of most aeroplane motors, principally in the cast state. Obtaining reliable castings is a difficult matter, and we have always to use castings of a weight considerably in excess of what is necessary for strength in order to compensate for their possible defects. We also use an alloy which is at least 10 per cent. heavier than we need because the foundries find difficulty in making sound castings of known lighter alloys. The need for research seems to be obvious, but it must be a sort of research that will help to produce the castings required, and not merely to make sample test pieces of some particular material. Some of these aluminium alloys are required to maintain their strength when hot and consequently their behaviour at temperatures above the normal must be investigated.

The amount of power that a petrol engine can give is frequently limited by the speed at which it can run; this in turn is sometimes limited by the risk of failure of the bearings. Very little indeed is known of the properties of plain bearings under the condition in which they have to work in an aeroplane motor; it is generally considered that the criterion of safety of a bearing is obtained by multiplying the average pressure by the rubbing speed, and if the result obtained is lower than a certain figure the bearing will be satisfactory. On the other hand, the designers of the Michell bearing assure us that the higher the rubbing speed, the higher can be the load per square inch. Here we have two opinions which are diametrically opposed, and it certainly needs research in this direction to enable designers to fix their bearing surface with some degree of certainty. It is certainly a remarkable thing that there are two alternative ways of looking at the problem, which give exactly opposite results; probably both of them are right to some extent, and it needs a good deal of research work to produce rules which engineers may use to fix their bearing surface with some degree of certainty. The properties of ball and roller bearings also need investigation, as there is much uncertainty amongst designers as to their most suitable form and the loads that can be carried.

Fuels.

The type of fuel that is used in a petrol motor has a considerable effect upon the working of the motor. We know that the addition of benzol to petrol enables us to increase the compression of the engine without fear of detonation, and that other materials can be added to give similar results. Research is neded to determine the most suitable fuel that can be obtained at a commercial price and in commercial quantities.

The fuel question, I might say, is a very large one. I have only time now to indicate that quite a lot of useful information probably will be obtained in the near future which will enable us to improve the efficiency of the motors.

RESEARCH FOR CONSTRUCTORS.

We now come to research from the constructors' point of view. First of all we will take the aeroplane constructor as distinct from the constructor of the engine.

Aeroplanes.

One of the most important processes with which the constructor is concerned is the joining of materials together, particularly the

gluing of wood and the soldering, brazing, and welding of metals. There is still no waterproof glue that is altogether satisfactory, and although much work has been done on the subject there is room for further research. The methods of soldering, brazing and welding have always been largely shop processes. There is little information to be had on the subject, and as these three methods are constantly used by all aeroplane constructors, further knowledge would be of advantage. Fluxes in particular call for attention, especially to determine which are easily usable and do not set up corrosion.

The manipulation of thin sheet metals seems to be so much a practical matter that it is difficult to suggest research. The present method is to leave it almost entirely to the skill of the sheet metal worker. The making of such things as metal propellers, spars and ribs for aeroplanes and the like present practical difficulties to the shops, and it is possible that research might be instituted to determine how best to work materials to get them to their required shape, and also in certain cases how to heat treat them after work without causing deformation. The best method of preventing corrosion also needs investigation, particularly if we are to use metal construction.

There is another peculiar problem which constantly presents itself to the aeroplane maker. It is to make stiff light forms of various shapes suitable for fairing which are weatherproof, and, if possible, fireproof. No completely satisfactory method has yet been devised, and it seems to me that an investigation on the subject might lead to useful results. In the general way the strength of these parts is unimportant, the chief requirement is that they shall keep their shape.

Engines.

The making of aeroplane engines presents a variety of problems in the shops. In the general way it is much easier to machine parts to the required degree of accuracy than to be certain that the material of which they are constructed is of the required strength and free from faults. The need for steels of uniform quality and of higher tensile strength has already been mentioned. The constructor is particularly concerned with the correct heat treatment of the material that he receives. It is not suggested that special research is needed in heat treatment, as this is bound up with the production of more uniform and better steels; the question is chiefly one of great care both on the part of the steel maker and the user.

In connection with the making of stampings, the flow of metal in the dies often has as great an influence on the strength of the stamping as the material itself. This, again, is hardly so much a matter for research as for direct experiment and the knowledge of the importance of using good methods.

Included in the heat treatment of metals must be case hardening, particularly of intricate parts. The life of most aero engines could be improved considerably if certain parts were specially hardened; this is not, as a rule, done on account of the difficulty of knowing that the hardening will be carried out in a manner which will not injure the rest of the part. Here, I think, is a large field for investigation, but again it is of a practical rather than a theoretical nature.

The difficulty of obtaining light alloy castings has already been mentioned. This is certainly a question in which the engine maker is vitally interested, and any help from research will be gladly welcomed.

Major Green.

RESEARCH FOR THE USER.

The requirements of the user in the matter of research naturally apply to the actual operation of aeroplanes. Many of his problems would be removed, or at least made easier by the researches already indicated, but certain of them are apt to be ignored both by the designer and the constructor. One of the most important of these is safety from fire both in flight and in case of accident. The paying load of an aeroplane is already small, and consequently we cannot afford to expend much weight in rendering aeroplanes fireproof. There are, however, a number of precautions that can be taken which involve little or no weight, and further knowledge of this subject will help to remove one of the gravest risks connected with flying.

Safe landing in small aerodromes is likely always to be of interest to the user, who very naturally objects to paying more rent for his ground than is necessary for safety. The research already suggested in connection with control at low speeds is possibly the most important factor of landing in small aerodromes, and probably more advantage will be gained by a knowledge of this subject than by the use of wings of an abnormally high-lift coefficient. Landing gears in the general way offer possibilities of improvement, but this is rather a matter of individual design than of any particular research.

Alighting on Water.

There are many countries in which it is difficult, if not impossible, to find ground suitable for aerodromes, but where there is plenty of water which can be used for the purpose. In some cases it is convenient to have aeroplanes which can make use either of land or water for alighting and getting off. With the limited carrying capacity of an aeroplane, it is very doubtful whether amphibians will be of commercial use unless the conditions are particularly unsuitable for either land or water aeroplanes. We have a fair knowledge of properties of floats and hydroplane boats. There is no doubt that this knowledge might be extended by further research. In the construction of boats and floats we still have a lot to learn, but this will probably have to be a matter of direct experiment.

Silencing.

The user is much interested in the comfort of his passengers, and in this matter the silencing of the engine and of the airscrew is of importance. The silencing of engines is fairly well understood, but involves in general a rather heavy expenditure of weight. The silencing of airscrews is more difficult, and perhaps the problem could better be solved by placing the passengers in cabins which are more or less soundproof. The subject is one on which little is known, and research might indicate methods of improvement.

Stability and Control.

In common with the designer, the user is interested in the question of stability and control. The research he needs is much the same as that already suggested for the designer, particularly control at low speeds. He is also interested, though I think to a very minor extent, in the use of parachutes. My personal opinion is that he is chiefly interested in not being compelled by law to carry parachutes, and in order to achieve this end, we must endeavour to make our aeroplanes so safe that the probability of needing parachutes becomes negligible.

Meteorology.

The user is interested in weather prediction, more especially in anything that will affect visibility, such as fog and snow. He also wishes to have reasonable warning of dangerous extremes of weather, particularly in countries which are liable to violent storms.

He is also interested in knowing the direction and strength of the wind at various heights, so that he may economise time and money by taking advantage of favouring air currents and in avoiding those which are unfavourable. This cannot be done to any extent until the pilot is enabled to choose the height at which he can fly, and need not be troubled by the risk either of a forced landing by flying too low or of getting lost when flying above the clouds.

Navigation.

The question of navigation presents no difficulties so long as the visibility is good. There are many reasons why it is not convenient to fly always in sight of the ground. When the wind is favourable it will generally pay to fly high, and it is certainly more pleasant to be in the sunshine above the clouds, where the air is almost always steady, than to be tossing about just beneath them. In addition to this, the economical speed of the aeroplane is greater higher up, where the air is less dense, than it is near the ground. We need, therefore, special arrangements on all established air routes, to ensure that the pilot can easily find his way when above or in the clouds, or when flying in foggy weather.

There are many ways in which wireless telegraphy and telephony can help, but it is essential that the gear carried on the aeroplane shall be as light and as simple to use as possible. There seems to be no reason why a pilot should not be able to fly from place to place blindfold with as great a certainty as he now does keeping in sight of the ground. The important thing to do is to convince the pilot himself that the gear with which he is provided is absolutely reliable. Until he is confident of this he will always be chary about losing sight of the ground.

Wireless control of the aeroplane itself from the ground is certainly a possibility of the future, and it may be that the pilot of an air liner will give up the control of the aeroplane when within certain distance of his landing place to a ground pilot, who will bring the aeroplane into port. It is permissible to look forward to a time when this method of control will be developed so that aeroplanes can be landed in their aerodromes with certainty at night, or in dense fogs.

Multi-motor Aeroplanes.

We heard this morning that in 95 per cent. of flights the aeroplanes reach their destination within four hours, and I am told we have still to improve on that figure a good deal; if we could absolutely cut out the chance of motor failure we should practically achieve this end; that is to say, there should be as few forced landings as possible. Aeroplanes have been made in which the power unit has been divided up into any number of motors up to six, but for many reasons the single motor aeroplanes is still, in practice, as reliable as the multi-engine machine. Various attempts at solutions have been made either by running the engines as separate units or by coupling them together by means of gearing. No solution can yet be considered as entirely successful. There is certainly room for research in this direction, and it will probably need close co-operation between the engine designer and the aeroplane designer if a solution is to be found.

Major Green.

Conclusion.

No one disputes in general the value of research, but the practical man is apt to be impatient with the research worker, and to complain that the results submitted to him are not sufficiently positive and clear-cut to be of much value. The research worker, on the other hand, frequently imagines that the designer is not taking advantage of his work in that he does not immediately improve his designs by applying the information given to him. The difficulty with the practical man is that the results of research are given in such a form that they are not easily understood by him, and for the sake of scientific accuracy the reports are sometimes so guarded and hedged around with conditions that the practical man will not believe them. At the same time we can only make real progress by acquiring a knowledge of the subject which becomes gradually more and more complete. Organised research and experiment and the free discussion of results are the only methods likely to lead to this result. The high position that this country holds in the development of flying is, I think, due almost entirely to the wisdom of the Government that set up an Advisory Committee and instituted research work at the very beginning of flying. The work carried out at the National Physical Laboratory, the Royal Aircraft Establishment and the Testing Stations of the Royal Air Force could not possibly be done by private enterprise, and it is by the information gained and the standard set by this work that the industry is enabled to produce aeroplanes which cannot be rivalled in any other country.

It is the opinion of the writer that help of this kind is of greater value than direct subsidy, and he earnestly hopes that even the pressing need for economy will not prevent research being carried out in the future in the same spirit as it has been carried out in the past.

The CHAIRMAN: My Lords and Gentlemen: I am sure you will agree we have listened to a very interesting and suggestive paper. Much of it is highly controversial, so that we may look forward to a very interesting discussion.

The author of the next paper is well known to all of us here. General Bagnall-Wild, as Director of Inspection, carried out with conspicuous ability the extremely difficult task of organising and directing the whole of the inspection of aeronautical supplies for the Royal Air Force during the war. To-day we have to congratulate him very heartily on his well-deserved promotion to the very important office that he now holds as Director of Research. I will now call on General Bagnall-Wild.

THE PROGRESS OF RESEARCH.

BRIG.-GEN. R. K. BAGNALL-WILD, C.M.G., C.B.E., M.I.Mech.E., M.I.A.E., F.R.Ae.S., Director of Research, Air Ministry: Research work for the Air Service comprises specific researches at establishments under the control of the Air Ministry, and in addition an important series of studies carried out at the universities by arrangement with the Ministry. There is, furthermore, much other research work carried out in the universities quite independently of the Government, the results of which are of great importance to the future of flying. It is, at least, as important for the Director of Research to be in touch with cognate researches in the universities and other research

organisations, at home and abroad, as it is for him to be cognisant of the developments aided by State finance through the Air Ministry. The chief research establishments under his direct control are the Royal Aircraft Establishment at Farnborough, the Air Ministry Laboratory, and further the air research work at the National Physical Laboratory is one of the biggest assets of the Director of Research. The practical applications of the results of research are tried out at the air stations at Martlesham Heath, the Isle of Grain, Biggin Hill and, by the courtesy of the R.A.F. Coastal and Inland Areas, at certain other air stations.

The Directorate of Research is, however, an engineering as well as a scientific organisation. It acts as the engineering department of the Ministry, and probably as much as four-fifths of its work relates to experimentation with specific appliances, efforts to develop such appliances along channels useful to aeronautics, and the test performances of approved air service material. The balance is research, pure and applied. To preserve the right relationship between these two divisions, and to see that the right men are employed for them, is, perhaps, the most important of the duties allotted to the Director. There is always a tendency for experimentation which promises quick results, whether positive or negative, to squeeze out the more lengthy investigations, even when the latter are of the more fundamental importance. A firm attitude and a long view are the right correctives.

Long experience has taught the universities the most suitable organisation by which research as distinct from ordinary technical work can be undertaken. This is found to require for its success a much larger amount of personal freedom of work than had previously been the rule in Government organisations. It is naturally somewhat difficult to adapt the new Government machinery to this new condition. The subject was discussed with much ability in the last Wilbur Wright lecture before the Royal Aeronautical Society. The lecturer, Major G. I. Taylor, F.R.S., pointed out the great difficulty of organising scientific research on the man-hour principle, adding that "in my opinion research work is so difficult and exacting that a man can only turn out his best work if he is completely free to go where his researches lead him, free to choose his own time for work, free from other duties which would divide his mind, and lastly, free to sit down and produce no visible result for weeks on end." This is a very important statement, and very true. In certain forms of applied research the problem is little different, and this is one side of the work with which the Directorate of Research has to deal. The other, larger, but fortunately simpler, mass of work consists in the design, development and ultimately the production of apparatus or methods which the work of the research organisation shows to be capable of serving some definite air purpose. In theory it may be possible to draw a sharp dividing line between these two classes of work, but in practice they tend to shade off into each other in a bewildering way, and such boundary as there is is liable to vary its position in accordance with the subject under investigation. Moreover, with limited funds it is sometimes necessary for the research worker who may have initiated a new development to see it through its infant difficulties, and mother it until is it in suitable form for the production stage.

It may, I think, fairly be stated that the biggest technical problem affecting civil aviation is the development and perfecting of the aero

engine: the nature of the ground organisation, the question of flying over or under clouds, the attractiveness of air travel to possible passengers, these and numerous other such questions turn on the fundamental issue of engine performance.

For service aviation an important feature is, perhaps, its relationship to sea power. This problem has been notably advanced by the recent tests carried out by the United States Government, the results of which have been the subject of anxious and careful study here. If, as appears from these tests to be possible, the defence of these shores can be entrusted to aircraft, an immense impetus will be given to aviation and to the scientific studies on which its development depends.

Aero engine research.

The ultimate aim of aero engine research is to produce an engine as free from breakdown as the average engine in a motor vehicle. It sometimes seems to be regarded as a matter for surprise that, with the many years of experience of the high speed petrol engine for motor cars, it has not yet been possible to develop for aircraft a high-speed petrol engine of equal freedom from the necessity for frequent overhaul. It must be recollected, however, that the engine in a motor vehicle runs, on the average, at about one-third of its full brake horse power, whereas until quite lately it was customary for aero engines to be run at from 80 to 100 per cent.—more often 100 per cent.—of their full load; it is only now, with the Napier "Lion" engine, that on the cross-Channel service it is possible to run on an average load of but 60 per cent. of the maximum. This, in my view, is the fundamental difficulty; it is, of course, much increased by the need for cutting down the weight per horse power to a minimum.

Whether, in addition to the attainment of some development that will cause the aero engine to be as free from sporadic "breakdown" as is the engine on a motor vehicle, it will be found possible to increase materially the fuel economy of such engines, and so to cut down the gross load, and therefore the horse-power required, remains to be seen. It may, however, I think, be said at once that it is very unlikely, that the internal combustion turbine will, for many years, if ever, prove a satisfactory prime mover for air work; the difficulty of obtaining material to stand the high temperatures involved, coupled with the low efficiencies even theoretically obtainable, do not make this an attractive proposition at the present time. Probably the steam turbine would be a better prime mover than the internal combustion turbine; but even here I think it quite doubtful whether it will, in the end, show any advance on a reciprocating engine working on the internal combustion principle.

Many pin their faith to the almost magic properties of specific fuel mixtures; but the work of Tizard and Pye and that of the Ricardo Laboratory has shown that the efficiency and horse power obtained from any mixture of the various volatile hydrocarbon fuels is, within 2 or 3 per cent., the same as from any other, provided that the compression ratio is not altered. Any advantage to be gained from a specific fuel mixture must lie in its relative freedom from detonation, and, therefore, in its suitability for employment at a higher compression ratio, with the resulting higher fuel economy. Aero engines at present are operated on the four-stroke cycle; to adopt a two-stroke cycle might, at first, seem advantageous when large horse-power for small weight is desired; but unfortunately such engines are less economical

in fuel, and the extra weight which has therefore to be carried in the fuel tanks is very likely to mask the gain in weight from change of cycle.

Experiments are in hand to determine whether it is better to replace the carburetter system by some method of direct injection. Dr. Ferranti is attempting this on a Tuxham two-stroke engine. At the Royal Aircraft Establishment tests are being made, with Professor Hawkes' assistance, to employ shale oil and operate on the Diesel cycle. For this purpose a single cylinder engine from an ordinary Otto cycle aero engine is being used, and it is hoped to run up to an engine speed of 1,000 r.p.m. One of the difficulties with fuel injection is to get a high speed. The freedom from fire risk afforded by such a fuel would be a substantial gain; economy in running cost should also result. At the Royal Aircraft Establishment work is also proceeding on the solid injection of a fuel consisting of 95 per cent. of alcohol.

The advantages which it is considered should accrue from the use of direct injection are these:—

(1) High-flash point fuel could be used, thereby reducing fire hazard.

(2) Cheaper fuel.

(3) Higher compression ratios, and therefore better fuel economy.

(4) Fuel supply to engine more positive than when it depends on small heads, and is liable to be upset by small particles of dirt.

(5) The elimination of the ignition system would remove a source of unreliability and trouble.

(6) As air only is compressed, the way is opened up to an economical two-stroke engine with its advantage of more even torque for a given number of cylinders, and (probably) less weight per B.H.P. By using a suitable air compressor of greater capacity than that necessary for normal 2-cycle working a super-charging engine would be obtained as a straightforward development.

One peculiarity which distinguishes aero engines from motor-car engines is that they have to be ready to operate at very low atmospheric pressures. The pressure of the atmosphere at 20,000 feet altitude is only about half its sea-level value, so that for an engine working on the most efficient mixture ratio, only half the weight of fuel and air would be drawn in on the suction stroke, and the horse-power would fall accordingly. Very successful efforts have been made to introduce an air compressor turbine, driven by the engine exhaust, in order to compress the inlet air to approximate equality with sea-level pressure. When this is done effectively the full horse-power is obtained at altitude. Using this device the American Army aviation authorities have shown that it is possible to achieve an altitude of some 40,000 feet. Experiments on these lines are also in course of being carried out at the Royal Aircraft Establishment at Farnborough, and preliminary tests have increased the ceiling of an old type machine from 20,000 to 30,000 feet.

In order to facilitate tests under high altitude conditions and save having always to fly the engines at such altitudes for this purpose, it is necessary to provide a special test-house in which the whole engine, with its intake and exhaust, can be kept at an air pressure, and

temperature, corresponding to that at the desired altitude. In the altitude test house at Farnborough the air inside a chamber about 10 ft. by 10 ft. by 12 ft. is thus treated. Care has to be taken to ensure that the air thus cooled does not deposit ice or snow in the engine; for this reason the air is cooled some 20 or 30 degrees below the point at which it is desired to use it, centrifuged to remove ice particles, and then allowed to rise in temperature and thus become "dry."

To carry out a scientific engine test during flight requires not only a measurement of fuel consumption, but demands also that the *weight* of the air used should be measured. This is no easy matter, but its achievement has been much aided by a suggestion made by Professor Callendar, F.R.S., to reverse a laboratory method employed by him for the measurement of the specific heat of gases. For air work the specific heats are known, and so the weight per second of the air flow can be ascertained. This is now under trial at altitude at Farnborough. The use of this apparatus and of the new R.A.F. thrustmeter should enable far more complete air tests to be carried out than have hitherto been possible.

The experimental flight carried out by my predecessor, Air Commodore Brooke-Popham, from Egypt to Mesopotamia and back, brought out with much emphasis the need for economising water on such flights. If water could be dispensed with entirely in favour of air cooling, a great step forward would be made; moreover, from a fighting point of view, it would be of great advantage since it would make the engine very much less vulnerable to hostile machine-gun fire. The staff at Farnborough have long been of the opinion that this was a possible development, and we now have the Bristol Company's "Jupiter" engine of 380 h.p., a nine-cylinder radial engine of which much is expected. There is also the Siddeley "Jaguar" of 350 h.p.; both these engines have been flown quite a lot, and have been most successful; whilst in some other tests a single cylinder, air cooled, has given as much as 222 b.h.p., with a brake mean pressure of as much as 134 lb. per square in. There are enthusiasts—I am one of them—who consider that an air-cooled engine of 1,000 h.p. should not be impossible of attainment, and that with one or other form of cooling an aero engine of 2,400 h.p. at 750 r.p.m. should be possible. An advantage of big engines is that the lower r.p.m. avoids the use of reduction gearing to the propeller (and so reduces weight of the power unit by some half-pound per b.h.p.).

A point which is sometimes overlooked when considering the relative merits of the concentration of power in a large single engine and its division between two or more smaller engines, is the additional weight per horse-power necessitated by the greater mass of engine "accessories" in the latter case. If from the weight of the power unit (including propellers) we deduct the weight of the engine itself and the fuel tanks (empty) the residue of "accessories" is found (from a study of a number of typical cases) to weigh about 1·3 lb. per b.h.p. for the multi-engined plant, compared with 1·0 lb. per b.h.p. for a single-engine outfit. This is for water-cooled engines. With air cooling the single engine accessories figure would be nearer 0·4 lb. per b.h.p.

When comparisons are made between the weights of air-cooled and water-cooled engines, it is sometimes forgotten that although in the former case the weight of radiator and water is saved it is

necessary to include, on the other side of the ledger, an item for the additional weight of the air-cooled cylinders. Thus in a comparison made recently it was found that although the gain due to the elimination of radiator, water, pipes and pump was about 0·7 lb. per b.h.p., there had to be set against this an excess in cylinder and piston weight of 0·46 lb. per b.h.p., so that the net gain was only 0·24 lb. If the fuel and oil consumption of the water-cooled engine be put at 0·50 lb. per b.h.p. hour and that of the air cooled at 0·58 lb., the two become equal as regards overall weight when a three-hours' supply of fuel and oil is included. These are figures to be borne in mind, though they do not, of course, affect the other advantages which successful air cooling would bring in its train.

Many efforts have been made to use other liquids than water for the cooling system. The choice, however, is a very limited one, as it is imperative to have a liquid which is everywhere cheap and everywhere readily obtainable. Oil cooling is, perhaps, the most promising alternative, and I hope shortly to arrange for a series of tests of this nature.

There is no doubt that both from the point of view of civil aviation and that of the Royal Air Force a silent machine is an enormous advantage. In the case of the former the intense noise continued for hours is one of the chief disadvantages from which an air traveller suffers. The advantages in the case of the service machines are obvious. The source of the noise is difficult to analyse, but the propeller and the engine seem to be equally blameworthy. The latter, however, is the simpler to deal with, and as a result of very numerous tests on different kinds of silencers, I am glad to be able to say that the simplest of them all is as efficient as any. This simple form consists merely in adding to the exhaust manifold a tube of about 3 inches in diameter perforated with some hundreds of holes each one-eighth of an inch in diameter; this tube runs nearly the whole length of the airplane, but as it contains no baffles whatever, the back pressure is but slight and only reduces the engine revolutions by about 5 r.p.m. Moreover, the extra weight, as added, say, to a D.H. 9 or a Bristol Fighter, is only 20 to 25 lb. It has been found that with this silencer in use it is possible to carry on conversation even when the engine is at full throttle. Propeller noises are much more difficult to deal with, but experiments are in hand which I hope may assist to a solution, or relative solution, of that problem also, though I doubt the possibility of any extensive reduction of propeller noise.

I cannot leave the subject of aero-engine research without expressing on behalf of the Ministry our extreme regret at the great loss which has befallen air research work through the recent death of Major Norman of the Royal Aircraft Establishment. The most striking attribute of Norman was his immense personal courage; coupled with this, in a most unusual degree, was his inventive ability and ingenuity in design. To whatever task his mind was directed some original and valuable result was sure to follow—often enough not along the expected route, and his was too bright a genius to trammel with rigid guiding lines, but of real value to the future of flying. Such men are rare, but when discovered are worth a host in themselves. One of the most anxious considerations of any Director of Research must always be to endeavour to discover genius of this

kind, and to afford it, when found, the scope that is its due—a task by no means simple.

NAVIGATION.

The most difficult of all problems in connection with "Navigation" is the provision of means in foggy or misty weather to enable an aircraft to locate the aerodrome for which it is bound, and to make a successful landing to it. Unquestionably it is this difficulty which causes pilots on long routes to prefer to fly under, rather than over, clouds. Professor Jones, in a paper read not long since before the Royal Aeronautical Society, gave many reasons why it would be better for such flights to be made above the cloud layer, but ample experience before then and since has shown that it is no use to expect pilots to do this until their minds are reassured as to the adequacy and reliability of the ground organisation enabling them to make safe landings through fog.

At one of the meetings of the Aeronautical Research Committee, Professor Lindemann suggested that the best means of landing in a fog might well prove to be the provision by the aerodrome so afflicted of two pairs of small kite balloons floating above the cloud layer, the first pair being at such an altitude as would enable a gliding machine, which passed between them, also to glide between the second, and lower, pair, and after an equal interval of time to land on the aerodrome; it is somewhat difficult, however, to get that equal interval of time.

In the case of thin fogs or ordinary mists it may be that the specially bright red ground-flares which are now being tried will suffice. In heavy fogs there is always the possibility, given the right ground organisation, of detecting the position of an airplane by sound, and of signalling to it by wireless when to glide down and in what direction. This has been done successfully at Croydon. Here it is necessary to consider the time element, and it is the last quarter of a mile that counts. The wireless operators may get the aeroplane by sound; they have then to transmit their wireless directions to the pilot; the pilot has to listen to them, and while that is going on he is particularly busy at the moment trying to land in the fog; and as it all takes place in the last quarter of a mile, that method is not really quite so successful as it might be.

Suggestions have been made to get rid of the fog either by mechanical means of pumping, or alternatively by electrical discharges or even by burning vast quantities of coal or other fuel in order to warm the air above the saturation point; these three methods, as a matter of fact, have been successfully tried on a small scale, but when they are figured out for an aerodrome of normal size the cost of their introduction is found to be prohibitive; I am not, however, despairing of the electrical discharges method, and am spending a small sum of money on experimenting in that direction.

When in 1912 use was made of the precessional movement of a gyrostat to measure the velocity of roll on one of His Majesty's ships, it was not contemplated that by far the most successful application of the apparatus would prove to be for air travel; it is known as the gyro turn indicator, and ample experience has shown that it is more sensitive and much more rapid in its indications than any other method that has been tried for indicating the turns of an aeroplane. Unlike the use of a constant azimuth gyro, this apparatus does not

need to be delicately balanced as regards the position of its centre of gravity, and is, therefore, remarkably fool-proof. Airplanes flying in a fog frequently get into turns without knowing it, and when they do so, the magnetic compass, particularly when of an old pattern, is pretty sure to indicate a turn in the wrong direction, and so thoroughly mislead the pilot.

Modern compasses are much less affected than were their predecessors by the yawing oscillations of an airplane, or even by moderately rapid turns off north, and this is due, in the first instance, to the work of Keith Lucas and Lindemann when at the Royal Aircraft Establishment, and later by the work of Dr. Bennett of Emmanuel College, Cambridge, and the late Lieut.-Commander Colin Campbell, of the Admiralty Compass Observatory. The Farnborough work showed the advantage gained by a long period, whilst the later inventors pointed out the great advantage of damping the oscillations of the magnetic needles even to the point of aperiodicity.

It is a natural speculation as to what is likely to be the amount of deviation error in the magnetic compass when machines are built entirely of steel. Such tests as have already been made are, however, reassuring in this respect. It seems that the deviation error in any machine is largely dependent on the proximity of the engine, and that this effect predominates whether the framework is constructed of wood or of steel.

As regards navigation either when flying over the sea out of sight of land, or when flying at any time above clouds, the necessary instruments to enable the position to be determined by the methods of nautical astronomy are now available. They have become sufficiently developed to enable the position to be obtained with a probable error of not over 10 miles. This is as high a standard of accuracy as is necessary for ordinary air work; it enables a check to be made on the dead-reckoning course, and upon any determinations of position derived from wireless methods.

The study of directional wireless is being steadily pressed forward. A particularly promising form of it is the rotating wireless beacon; this method offers the very considerable bait of freedom from the troublesome quadrantal error, but it, like other wireless methods, depends for its ultimate accuracy on a careful study of the conditions which determine the nature of the path followed by the waves.

MACHINES.

The question of stability is being continuously studied, and I hope in the future that it will prove possible so to organise the work as to give more time to this important subject. If possible, one of the National Physical Laboratory wind channels should be allocated entirely to this work.

Stability may be either inherent or automatic. Automatic stability is attained through the operation of some more or less complicated auxiliary mechanism, whilst inherent stability is stability due directly to the nature of the design of the aerodynamic surfaces, the disposition of weights, etc. If inherent stability can be attained there will be small need for automatic stability. At present the problem of longitudinal stability is to a large extent solved, but that of lateral stability still requires a great deal of work to be done upon it. Much has also to be done on the measurement of pressure distribution over wing

surfaces; I hope that in the near future it will be possible to give more time to this subject.

Not a little public attention has been drawn to the interesting arrangement of slotted wings proposed by Mr. Handley-Page. A large Handley-Page monoplane wing with a single long slot is now at Farnborough awaiting test. This wing also has short slots in front of each aileron. Two other new Handley-Page designs are also in hand. The results will be followed with great interest. The earlier trials had shown very remarkable results. The "lift" obtained constitutes an important consideration when clearing obstacles around an aerodrome; moreover, for getting off and on to decks, it was found that the launching run with the Handley-Page wing was less than half that necessary with the standard wing under similar conditions. Public attention has also been drawn to the "Alula" wing, and careful tests have been made of models in the wind channel; these have not so far demonstrated that a wing made in this fashion should be exceptionally good, but it is conceivable that the scale effect between a model and full-size may be unusual in a wing of this shape; the point is being looked into. Progress in full-scale methods is far more costly than first trying out with a model, but the conditions are not quite the same; for example, take the effect of a propeller on a controlling surface and on the whole machine on the full-scale, where you cannot reproduce very well the propeller effect in a model.

As regards propellers there is no doubt, as has been pointed out by my predecessor, that a complete metal propeller would be a great boon. I would even go so far as to say that for all Service airplanes in the East they are essential, even at the cost of a greater propeller weight. For sizes of over 450 h.p. there is reason to hope that the increase in weight will not exceed 10 per cent.

Now that the supercharging of aero-engines has been shown to be a possibility, it is necessary in order to take full advantage of it to provide a variable pitch propeller; these will also almost certainly have to be of metal. Work is, therefore, in hand in this direction at Farnborough, and I trust that it will be found possible to do all that is necessary without a disadvantageous increase in weight or complexity.

The ability to fly off or land on the deck of a ship is becoming increasingly necessary. Development work to this end is in hand, and I hope the future will show that amphibians as well as airplanes will be easily capable of being used for this purpose. We have very successfully landed both with amphibians and other types on the deck of a ship.

Further experiments are in hand to examine into the sea-keeping abilities of the large N.4 flying boats. These weigh some 30,000 lbs., and have engines giving a total of 2,600 h.p. You will gather that it is no light job to land a seaplane of that sort; they must live in the water.

And what of the helicopter? It is difficult to know what to say. Efforts are proceeding and public money is being spent; we shall, I hope, be rewarded for our foresight. Mr. Brennan's helicopter has flown to the extent of lifting the pilot and 250 lbs. useful load—an encouraging preliminary flight.

Much public attention has been drawn to the tests made this winter on different types of fuel tank proposed by various designers. As is generally known, these tests were made by inflicting on the tanks

submitted a destruction experiment analogous to that of a heavy crash.

The difficulties in regard to the construction of fuel tanks were brought home during the war. It was soon found that the use of a suitable rubber envelope would prevent petrol from leaking from a small bullet hole, but the problem to be solved was a much more difficult one than this. If an empty fuel tank were fired at, a small hole would be made in the metal wall at entry, and another at exit; if this, however, were done with a full tank, the size of the hole at entry would not be changed, but the exit hole would be enormously increased in size, sometimes amounting to the blowing out of the far side of the tank. The latter effect was, no doubt, due to impulsive pressure in the liquid, but the right steps to take in order to minimise its effect were not so easily apparent. As is now generally known, something very close to a solution was found in the introduction of a very thin-walled tank, coated on the outside with rubber, and known as the Imber tank; it was, however, somewhat heavy, and was not considered to be entirely satisfactory as a fuel container under the conditions of a crash. When a tank full of petrol crashes, there is initiated in the mass of the liquid an intense impulsive pressure not very dissimilar to that which is created when a high velocity projectile is suddenly brought to rest within a few inches.

MATERIALS.

The work of the Materials Sub-Committee of the Aeronautical Research Committee has led to the undertaking of researches of very great importance, not only for the future of aircraft construction, but for the engineering industry generally. The special need in aircraft construction which differs from previous engineering experience is the enforced weight limit. The long-confirmed custom of measuring the tensile strength of a material and then dividing this by some "factor of safety" of 5, 6 or 7 is inapplicable to aircraft, since the resulting structure would be far too massive. In aircraft, perforce, finer limits have to be worked to, and this renders it essential that the logical basis of design should be closely examined. The result of this scrutiny is to show the need to think rather in fatigue limits than in ultimate stress limits. The great difference between these two methods is seen in the effect of a tool mark or scratch on, say, a crank-shaft. Under a steady stress, local yielding would quickly absorb the minute area of high stress, but under an alternating stress the sensitive area is pulled to and fro until an appreciable portion of the shaft is weakened, and breakage results. A study of these matters is bringing forward new methods of testing and new methods of manufacture, and it has, moreover, thrown light on that "scientific puzzle," the spiral fracture of a shaft. Work at Farnborough has shown the ideal limits for tensile strength, and with certain substances this limit has, temporarily, been very nearly attained.

Tests on the fatigue of the materials used on aircraft are being carried out at more than one centre. Investigations on this, or allied subjects, are being undertaken at the Universities at Leeds, Edinburgh, Bristol and Birmingham, in addition to researches at the National Physical Laboratory and, to a certain extent, elsewhere.

Perhaps the most troublesome material in present-day aircraft is the rubber tubing used for conveying petrol, or making joints in the

petrol pipe line. It has to be of the "P.R." or "petrol resisting" tubing, and it seems, unfortunately, to be the case that the effective life of this rubber is but six months, so that by the time it has been shipped to a distant Air Force centre and been passed into store for a moderate time, a large proportion of its effective life—and sometimes the whole of it—has vanished. To avoid this serious difficulty the Royal Aircraft Establishment has fitted machines with piping of copper with a special union. I am happy to say that this rigid joint is in use to-day on a large number of aircraft, both service and civil, and I have not yet had a single complaint, which, I think, speaks well for it. There is also another form of substitute for "P.R." tubing, called "petroflex." It has this great advantage, that it can be fitted straight on to the existing pipeline and the "P.R." tubing scrapped without any undue trouble.

Petroflex is rather a wonderful material. It is made up of some ten layers, glued together, of the intestines of Chinese hogs, of which, fortunately, there seem to be illimitable numbers. Around these are layers of canvas, fire-proofed. Outside this, in turn, as a final protection, is a spiral of metal wire (aluminium in the case of land machines). This tubing appears to be totally unaffected by petrol, though care has to be taken to keep water away from its inside. Experiments have shown that the piping will stand as much as 200 lbs. per square inch of internal pressure. Fifty sets have been sent out to the East for trial.

A supply of the right quality of timber for building aircraft is one of the most serious responsibilities to those in charge of such matters. It has been of especial importance in the last few years, owing to the world demand for timber of all kinds, and the consequent indisposition of markets to take great trouble in sorting the timber or in drying it. This bears particularly hard on airplane users of spruce, and I am, therefore, very glad to find that Canada is now supplying spruce carefully selected. This was done by the enterprise of certain aircraft firms—not the Air Ministry. They got this spruce specially sent over from Canada, it having been carefully selected before shipment. When I was Director of Aircraft Inspection I had it inspected, and over 87 per cent., I think, passed as grade I. spruce. I would like you to bear the timber question in mind, because when we get to happier days and we are building aircraft in much larger quantities, we shall require spruce, mahogany, walnut, &c., and therefore we ought now to give this matter our attention.

The CHAIRMAN: My Lords and Gentlemen: I think we can congratulate ourselves that we have had two papers on research so mutually complementary as the papers we have listened to. Certainly these papers will ensure a very lively and very valuable discussion to-morrow afternoon.

Now we come to a paper on another branch of activity, a paper on "Airships," to be read by Major Scott. Major Scott's name will ever be remembered and respected as the hero of the first, and up till now the only, double Atlantic flight, and we welcome him and his contribution with enthusiasm and with extreme heartiness.

AIRSHIPS.

MAJOR G. H. SCOTT, C.B.E., A.F.C., A.M.I.Mech.E.: Owing to the incentive of the war the airship has been brought to that state of development where it may justly be said to take its place amongst

the useful inventions of the world. Like all other engineering achievements which have reached such a stage, there can be no question of it standing still; it is certain great efforts will be made to establish it as a means of long-distance transport, and to utilise it for defence purposes.

British airships are in a peculiar position: the British public really know little about their great possibilities, as although our existing airships are capable of carrying out long flights of three to four days, it has been impossible to demonstrate the commercial value and possibilities of this performance, as no ground organisation is available outside Great Britain. The public in this country have seen nothing but the irregular, although long, flights carried out by our ships.

The German public, on the other hand, are aware of the possibilities of the airship, as they have had practical demonstration of airships flying regularly on fixed routes for commercial purposes.

The airship position in this country has now reached a critical stage, and I hope to show you that issues of vital importance to the Empire depend upon the steps which we take now. As I have said, there can be no doubt that the world will continue the development of the airship, and eventially airships will be flying commercially on all the main world routes. Personally, for reasons which I give later, I hold the view that if a move is not made now, one will be forced on us at no distant date—probably within two years.

FOREIGN AIRSHIP ACTIVITIES.

My reasons for thinking that if a move is not made now by this country it will have to be made within two years, are based not on any revolutionary improvements in airship design (I state later that the present-day airship is, in my opinion, capable of founding certain important services), but on the airship position in other countries; briefly, the activities known to be taking place are as follows:—

America.

The United States Naval Department have arranged with the Allies for the construction of an airship by Germany at the Zeppelin works as part of America's share of aerial reparations; this ship, we may take for granted, will embody the latest features of airship design, and should be flying within 12 months. The United States Navy Department are also building in America the Z.R.1, modelled on a German ship. The U.S. Army have recently purchased the Italian semi-rigid Roma, which is the largest airship of its type in the world, and have also in commission several smaller non-rigid airships.

With such a programme progress will be very rapid. A large base at Lakehurst has been erected; it has a shed with twice the floor space of anything in this country, capable of housing ships three to four times the size of any built to date. There are also several other bases in being and in use by the Army and Navy authorities, notably, Langley Field.

It is also known that a powerful commercial combine exists in America to-day with a view to running commercial airships, probably in the first instance trans-continental, the Atlantic being considered a later development.

Major Scott.

I should like to quote from the United States National Advisory Committee for Aeronautics' Report for 1921 :—

> "Attention now being given to the development of types of airships to realise fully the advantages which the use of helium would afford should be continued. Such development would give America advantages for purposes either of war or commerce with which no other nation could successfully compete."

I think I have said enough to show that the United States means to develop the airship, and it must be remembered we shall have a practical demonstration of the capabilities of the modern airship within the next twelve months, when the ship Germany is building for America is flown across the Atlantic. On delivery of this ship in America a great incentive will be given to airship activity throughout the world.

France.

The re-erection of three large sheds, which were taken from Germany under the Peace Terms, is proceeding. These sheds are being erected—one near Paris, one near Marseilles, and one in Algiers. These, together with the two existing bases at Maubeuge and Marseilles, will place France in a very strong position when she can finance the construction of ships (which, undoubtedly, is her present intention) both from an international traffic point of view, and for the operation of an airship service from Paris to her principal colony.

Germany.

There is abundant proof that the Germans are firm believers in the future of airships. They have, in various ways, managed to keep their technical staff together, and are still in a position, technically, to design and construct airships.

The latest move, and one which, in my opinion, will give them what may well turn out to be a commanding lead in airships, is the arrangement now being completed between Spanish commercial interests and Zeppelin interests to establish an airship service between Spain and the Argentine.

There is no reason why the first leg of this route, say to Las Palmas, should not be operating within two years from now, in spite of the fact that a shed must be erected in Spain, and quite possibly in this time the service may have reached Brazil.

Italy.

As I have already said, Italy recently constructed a 1¼ million cub. ft. semi-rigid airship which America has purchased. They are now engaged in building a still larger airship of this type which will have a range of about 4,000 to 5,000 miles. Italy also has under consideration a commercial airship service from Rome to her North African colony, Tripoli.

From what I have just said you can estimate what the world airship position is likely to be within two years, and I leave it to you to decide whether this country could then continue to remain inactive without prejudicing the interests of the British Empire.

THE AIRSHIP AND IMPERIAL COMMUNICATIONS.

As stated by the Dominion Prime Ministers at their Conference in London last summer, and now universally recognised, the problem of speeding up Imperial communications is a matter of urgent and

vital importance to the Empire. The employment of the fastest modern liners on Imperial routes would not achieve a saving of more than 15 per cent. to 20 per cent. on present times of transit, and I believe I am right in saying that the cost of establishing such services would run into many millions and could never be operated economically.

To provide a real benefit we must use the air. I am a firm believer in the future of the commercial aeroplane, and have talked over this matter with many aeroplane experts. They agree with me that a satisfactory system of aerial transport over the world can only be established by both airships and aeroplanes working together. They agree that the work between main terminals in each country can only be carried out by the airship, these terminals being faced by aeroplanes. There is no doubt that a large amount of work has been, and is being, done as regards these aeroplane feeders; but the linking up of the main terminals is the first essential, and unless the airship is used for this purpose it is difficult to see how Imperial communications can be improved.

The cost of establishing airship services was very fully dealt with by the Imperial Air Communications Committee, but the fall in prices since that report was drawn up should enable considerable reductions to be made.

The technical position of the modern British airship.

It is now necessary for me to refer briefly to the technical position of the airship to-day in order to demonstrate to you that it is capable of playing an immediate part in linking up the Dominions.

With the technical knowledge and experience at our disposal it can be affirmed with certainty that an airship can be built to-day whose performance in all directions can be established beforehand, and which will not introduce any experimental and untried features.

In stating this, it is fitting, perhaps, to refer to the R. 38 disaster, especially as I regret to see that statements are current in certain quarters that this accident goes to confirm the general conclusion that airships are not yet sufficiently developed to be commercially employed. It is only necessary to refer to the findings of the Service Court of Enquiry to show how wrong such a conclusion is. In the findings it is shown that in order to outfly German military airships, a very high ceiling was necessary. This, of course, meant low factors of safety. The commercial airship does not require this high ceiling, and therefore the factors of safety can be considerably increased. Furthermore, the ship was designed some four years ago, when considerably less knowledge was at our disposal than to-day.

To form a conclusion that the airship is insufficiently developed for commercial purposes from the failure of such a ship as R. 38 alone, is to ignore the thousands of flights made by the German airships in all kinds of weather, to say nothing of the work of R. 33 and R. 34, and other British airships.

I would like to say here that Sir Richard Glazebrook, who was on the later Committee which has just completed the technical inquiries into the loss of the R. 38, and who will speak to-morrow, supports my statement.

The airship I propose would have a capacity of 2,500,000 cubic feet, giving a gross lift of 75 tons and a useful lift for freight of 12 tons for non-stop journeys of 2,000 to 2,500 miles. This would enable

35 passengers and 7 tons of mail and other goods to be carried, without an intermediate stop, from England to Egypt. A journey of this distance could be completed in 50 hours, or at a speed made good of 50 m.p.h. The hull would be of a rugged construction, built for a long life and low maintenance cost, and should last in continuous service for at least five years. The airship would be built with a factor of safety at least equal to that of R. 33 and R. 34, which ships showed themselves capable of standing up to the worst weather conditions, both in flight and at the mooring mast.

During the last 12 months I have carefully examined the daily weather charts which cover the entire route between England and Egypt, and in my opinion there is no doubt that this first leg of the Imperial Air Route could be run with a regularity comparable to that of steamships, and in the time I have given above—50 hours. For the next step, Egypt to India, we have not at the moment the same detailed weather information, but there is nothing in the information at my disposal which would suggest any difficulty in maintaining an equal degree of regularity over this second leg of the Empire route. Thus, allowing a stop of half a day in Egypt, India would be reached in $4\frac{1}{2}$ to 5 days, giving a time saving of approximately 10 days, or $66\frac{2}{3}$ per cent. over existing means of transport. A similar saving would also be effected to Australia and other points of the East. Put in another form, the opening of a service to India only would give a saving to Australia of fully $33\frac{1}{3}$ per cent. over the fastest steamship times.

Beyond India, on the Australian route, the meteorological data at present available is so incomplete that I do not feel justified in expressing any opinion at the moment as to the degree of regularity that could be maintained, although from the general weather conditions which are known there is no doubt that this route could be flown.

I have considered the airship as a whole, and discussed its performance on specific routes; but to give a true statement of the present technical position of the modern British airship it is necessary to deal very briefly with the individual parts separately.

Hull.

As I have already stated, it is possible to build an airship of 2,500,000 cubic feet capacity without embodying any features that have not already been tried out and proved in this country or in Germany; this hull would have a life of at least five years. This estimate is based on the careful examination of previous airships, an examination which shows that after a life of three years there are no signs of any deterioration of the framework. It should also be realised that it is comparatively simple to build in new girders where any local deterioration is found, and it is only in the case of general deterioration that it would become necessary to delete the airship.

Fabric.

In the past, British gas-bag fabric has given a certain amount of trouble. This fabric consisted of a cotton fabric base, on which is stuck two layers of goldbeaters skin, to give the necessary gas-holding properties. The medium employed to attach the skins to the fabric is a matter of the utmost importance. The Germans have employed a gelatine glue, whilst a rubber solution has been used in this country.

Also the actual method of laying the skins was different in the German case to that employed here.

In the course of extensive experiments which have been carried out in Egypt during the past year, it has been demonstrated that the thin film of rubber employed for adhesion suffers badly under tropical conditions, and is in all respects unsuitable substance to employ on airships which will have to do much flying in tropical or semi-tropical regions. Samples of German fabric stuck with gelatine glue which were also tested in Egypt have, however, not suffered in this way, and, therefore, by employing the German method of gas-bag construction there is little doubt that we can make gas-bags in this country which will give satisfactory results under all conditions.

Engines.

The requirements of an airship engine are essentially different from those of an aeroplane engine, yet no British airship engine has been developed.

In commercial airships the average flight will be about 50 hours; the engine will be required to develop $\frac{3}{4}$ power, with occasional stops, for the full period, whereas an aeroplane engine is only required to run for about 6 hours. The modern airship starts its journey with about 20 lbs. of fuel for every rated horse-power of the engines, while the corresponding figure for aeroplanes does not exceed five. This indicates the relative importance of fuel economy and engine weight in the two cases.

An engine designed for airship work may, therefore, have a higher weight per h.p., provided there is a corresponding decrease in consumption, and such an engine running at lower revolution would be more reliable and have a longer life. The Germans by developing the Maybach engine for airships, have produced an engine of this type, and it has given most satisfactory results.

A probable development in the near future is the introduction of the heavy oil engine, which would result in a considerable reduction in running cost.

Safety.

The question of the safety or danger of a modern airship may be considered under two headings: (1) dangers due to fire, and (2) dangers due to weather conditions. The dangers due to fire may be again sub-divided into those due to petrol fuel and those due to hydrogen.

As regards petrol, the danger from this source is, contrary to popular opinion, more serious than the danger from hydrogen; but, on the other hand, the danger from petrol is no more serious in the airship than from the same cause in an aeroplane. It is obvious that every effort should be made to eliminate it, and the introduction of a heavy oil engine would almost entirely remove this danger. In the meantime, however, much can be done by the mechanical refinement of the fuel installation, and the abolition of any contributory causes of fire, such as sparks from electric leads, which will render this danger almost negligible.

Turning now to the possible dangers from hydrogen, it should be emphasised that the ignition of hydrogen has been, in all cases of fire in rigid airships, a secondary cause only. These cases have been few, except for those due to enemy action, a point to which I give further consideration at a later stage.

Major Scott.

Weather conditions.

I think it is not generally realised that the airship is perfectly safe in the air as far as weather is concerned, and that on the occasions when modern airships of proved type have been wrecked it was invariably due to accidents happening whilst handling on the ground.

(a) *Electrical disturbances.*—The chief danger in an electrical disturbance is not, as is generally thought, due to lightning, but to the very violent air currents that might bring excessive strains on the hull structure. It is, however, even with the present meteorological organisation and with present air knowledge, comparatively easy to avoid thunderstorms. I can definitely say that thunderstorms in this country do not constitute a danger to airships, neither will they constitute a danger in the tropics, as with the development of airship routes the meteorological organisation will be extended to meet our comparatively simple requirements.

(b) *Snow.*—The danger from snow is the possibility of the airship becoming so heavily coated that she will be driven to the ground. Experience gained in the air and from maintaining an airship at the mooring mast points to the fact that little danger exists from dry snow, as this snow blows off and does not collect on the airship. Damp snow and sleet are the chief dangers. When flying through snow and sleet, however, at the first sign of snow collecting the airship can rise into the dry snow, 1,000 ft. in most cases being sufficient.

Mooring mast.

I do not intend to go into the details of the mooring mast, but I would like to state that the recent experiments, carried out at Pulham under the Controller-General of Civil Aviation, have proved, beyond doubt, that the mooring mast is a practical proposition.

The results of these experiments have proved and demonstrated :—

(1) That an airship can remain at a mooring mast comfortably in winds up to 60 m.p.h., riding through hail and snow squalls.

(2) That an airship can with ease leave a mast in a 40 m.p.h. wind.

(3) That an airship can land at a mast in winds up to 32 m.p.h.

(4) That necessary running repairs can be undertaken with safety on an airship at the mast.

From these results it is obvious that an airship can leave a mast or land to a mast in all ordinary weather, so that there is no difficulty in an airship working to scheduled time. Moreover, the danger of handling an airship on the ground is reduced to a minimum owing to the comparatively few occasions on which it will be necessary to put an airship into a shed, an operation which will only be carried out under selected weather conditions.

Before passing on from the technical position of the airship to-day, I would like to mention that in estimating the performance of the airship I have not taken into consideration any future developments which would improve this performance and which are now in sight, one of the more important of which is the utilisation of waste hydrogen as fuel. Experiments in this direction, which have been carried out and which have proved most satisfactory, indicate that a considerable economy in fuel may be exepcted, the direct result of which will be to increase the commercial load of the 2,500,000 cubic feet airship

mentioned before by something in the order of 40 per cent. over a 2,000 to 2,500 mile journey.

It may interest you to know that the present technical position as outlined would be considered by the German as pessimistic. I am also in a position to say that they would be prepared to build a ship with a higher performance than I have proposed, and to guarantee this ship to stand all necessary tests.

The value of airships for defence.

I would like to give here my views on the bearing which the commercial development of airships has on their uses for service and defence purposes. It is my firm conviction that the airship can play a most important part in the defence of the Empire, and the establishment of commercial services will give us in time bases and mooring masts at essential points throughout the Empire. I, therefore, suggest that when considering the commercial development of the airship we should not overlook the value of these bases for airship co-operation in naval defence.

It is, perhaps, unnecessary to emphasise the point that we must not think only in terms of the North Sea. During the recent war the airship was largely immobile, but with the successful development of the mooring mast this is no longer so. Given the existence of mooring masts and fuelling points, the airship is to-day the most mobile form of transport, over large areas, in the world. Thus concentration at any point or in any particular area would be secured at a maximum of speed and with a minimum of delay.

The advantage of this will be obvious when concentration is required for general naval operations, for dealing speedily with the operations of raiders—which to us will always be of serious moment—and, more important still, for patrolling the main trade routes of the Empire, and for convoying purposes in any part of the world. When you recall, as one example, that India, by airship, will be less than five days distant, these points gain emphasis.

In these circumstances I therefore say that with the establishment of Imperial airship services a new era will arise from the defence point of view.

I cannot omit the question of vulnerability. There is no doubt as things are at present that the airship is very vulnerable from the military point of view, largely owing to the use of hydrogen; but the question of the protection of the airship against incendiary attack has not been fully worked out, although experiments with helium and in the use of an outer envelope of non-inflammable gas have given very promising results. These experiments will undoubtedly go on, if not here, certainly in other countries, until satisfactory results will, I believe, be actually obtained.

Successful developments along these lines would eliminate the disadvantage under which the airship has worked in the past and works at present where heavier-than-aircraft can attack. But this limitation applies only as I see it where an airship is operating over waters controlled by the enemy, or in close proximity to hostile land bases. Over the large sea areas and along the main trade routes an entirely different situation arises. There, to be effective, attack by enemy heavier-than-aircraft will necessitate the use of aircraft-carriers. To my mind this necessity, even under present conditions, removes very greatly the handicap of vulnerability, as it will be

apparent that if the enemy do not control the waters, aircraft carriers will not be able to operate with any hope of success. This is most important, and is my reason for asking you to consider the commercial and the defence possibilities of the airship together.

In addition, little has been done to equip the airship with the most satisfactory form of armament, either for attack or defence. I believe, personally, that the airship would provide a good gun-platform, and with heavier armament and greater accuracy of fire than the attacking aeroplane would possess, it should give a good account of itself. The possibility of acting also as an aircraft-carrying ship, both for purposes of attack and defence, should not be ruled out.

I have put forward these views because I consider them of very great importance in reviewing the airship position. To sum up on this particular aspect, the real reason, in my opinion, why the airship is not employed extensively at the present time for naval purposes is not attributable to the lack of naval work on which the airship can be successfully employed, despite her apparent vulnerability, but entirely to the absence of mooring masts and bases in the various parts of the Empire.

The establishment of the necessary ground organisation in the Dominions and India is, therefore, of primary importance not only to improve Imperial communications and to develop commercial possibilities, but in no less degree to utilise the airship to the utmost for Imperial defence. The erection of these bases for an Imperial airship service, to repeat the point in another way, would immediately make the airship of considerable value for Service purposes, and conversely, the establishment of bases for Service airships would also be of great assistance in furthering commercial airship projects.

Conclusion.

In conclusion I would like to summarise my main points as follows :—

Firstly, technically the airship is to-day in a position, without waiting for further improvements, to be usefully employed for both commercial and defence purposes.

Secondly, given the establishment of certain bases and mooring mast equipment, the airship of to-day is the most promising means of solving the vital problem of speeding up Imperial communications. The information which I have laid before you proves conclusively in my opinion that the route to India could be successfully opened up immediately the bases are established.

Thirdly, with the establishment of certain bases and mooring masts, the present-day airship will become, through its greatly increased mobility, a vital factor in national defence.

These points alone, in my opinion, necessitate the most thorough investigation of all possible means of solving the financial problem, which is the only bar to the immediate initiation of an Imperial airship service.

There is, however, another point for consideration. Will any financial economy be effected by the temporary cessation of airship activity in this country? In my opinion it will not, as the position in foreign countries will, as I see it, within two years make a reconsideration of the airship question essential, and at a cost considerably in excess of anything which would be necessary to-day.

This is an additional and weighty argument in my opinion for making every endeavour to find now a solution to the financial problem.

I would again like to emphasise that the first stages of the Imperial air routes to be established are :—England–Egypt; Egypt–India; and then India–Australia; the establishment of the England–Indian route only, with its immediate benefit to Australia, would be a solution of a large part of the Imperial communications problem. If, therefore, the Dominions find it impossible to provide the whole of the money for the establishment of the complete scheme, it is urged that the England–Indian route should be concentrated on. The amount of money required for this route would be considerably less than that required for the complete scheme.

It is suggested that if, taking into consideration the value of establishing this route from both an Imperial and defence point of view, the parts of the Empire concerned could even do no more than finance the provision of the ground organisation, would not commercial interests, recognising the possibilities, be prepared to do their part? This seems to me to be a possible solution.

I have suggested the importance of airship work from the point of view of Imperial communications and defence; the commercial possibilities in reducing the time of transit to India from 15 days to 4 or 5 days, and of bringing Australia within 10–12 days instead of 35 days speak for themselves.

Finally, I would like to say that I do not want anyone to think I am making an appeal for the preservation of the present British airships just because they are airships, but because, as I have tried to tell you, it is my opinion that airships can do work to-day, if bases are established, which is of great importance to the Empire.

The CHAIRMAN : My Lords and Gentlemen : we have now completed the programme for this afternoon, and before adjourning I am asked to remind you that those who wish to speak to-morrow afternoon on the papers we have heard to-day are requested to forward their names to Mr. Oldfield or myself as early as possible.

Accordingly, I now declare the technical session adjourned to to-morrow at 2.45 p.m., and thank you for the close and kind attention you have given to the reading of the papers.

SECOND DAY. WEDNESDAY, 8th FEBRUARY.

MORNING SESSION.

The Right. Hon. LORD WEIR OF EASTWOOD in the Chair.

The CHAIRMAN: My Lords and Gentlemen, the Secretary of State for Air, Captain Guest, has asked me to express to you his deep regret at his inability to take the Chair at this session. Personally, I feel his absence for the additional reason that he has asked me to take his place. I trust that under these conditions you will grant me your kind indulgence, and I propose at once to abuse my power as Chairman by opening the discussion myself.

Two better papers could not have been presented to us to serve as a basis for useful debate, and their authors deserve our heartiest congratulations. From Lord Gorell, whom we all welcome to the ranks of those who direct our national air policy, we have had a picture of the present situation and some valuable reflections on policy, while from Colonel Bristow we have had a critical, a brilliantly suggestive, yet a commonsense analysis of the situation.

Let me for a moment adopt Colonel Bristow's attitude and regard the achievements of the last three years in civil air transport and make a summary of the lessons they convey. May I say that I am so intensely pro-aviation that I have a feeling of compunction in building up what might at first sight appear to be a somewhat derogatory case. You will all recollect how essential it has been in the past to sound continuously the note of optimism so that at least a fair start might be given to the new form of transport. But at this stage a more critical analysis, I feel, would be thoroughly justified. Up to date, what has civil aviation done for civilisation? What is it at present capable of doing? Surely, our three years' review compels us to confess to a very meagre result. In Great Britain the aeroplane has been unable to demonstrate its practical utility, commensurate with the cost, for any purpose whatever; in saying that, I except the cross-Channel service. That is a hard statement to make, but I find very little evidence to controvert it.

Turning to the Continent of Europe, I find myself in thorough agreement with Lord Gorell's belief. I find the contribution of State funds has enabled considerable numbers of very miscellaneous kinds of aircraft to fly more or less regularly over certain routes, carrying, in gross, relatively small commercial loads. It is not a result that I consider worth emulating, nor do I believe that, in the consideration of effort and cost involved, this sort of civil aviation yields any useful result. In America a somewhat similar position is found at present, except that the effort is directly State-controlled. It is rather more concentrated than in Europe, and it appears from the published results to be equally prodigal in life and cost. In other parts of the world, the picture is much the same—no results compatible with the expenditure, and no obvious progress in either a technical or a commercial sense. Remember that I have excepted the cross-Channel service.

What is the reason for, the explanation of, this disappointing result? Is it one which should lessen our faith in civil aviation? Is it lack of public support for the new form of transport? Is it jealousy of vested interests or lack of organising capacity and adaptability on the part of those immediately responsible? I think the answer must be that there is absolutely nothing to lessen our faith, and none of the other factors have been of outstanding importance in producing the results I have indicated. The main reason is to be found in the aeroplane itself, in the vehicles which have been utilised. Briefly, the aeroplane as we have had it, is not an instrument capable of achieving results of practical value commensurate with the expenditure involved, and that, I think, is the dominating lesson of the last three years.

But, along with that, I claim that we in Great Britain have learned infinitely more. We have learned enough to confirm our fondest hopes as to the ultimate value of the aeroplane when once its capabilities are greater and its deficiencies less. We have further learned in some measure the speed at which this ratio of good to bad points can be altered. If we could compare the balance-sheet of a modern cross-Channel machine with the balance-sheet associated with the machine of three years ago I feel certain that we could be entirely reassured that, given a continuance of this rate of progress, the time is not far off when civil aviation will stand without artificial support. On the world's civil aviation for the past three years much has been spent in vain and utterly lost. On the other hand, where a policy of concentration of effort has been pursued as in this country, where a cross-Channel service has been specially cultivated, the fruits of experience, however costly, have at any rate been harvested. The result has been a steady application of field experience to the design and development of a type more than suited to its functions.

That is why I thoroughly endorse Lord Gorell's remarks in comparing British effort with the activities of other nations. He says it is necessary to look a little deeper into the figures and ascertain the foundations upon which they rest. I feel that the foundations of our British effort are sound, and, in my view, the present phase of aviation demands our adherence to a progressive development policy. The problem is still, in a measure, one for our scientists, our designers, and our

constructors, and they have never failed us just so long as we have fed them with sufficient field experience and given them clear and definite enough practical demands on which to base their work.

The London–Paris route or the cross-Channel routes are the only developed air routes in the world, and on that demonstration field our future British progress must still continue to depend. That demonstration must be assisted by the State. I personally feel that the extent of such State help is now of a generous enough character for the particular object in view; but our designers and constructors require as a background to this effort of the State a continuance of abstract research on the fundamental factors of the problem, so that they may continually advance in entirely new directions as well as in directions where no further advance seems possible.

Having carried out our policy of concentration so far as regards the type and operational experience on the cross-Channel routes, the question arises, or will soon arise, as to whether we are now justified in advancing to the next step in the natural sequence of development; I mean, the next big step, because it is quite conceivable that a similar step in the form of an additional route somewhere else in the Empire might require support from the State and demonstration farther away from this country. However, the next big step is the Cairo–Karachi route. The efforts which have so far been made have been of a purely development character. Probably such development by the Royal Air Force must be continued, but it must be obvious that this work has been carried out with matériel embodying practical opinion and the knowledge or experience which the London–Paris route has given us. A general analysis of the conditions seems to show that a further development with modern machines and by private enterprise is rapidly becoming advisable.

Lord Gorell's review of the activities of other countries is of great interest on account of the measure of apprehension which appears to exist as to our more conservative activity. As I have indicated, I do not share that apprehension, and I would ask you, gentlemen, to consider yet another aspect of those foreign activities. These activities relate to countries which have depreciated exchanges and whose exchequers are seriously in debt, countries which have unsound taxation, and countries which, by their present uneconomic policies, contribute not a little to our own unemployment and to the hardship conditions in this country. Yet we find these countries expending efforts and money on air development, burdening their future and handicapping their own revival. Such policies cannot endure. What conceivable help can air transport at this stage in its development give to a peasant in Czecho-Slovakia? His railways should come first, and a healthier sense of proportion must be required to govern the policy and activity of these countries, so that the apprehension which some of us feel will no longer exist.

In conclusion, as chairman of the old Advisory Committee on Civil Aviation, let me simply say how much I welcome, how whole-heartedly I welcome, the establishment of the new Advisory Board. It will have this supreme advantage over the old Committee, that, as it has for its chairman the Under Secretary of State, it will be in a position of having a chairman who can see that its recommendations are promptly dealt with.

Lord Weir of Eastwood.

I will now call upon Major-General Sir Frederick Sykes, Controller-General of Civil Aviation.

Major-General Sir Frederick H. Sykes, G.B.E., K.C.B., C.M.G., Controller-General of Civil Aviation: My Lords and Gentlemen, I do not propose to say more than a few words, as I am glad to hear that there are many gentlemen present who wish to speak this morning.

We had yesterday the privilege of listening to able expositions of civil aviation from the Under-Secretary of State for Air, Lord Gorell, and from Colonel Bristow, and as the official to whom has been entrusted since its inception the executive official control of Civil Aviation, I wish, in a purely detached and uncritical spirit, to fill in certain gaps, and to make certain suggestions which may be of value in looking at the problem as a whole.

We are all of us concerned in laying down the broad principles on which aviation in this country can best be developed. Detailed resolutions as to the institution of this or that route, the allocation of so much subsidy, whether the General Post Office should or should not make more use of air mails, are only stones—very important stones, but still only stones—in the edifice, mere "nibbles" at the main problem as to how best to ensure for Great Britain and the British Empire the sovereignty of the air, like the sovereignty which since the days of Elizabeth she has held upon the seas; and that is what we are out to try to attain.

We are poorer, however, by some 14,000,000,000*l.* since 1914. Luxuries are strictly barred; our Government in the next Budget must practise the strictest economy; and there are certain things we must make up our minds to go without—that is to say, if the income tax is to come down.

Is aviation one of those luxuries which we can afford to forego? Everybody here will, I think, agree that the answer is: "We can't!" The air—I speak as a soldier, who at the termination of the War held the post of Chief of the Air Staff—materially helped, if it did not actually win, the fight. Next time air power will be decisive. The air knows no boundaries, and Great Britain and the Empire are therefore no longer protected by their engirdling seas; air power is therefore a necessity. How best can this be attained? "Sea power," says Mahan, "is based upon a flourishing industry." Substitute "air" for "sea," and the analogy is still true. Therefore, if we accept Mahan or the dictum of any other great naval or military strategist, the Air Force by itself is not air power, and after a brief-lived, if

brilliant, flash must wither if reserves are not immediately forthcoming. In the case of air those reserves will in the future be supplied by commercial aviation. As Lord Gorell truly said, service and civil aviation are to one another as the Navy to the Mercantile Marine. Wise generals, if they wish to maintain the strength of their units, must ensure a reserve of a least three men for every one in the firing line. To maintain an air force capable of prolonged resistance, the same ratio as a minimum in pilots, personnel, design and material is necessary.

At the present time commercial aviation, even if it would, cannot yet play the part of reservoir to the R.A.F. Colonel Bristow told us yesterday the very small number of machines we had this year and would probably have at the beginning of next year. Nevertheless, a nucleus has been formed, and this object must constitute one of its main claims for Government support.

The whole world is tired and sick of war. Pacts have been signed at Washington; navies reduced; and optimists have thought to see the first signs of an approaching millenium. The king, however, who to show his good faith not only disarmed all his troops but burned all his weapons, was a fool, and almost next day his neighbour invaded his territory and cut off his head No, the wise man when peace was declared cut his armed forces down to a minimum which might form a nucleus in case of need, and sent the others out to trade and peaceful adventure so that they might be strong in time of stress.

Surely Great Britain is not going to stultify her great efforts after peace by saying in effect, "I know navies are out of date, but I have here a weapon far more deadly and far more effective which I intend to use and exploit to its utmost." It is the development of peace attributes which is in true accord with the agreements made.

Peace and commerce never yet looked well tied to war's chariot, and, gentlemen, as Controller-General of Civil Aviation, I plead for something greater than a measure of financial support, namely, that you consider whether in these latter days the surest method of developing civil aviation, a potential asset of incalculable value to Great Britain and the British Empire may not lie in freeing her of the blighting incubus of military end-all and be-all, and allow her to go her own way as a peaceful, not unproductive, sister, a child as yet, but in time capable of assisting and even of being essential to the fighting arm.

With reference to research,—research, both abstract and concrete, is the keynote of progress; but, as Colonel Bristow so ably said, progress in design must depend on the amount of flying. It is clear that for economic reasons new designs cannot be tried out other than experimentally except by commercial use. Real progress in every direction is, therefore, dependent upon commercial activity.

I have said nothing of what commercial aviation may do within the Empire, of what indirect advantages it may confer by speeding up that all important question of communications. That, too, must come; but we want to get the cross-Channel lines running satisfactorily before striking out further afield. I am content to throw this apple into the arena and to ask your views on these three points: (1) Is aviation a necessity of our national life, and therefore to be afforded at any cost? (2) Can service aviation exist without its civil counterpart? (3) How best can civil aviation be developed.

For myself, I am convinced that, as yet, civil aviation cannot fly by itself; that support must be given and is justified; that we run as grave a risk as was ever faced by any country if, for want of support, we allow the aviation industry to fade, wither, and die; and that we are wrong if, instead of following the advice vouchsafed to Imperial Rome: "*Hae tibi erunt artes pacis imponere morem,*" we tend to choose the path of beating our ploughshares into swords.

The CHAIRMAN: With great pleasure I call upon Colonel Armstrong, President of the Federation of British Industries.

Colonel O. C. ARMSTRONG, D.S.O., President of the Federation of British Industries: My Lords and Gentlemen, as President of the Federation of British Industries, I have great pleasure in associating that great industrial body with the objects of this important Conference. The subject is one which has been in our minds for a long time, and we have endeavoured, so far as the experience hitherto gained and the information available allows, to come to some definite conclusion as to the potentialities of commercial aviation from the industrial point of view and as to the facilities which are necessary if aviation services are to be of substantial use to industry. The subject is, however, one of great difficulty, and depends to a very large extent on technical considerations, upon which it is very difficult for anybody but an expert to form an opinion. I can therefore only deal with it very tentatively and on very broad lines.

I may say at once, however, that the Federation is convinced that air transport can and will be of the greatest service to industry and commerce. They also feel that it is of very great importance that sufficient support should be given to the pioneers of civil aviation in the early stages. I am not, however, going to express any opinion as to the form which that support should take.

For months and even for years past the Federation has been pressing with all the forces at its command for a reduction of Government expenditure and of taxation: of course, in so doing we desire the reduction to be upon unproductive rather than upon productive expenditure: none the less, we cannot but recognise that the question of finance may probably weigh with the Government very strongly, even in regard to so vital a subject as that which we are here discussing.

We feel, however, some small doubt whether the Government has not tended to look at this matter rather too exclusively from the point of view of military aviation. Of course, the interest of national safety must be paramount, but experience would seem to suggest that a

great military Air Force can best be built up on the basis of a great commercial air transport industry. As has often been observed, this has been the line of development in connection with other branches of transport, and we would desire to submit for the consideration of His Majesty's Government that when once effective civil air services are built up on the basis of private enterprise, research and development will proceed far more rapidly and efficiently than they will do as part of a military machine. Whether a change of view on the part of the Government should be reflected in the transfer of Government expenditure from the military to the civil side is a matter upon which I should hesitate to express an opinion. I merely refer to the question as one which deserves special consideration.

Another point which occurs to one in connection with the question of Government support touches the General Post Office. As I shall show later on, it is in the direction of mail and passenger services rather than of goods services that aviation seems likely at the present time to be most serviceable to industry and commerce. Here, again, I speak with diffidence; but it does seems to me that the General Post Office has not been so sympathetic to the idea of air mails as it might have been. We feel not only that the range of mail services might easily and even profitably be extended, but also that the Government has perhaps not done all that could have been done to bring the existing services to the notice of the public. There seems to have been an unnecessary amount of difficulty and delay even in regard to such an apparently trifling matter as the creation of a special air mail stamp, which would, we believe, have exercised substantial influence as an advertisement for the air services.

I will now turn to the practical side of the question and deal with industrial requirements and the potentialities for their supply in so far as existing experience enables one to form an estimate. First of all, in regard to the carriage of goods. I gather that the actual tonnage of goods carried during the first three-quarters of 1921 by aircraft on the air lines of the United Kingdom, France, Belgium and Holland were as follows:—the United Kingdom, 12¼ tons; France, 126 tons; Belgium, 14 tons; and Holland, 27 tons. So far as this country is concerned, the total value of goods carried is practically of no importance; it seems to me, therefore, that, so far as the general industries of the country are concerned, we can ignore for the present the potentialities of the air service for the carriage of goods. Urgent parcels, perishable goods, and goods of small bulk and large value will, no doubt, be carried by air, and the availability of such a service may in individual instances be of extreme importance, but, as I say, for the general industries of the country the matter hardly comes into consideration.

The question of passenger service and mail service is, however, of very much more importance. In both these respects it would seem that the experience gained from the London–Paris service has amply justified the belief in the practical value of carriage by air, but from the commercial point of view it does seem that the London–Paris route does not really give a fair test. The distance is too short to enable the full advantage to be gained from the speed of the aeroplane. The same will apply to the London–Brussels route when it is working. The advantage would be considerably increased if services could be started to and from the more important provincial cities of the Kingdom, though, presumably, there is not yet sufficient evidence of demand to justify such an extension. One looks forward, however, to a development on these lines in the not very distant future.

None the less, it seems to me that the real benefit of air services, both for passengers and mails, can only be gained on very much longer routes. Anyone who studies the question impartially must, I think, immediately be struck with the enormous gain which would accrue to us, both commercially and imperially, if we could link up the distant parts of the Empire with the mother country by oversea air services I feel that if the needs of the commercial community are to be met, it is essential that the long-distance services should receive early and strong support.

We have heard and read most sympathetically statements regarding the proposed Imperial Airship Service, of which Mr. A. H. Ashbolt is so able a champion. Although I understand that New Zealand and South Africa do not see their way at present to co-operate in the scheme, it is to be hoped that, with the co-operation of Australia, a service to that great Dominion may be established in the near future.

Even more important, perhaps, will be an effective service through Egypt to India and Africa, and one cannot help feeling that if the initial expense of such a service could be met, the cost would very quickly be defrayed by the business community through the profits of the mail and passenger services. Of course, I fully realise that the expense to the individual of such a service must considerably exceed the expense of other forms of transport, but to the business man the question of expense has always to be considered in relation to the value of the service which is offered. It seems to me that if, as has been suggested, letters could be carried to India for 8*d.* or some similar figure, the amount of postal matter which would be sent from this country by air to India would be very large. If, as I understand to be the case, a reply can be obtained from India within two weeks, I do not doubt that a very great proportion not only of the business but also of the domestic correspondents would take advantage of the more rapid means of communication and pay a rate which would easily enable the cost to be covered. It is true, of course, that aircraft can hardly expect to compete with the telegraph, but the advantage of being able to send hundreds or thousands of words by letter and of obtaining a reply upon the same scale is such that the cable service and the air service would hardly be in competition. The above consideration, no-

doubt applies also to passenger service, though perhaps to a much less degree, for it may take some little time to educate the general public to the idea that travelling by air is as comfortable or as safe as travelling by other means, even where the more old-fashioned method involves a long journey by sea. None the less, I cannot help thinking that an air service to India, Cape Town, or Australia would meet with substantial support from the travelling public. We therefore desire to urge His Majesty's Government to give special attention to the possibility of extending these long-distance routes which seem to offer both the most important facilities to the public and the greatest source of profit to the promoters and therefore to necessitate the smallest relative expenditure from Government funds.

I do not propose to go into more detail on this subject, for there are so many present here to-day who are more able to deal with it than myself. I would only point out that at the present moment there is running a service from Paris, *vid* Strasburg and Prague to Warsaw, while the United States are maintaining a mail service between Florida and Cuba, as well as between New York and San Francisco. There is also a Belgian service operating on the Congo.

I am sure that I am expressing the sense of the whole of the business community when I say that we hope that, through the co-operation of His Majesty's Government, the Governments of our Overseas Dominions and our own most active and efficient aviation industries these important Imperial services on which the real future of air transport depends may soon be in working order.

Major-General Sir W. S. BRANCKER, K.C.B., A.F.C., representing the Air League of the British Empire: My Lords and Gentlemen, I speak on behalf of the Air League, whose first object is to educate public opinion regarding the tremendous importance of aviation to the British Empire. Time is short, so I cannot waste it in oratory, and I must crave your forgiveness if I seem abrupt or even rude. The speeches made yesterday depressed me, and when I look round this meeting I must confess that I am again depressed; I see friends, enemies, acquaintances and people I know, but I can see practically no new blood at all; the fact is that we experts, enthusiasts and government officials are stewing in our own juice. The British financial magnate and the British business man are not taking the interest they ought to take in aviation, and it is only you gentlemen of the Press who can really make this Conference of some practical value by arousing public interest in its proceedings and in the opinions that are expressed by those who take part in it.

As Lord Weir may cut me off in the middle of my speech, I am going to start with the thing I intended to say last of all. There are, no doubt, people in this room—you will remember what Colonel Armstrong said just now—who are supporters of the line-of-least-resistance policy, the non-constructive policy, and who say, "Cut down the money spent on military aviation and give it to the civil department." Now, I know something about military aviation, and I will tell you flatly that that policy is absolutely wrong. The military side has already been cut down to the bone; it has been cut down further than is really justified when you think of the responsible duties it has to carry out. I can tell you definitely that the Air Force and its administration are absolutely all right. It is better and more economically run than either of the other two older Services. I think Sir Eric Geddes will agree with me so far. It is not wasting the taxpayers' money; it is actually saving it already in Iraq, and I congratulate the Government in their late decision to save yet more money by making Palestine an Air Force Command. I think there is going to be a saving of something like 15,000,000*l.* a year by replacing the Army by the Air Force in Iraq. Egypt and India offer further possibilities of economy to-day if the problem is faced squarely, and although I am not a sailor I know that much money can be saved by replacing naval establishments by Air Force establishments as soon as the Governmen is strong enough to break down the conservative opposition of the old admirals.

For the last year a subtle campaign has been going on against the continued existence of the Air Ministry. It was instigated by the two older Services for various reasons. One can quite sympathise with the feelings of the general staff of the War Office and the war staff of the Admiralty, who see power, establishments and good appointments slipping away from them. But their campaign has lately been supported by a small party who are actuated by motives of jealousy, self-interest and stupid conservatism. I think this party has even had recruits from discontented and inefficient members of the Air Ministry itself. I hope that Sir Eric Geddes' axe has killed this dragon already; I mention it because it may still be wriggling into some form of resuscitation. A distinguished leading daily paper two or three days ago published a very long article by a distinguished officer whom I know sufficiently well to say that he knows nothing whatever about the thing of which he was writing. Unfortunately, that same daily paper published a leading article, which, I think, is a very ill-judged one.

Therefore I suggest to you, gentlemen, who have the cause of aviation really at heart that you should refrain from throwing stones at the Air staff who are really building up soundly and efficiently a Service which is going to be of great value to the Empire, both for its economical administration and because it will be preserving the safety of the Empire very cheaply.

Now, to come back to the point at which I started, I would like to criticise something which our Chairman (Captain Guest) said yesterday I am rather sorry he is not here to-day to hear it. I cannot agree with his statement that it will be many years before air transport lines within Europe will pay their way; I think that is a most unfortunate and pessimistic statement. The London–Paris air service would pay to-morrow if the

transport companies had been nursed over their teething troubles at very little cost in 1919, 1920 and 1921, and if the French Government had been persuaded not to cut rates against us by means of an overwhelming and absolutely unsoundly large subsidy. No doubt, in his recent negotiations with the people who are interested in the present subsidies, he has been allowed to believe that aerial transport is ruinously expensive. Well, that is not so; he has been misled, and he should not believe it. An aircraft service is not ruinously expensive if properly managed.

I agree with Captain Guest that the Paris service is of very little value to us as a nation. It really only exists to-day as a result of political opportunism. Its only real value is, of course, that it forms an experimental air route stage, from which experience can be gained for bigger things; but it is no part of any big, far-seeing policy as regards Imperial air routes, and it is really of no value, so far as I know, to the business man. I doubt if anything has been added during 1921 to what we already knew in 1920, and it is time that some real Imperial developments were undertaken on the experience which has been gained by that experimental service. I therefore rejoiced to hear our Chairman yesterday mention that they were considering the direct route to India, which I firmly believe, if it could be undertaken at once, would within six years, carry our mails from London to Delhi in seventy-two hours.

We are promised another Committee. We had had several committees, starting in 1917; the recommendations of all but the last were either shelved or put into operation too late, or in conditions which were not anticipated when the recommendations were made. The last committee produced the present state of affairs which, I venture to think, is most unsatisfactory, but I come to that later. I do not much like committees; in the Service they used to be the recognised method of avoiding difficult decisions and I only trust that this committee may not prove to be a scarecrow erected for the purpose of frightening away angry and voracious critics.

Now, Gentlemen, I would like to turn to the paper read by Lord Gorell yesterday. I must congratulate him, first, on a very sound and moderate paper, and I am glad that he did not afflict us by talking of blazing trails or Clapham Junctions or anything in the line of hot air. I have to admit, however, that it depressed me because all through he seemed to be rather damning his own case with faint praise. Roughly, I gathered that he implied that we cannot go beyond the cross-Channel services until these services have been made to pay; that the public must ask for aerial transport before the Government can do anything serious; that it was probably better to let other people burn their fingers before we did anything. But I think that Lord Gorell forgets the peculiar qualities of aviation. All these excellent principles probably apply to railway engines, motor-cars, cinema theatres and other interesting commercial enterprises, but they do not apply to an enterprise in which, by burning their fingers now, some of our various neighbours may be able to knock London flat in ten years' time, or become the owners of the most rapid means of communication between ourselves and our overseas dominions.

France's great and growing activity in the air during the last three years has given employment to her skilled aircraft artisans, work to her factories, and money to her drawing offices. All the pre-war organisations are prosperous and working, whilst half of ours have practically vanished. Lord Gorell implies that the lack of progress in design displayed in the Paris Salon was due to the heavy subsidy to air transport. I agree with him that the French subsidy is absurdly high, but, for the life of me, I cannot see how that can kill design. The Salon proved that a very large amount of money was being spent on design, that the French drawing offices and staffs were prospering and working hard, but that, for some reason or another, certainly not from too much money, their ingenuity and inventive genius in aviation from being considerably ahead of us in 1910, is considerably behind us in 1920; but that has nothing to do with the subsidy, which has come in quite lately.

Lord Gorell put a great deal of weight on the fact that it might be more expensive to carry mails by air than by ordinary methods. Well, if money is the only factor to be considered, then why not cancel the huge subsidy received by the P. & O. and carry our mails to India in sailing ships? It would be far cheaper, and, apparently, time is no object.

I cannot understand Lord Gorell's arguments in favour of the Air Force operating Imperial lines. He seems to indicate that military aerodromes do not cost anything, whilst civil aerodromes do. I do not know, but I should think they cost exactly the same, and actually military services must cost more to the taxpayer than commercial services, as they are run without any idea of the rigid economy necessary to make them pay, but, of course, they are used as a valuable means of training pilots in long distance flying.

Lord Gorell has made one thing clear by his statistics. Everyone, even the poor beaten and down-trodden German, is doing infinitely more than we are; their experience, the numbers of their skilled personnel, their organisation, are all growing up, whilst ours have steadily depreciated and dwindled since we led the world in 1919; and the question is, Why? The business man should want to know why, the public should want to know why,

The reasons are various. First, we are divided against ourselves: the War Office and the Admiralty are trying to smash the Air Ministry; this all does harm to the cause, and I earnestly hope that the Government will accept the Geddes Committee's recommendation to create a Ministry of Defence and so stop that sort of silly nonsense.

The next trouble is that airships look upon heavier-than-air-men as their enemies and

vice-versâ. That is absolutely wrong; I am afraid the Government has encouraged this fallacy somewhat because, as far as I recollect, no Committee has ever discussed both together, and it has always appeared that the money spent on one was going to be taken away from the other. That is wrong, and they must stand together; they are not rivals, but allies, and they must fight against Government apathy hand in hand.

Then the military side of the Air Ministry is barely on speaking terms with the civil side: each covets the other's money, and there seems to be no serious effort made to induce them to co-operate instead of fighting. All that does harm to the cause.

Secondly, and most important, in my opinion, is the fact that the Civil Aviation department has never had a policy. It has merely been a flag in the wind of political necessity. I say, "the Civil Aviation department" because, unfortunately, since the end of the war we have had so many changes in the office of Under-Secretary of State, who is more or less responsible for civil aviation, that none of these gentlemen has really had time to formulate a policy. Our Civil Aviation department seems to have been obsessed by certain wrong principles; first of all, that subsidies are against British principle and practice; in the second place, that competition is most desirable; and, in the third place, that aerial transport is no good unless it pays its way once. I think all those principles are wrong. Take No. 1; we have always subsidised mail-carrying; does anyone pretend that the amounts given to the P. & O. to carry the Indian mails are covered by the sums received for the stamps on the Indian letters and parcels? No. Is the sum about to be paid to re-establish the Brindisi–Port Said service for the carriage of Indian mails going to be recovered from the public? No. This wrong principle has now been abandoned, and, with the irony of fate, the Civil Aviation department have gone wildly the other way and are now giving too much for very limited results.

Take the second; compctition amongst British companies cannot be good for a new activity such as aerial transport. We have got quite sufficient competition from the French, Dutch and Belgians, and will have more from the Germans. We are merely helping people to ruin one another and so destroy more aviation resources. If I offered to build a railway across the Syrian Desert, the Government could not go and ask someone to build another in order to have competition. Lord Gorell has impressed upon us the enormous importance of "trustworthiness"; I quite agree, and this petty competition is the sure road to untrustworthiness; it leads to overworking and undermanning equipment, overworking and underpaying pilots, waste of money on useless advertisement, and consequent forced landings, crashes, unreliable running and general loss of confidence.

The third principle is also wrong; aerial transport *will* pay, but even if it would never pay, that is no reason to say that it is no good. The telephone service does not pay (at least, it did not); should we therefore abandon it? Suppose all railway lines and telegraph lines that had been constructed in the past, which could not hope to pay for many years, had never come into being, the world would be a long way behind its present state of development in communication. No; it is not for the Government to demand that aerial transport should pay. It is for the Colonial Office, the India Office, and the Post Office to accept the responsibility of developing this new means of inter-communication and rapid carriage of mails, and I believe they might have done more if the Civil Aviation department had never existed in its present form. It has been a fifth wheel in the coach, a wheel which has been completely jammed and which has refused to go round. Its existence has removed the responsibility from the other departments and its lack of policy, lack of decision, and refusal to help intelligently have destroyed confidence in aerial transport, both in Government Departments and in business circles.

The proof of the pudding is in the eating. In the autumn of 1920 the Civil Aviation department was giving wonderful descriptions of all-Red routes all over the world. They had 300,000*l*. unexpended in their pockets from an annual grant, and absolutely refused a penny of help to four air transport companies, all of whom were threatened with bankruptcy and were crying out for assistance. One of Lord Weir's Committees had definitely recommended assistance five or six months earlier Three months later the same officials were practically bribing the two remaining companies to go on running at heavy expense to the taxpayer in order to save the face of the Government for political purposes, whilst the whole situation was thought out and the present scheme put forward as a more permanent arrangement. This scheme was published just previous to Captain Guest's arrival at the Air Ministry last summer, and I think he will remember that I wrote and implored him, if it was not too late, to stop this foolish competitive system and reconsider the scheme for a big national company; but I fear that he arrived too late. In that letter I pointed out that in the present system I feared that either the small competing companies would combine against the government and force them to give a greater subsidy than is justified, or they would mutually cut one another's throats.

Well, in the C.G.C.A.'s half-yearly report, published at the end of 1921, on page 11, in the middle paragraph, you will find a diplomatically worded admission that my first fear has already been justified; to put it bluntly, the two operating companies said that they would not go on unless better terms were offered, with the result that for the coming year the bonus has been increased from 25 per cent. to 75 per cent., and additional financial assistance towards insurance is also promised. The result is that the subsidies are infinitely greater to-day than would have been necessary if a sound policy had been adopted two years ago, and I say unhesitatingly that they are greater than is necessitated by the present cost of running a non-

competitive British cross-Channel service, and greater than is justified by the importance of these services to the nation. In fact, the taxpayer is not getting value for his money.

Whether my second fear, the fear of mutual throat-cutting, is justified remains to be seen. It is quite likely; and if that comes about, the tax-collector will have been paying very highly for destruction instead of construction. This scheme has another great fault; it limits all assistance to British air transport development to cross-Channel services—a hopelessly short-sighted policy.

That is briefly my criticism of the present Government policy. However, I am glad to hear that a Committee is going to be set up to consider the bigger policy. If I had time, which I have not, I could criticise the past policy—or the lack of it—on the part of the Society of British Aircraft Constructors, and also the attitude and the statements of some of our business men regarding aerial transport; but I have no time. Now, destructive criticism is useless and dangerous unless supported by constructive suggestions. Lord Gorell has indicated that he believes in the policy of employing military units to develop air routes. Well, the present Cairo–Baghdad route provides very useful training in long-distance flying to young pilots, and provides a most valuable means of rapid communication between Egypt and Iraq. But commercially it is teaching us nothing; we are not learning how often in the year a pilot can fly across the desert, or how many mechanics is the minimum number necessary for the service, or how long machines can run on this and no other work, or what commercial load can be counted on; at present it is merely a military operation, being efficiently carried out with an unlimited supply of aircraft, pilots and mechanics.

My first suggestion is that the Government should once more take up the question of a really big and influential national company, in which they should have a definite participation and should have a share of control, for the purpose of developing at once those routes which are of the first importance to the British Empire, particularly as regards carrying the mails; for example, Delhi to London, a journey which, if tackled now, could, I believe in six years' time, be performed in seventy-two hours, or Aden to Mombasa, where at present the British mail carrying arrangements can only be described as scandalous. Failing this I do not see why it should not be possible for the Colonial Office, the India Office and the Post Office to get together and try to induce big men connected with each of the countries for which they are responsible to run the most important services between this country and our own overseas dominions. Either of these two projects will cost the taxpayer very little, and it will do a great deal towards strengthening communications between ourselves and our overseas dominions. I believe that the Postmaster-General has saved ten millions on this year's budget. Why not keep half a million of that money to develop really useful air-mail routes during the next few years? Actually I suppose it will lapse to the Treasury to be employed on keeping alive some perfectly useless Government Department whose vested interests make it difficult to destroy.

Lord Gorell has twice mentioned the importance of bringing these facts about air transport home to every industry and to the general public. This is the object of the Air League; we are ready to do everything in our power to help the Government towards that end.

That is all I have to say, Mr. Chairman and Gentlemen, except to express my conviction that our whole future depends on our power in the air, and it is through civil aviation that we shall get the power that is justified by the importance and the size of our Empire.

I have a definite resolution to put before the Conference, as you know, Sir, but I think it would be wise to hold it up until some further discussion has taken place.

The CHAIRMAN: I now have pleasure in calling upon General F. H. Williamson.

Brig.-General F. H. WILLIAMSON, C.B.E., Assistant Secretary of the General Post Office: Mr. Chairman, my Lords and Gentlemen, on behalf of the Post Office, I desire to say a few words by way of explanation of the activities of the Post Office, which will, perhaps, answer some of the criticisms that have been made. I gather from the remarks of General Brancker that the Post Office in this respect is supposed to be rather under a cloud. I would like first of all to give the Conference a summary of what was actually done during the season of 1921 in regard to the development of the air-mail services. Speaking first of the Continental services, the most important of course is the subsidised route between London and Paris. That gives an extremely efficient postal service; it is possible to post a letter in central London and have it delivered in Paris the same day. So long as there was a morning air service run from Croydon, it was possible for the business man in the provinces to post a letter by the ordinary night-mail at the end of the business day, and for it to be delivered in Paris during the following afternoon in business hours. In fact the proportion of the total mail represented by this correspondence posted in the provinces came to something very considerable.

In the working of the service there was a very remarkable difference between 1920 and 1921. The total number of letters despatched to Paris was increased by over 40 per cent. It is only fair to say that the total number that season was only about 31,000 and that the proportion of the total mail to Paris represented by that number is quite small. It can also be said that the use made of the outward mail service to Paris is greater than that made of the inward service, the letters received from Paris in 1921 being only 45 per cent. of the number sent from London to Paris.

Other continental services were run, but not by British companies. A Belgian company ran a daily service between London and Brussels as no British service

was in operation, and use was made of that for the conveyance of mails. The fee was substantially higher than that on the Paris service, 4*d.* an ounce being charged instead of 2*d.* The efficiency of the Belgian service was not so great as that of the British subsidised services, and the quantity of mail sent was very disappointing. The service came to an unfortunate end before the close of the season owing to the fact that the aerodrome and aeroplanes of the company were burnt.

The third continental service was much more important, that was the service with Holland. There were really two distinct services. On the first service an aeroplane was flown every morning from London to Amsterdam by the K.L.M. Company. That offered a very substantial advantage in the conveyance of letters posted late in the evening in London and letters posted over-night in the provinces, which got to Amsterdam early in the afternoon and were delivered the same day; it was a very considerable saving of time as compared with the ordinary course of post. The service was rather more expensive than that to Paris, as the terms which had to be made with the Dutch Company were higher than those which had to be made with the British subsidised Company; the fee was 4½*d.* per ounce. The efficiency obtained on this service was 89 per cent. and the total number of letters sent during the summer season—April to September—was, outward, 8,300, inward, 16,000; the service came to an end at the close of the summer. It is rather curious to notice in this respect that the use made of the service from Holland is very considerably greater than—in point of fact, it is double—the use made of the outward service.

The second service was an experiment in the combined use of train, boat and air service. Arrangements were made with the Dutch company, under which a service was run from Rotterdam, in conjunction with German companies, to Bremen, Hamburg and Berlin; they worked in close connection with the night mail from England, and the result was that a letter posted in the City of London up to six o'clock in the evening—the ordinary night mail—reached Rotterdam about seven o'clock the following morning and was sent on immediately by aeroplane to Bremen, Hamburg or Berlin, so that it was possible for letters posted in the evening in London to get delivery in those towns the following afternoon. On the whole, the service was remarkably successful.

Lord Gorell, in his opening speech, remarked on the general lack of public interest in this country in air-mail services. There is a striking illustration of this in the comparative use made of the service to Germany and the service from Germany. As these services worked in both directions, it was equally possible to post a letter in Brussels late at night or early in the morning in time for that letter to reach London by air the following evening and to be delivered in London and in most of the provincial towns by the first post. The difference in the use made of that service by business men in each country was remarkable. The largest number of letters sent in one month by the outward combined service to Germany was 480, whereas the highest number of letters received in one month from Germany by that service was 2,540, which is over five times the number sent in one month from England and almost double the number sent from England during the whole of the season.

Turning now to the long-distance services, the most interesting and the most useful of those is the Cairo–Baghdad route. As I suppose everyone knows, that was started in October, 1921, by means of R.A.F. machines; arrangements were made for a regular flight once a fortnight from Cairo to Baghdad, working in connection with the P. & O. steamers from England. The service continues to run once a fortnight and gives an acceleration of anything from eleven to eighteen days to Baghdad; it is the most successful of all our air-mail services, and there has been a steady increase in the traffic ever since its commencement; it takes sometimes one and sometimes two days to travel by air from Cairo to Baghdad as compared with over twenty days when letters go *vid* Bombay and Karachi. In the first fortnight of the service, 125 letters were sent; by Christmas the number sent had reached 940, and at present the average is over 900 letters. This is interesting from the very fact that it is the first instance in which we have been able to give an air service over a very considerable distance, presenting great and important advantages. It is remarkable that in this case the air-mail is about 10 per cent. of the total letter mail as compared with substantially less than 1 per cent. on the London–Paris service.

There are two minor long-distance services which are used by the Post Office. There is a service working in the Belgian Congo which saves something like eleven days in the course of post to the interior of Africa, and arrangements have been made by the Belgian Post Office to put that service at the disposal of the British public. The arrangements are extremely simple: there is no fee payable by the sender, but three francs per twenty grammes is payable by the receiver. The use made of this service is extremely small. Not many letters are sent to the interior of Africa, at any rate to that part of the Upper Congo that is reached by aeroplane.

Then there is a French service from Toulouse to Morocco (Casablanca). For that service letters are accepted by the British Post Office, and we send a fair quantity by air-mail: the service runs four times a week and represents a gain in the delivery of letters of several days over the ordinary route. The minimum fee is 3*d.* per half-ounce, and some 26 letters are received for every air despatch.

One of the other developments of the cross-Channel service is the air-parcels service. For reasons which it is not necessary to go into in detail, the ordinary parcel service between London and Paris is extremely slow; it can easily take a parcel posted in London a week to be delivered in Paris. Arrangements have been made by the Post Office with the Instone and Handley-Page

companies under which parcels for Paris (only) are handed to them at the aerodrome, the companies undertaking the air transport and delivery in Paris. Recently there has been a considerable extension, and thirty-three offices in London and thirty-five in various provincial towns accept parcels for conveyance by air to Paris; they are handed in at specified post offices in the towns concerned and taken down to the aerodrome at Croydon; from there they are taken over to Paris by aeroplane and delivered normally the same evening. I should like to say that the French Customs have co-operated with us very well in these services, and it is now possible for a parcel to be posted in London in the morning, cleared through the Customs and delivered in Paris the same evening. I think that this is the most useful postal service which is given at present on any of the Continental air routes, but I must say that the use made of it has been disappointingly small. Not very long ago we increased very considerably the number of towns in the country where air parcels could be accepted, and there was a certain increase in traffic, but the total quantity is extremely small, considering the great advantage offered.

In regard to the future, it is true, of course, that the present developments are full of promise and that they show really extraordinary efficiency, but at present it is obvious that the air-mail service is still in its infancy. In establishing any new air service, the Post Office has to consider four essential conditions: (1) the regularity of the service; (2) the cost; (3) the distance over which the service operates; and (4) the possibility of night flying. As Lord Gorell remarked in his opening address, the most essential condition of all is regularity; the Post Office, of course, must consider that it is a trustee of the correspondence that is handed to it by the public, and it must take full account of its responsibility in arranging for an extended use of the air service. In certain parts of the world, owing to the deficiency of communications, the ordinary mail services are irregular, and one can never be certain that a letter posted to-day will get to its destination before a letter posted next week. We find that that irregularity is a source of greater irritation to the business and private world than anything else.

As regards the regularity of the mail services, there was a great improvement in 1921. One of the subsidised companies on the Paris service during the period April to August maintained an efficiency of 100 per cent., and but for one very trifling accident the other company would have attained the same high level of efficiency. It may be said that the weather in 1921 was unusually good, and in any case one has to take into account the winter service. A mail service must work equally in summer and in winter, and it is regularity in the winter service that is still one of the great desiderata.

In regard to the cost, under present conditions the cost of air conveyance is relatively high, and it is not possible to divert mails to the air without levying an additional fee in respect of the additional cost. May I say incidentally that, in spite of the very generous subsidies given in other countries, the fee charged by the British Continental service to Paris is lower than that of any other European country except Germany. It is rather difficult, on the data at our disposal, to form any definite conclusion as to the relation between the amount of the air fee charged and the use that is made of the air service. We had a very interesting instance of the effect of the reduction of fees when the fee charged on the London–Paris service was reduced from 2*s.* per ounce to 2*d.* in July, 1920; one would have expected that drop to be followed by an enormous increase in the number of letters, but as a matter of fact, the increase was only 200 per cent. Another instance can be given from the Baghdad service. When that service was started the fee was 1*s.* an ounce; it was thought at first that there might be some danger of the carrying capacity of the Service aeroplane being exceeded by the amount of correspondence. It was soon found, however, that the smallness of the fee did not involve this risk. At the beginning of December, just in time for the Christmas mail, the fee was reduced from 1*s.* to 6*d.*, which has approximately doubled the amount of correspondence sent.

The only case of increase in the air fee is on the Belgian service. In 1920 a service was run by a British Company and the fee charged was 2*d.* an ounce; when that service came to an end the Belgian company took it over, and the rate was raised from 2*d.* to 4*d.* an ounce; the average number of letters per week in 1920 was 950, and it dropped to 180 in 1921. It is not very easy to show the proper bearing of these statistics; it is possible to exaggerate the effect on the volume of correspondence of a reduction of fee, where, from a financial standpoint, that reduction results in a substantial increase in the weight to be carried by air without any actual increase in the amount available for payment.

Another point of importance in the question of cost is that under existing conditions air-mail cannot be diverted from existing rail and sea conveyance without additional cost. The normal arrangements made by the Post Office with steamship companies, railway companies and foreign administrations are based on fixed payments for a fairly long period with no allowance for variation in weight carried within quite considerable limits, and the mail may increase or decrease by 25 or 50 per cent. without affecting in any way the payments made by the Post Office. This makes for very considerable difficulty in the question of the transfer of mail from conveyance by ordinary means to conveyance by air, and it must be admitted that air conveyance represents an additional cost to the Post Office. These conditions will be altered when the cost of air conveyance comes down much nearer to the level of the cost of conveyance by other means of transport, and when air services are established on such a scale that substantial diversion from the existing means of conveyance will become both possible and desirable.

Brig.-General F. H. Williamson.

In connection with this question of cost, I may mention one other figure which I have not seen mentioned by any of the service papers. It is with reference to the United States Post Office, who issued an official *communiqué* in January, which said that the estimates which had hitherto been published called for considerable modification, that recent calculations had been made according to which the ton-mile cost of existing air-mail services in America is six dollars or about twenty-eight shillings, and that by certain structural improvements it is hoped to reduce this to about two and a half dollars or twelve shillings. These figures are considerably higher than any hitherto published in the official statements of the United States Post Office.

The third question is that of the distance over which air-mail services operate. On a short distance the time occupied in ground service is so great that it materially reduces the advantage in point of time—on the London–Paris service the ground service at both ends has occupied as much time as the flight. The real development in the air-mail service will come when we get to longer distances. That question of longer distances is coupled with the other question of night flying. With long distances and night flying it will be possible to have an aeroplane taking the night mails from Croydon, say, at 9 or 9.30 p.m, flying all night, and delivering them in time for delivery next morning in Berlin, Bale, Turin, Copenhagen, and, possibly, as flying improves, even in Christiania and Stockholm. When the London night mails can be regularly delivered by air by first post in such places as those above mentioned, obviously the whole question of air mails assumes a very different aspect.

I should like to make some reference to the question of the air-mail stamp which was referred to by Colonel Armstrong. Such a stamp would have a certain philatelic interest, and possibly for a time a certain advertising interest, but it would be of no practical utility and would be a real obstacle to the use of the air-mail by the Post Office. Letters can now be posted for despatch by air-mail in any pillar-box at any time bearing ordinary stamps provided that they are marked "by air-mail," or carry the air-mail label, which is supplied free by the Post Office; all that anyone has to do, if he wishes to send a letter by air-mail, is to put a 5*d*. stamp on it, mark it as I have mentioned and put it into a pillar-box or a post office box. The introduction of an air-mail stamp would restrict that system of posting.

I should like to have said something on the other suggestion that on certain routes first class mails should be diverted to air. The obvious case is the London to Paris route; the aeroplanes on that route fly by day only, but letters are posted at the end of the business day. What would be the effect on the London business man if, instead of his letters travelling by night and arriving in the morning, they were held over to be carried by day and arrived in the evening? That is the only comment I have to make on that particular suggestion. I am sorry that I have taken up so much time, and I only hope that what I have said will not be taken as indicating any pessimism or lack of enthusiasm on the part of the Post Office.

Mr. F. Handley-Page, C.B.E., F.R.Ae.S., Director of Handley-Page Transport, Ltd.: Mr. Chairman, my Lords and Gentlemen, I would like to associate myself with some, though not all, of the remarks made by General Brancker. I, too, had a feeling of depression after hearing the speeches yesterday, especially in regard to the opening remarks which were made. I listened with astonishment to the Minister responsible for dealing with air matters saying that he had little hope of the development of air travel in Europe owing to the highly-developed railway system that existed, and that the future of air transport and travel must lie in the Colonies. In other words, where traffic exists it must go by rail, and where there is no traffic aeroplanes can be used. It reminds me very much of what a correspondent wrote to me from abroad in regard to air transport in the particular country from which he wrote; he said that air transport would not pay in that country unless high fares were charged, and if you charged high fares you would have no passengers.

I have never been in the privileged position of travelling abroad by rail as a British Minister of State; but speaking as an ordinary individual who has experienced the bother of travelling by rail and the intense discomfort of the crowded Customs, and who, on the other hand, has enjoyed the freedom of travel by air to Paris, there is a very considerable argument in favour of the latter. It takes approximately 2½ hours to get to Paris by air—approximately 4 hours if you include the motor car journey at either end—as compared with a minimum of 7½ hours by train. Perhaps in making the comparison, Captain Guest was thinking of his previous somewhat unfortunate experience of travelling by air to the last Conference in Paris.

The question of a subsidy for flying, and whether flying itself is necessary, was touched upon in both papers. When the necessity of flying is urged, there is one thing that is somewhat overlooked by the constructor, who thinks that the complete machine is probably the finest ever made and that the transport company only needs to take it, fill it up with passengers and fly it to its destination. He overlooks the fact that it is only when the machine is on service that you can find out what is necessary in the way of ground organisation and personnel, in obtaining mutual confidence between pilots and their mechanics, and in the commercial side getting confidence in the service so that they can book passengers and freight and boom the service. All this has to be learned in the hard school of experience, and no amount of talk or production of paper balance sheets showing 200 per cent. dividends can ever teach you how to organise a service; it can only be done by flying. At the present time, when the technical equipment is such that the cost of running is high, subsidies must be granted so that the service may be maintained and this operational experience gained.

I very much regretted hearing certain speakers belittling the foreign designs and what is being done abroad in regard to commercial aviation. I have had an opportunity during the past year of visiting the United States, Holland, Belgium, France and Germany, and of seeing the commercial aviation services in those countries. In America in particular, although the Secretary of State did not think much of the possibilities of development there, the air-mail service has proved a great boon in conjunction with the railway service.

In a similar way, sufficient credit has not been given to foreign designs. It must be remembered that people abroad may not have developed on lines which are in accordance with our ideas of what aeroplane development should be. I may say, perhaps with some truth, that their wings are not designed in the right way, but it does not follow that my view is right. I have heard criticisms made of foreign designs which show that people have not appreciated the progress which has been made by those designs. I think we want here to look to see that we are making progress ourselves, and progress in the right direction, rather than to endeavour to obtain a false position by belittling what has been done abroad.

Lord Gorell touched on the question of establishing air routes abroad and stated that these must necessarily first be commenced by the R.A.F., because at the present time they are not commercial propositions. I should like to ask—What is a commercial proposition in running aircraft? It is running a service for the carriage of passengers, of freight, or of mail at such a price that the man who travels or sends goods by it is recompensed by the service that he gets at the price he pays. The price that is charged to-day, no matter what service he takes, is only rendered possible by the subsidies that are paid. In a similar way abroad the services which are being run are really being run as R.A.F. commercial services. Why is it not possible to run them as ordinary commercial services also? A subsidy such as is granted on the London–Paris route, if granted for these services, would make them commercially as possible as the London–Paris service is to-day. If the services are to be eventually commercial services, then let them be organised at the beginning on a commercial basis so that they may develop on commercial lines.

An Imperial air route will come from small beginnings made by the establishment of routes such as those I have mentioned. I am not looking forward to the sudden organisation of a big company with many millions of capital drawn from reluctant financiers in the City of London, who will organise a great airship service over a big air route. It is much more likely that small local services will be started; for instance, one between Egypt and short distances around; another in India and another in Australia, and then, when those are running successfully the links will come to join them up and to make a big air service across the Empire.

Therefore I think it would be very much better, if it were possible, that these first services that are now being started were run by commercial companies rather than by military organisations, because a commercial company would have its eye to the commercial future and not merely to development from the point of view of a military asset.

There is one final point I should like to touch on, and that is the comparison which has been made between the quantity of goods which has been carried by foreign companies and by companies in this country. Last year only a restricted service could be run by the British company, and that was filled up with passengers. It would have been possible to obtain goods to a greater extent than any of the others obtained them if the services had been run at a cheaper rate. The new rate proposed to come into force this year will enable goods to be carried at rates only very little in excess of the passenger rates obtaining on the railways, and I think we shall have a very good guide as to whether the regularity and efficiency shown in the past by our air transport companies will not cause a large volume of the traffic now taken by railways to be carried by air.

I would like to thank Lord Gorell for the very exhaustive way in which he has explored everything that has been done in the various countries abroad, and Colonel Bristow for the interesting and humorous remarks he made in regard to the development of civil aviation.

Sir Samuel Instone, Director of the Instone Air Line, Ltd., and a representative of the Chamber of Shipping: My Lords and Gentlemen, I wish to associate myself with the compliments that have been paid to Lord Gorell and to Colonel Bristow on the very excellent papers which they read to the Conference yesterday. I am also sorry that the Minister of Air is not present to-day. That, of course, is not out of any disrespect to Lord Weir, whom we are very proud to have with us after what he has done for commercial aviation, but I should have liked the Air Minister to have heard the remarks which have been made and which will be made as to the opinions that he expressed on the future of civil aviation. I was shocked as a business man, I must say, and I commenced to ask myself whether we had come to praise Cæsar or to bury him; in other words, whether we had come to the funeral of civil aviation. It was very unfortunate that just at a moment when one is trying to interest oneself commercially and financially in civil aviation and its possibilities and to induce one's friends to take part in that development, one should have heard from the fountain head that, in his opinion, there is no future for civil aviation and no possibility in Europe of it being made a commercial success. If I were of that opinion I should not be wasting my time here to-day, I can assure you. I have taken part—a small part, perhaps— in carrying on civil aviation, and I am optimistic enough to believe after my experience that, given the assistance by the Government which one

has a right to expect, there is a future for civil aviation, and a great future for it.

I was pleased to hear from Lord Gorell that he has appointed an Advisory Committee. That is a very excellent idea, but I very much regret that, although he has seen fit to appoint that Committee and has given an indication of the branches of commerce he intends to invite to form part of it, every phase seems to have been thought of except the one that is going to run the aeroplanes. I hope, therefore, that Lord Gorell on consideration will find a chair for the representative of aviation service and navigation companies. If not, it seems to me that it would be a case of the doctors assembling to consider the fate of a patient while the patient had no say in his final cutting up.

I think I was the only one to tell you at the last Conference that aviation could not be run commercially without assistance. That caused great surprise to certain individuals, but it has proved to be correct, and that position exists to-day. That it will be a success I have not the slightest doubt. A great deal has been said about the position of the British Empire *vis-à-vis* other countries in respect of civil aviation. I want it to be clearly understood that, in my opinion, we in this country can do the same as others, and more if the country is prepared to pay the same price as other countries. It is true that civil aviation has not made the strides one would have expected it to have made since the last Conference; but of one thing we may be proud, and that is, that, although other countries may have more machines flying and more routes open, nothing that they have produced in the way of machines, personnel, or measures of comfort and safety surpasses the British product, and it is still a fact that travellers of nearly all nationalities will, in preference, travel by an English machine piloted by an English pilot, whenever they can. That is a position we must not lose.

The sum total is, therefore, that there is no cash in aviation at present; I do not care what anybody says to the contrary. The actual heavy loss may, I think, be prevented by a subsidy. It is therefore apparent that the number of lines and routes worked may only be measured by the size of the subsidy until such time as it can run alone. That there is a great future for civil aviation, I am sure nobody can deny. That civil aviation is most essential to the Empire is also undeniable, and that England must at least be on equal terms with other countries is an argument that I think nobody dare oppose.

The question is, how can it be done in the face of the outcry for economy? In my opinion, it can be done; and it can be done even at a less cost than is spent to-day in the aggregate on aviation. I think I am right in saying that 18,000,000*l.* is appropriated yearly for flying and aviation services, and out of this enormous sum but 200,000*l.* is grudgingly spared for the Civil Aviation department in subsidies. It has already been stated that 100,000*l.* out of that sum is to be spent on machines. We have a splendid Air Force—all honour to them. It is a great Air Force, and its exploits brought fame to it during the war the whole world over; but to me it is a question, and I find it hard sometimes to find out, how the balance of 17,800,000*l.* is spent. It seems to me that out of this great sum an enormous saving could be made, part of which could be used for the purpose of the development of civil aviation. As I said before, it is difficult to believe that it can be spent, and it puts me in mind of a play that was produced some years ago called "Brewster's Millions," in which I think, a man had to spend a certain number of millions in a certain time and if he could not spend them he lost his job. I can quite imagine, or I think I can, councils being held in certain quarters to find out how best to get rid of it in the quickest time, possibly before the next budget comes along.

I should have thought that half that sum would cover our present essential requirements, and that much more use would be made of the possibilities of the reserve forces created out of civil aviation to meet our future needs. Even with this reserve, in my opinion, economies could be made. It is, perhaps, a little outside the sphere of one connected with civil aviation; but I think if more co-ordination took place between the Naval Air Service and the Army Air Service, savings would be effected. I will give an instance: We have a coastguard service—all honour to it again; it has a great and glorious record of past services. But have we not outgrown it? I believe there is a coastguard station about every three miles round our coast, guarded by a body of very fine men, who take their turns on look-out with a telescope. They walk up and down the cliffs, looking out, in that antique system, by means of a glass. Now I say if this coastal guard was carried out by amphibian aeroplanes, each having a patrol of 100 miles and each in constant touch with the depôt on shore by wireless, greater economies could be effected and greater efficiency obtained. Speaking as a shipowner—and I think other shipowners will agree—if a machine is watching the horizon and sees anything in need of help, it can render far greater assistance than is possible to the present coastguard service. I believe a great saving could be effected by such a service, and I commend it to the consideration of the Air Minister.

In conclusion, I would say that civil aviation should be looked into much more than it is by business men and employed in every possible sphere. As you know—or perhaps you do not know—my own firm employed an aeroplane originally in its private service. We used to send our own men over to France with contract notes, and they were back with the contract notes signed for the delivery of coal before our competitors could wire over—days before. That was immediately after the armistice, and we were great gainers thereby. I must say that a great deal of business could be brought about by firms sending individual sellers, travellers and buyers to certain places in Europe, as has already been done on a small scale, and if they do not like to buy their own machines, of course, there are those which are already running on the lines.

A great deal ought to be made of this in the way of passenger carrying in all directions, goods services, postal services, for despatch carrying and so on; in fact, the aeroplane should be used wherever possible. India has been talked about by his Lordship in the Chair, and the Press has been mentioned by previous speakers. I may say that my firm have had India under discussion for some considerable time, and so soon as aerodromes are constructed in proper places and the machines and passengers are guarded in a proper manner, I think the service will be commenced; anyhow, my firm are prepared to have a shot at it. As regards the Press and the way in which the members would avail themselves of the service, I may say that negotiations have been under way for sometime — I am not going to give them away for the benefit of our competitors— and I think his Lordship will have the pleasure of seeing a contract fixed up soon for the conveyance of newspapers in certain quarters.

In conclusion, let me say this: let the British service dominate the air, not in any aggressive manner, but by sheer force of habit and merit and the proved qualities of the machines. I want our people to get the air sense as they have the sea sense; that can only be achieved by putting well tried experienced firms in a position to carry on the fight on equal terms with their Continental competitors.

Sir CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., F.R.Ae.S., representing the Institution of Electrical Engineers, and Vice-President of the Air League of the British Empire: My Lords and Gentlemen, I think it was either the Secretary of State for Air or the Under-Secretary of State who referred to the lack of sustained interest in aeronautics. This is certainly very remarkable, despite the fact that the Royal Aeronautical Society has done its best ever since its formation so far back as 1866. It has always seemed to me highly important that it should be recognised that air warfare is of materially greater value to this country as a means of defence than naval warfare. The Air League has been exerting its utmost to call public attention to that fact for a long time, especially of late.

There seems to have been a little difference of opinion between the Secretary of State for Air and some of the remarks of Lord Gorell (the Under-Secretary) as to the relative use of aviation by France, Germany and the United States in comparison with this country. I am sure that anyone who takes a broad view of the position (aeronautically speaking) in different countries must be rapt with admiration at what is being done by France, by Germany, and not least, by the United States; all of these countries are in a better position than we are, taking it all round.

I was glad to gather that the ultimate official reason for the scrapping of airships was not the unfortunate disaster to R. 38— over which we lost so many fine men (not least Air Commodore Maitland)—but was due rather to the natural desire for economy. The great value of airships is, I consider, incontestable for long routes. Airships and aeroplanes each have their proper place, and, in my opinion, the natural sphere for aeroplanes is as a connecting link with airships for the long trunk routes.

The inconsistency of newspapers was referred to by the Under-Secretary of State, but his criticism did not appear to me to be quite correct. Whilst I have no sort of connection with any newspaper, surely the line taken by newspapers has not, in reality, been marked by inconsistency. They criticise the lack of economy, but because you criticise lack of economy it does not mean to say that money should not be spent in strictly national interests. I should imagine they might say that the continued expenditure on "doles," for men who prefer taking them to working, is perfectly consistent with urging at the same time that money should continue to be spent in the interests of imperial defence and defence by means of aeronautics, particularly when we remember the fact that aviation is the cheapest form of warfare.

But the direction in which I would more particularly urge that there should be no stopping of expenditure is in connection with research. If we abate expenditure on aeronautical research it will mean that our efficiency will go down, and not only that, but what is perhaps more important, we shall lose the men that are engaged on it who may go to other countries. We are also in peril of losing our highly skilled pilots.

There was a phrase, used I think, by Captain Guest, that "we have to consider what would be likely to receive most public support." I do not know whether that means at election time; but I must say personally I feel very strongly that the public are entitled to expect guidance as to what is best for the country as a whole from those who are in the best position to know— that is to say, statesmen and Government officials. The suggestion appeared to be that Government officials are supposed to watch and wait for the views of the general public. That does not seem to me to be the correct line.

I think most people have discovered now that financial assistance is absolutely essential at the present time to encourage (*a*) expenditure in a private way, and (*b*) research and other work for the purposes of development. This, in connection with Imperial defence and Imperial trade, is surely as reasonable as subsidies meted out for cable communications with various parts of the Empire.

The cross-Channel services have always struck me as being mainly useful for experiment and trial. The encouragement meted out by the Post Office for the purposes of air mails does not greatly appeal to me. I have made certain trials of the cross-Channel air-mail services; I have sent letters by the ordinary mail, posting them myself, and letters by air at the same time. I have done that four times, and three times out of the four the ordinary post beat the air post. I was in close touch with the person that I

was in communication with at the other end, so we were easily able to compare notes. Allow me to say, in order that there may be no question about it, that these unsatisfactory results were in no way due to lack of efficiency on the part of the aeroplane; on the contrary it was the connecting links that were at fault.

We had an interesting speech from the representative of the Post Office just now, but it certainly seemed to me from one experience he mentioned of communication by mail between this country and Germany, that the German Post Office encourages the public to send their letters by air a good deal more than our own Post Office are doing. That was the way it struck me. However, one can but speak from one's own experience; I certainly did my very best to get to the bottom of things, and I can say this: it does not seem to me that the air postal service is receiving the encouragement that it ought to.

I have always felt, and I think probably a great many others do, that the most important point in connection with an air service for long distance Imperial routes, is the supreme need for developing inter-imperial trade. The cables have done a great deal of work, and wireless does a great deal of work; but if you want to get the best results by communication over long distances, I maintain we should do it by air, on account of the enormous superiority of personal interviews over any messages sent by cables, by wireless or in any other way. It is vastly important in a diplomatic sense, and it is also of the highest value for commerce as well as in other ways. It takes the ordinary mail five to six weeks to get to Australia, whereas it is a matter of about a dozen days by air.

I am very glad to hear that there is a prospect of an inter-imperial Air Conference and an advisory committee for civil aviation. It seems to me that this sort of thing ought to be extremely useful.

Despite all safety statistics, I am bound to say that my own experience is, possibly due to thinking too much about the unknown, that you cannot well talk about air locomotion as being strictly safe. Every time I have been up I have always been quite pleased to reach mother earth again. It is that feeling that we have yet to get down in safety that makes some of us uncomfortable.

But what, personally, I should be disposed to lay almost greater stress on is the lack of comfort. For long distances—which is in actual fact, the main way in which air communication is at the fullest advantage on account of the great speed as compared with other methods of locomotion—it is at present an extremely uncomfortable, as well as monotonous, business to travel by air, and I sincerely hope rather more attention will be given to this question of comfort.

Colonel Bristow, in his highly useful and humourous paper, made an allusion amongst other things to more favourable insurance for the traveller by air. It seems to me that that is one of the most important ways of developing aeronautics. We must get some better conditions for insurance if there is going to be a greatly increased number of people travelling by air. I should not like these remarks to be translated by any insurance agent into a suggestion that I am anxious to have an interview.

I want to say, now, that although it is true I am representing the Institution of Electrical Engineers, I do not think there is any fault to be found with regard to the electrical work involved in aviation—that is to say, in the application of wireless telegraphy. The Marconi Company have done everything that was wanted, and I do not think there is anything lacking in their provision.

In concluding, I wish to propose a resolution. It is with reference to something I have not yet touched on, and that under the head of economy. It has often struck me that if the Ministry of Transport is to continue, aerial transport might very suitably be worked in with the Ministry of Transport, or, failing that, with some other civilian department. But all those officials who have been doing important work in the Air Ministry should undoubtedly continue in their work. My special object is administrative economy to meet the prevailing needs of to-day.

The other course of economy which has also struck me for some time past is that a Ministry of Defence, covering the Navy, the Army and the Air Force, would bring about considerable saving; and, to my mind, it would also break down a great deal of jealousy and ill-feeling which certainly seems to take place mainly against Air officers on the part of those belonging to the older Services.

My resolution, however, is primarily in connection with civil aviation, which is the main subject of this Conference. It is as follows:—

> "That it be suggested to His Majesty's Government that, for the purposes of economy, aerial transport be dealt with in future by the Ministry of Transport, or some other civilian Department, such officials of the Air Ministry as are needed being taken over by the Transport Ministry."

(Cries of "No, no.")

I have not discussed this resolution with anybody yet and it may not receive any support. On the other hand, there may be people who would wish to support it. I know, of course, it is a bold suggestion to make in the presence of many of those here, but that is my own feeling.

The CHAIRMAN (Lord Gorell): I did not know that Sir Charles Bright was going to propose a resolution, and I had not any notice of it. There are a great many other people wishing to speak, and if that expression of opinion was the general feeling, perhaps we might dispose of that resolution right away, and then get on to the other speakers. I do not know whether in view of the expression of opinion that has been manifested, Sir Charles wishes to press his resolution?

Sir CHARLES BRIGHT: Not at all. I mainly put it forward for ventilation purposes.

The CHAIRMAN: Thank you. We have one resolution of which General Brancker has given notice, and I propose to take that at the end of the Session.

Mr. G. F. LUKE, F.R.G.S., representing the Federation of British Industries: My Lord Chairman and Gentlemen: As a member of the Federation of British Industries I should like to associate myself with the views expressod by our President. The success or failure of civil aviation or air transport very largely depends on the interest and support which industry in this country gives to it, and it is therefore very meet that the Federation of British Industries is represented at this Conference so that having heard the very interesting papers, which were read yesterday, it can bring home to its members the advantages which transport by air, whether it be passengers, merchandise, or mail, can provide.

As referred to in the first paper by the Under Secretary of State for Air, two of the main sources of revenue of an air transport company should be mail matter and freight, and it can hardly be disputed that except to a few devotees the facilities offered by the existing air mail and transport services are unknown to the great majority of industrial Britain. With special reference to the air mail services I might state that in the provinces I have found the Post Office officials responsible for supplying information in regard to this are often as ignorant of the details thereof as the inquirer.

Then with regard to the transport of goods by air, it is time that some system of payment of freight charges on delivery was devised so as to obviate the delay which at present occurs between the time the goods arrive in London and their forwarding to the consignee. Take, for example, a consignment from Paris for Glasgow; the consignment leaves Paris and is delivered to the transport company's forwarding agent in London the same day; the latter then writes to the consignee stating that on receipt of the amount of freight and charges the goods will be forwarded to their destination. This means that it takes a consignment 72 hours to do the journey from Paris to Glasgow, whereas if a payment-on-delivery system was inaugurated it would take only 24 hours.

Speed being the quintessence of commercial aviation it is vital that such details as these should be carefully studied and organised, otherwise the mere fact of the journey from Paris to London having been accomplished in 2½ hours is of no avail.

Lord Gorell has told us it is necessary to have a much fuller realisation of the potentialities of the air service, and in this connection I might say that perhaps too much stress is laid on the fact that letters or parcels from Paris to London will be delivered on the same day.

Commercial aviation if it is to pay its way will require to have the support of the whole of Great Britain, and not only of the capital. Canvassing for trade by regularly appointed agents of the transport companies should be undertaken in all the big industrial centres of the country, so that it may be brought home to the business man that the transport of goods by air is a commercial proposition, and not merely the hobby of an exalted few. Until such time as the internal air lines referred to by the President of the Federation of British Industries are organised—and the organisation of these will be difficult on account of the climatic conditions of our country—special arrangements should be made with the railway and express companies so that the goods destined to be forwarded to the continent by any air routes should receive preferential treatment and priority over all other freight. In this way the continental air services will have a constant feed of freight from all over the country, and the measure of their success will be the measure of the rapidity and reliability of the service which they give.

I would now like to touch on the overseas services referred to by our President. It appears to me to be abnormal that the continental service should end at Le Bourget, and that we should be dependent on the French lines to carry our passengers, merchandise and mails from there to the four corners of Europe, not to speak of North Africa. I think it is essential that some agreement should be arrived at taking into consideration the curious situation of our country as an island, and we should endeavour to get them to consent to make the air port of Le Bourget an international port. In the light of existing circumstances in no sense can Le Bourget be called a terminal port. It is in fact, essentially a port of transit or of junction, and as such it should be possible for British air transport companies to make Le Bourget their headquarters and their starting point for air lines to Spain, Italy, Poland, and all the countries of the near east. If the air port of Amsterdam could be organised on the same lines as I have outlined above, it would mean the opening up of British air routes to all the Scandinavian countries and Baltic States.

Lastly, with reference to imperial services, there can be little question that the pivot of all such proposed imperial services would be Egypt. The political situation of that country at the moment is anything but satisfactory, and if for no other reason than that, seeing it is the pivot of our future imperial services, it is necessary that we should have a sufficient mandate over any form of government which may be established there, so as to secure an undisputed right of way for our aircraft in the future.

Even if at the present time the finances of our country and those of our Dominions do not permit of our establishing immediately an imperial air mail and transport service, nevertheless we should take steps to prepare ourselves against the time when we will be in the position financially to inaugurate such services, so that our sons may profit by our forethought to the benefit of the Empire hereafter.

The CHAIRMAN: Gentlemen, I have been asked to read a paper which the Chinese Chargé d'Affaires (Mr. Chao-Hsin Chu) was specially anxious to read himself, but he was prevented from coming, and asked that his paper should be read from the Chair. It is as follows:—

[Mr. CHAO-HSIN CHU, Chinese Chargé d'Affaires *ad interim* in London]: I only intervene in this discussion for a very few moments because the promotion of mail-carrying by aeroplane finds warmer support in no country than in China. We have already made substantial progress ourselves in that direction. Some of you may not know that we have a regular aeroplane service under the auspices of the Aeronautical Department in Peking, carrying the mails as well as passengers between Peking and Tsinan—about 300 miles in distance, and this service is soon to be extended as far as Shanghai.

I have here pictorial reproductions in a popular Chinese paper, which show that the interest of the people is very keen in this new scientific development. By this time you all probably known that the postal service in China is—although I say it—very finely developed, although we have to encounter natural obstacles of which you here have no conception. Look at the size of the country! Look at its relative lack of adequate modern transport. Yet all over the vast territory of the Republic the mails go even now with striking regularity and security, but the new air service will impart the one thing lacking—speed. In countries which, like China, have to make up much leeway in modern transport, and which have to face grave problems of huge financial outlay if we confine ourselves to either the fixed metal road of the railway or to the shifting bed of our vast waterways, the value of cheap, rapid and reliable air carriage of mails cannot be too highly eulogised. We have even—and there are not many nations which have set the lead—devised a series of air-mail stamps, and here also I have the representations of the stamps. Furthermore, let me remind you that the aeroplanes in our mail service are of English production, namely, Vickers' aeroplanes.

I see a great future for the air-mail service in China, and also for the air mail service to China. It must come. Already we see what I may almost call a timid beginning. Here you have started with your air-mail to Paris, by which late letters can be forwarded to the French capital and so catch the mail which left overland some hours before. And I have always marvelled at the cheapness of the letter rate. It is true the air letter now only goes from London to Paris, but the time will come when it will go on for at least a large part of the journey eastwards, and then in the time of the next generation, if not in our own, the whole long flight will be carried out in relays. By then I can promise you that China's air post will cover the whole country, and we shall undertake to do this.

We have in China not merely an interest in the promotion of internal air mails, but equally in the extension of external. We are a country largely dependent for our ever-growing trade and intercourse on the best communications possible with the outer world. For reasons over which we ourselves have no control whatever, I am bound to say they always seem to me to be going to pieces. For instance, the great Siberian Railway on which the Far Eastern mails from Europe largely relied in the past, is not now in working order, has not been for some time, and may not be for a considerable period to come. The war, in addition, largely demoralised sea transport, and although this is now being gradually built up again, it is to a large extent very slow, and those who have the misfortune to use the mails to China to any considerable extent, must be painfully aware of the very great delay. I do not suggest that, even with our mails, we may have perfection, but at any rate we must have an improvement, even if only sections of the route are taken in hand by fast letter-carrying aeroplanes. What you in Europe, therefore, are doing meets with our very warmest support, and I can assure you that we in China are developing rapidly upon the same lines, and that the Chinese Post Office, which I claim to be one of the most progressive in the world, will soon be thoroughly up-to-date in this respect.

Mr. A. H. ASHBOLT, Agent-Genera for Tasmania: My Lords and Gentlemen: I want to make a few remarks on the other side of the question. So far the discussion has all been upon aeroplanes. I want to say a few words now on my pet—airships.

Like other speakers, I must confess that I was very disappointed indeed at the remarks of Captain Guest in his opening address. Nothing could be more pessimistic than his statements. Whether he was deliberately pessimistic as a matter of Government policy in the interests of economy I cannot, of course, say, but it was a regular douche of cold water to hear his view that it would probably be eight or ten years before sufficient cash would be available for the commercial establishment of airship services and that he did not think a delay even to that extent would be prejudicial to British interests, inasmuch as he was under the impression that the statements made regarding the activities of other nationalities were much exaggerated. I feel sure that his statements do not represent the spirit that has built up our nation and Empire. Certainly, I was pleased that Lord Gorell, also speaking in an official capacity, did not keep step with Captain Guest, and his considered belief that the long-distance routes must be covered by airships with aeroplane companies acting as general feeders means that the two aerial forces must develop side by side in natural complement of each other. The only good point in Captain Guest's statement was the announcement that the British Government had decided to extend the life of the airships until June 1st, giving us another respite.

Now, with regard to one or two other statements made by Captain Guest and Lord Gorell. I have already deprecated the

pessimistic statements of the former that cash would not be available for airship service for eight or ten years and would draw the attention of this Conference to the statements publicly made by me in this connection, viz., that provided the cash for the two-year experimental period recommended by the Imperial Air Communications Committee is furnished by the British and Dominion Governments, commercial interests are definitely prepared to find all the cash required for the establishment of commercial services to Africa, to India, and to Australia, for a fortnightly service to follow on that two-year experimental period. Therefore that wipes out the statement that commercial cash is not available, provided the preliminary work is done at the expense of the Government (which the commercial interests think should be the case) and provided also that there is a reasonable subsidy paid by the British and Dominion Governments for services then to be rendered. It has been stated that air services should not be dependent upon subsidies, and that aerial lines should develop in the same manner as railway and steamship communications have done. That is all we ask. When that statement was made they are forgetting, however, that nearly all the large Continental railway connecting routes were constructed on the basis of large land grants as a consideration for the establishment of railway routes, simply a subsidy in another form. Similarly, most of our large steamship companies in their early days, were developed by subsidies, and in many instances, still earn them. It must also be remembered that both railway engines and steamships were developed in a small way first, and gradually grew. With airships, however, this is not quite so possible; the establishment of an adequate ground service being a necessity which alone means considerable capital expenditure. Reference has also been made to the estimated cost of developing airships for the two-year period recommended by the Imperial Communications Committee. This cost as stated is approximately 1,380,000*l.*, but since July when these estimates were made there has been a considerable reduction in the cost of labour and material. I have already stated, and I reiterate, that the provision of 1,000,000*l.* by the British and Dominion Governments will establish a through service to Australia and if through unforeseen circumstances the 1,000,000*l.* is exceeded for so establishing, the commercial interests already referred to would undertake the completion of the capital expenditure required over and above the 1,000,000*l.*, if necessary. The suggestion that was made yesterday that Australia might be asked to divert her suggested contribution of about 250,000*l.* to link up an aeroplane service with Singapore is, to my mind, farcical, and I do not think it would be seriously considered in Australia for five minutes. It is the deliberate opinion of most experts that an aeroplane service from England to Australia is not likely to be consummated under twelve or fifteen years at least, and there must be considerable improvements on to-day's patterns before that is possible.

Coming back to airships, however, the main thing is to establish the ground work and airships will soon be shortening the time between the furthest points of our Empire. The question of revenue will then become a big factor and in this direction the assistance of the Governments is again a necessity, inasmuch as they control the mails and without the instruction of a Cabinet minute no Postmaster-General, I am afraid, will divert mails from the existing channel unless the sender specifically instructs and pays postage accordingly. That, however, is a detail that it is really not necessary to go into now. The main point is not, as was yesterday suggested, to sit down and wait for somebody else to develop and then try to catch up. Do not belittle the actions of other nations who will be our competitors. Surely the last war should have taught us the undesirability of taking no notice of action going on around us, living in a fool's paradise and then having to pay dearly to get ourselves out of the mess. In these matters let us lead, not follow; let us handicap our competitors, not let them handicap us.

Now, I do not believe in destructive criticism without being able to make practical suggestions to overcome the difficulties which undoubtedly exist. Yesterday I listened very attentively to the papers dealing with airship matters, particularly Major Scott's, who in my opinion is the greatest British expert on airships living, and whose summing-up of the position makes it clear that, technically, airships to-day are in every respect equal and suitable for useful employment for both commercial and defence purposes without waiting for further improvements. That is Major Scott's considered opinion, and he knows as much about that matter as anyone in Great Britain. He states, and it is recognised, that the only obstacle to the immediate establishment of the Imperial airship service, which, as you know, I have been advocating for some months, is merely the financial hurdle of establishing ground bases. Now my experience of Major Scott is that he is one of the most conservative men existing; he never makes an assertion or a single move forward without positively knowing he can do better or more than his statement or claim, and his paper must be considered as an authoritative statement of the position of airships to-day, and what can be done without running undue risks. Once the financial hurdle is jumped, Major Scott's claims can be put into commercial operation immediately the ground organisation is prepared, and that, owing to the declared operations of other nations, we will be forced to tackle the business in two or three years time whether we like it or not is quite clear—not wait for eight or ten years, as has been indicated. The extra expense of making a start in two or three years time will be much greater than the comparatively speaking small amount required to go ahead now. We British have an unfortunate trait of always waiting until

we get a nasty jolt before tackling the fight in grim earnest. It was the early realisation of these possibilities some six months ago that started me on my mission to save British airships and personnel and to evolve the scheme subsequently discussed by the Premiers at the Imperial Conference last July. Unfortunately, for financial reasons, New Zealand and South Africa have turned the proposition down, owing to their inability to contribute towards the 1,000,000*l.*, which they were asked to share with the other Dominions and the British Government. To-day, therefore, the original proposal as discussed before the Premiers hangs upon the decision of India, and if India turns the proposition down it would then mean the finish of the airship proposals now under consideration, unless some alternative proposals can be suggested.

My alternative proposal is one that I do not want to see brought into existence, except as a last resource. I do not want to see this alternative brought into existence if our own and the Dominion Governments can recognise and appreciate the responsibilities which, in my opinion, attach to them in these aerial matters. However, if unfortunately the Governments should turn down the proposal completely, then my alternative is that instead of the Governments finding the 1,000,000*l.* asked for in respect of this two-year period, an arrangement be made under the Reparations Treaty for Germany to supply material in reduction of the reparation amount due to Great Britain and the Dominions. This precedent has already been established by France, Belgium and America, but so far has not been accepted in full by Great Britain, although she received ships from Germany as part of her reparations payment and to replace her mercantile marine. I quite realise, however, that, generally speaking, British conditions are very different to French and Belgian, both of which countries are being supplied with material and goods which they are unable to produce themselves; but America is having a new airship built in Germany with the consent of the Allies, the cost of which will reduce the amount due by Germany to America—exactly what I am now suggesting for Great Britain. Any material supplied by Germany to Great Britain apparently means so much less work for British workmen. This, however, would not be the case with airship material because if the present scheme breaks down the whole Imperial airship proposition crashes and British workmen cannot be employed to construct either stations or ships. In the event of the present proposals breaking down there is no difference between British workmen having no orders for airship construction and such material being supplied by Germany. On the other hand, British workmen can easily be employed by the Governments concerned agreeing to provide the 1,000,000*l.* required for the two-year experimental period. If the Governments do not find that money there is then no work in this direction for British workmen and consequently no reason why an arrangement should not then be made with Germany to supply in reduction of the reparations amount. Supplies under these circumstances do not detrimentally affect British workmen, and their establishment would pave the way for a quicker resumption of employment for British workmen in the extensions which will naturally follow the preliminary establishment. Under this proposal Germany should supply material and equipment, complete in every detail, delivered at the different air stations necessary to complete the Imperial Route suggested, viz. :—

From England to Egypt and India.
From India to Australia.

The actual cost of labour to erect stations in Egypt, Ceylon and Singapore, &c., is estimated at from 150,000*l.* to 175,000*l.*, so that the provision of 175,000*l.* should be ample, such cost to be paid by the British Government.

The three stations (masts only) necessary to connect up India and upon which the labour costs are estimated at from 60,000*l.* to 75,000*l.*, are recommended should then be paid for by India.

The cost of labour for erecting one station with shed and two mast stations in Australia is estimated at from 150,000*l.* to 175,000*l.* to be paid by Australia.

That practically means a total expenditure on labour by the British and Dominion Governments of about 350,000*l.*, the balance representing material being found by Germany in reduction of the Reparations amount. Such a proposition reduces the capital expenditure to labour only provided by the countries interested, and in the case of India and Australia spent in the countries so interested.

In addition Germany should also be asked to supply three or four airships of somewhat similar type to that now being built by them for the United States Navy Department, it being understood that this boat is actually constructed as and on the basis of a commercial ship.

On this alternative basis, if it were necessary, and on the general principles previously outlined by me on other occasions, I give you the positive assurance that commercial interests are prepared to find the necessary capital to run the business on commercial lines. As a British subject I would, however, infinitely prefer that the Governments concerned find the capital amount of 1,000,000*l.* required, and utilise British material and British labour, but if Government financial conditions are such as to make it impossible for them to find that 1,000,000*l.* then this alternative proposal is the next best thing, and there is ample precedence for its acceptance. But I again reiterate it is an alternative that should not be considered unless the Governments concerned absolutely refuse to find the comparatively speaking small amount of 1,000,000*l.* spread over two years and divisible between Great Britain and the various Dominion Governments. Realise that the amount of new money is so small that it puts an entirely different aspect upon the proposition. In view, too, of the rate of evolution going on all round and the

recognition of the necessity of speeding up Imperial communications, can we afford to wait eight or ten years as suggested?

My Lords and Gentlemen, I have pleasure in placing these facts before you in the hope that they will receive the serious consideration of the Government Departments concerned.

The CHAIRMAN: I understand that there are a number of other speakers who have sent up their names. There are also a certain number for this afternoon, when Lord Weir will again be in the Chair. I have no doubt that a great number, since the papers run into one another to a great extent, will be able to speak this afternoon even if they are dealing with the papers of the morning session; and I might say that any who are not called upon to speak may if they choose to do so, send their papers in to the Air Ministry, and we will include them in the final Report of the Conference.* I will call upon Colonel Barrett-Lennard.

Lt.-Col. J. BARRETT-LENNARD, Director of Handley-Page Transport, Ltd.: My Lords and Gentlemen: I shall speak as briefly as possible as time is running on. I shall deal only with two matters. In the first place I do not think the Conference ought to break up so far as it is a Conference relating to civil aviation without expressing the great indebtedness under which the transport companies lie for the very great assistance which has been rendered to them by the Controller-General of Aviation and the very able staff under him. They have had to administer a policy; they are not to blame for that policy at all, and in the administration of it they have acted in the most sympathetic manner; they have not spared themselves or their time, and the transport companies lie under a deep obligation to them for the services of the Controller-General of Civil Aviation and his very able staff.

The other matter with which I want to deal is more or less a paraphrase of the subject that has been dealt with by very nearly every speaker. I may remind you that the first day of this Conference was taken up by an exhibition of the machines and organisation for commercial aviation; of the remaining two days, one-half was devoted to civil aviation. At such a time and on such an occasion the Secretary for Air is "not afraid of saying that there is little or no hope of a real commercial success being obtained in Europe." One could have understood his saying that in present circumstances money was not available for the support of commercial aviation. It is most difficult to conceive a reason why he should have commenced the proceedings of the Conference by throwing icy cold water on its main object. But we listened to his weighty, and probably well chosen words, carrying as they do the great authority of his position, and they introduced an air of gloom from the initiation of the Conference which has had its reflex action throughout. And—I am sorry I must take this attitude—what one immediately asks is : can there be an Air Minister who does not believe in aviation?

I will detain you very little more, but as the matter is a public one and our friends of the Press have been kind enough to give a good deal of their space to us, I want to refer briefly to the question of subsidies. I want to say that so far as the aviation companies are concerned, or rather one of them—there are only two—we are not in the least grateful for the subsidies given to us by the Government. We think we have done just as much for the maintenance of civil aviation as the Ministry has done by its grudgingly given subsidies. It is popularly supposed from the attitude assumed towards the aviation companies that we are making a lot of money out of the thing; so far as one company for which I can speak is concerned, it has spent more money in the attempt to establish civil aviation than the whole amount placed at the disposal of the industry by the Ministry. I want to tell you exactly what the subsidy is; it is a very ingenious arrangement by the Government—of which I make no complaint; they provided a limited guarantee for the carrying on of the service; their loss was limited; the loss falls most on the aviation companies and their loss is not limited. On the other hand, the subsidy arrangement provided that in no circumstances could the companies get anything out of the Government which provided for a profit of more than ten per cent—or some small percentage.

I am one of those old-fashioned business men who believe that subsidised industries are not as a rule of any benefit to the giver of the subsidy or the recipient; but the circumstances of the present case are quite exceptional, and I have no doubt that in the steps that were taken by the Government and by its representatives, including the present Air Minister, they very carefully considered whether advantages were to be obtained by the granting of those subsidies.

The fact is that the French Government have fixed a rate of fare which is not an economic fare; had it not been for that there would have been no necessity for subsidies. It might not have meant that civil aviation would have been commercially profitable, but at least we should have been on the basis that we should have been able and should have had to charge a fare which represented the cost of the service.

Then really the basis of the problem is the traffic available. The traffic this year has been greater than in any previous years. You cannot very well make comparisons; but the traffic has increased and estimates have been made of a further increase in traffic next year. Not very efficient machines have been flying and a certain amount of traffic has been available, and the full amount to be obtained by that traffic has been received and has resulted in a loss; but with an increase in the traffic there is a possibility anyhow of a nearer approach being made to

* Papers and portions of papers included in this Report, although not read at the Conference, enclosed in square brackets

balance between outgoing and incomings. There are two aviation companies going at the present time, and each of us has to maintain a headquarters staff and has to bear certain overhead charges. The other firm advertise, and we advertise, and we are competing frankly for traffic. At that time the Air Ministry thought fit to introduce a third competitor. That I make no complaint about; I merely suggest that if the question is one which depends on traffic you cannot very well bear the overhead charges spread amongst three companies which you could if it were only in the hands of one or two.

I am a newcomer to aviation; I have no technical knowledge whatever; I am merely a business man; and in spite of the great authority which impressed us at the opening of the Conference I want to conclude on this note. We have to overcome the immediate difficulties which exist. Aviation has before it a field unlimited by many of the considerations which apply to railways and ships, and I believe that there is a great future before it.

Mr. T. INSTONE, Director of the Instone Air Line, Ltd.: [I have heard with great dismay the remarks made by Captain Guest at the opening of this Conference, and I must say that I was thunderstruck at the views expressed regarding the future of civil aviation by the Minister for Air.

I had thought that Captain Guest was one of the greatest friends that civil aviation had in this country, and when I had the opportunity of meeting him some few months ago he gave me this impression. Therefore, I was all the more amazed at what he expressed regarding civil aviation.

It may be, of course, that he, being the head of this important branch, knows something very important, which information we ordinary business men cannot obtain. If that is so, I think we should know exactly what it is. I had always understood that it was the Ministry's aim, and indeed the aim of the country, to get experienced business men interested both practically and financially in civil aviation, and, if I may say so, I think that we had started to get those people to take an interest in what we thought would be in time a commercial proposition.

After the Minister's statement, however, it is a question whether these business men, like myself, already interested, should not endeavour to get out as quickly as possible, and I am speaking for myself and for my co-directors, who are all men of affairs. We have no time to take up business in which there is no future.

In one portion of Captain Guest's opening remarks, he stated that in his view there is no commercial future in civil aviation, and then he goes on to say that the great future lies in the far-distant routes of the Empire. This is rather inconsistent. I agree with him, however, that the great future for civil aviation lies in an Empire air route. The first portion of this Empire route, however, should be the cross-Channel service, and after all, this service is one that must be absolutely proved beyond a shadow of a doubt as regards usefulness and necessity. This route must "blaze the trail" until the time is ripe for the real expansion that is necessary for an Empire air route, but until such time is ripe, civil aviation in this country, like every other, must be financially assisted by the Government.

The suggestions which Lord Gorell referred to in his paper have been most interesting, and I will only deal with the chief points concerned with practical aerial transport.

I absolutely agree with him that the great goal which British transport companies had in view had been chiefly to obtain the public's confidence, and the trustworthiness of their machines. I think that during the temporary scheme of subsidy of the cross-Channel service, this has been more or less amply demonstrated and it will go a long way to prove that the pioneer work of commercial aviation has been left far behind.

I am sure that you will agree that six months' practical experience—in no matter what sphere of business life—is worth five years of theory, and I maintain that what you have heard to-day has been mostly theory. I will endeavour (and briefly so) to give you some facts of actual working, but without going too deeply into figures, which can, as we all know be made to represent anything. I will therefore at once deal with the question of the subsidised cross-Channel service which is so important to all who are present at this Conference.

After hearing General Brancker's remarks, it will perhaps be news to him, in spite of his amusing satire, to know that transport companies that have so far run on the cross-Channel service, have lost a considerable amount of money, and when he states that the Government have more or less been coerced into giving better terms than they should have done, this statement is absolutely incorrect, and entirely misleading.

On the contrary, I am bound to criticise the way in which the subsidy has been arranged for the coming period. I warn the Ministry that they have made a very great error indeed in having three firms on one route in competition with each other, where there is only traffic enough for one, or at very most two, to run successfully, especially to compete with the very live competition forthcoming from the French this season.

In my opinion, and I do not speak without knowledge, the traffic that exists is not sufficient to keep three British companies successfully in being. During the six months of the temporary scheme—in which time we had the finest summer experienced for years—British machines carried 4,006 passengers, and the French 3,499. The other, winter, months the number carried was infinitesimal. Assuming there is a great increase of passengers during the coming six months—say there are 10,000 passengers for British machines—if this is equally divided between three companies, then neither company can possibly pay expenses, but must lose not be heavily. What should have been done is which not alone to meet the views of [illegible] oval of any critics against monopolies [illegible] tion on the part of wider sphere of influe[illegible]e it may deserve —to have had one [illegible]ty o[illegible]ere is much), and [illegible] and [illegible]y other [illegible]

companies on the Paris service, one on an Amsterdam–Rotterdam route, and another for Brussels, even on better subsidy terms.

Where the great danger is ahead, and where, in my opinion, the subsidy scheme is wrong, is, no definite subsidy provision has been made for the winter service. I say emphatically that no British company can possibly run during the winter months on the present supposed liberal scheme of subsidy.

At present, it is absolutely impossible to keep a first-class staff of the best pilots, the best mechanics and the best labour during the winter months on a scheme of subsidy, which is paid on the number of passengers and goods booked, when the machines cannot run for days at an end.

This country, especially London, experiences more fog (which after all is the greatest enemy of aviation) than any other country, and if the Government does not take into consideration a proper, fair and equitable basis of subsidy for the winter season, then Captain Guest's remarks "that there is no future for commercial aviation" will really come into force, because there will be no aviation companies left to carry on—in this country.

What the Ministry must be prepared to do is to state (and announce the fact without delay) that under their present scheme of subsidy they cannot possibly use the amount at their disposal. They must therefore assist the companies and compensate them on a liberal scale, or assure them for the present against loss during the winter months, from the annual balance they will have left.

I will also say this: that if once the business people, who are already interested in British commercial aviation, decide definitely to abandon it, through lack of proper Government support, its progress will be retarded for many, many years.

In conclusion, without going into more details, as time is very limited, I will only say that it is an indisputable and acknowledged fact, not only in this country, but in every other country, that civil aviation must be subsidised for some time to come before it is put on the sound commercial basis on which we all hope to see it.]

Squadron-Commander J. Bird, R.N., a Director of the Super-marine Aviation Works, Ltd.: [When Major-General Sykes, 18 months ago, spoke in this Guildhall on Civil Aviation, he laid strong stress on the fact that these Conferences were to enable the City of London and commercial men to keep in touch with the progress of commercial aviation. It is disappointing therefore that practically the whole reference to commercial aviation has been in connection with passenger and mail-carrying aeroplanes and airships only, and that nothing has been said of the many other uses to which aircraft can be put—uses of direct interest and importance to the financial men of the carrying

* Papers and the Secretary reviewed civil aerial [illegible] countries and certain of in this Report, alth[illegible] who would like to refer Conference, enclosed i[illegible]

Mr. A. H. Ashbolt.

to the commendable action by the Bahamian Government in offering an aerial mail contract to the company which has been operating in the West Atlantic, which offer could not be taken advantage of through lack of support of the British Air Ministry. The result is that an American company is now operating there.

Presumably, in view of the Secretary of State's remarks with reference to the continental services, some help may now be expected for the other branches of commercial aviation now being carried on by British enterprise and British machines throughout the world.

Surely commercial aviation covers other work than carrying mails and passengers. Would not the business men present be interested to know of what has been done in other spheres? Let me give a few examples of actual work done. Surely timber merchants would be interested to know of the thousands of acres and thousands of pounds' worth of timber which have been saved from fire by aircraft forest patrols; also that different classes of timber have been spotted and located by aerial survey—thus saving thousands of pounds and great time. Those interested in the oil industry would like to know that the presence of oil in the midst of virgin jungle has been successfully located by aerial photographic survey. The medical profession, bacteriologists and botanists would like to know that pests, such as mosquitoes, have been traced and tracked to their breeding grounds by aircraft, and that destructive blights have actually been successfully treated from the air. Those interested in the fishing industry would like to know what has been accomplished in the way of fishery patrols, whale and seal spotting. Most important work has been done here. Exploration companies should know of the progress of marine and land survey. Shipping companies should be intensely interested in the progress of marine aircraft.

The most extraordinary fact is that practically all commercial development throughout the world, which I have just mentioned, is being carried out by seaplanes and flying boats. It would appear from the Under-Secretary's paper that the department of Civil Aviation knows not the seaplane or the flying boat, yet we are a maritime nation, with far-flung colonies, and surely the greatest future for passenger and freight carrying aircraft must be over the sea.

Compare the cost of Croydon airport with every seaport, which already has its aerodrome for marine aircraft ready made at no cost. Compare the cost of the land lighthouses and aerodrome lighting schemes with the existing lighthouses, lightships, and gas buoys by which all seaports are lighted, and which are all that is required by marine aircraft for night flying.

There is no need to fly at great heights over the sea; the sea is a continuous aerodrome. Landing at night and in a fog is far easier on the sea than on the land. Customs organisation already exists at every seaport, and, as regards competition, the 20-knot steamer

is nothing like so serious a competitor as the 60-mile per hour train.

What is so universally unknown is that marine aircraft are totally different from land aircraft; their problems, of design, material and construction are entirely different and the problems of their all-important personnel vary considerably.

The Secretary of State referred to amphibians and the importance of their development for civil purposes. The Under-Secretary, however, stated that there was no immediate hope of an Irish route—the only route so far mentioned on which amphibians must be used. Yet the amphibian type was the direct outcome of trials instituted and carried out by the department of Civil Aviation, and it seems a great pity that it has been left entirely to the service side to continue this line of development.

I do, therefore, strongly urge, my Lord, that marine aircraft may in the future receive their fair share of encouragement and practical help, and that greater and greater importance may be attracted to the considerable possibilities in the use of aircraft in the directions I have indicated—possibilities which are without end and which open up a fascinating vista and which mean—and this is a thought which will appeal to the city man—actual dividend earning.

In conclusion, I trust that the new committee to be set up will include representatives conversant with the problems and possibilities of marine aircraft, and will also be directed to give special attention to the commercial possibilities of aircraft apart from the carriage of passengers and mails.]

Mr. E. HUSKISSON, representing Messrs. Thos. Cook and Son: [The experience of my firm, Thos. Cook and Son, gained as it is all over the world and from all kinds of travellers, may be of some use to this Conference.

Since air travel was first mooted we have followed its developments most carefully, and from the beginning, placed our worldwide, and, I may say, unique organisation, at the disposal of air transport companies. Our experience commenced before the war, when, apart from certain experimental airship flights in Switzerland by airships of a French company, we had commenced to book passengers for flights in the passenger-carrying Zeppelins, flights which, until the Great War brought such business to an abrupt conclusion, showed signs of becoming quite popular.

Our experiences coincide with the views expressed by Lord Gorell, the Under-Secretary of State, that the most important point, to popularise and thus bring about the commercial success of aviation, is to convince the public of the safety of air travel. The progressive percentages of reliability mentioned at this Conference, will be widely used to emphasise the relative reliability and safety to which commercial aviation has attained. We have found that, as mentioned by Colonel Bristow, potential passengers do take a great, although possibly very non-technical, interest in the machine it is proposed they should use. We find that a twin-engined aeroplane is preferred to a single engined one on the assumption that in case of failure of, or accident to, one engine, landing can be safely effected with the remaining engine. Intending passengers also show a marked preference for aeroplanes carrying a large number of passengers. A standardisation, as far as possible, of the aeroplanes used by the transport companies, so that passengers can rely on certain known types of machine would help matters. We entirely associate ourselves with the remarks made as to necessity of reducing cost of air travel as far as this may be practicable and also regarding normal amounts of luggage being allowed to accompany passengers on payment of a reasonable charge.

I think Colonel Bristow was a little unkind in his remarks that booking agencies prefer a system of reliability of departure rather than a reliability of arrival. Speaking on behalf of my firm we attach the greatest importance to 'planes arriving on time. Many passengers use the air route in order to make speedy connections beyond. We think there is a great future in air travel which we have been striving to assist by propaganda, &c., in all parts of the world, suggesting use of airways and familiarising the public with air travel and services, but such future is only possible with public confidence, which reliance on due arrival at scheduled times, with every safeguard for travellers' safety, can alone create.

On relatively short journeys, well provided with convenient and frequent alternative services, the advantages of air services must be more striking than they have yet been. Whilst the actual air passage from London to Paris may be only from two to four hours, taking into consideration transport to or from, and formalities at aerodromes, the saving of time over the older methods of travel is often not very great and it should be the effort to shorten as far as possible the terminal delays.

I may say, in conclusion, during last summer we were frequently unable to book by air services, passengers who were inclined to travel in that way, owing to lack of machines and accommodation when required at short notice. Although the exceptional [illegible] undoubtedly assisted last season's [illegible], with an increasing number of those [illegible] travelled by air, acting, if satisfied by [illegible] who [illegible] experience, as the best of advertis[illegible] in their own [illegible] air travel, we feel [illegible] ise-ments [illegible] of air travellers can [illegible] increased number [illegible] confidently be looked for.]

[illegible]MAN: [illegible]ould [illegible] we adjourn, perhaps it would be a convenient moment [illegible] moment to take the resolution which General Brancker has put forward (on behalf of Mr. Holt Thomas), which I do not think is contentious, and certainly from the point of view of the Ministry, I think there can be no opposition to. The resolution is as follows:—

"That in view of the necessity of increased rapidity of communication within the Empire, and in view of the progress made by other nations in

civil aviation, this Conference calls upon the Government to give due and immediate consideration to the foundation of an air mail throughout the Empire."

I think I did say yesterday that we had, in fact, decided to do that, but there does not seem to be any harm in passing such a resolution to enforce it. (Agreed.)

I declare this session closed, and the technical session will begin at 2.45 p.m. I have no doubt Lord Weir, who will again be in the Chair, will enable many of those who wished to speak this morning to speak this afternoon.

AFTERNOON SESSION.

LORD WEIR OF EASTWOOD in the Chair.

The CHAIRMAN: Gentlemen, I have been handed a list of those who were unable to be heard at this morning's discussion, and I will do my best to give them an opportunity of speaking this afternoon. but I think you will agree with me that as this is the technical session the technical side must have preference; accordingly, I will call at once on Captain de Havilland. But just before Captain de Havilland speaks, I would impress on all speakers the absolute necessity of confining their remarks to a period of not more than ten minutes this afternoon. We have a very long list. I would say to those gentlemen that they are at perfect liberty to develop and expand their points in writing, and their remarks will be embodied in full in the transactions. I trust that with that explanation we may be able to complete our programme this afternoon satisfactorily.

Captain G. DE HAVILLAND, O.B.E., F.R.Ae.S., (The de Havilland Aircraft Co., Ltd.): My Lords and Gentlemen: Major Green's excellent paper raised a great number of interesting matters for discussion, and I propose for a few minutes to deal with those points that seem to me of more than ordinary interest. There can be no doubt that safety is one of the first matters for consideration. Owing to the large amount of research carried out on the strength of aeroplane structure we can now be practically certain of building machines that do not fail in the air, always providing that there is reasonable duplicat[illegible] of vital members. I think this matte[illegible]on duplication of the stress parts is of [illegible]r of Civil Aviation. No amount of researc[illegible] great fact that the presence of an internal fla[illegible] will importance. [illegible]he structure; there[illegible]w in a show the pre[illegible] the duplication [illegible]efore the vital part of th[illegible] more complete [illegible]appo[illegible] the safer will be the machi[illegible]e refer[illegible] ca[illegible].

The danger from [illegible]ion be almost eliminated, as Major Green points, out. The research into the use of heavy oil fuel should be pressed forward with all speed; the use of heavy oil would not only ensure safety from fire, but the fuel costs would be considerably reduced.

The comfort of passengers is receiving more attention and much improvement is in sight. It seems doubtful whether it will be possible entirely to eliminate air sickness because it is not yet clear why air sickness is apparently less common in open machines than in closed cabins. It certainly does not appear to be connected with ventilation.

The elimination of noise is important. Exhaust silencing does not present serious difficulties, but research is required in the matter of air screw silencing.

Major Green touches briefly on the subject of single engine versus multi-engine machines. I fully agree with him when he says that the single engine type is in practice as reliable as the multi-engine type; this means that at present the multi-engine machine does not gain in safety through having two or more engines; in fact, it may be that the reverse is the case.

The question as to the most suitable type of machine is too involved to be settled by any sort of model research; it must be settled by analysing the data available from practical experience. There is at present little to go on, but taking a broad view of the multi-engine versus the single-engine case, it would seem that to make the multi-engine really safe it would be necessary to decrease the load to such an extent that it would be an impossible machine from the point of view of economy, because the running costs would be abnormally high.

In considering the question of applying results of wind tunnel tests on model wings I think Major Green appears to take rather an extreme view of the discrepancies. Reasonable prediction is generally possible even with unusual wing forms.

Major Green's remarks on metal as compared with wood are very interesting, and while agreeing that meta will ultimately find its place, I think it is too early to press this type of construction. It is very difficult to find any advantage in metal at the present time, but the disadvantages are manifest as shown by Major Green's remarks. He says that so long as wood is used, the making of aeroplanes will be a matter of art rather than science, but later on he remarks that the manipulation of thin sheet metal is difficult, and the present method is to leave it entirely to the skill of the sheetmetal worker. That seems to me somewhat contradictory, but in any case it tends towards not making machines economically in metal. Major Green states that machines can be built in metal so as to weigh at least no more than machines built of wood, so we have gained nothing here, but have a machine at least twice as costly. As regards safety, there is hardly sufficient evidence to say that metal is not so safe as wood, but there are serious difficulties to be overcome as pointed out by Major Green. It seems to me that the gradual evolution of design may tend towards that direction which calls for more metal in construction; this state of affairs is not yet clearly in sight, and therefore is it not too early to spend much time and money on research into metal construction when there is no actual gain from it?

We have not much knowledge of the life of machines of wood construction, but I would suggest that it is very much longer than is generally supposed. It would seem that much valuable data could be obtained at little cost by a series of tests of some of the

oldest machines still in flying order. These machines should be of a type that existed in fair numbers, and if new machines are also available it would be of great interest if the machine chosen for the test could be first tested for performance. It is sometimes suggested that a machine loses performance after, say, a year or so of service; personally, I doubt very much whether a machine loses any measurable performance even after three or four years' flying, but in saying this I, of course, only refer to the aeroplane itself and do not take into account engine variation.

I can hardly agree with Major Green when he says no further research in wood can be of much importance; plywood is one of the most useful materials for building economically and safely; but there is little doubt great improvement could be made whether in qualities or preservation of plywood if made the subject of further research. I am not prejudiced against metal construction as such; but while we can make machines of wood that are as safe or safer, and of the same weight, but at least half as costly as metal machines, it would seem there is still room for research in matters connected with wood

I fully agree that one of the most urgent matters for research is the problem of control at slow speeds; there is much room for improvement, and as Major Green points out, in this direction lies one of the chief improvements in safety. There is another and important aspect of the problem of control at low speeds in connection with wings of high lift coefficient. There is at the present time a general tendency to develop high lift efficiency wings, and in some cases fairly good results have been claimed. But the matter has not yet reached the stage where it can be of definite practical value, and practical research is unfortunately rather slow. It seems to me that a matter of this sort must largely be worked out by the designers' machines, and this means a fair amount of full-scale testing in the air. It is obviously wrong to hand over a new design of machine as a tried-out article when it has only had two or three hours' flying. It is like making a car designer hand over a new model without proper test; and the result is disappointing to the designer and the user. At present, designing firms are not given facilities for testing out new machines ordered by the Government, and cannot afford in these days to take full risks themselves. I feel confident that if reasonable facilities could be given for a series of tests to be carried out by designing firms it would result in greater satisfaction to both sides, and would enable definite data to be gained in the shortest possible time.

Lieut.-Colonel M. O'Gorman, C.B., D.Sc., Chairman of the Royal Aeronautical Society: My Lord President and Gentlemen: I should like, first to say that so far as our Society is concerned this Air Conference is welcomed as an opportunity for the exchange between the persons who are, and the persons who are not, in the Ministry, so that each may know the others' points of view. It is desirable that the Air Ministry staff should be acquainted with the way the wind blows in the outer world, and that the outside people may see which way the Ministry themselves are tending—which way their wind is blowing. One of the things which enables us to detect which way the wind is blowing is a straw, and there fell from the lips of Lord Gorell what I think is a sad straw. It was an aside—that useful weapon of the skilled orator which Lord Gorell is. I wrote down the words of his aside at the time, and I should like to read them. He said: "It would be a disadvantage in the position which I hold, to have technical qualifications." I I do not for a moment agree with Lord Gorell that he is devoid of technical qualifications, but I wish to express regret at the direction of the current of thought underlying that aside. It is not a disadvantage for any person, public, private, political, administrative, military, or anything else, to have technical qualifications. It is immensely to his advantage.

The contrary view has become a catchword caught from one another by those who anticipate technical criticism and so forestall it. I am unaware that there is a person, or has ever been a person, of distinguished scientific qualifications in either the Air Council, or in the Army Council. I imagine that there are in the Admiralty, though I am ignorant of what there may be in that branch. If this is the result of that catchword it is very deplorable, and I will venture to give a reason why it is deplorable. In the days of old, say, the days of the blunderbuss, when the great movements of troops, when the strategy and when the tactics which were to be adopted were being discussed in the Army Council of the day, the persons on the Army Council were fully acquainted with the ultimate technique of their mobile force, *i.e.*, the horse, the horse and cart, and the man on his feet. The General then was fully apprised of exactly what was the ultimate that could be got out of them, and how that ultimate could be got out of this or that combination of them. The Army Council of that day were, in fact, experts in the science of their locomotion. The difference which modern aircraft has introduced into the whole machine is that unless you have within your high command persons of technical attainments, your Council are not acquainted, as the old Generals were, with the ultimate rate of movement and manœuvre and of the ultimate possibilities of the material which they have to employ. That makes a very great difference, and therefore whereas in those days you had technical experts in that kind of post, now, it is a disqualification for those who may seek any such post to have those technical and scientific attainments. I maintain it is not a disadvantage—to put it no stronger than that and I urge that the reverse is the case.

To pass on to another point. The Conference by its existence invites us to express approval on the one hand and criticism on the other—approval which would not be intended to be patronising and criticism which would not be carping, approval of any particular intention or action on the part of the Air Ministry where it may deserve approval (and I think there is much), and

criticism of the intentions or actions which appear to be susceptible of amendment. Let us take as starting point the basis of aeroplane design. That was the basis of Major Green's paper, and I think he dealt with his subject, and General Bagnall-Wild after him dealt with his subject of design and research and matters relating thereto, so very well that when General Sykes this morning described this Hall as an arena, the thought that he was a Christian exposed to the tigers may have flashed into his mind, yet I am bound to say as far as this poor tiger is concerned he has no Christian. I do not want to bite him at all. Knowing him as an old friend, I think he would react better under suasion. Therefore, basing our aims on the development of design, it is mainly there that we find the hopes of seeing fulfilled those magnificent promises which we observe in the papers. We find ourselves forced to refer constantly to research and to the wise direction of that research. Major Green says that the designer must know the users' point of view. Now that is very important, since that evidently gives part of the direction to research, and is rather overlooked, but even this is not so much overlooked as the complementary statement, the new aspect which I wish to insist on, namely, that the user must know the designers' point of view. Do the wing commanders, the air-strategists know the designers' point of view? I doubt it!

Harking back for a moment to the earlier remarks which I made on a totally different subject, about having at least one scientific person within the high command, you will observe that in his absence the user, that is, the high command, might happen to be incapable of understanding the scientific point of view, and if the user does not understand the designer's point of view, or the designer does not understand the user's point of view, or both, then the rate of progress will not be as good as if that happy state of affairs existed which I am suggesting, namely, that they should understand one another.

Anybody who has his eyes open knows that in any industry a bad and ignorant purchaser conduces to a bad article—an ignorantly produced article. If motor cars are bought exclusively because they are well varnished and padded, then they will be well varnished and padded, but they will not be good motor cars. Similarly, if you have not the intelligent and scientific user, then you will not have the good aeroplane, and if any other country develops the good purchaser the technically competent air council, that country will quickest have the good aeroplanes.

That brings me to the next point I want to mention. I think we here are entitled to express our approval of a step recently taken by the Air Ministry, and that is in relation to the formation of a Staff College. Major Green in a paper before the Royal Aeronautical Society some little time ago pointed out that if you want design in fighting aeroplanes you must know what that fighting aeroplane is going to do. On the other hand, if as a member of the Staff College you propose to say how the fighting aeroplanes are to be handled in a fight you must know what those fighting aeroplanes are going to be. It is certain that the tactitian and designer each depend on the other for sustenance—like the two snakes biting each other's tail. They must thoroughly understand each other. Let them swallow each other—it is the best thing that could happen—and they will then fully appreciate the flavour of each other's thought. We shall then have the scientist present at the study of air tactics and the military user following the technics of design.

Lieut.-Colonel M. O'Gorman.

Air Force pilots are not individually the purchasers of their aircraft, nor are civil transport pilots the purchasers of civil transport aircraft. They do not for the purpose of good piloting need to know how to issue commands for tactical fighting or strategy, nor look after arrangements in civil work, yet their co-operation is required in relation to that handling of aircraft of which they are past masters. If hereafter they be taught sufficient science to be able to express their opinions in a quantitative manner instead of emotionally, their value to the designer will be increased manifold. What I am pleading for here is that the increase in the value of the pilot to the designer may be secured by making quite sure that the young cadets who are being trained may have sufficient technical training to be able to express themselves not in terms of "awfully bad" and "jolly good," but in terms of ten per cent. or something measurable and appreciable by the designer, so that the designer can act thereon and evolve a machine.

It really comes back once more to the dictum, given a good purchaser you get a good article. The purchaser does eventually dictate what the article will be.

I will therefore summarise in these words. I would ask that the Air Ministry (1) may press on the technical education of pilots; (2) I would ask them to press on the infusion of high scientific skill and training, particularly into the highest administrative body; (3) I would ask them to press on the study of tactics and strategy of the air, and let the designers have free access to it all—let it not be a hole and corner business in some obscure place from which a Pontiff emerges with a specification, and which says: "This shall be the speed, this shall be the performance." Let them know what the article is and why it is wanted. Let them know, for example, if we discover how to use a gun which can be fired accurately otherwise than in the line of flight. Such a fighting equipment conduces to a totally different vista from that opened up by the fighting machine which is limited to only firing in the line of flight. Finally (4) let us press that the ultimate high authority have an assessor—a committee or man—who is competent to understand in the last detail both design and technique.

[There is another matter which I should like to mention. It is commonly agreed that engine stoppages are not only the chief

cause of forced landings and accidents, but are the main reason why night flying—on which the great future of aeronautics depends—is too hazardous to be commercial.

There is an error amounting to an illusion that engine breakdowns are the cause of this disability; the fact is that the existing reliability of the engine for any three-hour run such as the Paris flight is adequate, or so nearly adequate that the matter would be within the realm of obvious feasibility. What we fail to do is to develop and utilise the reliability which we have. Engine stoppages are about nine times as numerous as aeroplane accidents and also about nine times as numerous as engine breakdowns or failures; if we had 100 per cent. reliability of the engine we should still have 90 per cent. of our engine stoppages. The cause of these stoppages demands immediate, urgent investigation with all the forces at our disposal by the study of all the daily occurring incidents —by the analysis, tabulation and classification of the causes of such engine stoppages.

In the investigation of the way to prevent fire in aeroplanes the utmost value was found to be attachable to the statistical form of inquiry. But statistics can only be used if they are founded upon a sufficiently wide record. We must take for, say, six months from now the story of every engine in flight in the military and naval use of aircraft, and add to this as much as we can get of the data from aircraft on civil transport duty and from the aircraft used for experiment and research. This story should be extracted and the resultant statistics, which could be handled by the accidents investigation department, should, I suggest, be handed in to the Research Committee, which has an Accidents Investigation Sub-Committee, constituted for just such a purpose as this.

It will then appear what is the predominant cause of stoppage, whether petrol pipes, petrol unions, ignition failure, forgetfulness in filling tanks or radiators, the absence of petrol meters, the failure of pressure pumps, of lubricating pumps and devices, dirt in tanks or in jets, &c., &c. Quite possibly some one cause will be responsible for 60 per cent. of the trouble, and if we concentrate on this, a remarkable advance will be made out not only towards safety, but towards the real utilization of the good qualities of the engines which we already possess.

I repeat that it is imperative to get the records relating to a wide enough range of craft in a short time and to utilize the military uses of aeroplanes. It will, of course, be troublesome and annoying to make so much report-writing over details of engine stoppage, any one of which is obviously trivial, but the mass of information obtained will not be trivial—it will be cardinal.

I trust that orders to this effect may be given at an early date, if this suggestion—which emanates from the Accidents Committee—is found to meet with approval, accompanied by an instruction to that Committee to conduct a scientific inquiry into the trouble and its cure. So shall we most quickly have safe flying, night flying, and dividend paying aerial transport.*]

Professor L. Bairstow, C.B.E., F.R.S., representing the Royal Society: My Lords and Gentlemen: I wish first of all to call attention to an early remark in General Bagnall-Wild's paper. He there says that so much as four-fifths of the work in his department is engineering, and the residue is research. It may seem in some respects a minor point, but under the circumstances, it appears to me that it would be better that his department should retake its old title—that of the Technical Department rather than the Research Department. This Conference comes at a time of retrenchment, and it is possible to cut down expenses by 25 per cent., and at the same time eliminate research. That is, we might have a nominal research department that is not doing any research. During the past years all national services have been cut down, and we have been very near to the point of extinction of research on the aeroplane side. I think it is fair to say that the situation is a little better than it was at its worst. In a recent article in the Franklin Institute Journal, the Chairman of the Executive Committee of the National Advisory Committee on Aeronautics in America said: "Scientific investigation forms a most important feature of aviation and can only be conducted by trained students. Those countries which have developed the best airships and aeroplanes have devoted the most thought, time and money to the underlying scientific facts." I have little doubt that he was referring to Germany for airships and to Britain for aeroplanes, and I should associate myself quite closely with those views.

A point raised by Major Green quite early in his paper was the relation between the results obtained on models and those on full scale. All versed in the subject agree as to the desirability of more accurate knowledge on this subject, but there is some considerable divergence as to the relative urgency. Major Green suggests direct comparison between full scale and model experiments, and such things have been in operation continuously for many years past. A small sub-committee of the Advisory Committee on Aeronautical Research was appointed some time ago that surveyed the whole of the available information and put in hand such experiments as could be expected to lead to results in the immediate future. Although we are pressing forward on that particular subject, I think it is almost certain that the reply to the question will not come from experiments either on the model or full scale, but from the Universities. This problem was stated in 1851, and ever since that time various people ave been endeavouring to get solutions. Aviation in particular has encouraged students to devote attention to the

* It has been arranged that the Air Ministry will place at the disposal of the Accidents sub-Committee of the Aeronautical Research Committee periodical reports summarising the particular causes of engine failures in the Service, found to be of a recurrent nature.

subject. A good deal has been done in Sweden and the greater part of the obstacles are now being got out of the way. An answer got from pure theory, that is, purely mathematical calculation on first principles, will, I think, be more convincing to the designer than any comparison we can hope to get between model and full scale in the next ten years.

A further point referred to by Major Green related to the lack of contact between designer and research worker. Colonel O'Gorman referred to the lack of contact between the designer and the user, and I should like to associate myself with him in advocating, at any rate for a time, the suppression of all water-tight compartments.

Major Green says, in particular reference to the relation of designers and research workers, that the latter do not place their results in such a form that the designer can apply them without the exercise of a great deal of effort and thought. From the research workers' side it is argued that hard and fast rules as applied to a new service are a source of very considerable danger; we have had one particularly noticeable instance of that in connection with our recent airship mishap; aviation is still far too near fundamental principles for the safe application of routine methods. It is true that the procedure of the designer, as at present applied, is fairly simple, and we should be surprised if a new aeroplane failed to leave the ground, or having left the ground failed to reach a speed within ten miles per hour of its predicted speed; we should also be surprised if the structure of an aeroplane failed during flight. Although modern aeroplanes have not got these major vices, they have unfortunately a number of minor ones, and those minor accidents account for the fact that the accident ratio in aviation is quite unparalleled in any other walk of life. Many of the troubles could be removed without new knowledge and are of the class in which come breakage of petrol pipes, failure of ignition system, and such minor matters. These matters could be taken in hand by the designer at once if it were not for the fact, pointed out by Captain de Havilland a few minutes ago, that the moment an aeroplane takes to the air it passes from his control. Is it impossible, as suggested by Captain de Havilland, so to change the organisation for new designs as to give the designer some interest in, and payment for, the improvement of the aeroplane in its details?

Other matters need more knowledge than we at present possess. It is not uncommon in reading accounts of accidents to see some such passage as this: "The accident was due to bad piloting causing the aeroplane to lose flying speed near the ground." I wonder that pilots, who as we all know, are very carefully chosen from the best specimens of our humanity, have not protested very strongly against such a half truth; an aeroplane at low speeds is tricky, in some cases quite spiteful, and in the habit of laying traps for a pilot. Surely it is a matter for the designer to reduce the vices, and for the research worker to provide him with the data necessary. Whether the best is being done in the way of application of research work or not, it is certain that we are greatly handicapped at the present time in providing the necessary knowledge by an unsuitable organisation as much as by a lack of money.

Professor L. Bairstow.

One final point referring to airships. A point was made by Major Scott, and—knowing the cause of the accident to the R. 38—I would like to associate myself with his statement that serviceable airships can be made at the present time. At the same time, if we learn the lessons of the past, we could hope to produce much better airships in the not too distant future.

Professor F. W. BURSTALL, representing the University of Birmingham: My Lords and Gentlemen, the point I wish to bring out is the question which General Bagnall-Wild has alluded to with regard to the co-operation of the Universities in assisting research in connection with aeronautics. First, I would point out that the Universities, speaking for the northern group, are very sympathetic, but they find themselves like nearly all other public organisations in a very serious financial position, and as retrenchment will to some extent take place in the direction of certain lines of research, it may be that they will be unable to do all that they will wish to do in connection with the basic problems of research work.

I confess the only point I can speak about with any sort of authority is about the motor itself. I was much interested in General Bagnall-Wild's statement with regard to certain forms. It is clear that the ordinary petrol motor working with a carburettor has very nearly reached the limit of economy and practicability; that, I think, is shown by the very beautiful classical work of Ricardo, who certainly has, in my opinion, settled the problem of the ordinary straightforward petrol motor. The suggestion of General Bagnall-Wild—and quite a correct one—is in the direction of injection; he does not allude to whether the injection proposed is either solid or air injection. I should like to make some remarks derived from fairly extensive experience in both these matters in connection with Diesel motors. Air injection is, of course, much the more efficient method of atomising and preparing the fuel for combustion; it has the difficulty, however, that a motor of 2½ lbs. per horse-power in weight cannot be made with air injection Solid injection, which is rapidly taking the place of air injection for heavy stationary engines, labours under certain disadvantages; these disadvantages are due to the fact that whereas with air it is possible to exercise a pulverising and disruptive effect, oil when injected solidly through any form of orifice cannot be broken up in the same manner. The result of these experiments, as far as I am concerned, showed that the engine was completely blocked at a speed of revolution of 600 per minute in the case of air injection, and of 450 to 500 for solid injection; in both these

cases, of course, crude oil was used, because it has the peculiarity that it is very much easier to inject crude or heavy oil rather than light oils with a very low viscosity. I cannot help thinking that if it is seriously proposed to undertake development in these directions, more basic research will be required; *ad hoc* research is very good, but it will not solve a problem of this extreme difficulty. To do that it is necessary to set to work and investigate the problem, not from the engine side, but by endeavouring to obtain a quantitative idea of the rate at which various methods of subdividing the liquid are accomplished. It will not be proper for me to go into details, but the method adopted is a photographic one in which an experimental sprayer is tested by photographing the form of the jet produced. Possibly, it would be more economical in the long run to spend a year or two years on this problem in this way rather than to attempt it by working on the engines in the very first instance; I speak feelingly as I lost six months by attempting to solve a problem on an engine rather than go to work experimentally.

I can only hope that any remarks I have made will be helpful to the Air Ministry. We are all very anxious to justify the Universities in the public eye, not merely as teaching bodies, but as bodies to promote and widen the knowledge of mankind.

Professor Sir RICHARD T. GLAZEBROOK, K.C.B., F.R.S.: My Lord Chairman and Gentlemen: Research is a word that has been blessed by many lips during the last two days. The Secretary of State for Air in his introductory remarks told us how all progress of the past had depended on research work—fundamental research work. The same tone was taken up by Lord Gorell in his most interesting address, and the two readers of papers yesterday emphasised that point. You, too, sir, in what you had to say this morning, again called attention to the necessity for fundamental research. It would, therefore, hardly seem necessary for me to rise now and impress on this Conference the need to attack a number of fundamental problems and endeavour to solve them in order that the conquest of the air may be made more complete and more perfect. I trust that that may be the view of this large meeting, and yet, as you know quite well, only some few months ago there was a grave danger that all the funds that were available for research work in the National Physical Laboratory might be cut off. That danger, thanks to yourself in great measure, and to others, no longer exists, I think, but it does seem to indicate that the full importance of research was not realised in high quarters in the way in which I and those who have joined with me in working on research in connection with aircraft for the past ten years had hoped.

To turn now, however, to some of the details; you have heard from Professor Bairstow and from Professor Burstall some, at any rate, of the problems of fundamental research that await solution, and you will have realised the difficulties of those problems. You will realise, I take it, that all problems of fundamental research are problems of great difficulty. Some few years ago, Sir Joseph Thomson, in speaking on this subject, remarked that by means of fundamental original research you might produce a revolution in a subject, whereas by means of *ad hoc* and technical research all you could hope for was some small and slow reformation. I trust it may be possible for many years to come to give every support to the fundamental research. At the same time, I would voice a warning as to the methods whereby that can be done. General Bagnall-Wild quoted yesterday, and I am sure with the approval of this meeting, from some remarks of Major G. I. Taylor in his recent lecture before the Royal Aeronautical Society. He said the man who is to undertake fundamental research must be absolutely free. You have to find the man, you have to trust him, and you have to let him go his own way, and feel confident that in the end the advantages that will follow from the solution of the problems with which he is engaged will be immense and will be lasting.

But there are many other things between what I may call fundamental research of this character and *ad hoc* investigation that are necessary for the solution of many of our problems; we heard about several of them from Major Green and from General Bagnall-Wild yesterday. The one that Major Green discussed, Professor Bairstow has alluded to, and I need say little more; we realise, and realise most fully, the need for establishing a secure and firm connection between the results of our model work in our wind tunnels at the National Physical Laboratory and elsewhere, and the behaviour of aircraft in the air, and we realise that all that we ought to know in regard to that connection is not yet known. I am not quite sure that Major Green has realised to the full all that has been done just lately, but investigations have been going on at the National Physical Laboratory and also at the Royal Aircraft Factory on this matter, and I fancy that the knowledge we now have is very appreciably in excess of that to which he was alluding when he spoke. We have to realise that if we are to endeavour to solve the problems in the way indicated it means the development of instruments and apparatus which will be of use not only for that purpose but for many other investigations that are needed.

Turning now to another subject, he spoke of the necessity for safety and economy, and mentioned safety as the first requisite. Thus, I take it, one of the most essential pieces of investigation that is required is that we should gain a more intimate and accurate knowledge of the stability of aircraft in the air, not only longitudinal stability about which we already know a considerable amount, but lateral stability, and the behaviour in circling flight and other conditions that may arise in air currents. For that both air channel experiments and full-scale experiments are needed, and I think those who are at present in charge of the research work, both at the Laboratory and at the Aircraft Factory, are fully aware of the importance of that work.

Another point is that investigation is wanted and more knowledge is necessary as to the distribution of the air pressure on the wings of the machines, on the propellers and on other parts of machines.

May I turn for a moment to what is being done at the National Physical Laboratory and elsewhere. I happen to have had put into my hand in the ordinary course of business only a few days ago the list of the work in hand for February at the Laboratory. I find there are six or seven air channels at work; the first channel,the large channel, 7 × 14 ft., is engaged in a general investigation of stability with complete models; the next channel is engaged in tests which the Research Committee decided was the method to attack the general problem of the behaviour of the air screw; the next is engaged in a general investigation of stability with complete models; the next is occupied with certain international trials, trials on models that are to be tested not only here in England, but in France and Italy and in America and, I think, Japan, with the idea of endeavouring to collate the results of examination and experiments in all those countries; other investigations are in connection with the pressure on wings, and quite a number of other matters of that kind; the general theory of aeroplane and airship structure; the theory of stability of aeroplanes and airships; the theory of elasticity as applied to materials of construction; the sound of airscrew and streamline wires. I merely quote from that list to show you that there are problems, some of them fundamental, others having some slight *ad hoc* reference, which are occupying very fully the time and attention of a highly-skilled staff, some of them the successors of those who have in the past done so much to place our knowledge of aircraft on a satisfactory basis.

I could go through the programme at the Royal Aircraft Factory in a similar manner with almost similarly satisfactory results, although it is true that owing to shortage of staff in some respects progress has not been as rapid as many of us could wish. I think General Bagnall-Wild himself realises very fully the importance of that progress, the necessity that we should advance more rapidly with certain of these fundamental questions, and that we may trust to having his full support and sympathy in our endeavours.

If there were time I could go into certain questions relating to other subjects bearing on aircraft, for example, the nature of fatigue fracture, the properties of steel alloys, the properties of aluminium alloys. Thanks to the help that we are getting now from a scheme which was introduced some few months ago by the Research Committee, supported by the Department of Scientific and Industrial Research and to assistance from the numerous Universities, progress in all these directions promises to be very rapid.

Just one final word as to airships. Here, too, we recognise the financial difficulties, and I am not about to press for large expenditure or for great schemes. Still there is some work that we might do and which, in my opinion, we ought to do. We were reminded yesterday of the terrible toll that was taken last autumn by an airship accident; we were reminded—the phrase was used—that now the debt to nature had been paid. Gentlemen, was it necessary that we should have to pay that debt? I venture to think that one lesson that we may learn from it is the importance of research, the necessity for applying without fail, unhesitatingly, the results of research. It appears now that information existed before the accident which, had it been utilised to the full, would at any rate have sufficed to throw grave doubts on the safety of the structure of that ship. If you ask why it was not utilised it was because the information was avowedly incomplete, and because those who were responsible for the design and for the structure of the ship did not feel that in the results of the air channel experiments which were available there was sufficient certain information to guide them in their design. The point that Major Green made was that what was wanted was the connecting link between the full scale and the model research. For some time past the demand has been made for full scale information in connection with airships. I entirely agree with Major Scott in what he told us as to the possibility of constructing a ship, suitable for present-day commercial wants, of somewhat low ceiling it may be, and of sufficient strength, but only by putting material into the structure and thus reducing its useful load; I am sure that it is not possible for us to combine safety and the high performance that was called for in a ship such as the R. 38 without further full scale work.

The subject is very complex. Consider what the forces are which an airship has to stand; they may be from gusts of air, air pressures of varying amounts and directions on various parts of its surfaces. We had some knowledge of those from model experiments, but more knowledge was needed. More information might have been obtained from models, and there is certain information, but not complete information, as the result of full scale work; Mr. Campbell and Mr. Parnell, whose loss we deplore, had both pressed time after time for more full scale work.

I should like to refer to such full-scale experiments as were made previously to the tests on R. 38. They were mainly experiments to determine air pressures in certain parts of the ship, and are as follows:—

R. 31.—A very few experiments made and not reported on. (One flight only?) Fins broke in flight and ship put out of commission.

R. 26.—Unsuccessful attempts. Ship deleted owing to being put on to experiments on mooring with the wire system, in which, I understand, she was tested practically to destruction.

R. 32.—Pressure holes on upper fin and rudder. Several experiments made, including some during

rapid manœuvres of rudders. Deletion delayed for some weeks in order that further experiments might be made, but, as the weather continued bad, she was deleted last Easter.

R. 33.—Preparations made for measurement of pressures along a line on the hull. No experiments made owing to ship being put out of commission.

What I wish to press, and there is an opportunity now, is that experiments of this kind should be put in hand before the available ships are deleted; I do not think it would cost a very large sum, and I should hope that means might be found for securing the sum required; at any rate, I am sure that unless work of this kind is done on existing ships before they are destroyed—and I presume that their destruction is to come about some time towards the middle of this year—the first thing that will be necessary when we again start, as we are going to start, airship navigation, will be to build a ship or ships on which these experiments can be made. Until the results of experiments such as I have endeavoured to indicate are known I am confident that we cannot build ships with the security that is necessary, and at the same time with the high performance that is desired.

Might I almost suggest that some work of this kind is due as a debt to the memories of those brave men who sacrificed themselves that we might have further knowledge, and whose memories we can commemorate by carrying out work which the leaders among them had pressed for time in and time out during the last months of their lives.

Mr. A. E. L. CHORLTON, C.B.E.: My Lords and Gentlemen, I should first like to congratulate the Conference itself in having a birthday. At one time, it looked as if the first anniversary was not going to be actually a birthday. At the last Conference I suggested that in future ones it would probably be found necessary to divide the work in order that it might be better done, and I feel with all diffidence to-day and yesterday that neglect to do this has been very unfortunate. We have had a sort of mixture between pious opinions, propaganda, and scientific and technical discussion. I think we might have had the technical part at any rate divided in such a manner that it could have been adequately dealt with, and then we should have had a really thorough and sufficient discussion upon the many points that have arisen; you cannot in one day cover the whole ground, and at the same time there must be considerable difficulty on the part of the Press in sorting out differences between what you would call the general view of aviation, and the particular view which is technical and research. I do beg of the people who are in authority that in case we have the good fortune to have another Conference in a year's time they may see their way to divide it in this manner, and to have the whole subject thoroughly discussed as is usual in such Conferences, as, for instance, in the case of the British Association, and so on.

Now, because the time is short, I would like to confine myself to the research side of the question, and particularly to the way it is applied. I should like to congratulate the two authors of the papers on the excellence of them, and the way they have dealt with all the subjects that have come under their notice. Before going into what is rather my chief point, I would like to deal with a point that Major Green raised; he gave a curious juxtaposition of two theories with regard to lubrication and bearing area; (this unfortunately ought not to be discussed here, but here it is); he gave us the accepted way of calculating the load on the bearing area—that is to say, to ascertain the pressure on the bearing and multiply it by the rubbing speed—and pointed out that according to the other theory the greater the speed, the greater is the load that may be carried. He said, how can you explain this apparent paradox? I do not try to explain it; but he had left one thing out, and that is temperature; I think you might more readily accept the load on the bearing as being a question of temperature. So long as you do not exceed a certain temperature, so much will be the load you can carry. The smaller the bearing, the greater the care you must take to prevent this temperature rising; in other words, with a heavy load a great deal more oil is required and greater space to carry the oil.

With reference to research itself and the way that it is applied, I was very pleased to see the way that Major Green dealt with it. We did not have a long string of thermo-dynamics, and the possibilities of the gains we were going to obtain thermo-dynamically. There was reference to the need for greater consideration of metal construction, and I really think there ought to be more concentration upon this side of the question. There is a tendency—it is easy to understand—to concentrate too much upon the gains that can be made in the thermo-dynamical side of the engine, and yet we know very well that they probably do not exceed 10 per cent. when you have made them. I have been one of those people who all along from the beginning have believed in the light-weight engine; in the days immediately after the war one got very little support, and yet I think everybody will agree that the engine to-day that has got all the business has got it in the main because it is lighter than the previous engines. So far as air work is concerned you must have a light weight engine; reliability, of course, is requisite—all engines must be reliable—but you must have them of light weight. When you think of the difference it makes in the number of people you can carry as expressed in their fares, you realise how much more important it is to attack the problem metallurgically than thermo-dynamically. When you think of magnesium, the weight of which is one quarter the weight of steel, you see the prospect of gain there—much greater than you do in your 10 per cent. from the heat side. If it had been possible to construct an engine made of a metal similar to a

magnesium alloy, it would save, for instance, in a Paris flight, at least four passengers—about 24*l.*—against the 10 per cent. from the heat side.

Now, the work in connection with metallurgy has up to the present been very admirably done by the National Physical Laboratory, and we all feel an admiration for the success in obtaining metals like, for instance, the Y metal, which is something we are going to find very useful in our work. But it does not go far enough, and it is, with all respect to that side of the question, too much of an academical way of tackling it. What I would like to say, if I might be allowed to suggest it to the Director of Research, is that he should get more on to his side the great business concerns of the country, who made the country. Those great industrial combinations who search out for ways of tackling problems of this nature always with a view of applying them—those are really the people whom he must get to work on them if he is going to achieve the light-weight engine from the metallurgical point of view. Let him induce some of those concerns to examine this problem either from the aluminium and magnesium side, or from any other side of light specific weight, and encourage them as they must be encouraged financially to enter into this investigation with this object in view. I feel particularly strong about this point because, again with all respect, I think it is a little neglected.

Major Green made special reference to the necessity for more reliable high tension steel alloys, and here, though looking at it from a slightly different angle, I believe he was perfectly right. There must be further steps taken to ensure that the aero-engine in the future can be safely made with a much greater reduction in weight than at present it has.

Professor B. Melvill Jones, A.F.C., representing the University of Cambridge and the Royal Aeronautical Society: My Lord President and Gentlemen: I propose beginning by putting forward a definite suggestion for the consideration of the Conference. I believe there is a very great danger in the way of technical development in this country, or any other country, in aeronautical matters; and I think that it is likely to arise (though it may be avoided) through a gap such as existed before the war between theoretical and technical people and the flying people. That gap was closed to some extent during the war, but I think there is serious danger of it opening again. During the war, there were a large number of people—Colonel Hopkinson, I think, was one of the most eminent—who took to flying while at the same time doing technical work; and possibly in the Air Ministry we shall always get that. But on the civil side it is going to be extremely difficult to train the new men coming along in actual flying. I know it is to some extent a controversial matter, but I myself believe it is essential that a large proportion, or at any rate a proportion, of the technical ability of the country should consist of people who have direct personal experience of flying, that is, who are flyers.

Before putting forward the suggestion, I should say that we are doing our best in this way; we have certain officers of the Air Force who come, to us for example at Cambridge, for general engineering training; I think that is a very useful and hopeful thing, and we are doing our best in that respect. That deals to some small extent with the service side, but on the civil side the position is this. Various universities about the country and other institutions are producing technically trained men. Some of those are anxious to make their lifework aeronautics, in fact, insist on doing so! Those that I know come to me and say: "Do you think we should learn to fly?" The answer is, generally, "Yes"; they next ask, "How are we to learn to fly?" and the answer is "I don't know." It is, of course, far too expensive for them to learn at their own expense.

The suggestion I would like to make is this: that the Air Ministry consider an arrangement for a very small reserve to be formed consisting of quite a few men—possibly five or six a year to start with, or possibly more—chosen from the men coming forward out of the universities or any other institution where a man has an opportunity of proving his technical worth; that they should take these men (the whole point being that they should be good men) and give them a year, or not more than a year and a half, of training in the Air Force, teaching them to fly and to be Air Force officers, as well as can be done in that short time. This course was adopted before the war—I do not know whether it is adopted now—in regard to the Royal Engineers. Men used to go through a year's course and then move on to the Reserve, that is to say, they went back to civil life, but were at the call of the Royal Engineers in case of need. If that were done in the Air Force it would have two advantages; it would tend to minimise this danger that I have referred to, and it would ensure to the Air Ministry that the technical people dealing with civil work should be men who know by personal experience—and that is the only thing really of any use—the requirements of military needs.

There is another point to which I would like to draw the attention of the Conference. Much has been said about safety, and about the necessity for regularity of flying; everyone will agree that those two are the fundamental necessities in commercial work. Regularity of flying means flying in all weathers, or as much as possible in all weathers; that involves flying in misty and bad weather, and it involves going into clouds whether you want to or not. Now there is an instrument available called a "turn indicator," which will make all the difference between danger in the cloud and comparative safety. I have discovered to my surprise that the cross-Channel machines are not equipped with this instrument—or many of them are not; I should like to urge that they should be so equipped. I will go so far as to say this—a statement that I

am certain will be criticised, but which I believe to be true—it would be worse for a pilot who has to enter clouds, for some reason or other, to lose his turn indicator, if he has one, than to lose the whole of the rest of his instrument board. This is a very strong statement I know; but I know that there are pilots who, from experience, will back me up in it. I would say further that, if I had anything to do with an insurance company, I would definitely insist that that particular instrument should be carried on any machine attempting a regular service.

On the question of airships, the thing that interested me in listening to yesterday's speeches was the fact that indirectly the whole of the earlier speeches of the day were a very strong advocacy of the airship. With the exception of the statement that airship work will cease the whole of the arguments advanced strongly advocated their use, for the following reasons:—

> It was stated that the aeroplane is only useful for moderately short journeys of 200 or 300 miles in the immediate foreseeable future.
>
> It was stated, rightly or wrongly, that there is not much future for the aeroplane with these small journeys in Europe.
>
> It was further stated that it is essential to develop our long distance imperial routes.
>
> It was finally stated by Major Scott, an acknowledged expert, that the airship can carry out these long distance aerial routes.

The chain of argument seems to be complete. Yet on the top of all this comes the decision "We will not go on with the airship at all."

I think we want to realise with what we are going to be faced. It seems to me absolutely undoubted that what Major Scott said was true, that the airship will be the long distance carrier, aided at each end by aeroplanes. In other words, the airship is the key which will develop aeronautics about the world. I believe if anybody in this room to-day suddenly had a vision of the world in 50 years to come and the position of aeronautics at that time, and came back to this room and told what he saw he would not be believed. I would not believe him myself. It will be something enormously bigger than we can foresee. The whole of the technical opinion I have ever come across is in agreement that the airships will be the key of that situation. What is the money that we are considering now—1,000,000*l.* or so—in comparison with the question as to whether we are in a good position or in a bad position in relation to that aerial activity which will almost certainly develop?

If the bulk of airship work is to be shut down, do not let us invent a kind of guillotine by which some junior clerk when he sees the word "airship" on an estimate of any description puts a blue pencil through it. I do not say that is done, but that is what I am afraid of being done. Let the minor experiments at any rate go on, and if possible, as Sir Richard Glazebrook suggested, keep these airships that are existing for full scale experimental work. To say that we can take the problem up in five or ten years time is to assume one of two things: either that the airship will not advance technically between now and ten years' time, which is ridiculous, or that we are prepared solemnly to sit down and let other nations develop these things and then pick their brains. At the very lowest estimate, I do not think that is dignified.

Mr. J. D. North, F.R.Ae.S., Messrs. Boulton and Paul, Ltd.: My Lords and Gentlemen: I feel very gratified at the opportunity of coming to this Conference at which I felt sure I should learn something which would enable me to appreciate what has been called the apparently unhealthy state of aviation; particularly I desired to know whether there was anything in the aeroplane itself which had contributed to that condition. When I heard the Secretary of State for Air yesterday, I was led to the conclusion that the present trouble was a sort of inevitable anæmia out of which we might expect to grow, but this morning I understand from General Brancker that it was a touch of administrative indigestion to which he has at once administered a strong dose of ginger.

It has been very gratifying to hear the opinions which have been expressed as regards the future of the aeroplane as such, and I myself feel that we have in the immediate future real prospects of improvement, provided we are able to carry on the work. I should like to support in particular what Major Green has said on the subject of metal construction, in spite of the fact that Captain de Havilland suggested metal aeroplanes were going to be or are twice as dear and no lighter than wood machines; I would venture to say, on the contrary, in my experience we can now make machines in which the structure is at least 10 per cent. lighter, and which are very little more expensive, if anything, than wooden aeroplanes; and further that by the use of high tensile steels combined with light alloys a reduction in weight of 25 per cent. is well within sight. That combined with other improvements which have been foreseen as the result of hard work, will, I hope, help to place civil aviation on a more satisfactory financial basis.

I quite understand that civil aviation is in one very great difficulty. Like all transport undertakings, it can only really succeed on a large scale, but it is obvious that we cannot possibly hope to work on such a scale as is at present necessary to enable financial success to be attained, and so we are compelled to fall back on the subsidization of our operations and experience, and also, what is equally necessary, the subsidization of our research both at Universities and Laboratories, and for the designers.

Mr. H. P. Folland, M.B.E., F.R.Ae.S. (Gloucestershire Aircraft Co., Ltd.): My Lords and Gentlemen: It was with great interest that I heard Major Green's and

General Bagnall-Wild's papers, both of which open a wide field for discussion. It is rather surprising that after all these years the aeroplane is practically, from the point of view of design, in the same position as it was six or seven years ago; it appears that one Italian engineer, Caproni, has made one endeavour to strike away from the orthodox structure; but unfortunately his efforts, which were on such a large scale, were broken in the initial stages. It would be rather interesting to have some research and investigations on machines of that type; it is obvious that with the larger types of commercial machine—one has to consider a greater quantity of passengers or goods, and ventilation and other considerations—the question of accommodating passengers would be a very important item; and it appears to some extent that Caproni was probably on the right track in regard to the commercial type. It is, of course, a big experiment for an individual concern, but an experiment that will afford a large amount of research work in both model and preliminary trials.

With reference to steel structures, I am afraid I am not in favour of either Mr. North's or Captain de Havilland's ideas; not only at the present time does the steel structure appear to be extremely expensive, but in many cases, it contains a vast number of small parts rivetted together by a vast number of small rivets, so that there would seem to be a probability of weakness occurring, should a small rivet fail. We must further consider the conditions under which the aeroplane has to work, and take into account climates and changes of atmospheric conditions. It occurs to me that the solution is that of the wooden and steel structure, and I would suggest that for the time being, all the main structure, that is, spars, compression members and tie-rods—parts likely to be affected by atmospheric changes—should be made of steel tubes, while the surrounding portions, that is, ribs, struts, should be of wood, thereby saving a certain amount of weight and ensuring a cheap and light structure for all classes of conditions.

On the research side, we have heard some suggestions that certain money is to be allocated for helicopters. Before the helicopter can be any great success the engine itself must still further be made more reliable; and it appears to me that money instead of being spent on research work in connection with the helicopter could be well devoted to the development of engines, perhaps not on exactly orthodox lines, but to research work in the development of the two-stroke engine and the petrol turbine.

[Another subject for research is the question of suitable bodies for water-cooled engines and radial air-cooled engines in connection with stability and total head resistance. Whilst the air-cooled engine is favoured owing to the troubles accompanying a water system, it has only been used successfully in tractor machines, and research regarding air-cooled engines as pushers, as well as on the method of cooling would be of great use to the designer.]

With reference to commercial types, the design at present appears to be a military type with Limousine body; no attempts have been made to improve the commercial machine, during the past few years, with the exception of new types of wings, the slotted wings, &c.

I think some international rules should be made with regard to points such as load factors, landing speeds, petrol systems, &c., which are of vital importance. At the present moment it is quite possible for a foreign constructor to construct a machine with a load factor of safety, say, of three or four, whereas we have to construct with higher factors of safety. The foreign machine will thus probably save 300 or 400 lbs., which can go as useful load, and, therefore, I think that it is necessary to have some international rules on the lines, say, of the Board of Trade.

Captain G. T. R. Hill, M.C.: My Lords and Gentlemen: I wish to speak on one subject only, and that is the all-important question of safety; Colonel Bristow in his able paper raised the question first, and I think a very large percentage of those who have spoken have also referred to it. I may say that in the main I agree with almost every point of Colonel Bristow's paper, and I must say I do admire a man who can get up in public and, without turning a hair, admit that he has charged first-class fare and a half for providing fourth-class accommodation

As regards the question of safety, I feel with the ordinary man in the street that the casualty rate due to air transport has been very carefully disguised by its publication officially. We read of a casualty rate of ·0005 (or something like that) passengers killed per mile flown; to me that means nothing as I see it written down—·0005 of a person does not interest me at all; it does not conjure up any vision of an accident in my mind. But in order to bring it before you more vividly I would like you all to imagine what would be the result supposing travelling in the London Tubes was as dangerous as travelling by air; I think it would probably surprise everyone to hear that if that were so then every day in the London Tubes something like 300 people would be killed. Of course, that figure is open to argument, but I think it does bring before us very vividly the real extent of the danger that does lie in aviation at the present time. The public, although they may not realise it quite like that, believe that air travel is dangerous, and I think they are quite right. Insurance companies can multiply that small decimal I was speaking about, and then they find that they must charge very appreciable premiums, and that they cannot allow aviation risks to be covered by the ordinary life insurance premiums. What are we to do about this? Something, it seems to me, must obviously be done. Year by year we do make steady, if slow, progress; much time and money is spent, but we have not yet reached safety in air travel. I feel now it is up to each one of us to bring out into the limelight any scheme he may have for increasing the safety of air transport, and I would put forward my own scheme, although

I find I am pushing it against so great an authority as Captain de Havilland. My own scheme which I laid before the Royal Aeronautical Society last year is to provide an aeroplane equipped with two engines of such power that if one fails the other can bring the machine safely to its aerodrome if necessary; anyhow the aeroplane can carry on without the danger of being forced to the ground. I will not go into all the details which are known to the Air Ministry except to say that if my scheme were successful it would avoid many of the dangers which are inherent in the present arrangement of twin engine aeroplanes; in my scheme the two engines are entirely independent of each other.

Colonel Bristow stated that at present the aeroplane engines on some machines can be run at only 60 per cent. of their maximum possible power at cruising speeds, which seems to me to suggest that we are very nearly at the stage of relation of engine power to weight of being able to run at a minimum power of 40 per cent. of our maximum; in that case, my idea is that one engine should be able to provide 40 per cent. of the maximum output of the two together. If so arranged, should one engine or its installation fail, an aeroplane would not be forced to descend, and that to my mind would very largely increase the confidence of the public in aerial travel; if they were certain in their minds that if an engine failed they would not be forced to descend rapidly, I feel they would flock in much greater numbers to the aerodromes for the purpose of travelling by air.

It seems to me the position is rather like this: Suppose that at present the risk of mechanical failure is one flight in a thousand —I do not say it is that, but take that as an example— if the plant were absolutely duplicated and the two engines were independent, the risk of breakdown would then be one in a million. So by that means we reach an entirely different degree of the risk of a forced landing. I think if one day Mr. Handley-Page, say, were able to placard the country with notices to the effect "My aeroplanes are now a thousand times more reliable than those of my competitors" that that day would be the dawn of a new era in aerial transport.

Major H. Hely Pounds, representing the Royal Colonial Institute: My Lords and Gentlemen: I am here as a representative of the Royal Colonial Institute. That is an organisation which has interests which are world wide. In all parts of the world where there are colonies we claim we have interests, and especially throughout the over-seas dominions. We have our branches and corresponding secretaries, and have recently established a Committee at the headquarters of the Institute here in London to consider matters of aviation. I would like to say on behalf of the Institute that so far as we can we will in every way in our power encourage the development of British Empire aviation. General Brancker in looking round the room when he started to speak referred to the fact of his not being able to see any new blood; may I submit myself as new blood, and should I in any way get a little warm or near to boiling point, kindly put it down to my youthful enthusiasm.

The Secretary of State for Air in his opening remarks made a comment which certainly did surprise me—I was a little bit uncertain as to whether I actually heard correctly what he said, but it has been confirmed by various other speakers—it was to the effect that we were possibly going through for some considerable period a state of indefinite depression during which we should not be able to do very much in commercial aviation, and that it would not matter if we lost the whole of the personnel which has been established during the war, as we could later on re-establish that personnel the same as we had it during the war. Gentlemen, I submit that that is rather startling, and I can hardly imagine anybody in a position of authority suggesting that we can afford to lose all that time and later on begin all over again; we have got to get a move on and we have to keep the organisation that we have in hand unless we are going to lose the race; we learned a good deal during the war as to what catching up meant. Look at what it cost us to catch up; do not let us be "had" again. Let us keep in front as long as possible, and let the other fellows do the catching up.

Lord Gorell referred somewhat jocularly to the inconsistency of newspapers which in one series of articles or columns preached economy and anti-waste, and in another series of articles or columns advocated spending money on the maintenance of the air service. I submit there is no inconsistency in that; it is all right spending money in a sensible way, on something that is going to give valuable information; but, of course, keeping large numbers of officials and paying doles to men who do nothing mean waste of money. The money that it is advocated should be spent on the air service would be well spent even if you only got negative results and found out you could not do certain things, that is, it would be better than if you did not try to find that out. Lord Gorell also referred to the difference between public interest here and on the continent. Is not that a matter of window-dressing? The business man knows he has to display his goods, and he has to advertise. But what is happening here? Nothing; there is no window dressing in this country. In France, they have aeroplane services going all over Europe; they have their passenger travelling boats or ships or aeroplanes, while we have nothing. The consequence is that our people do not hear anything about these services; they are not encouraged to know anything. So far as we are concerned I am quite sure that if the other organisations who are trying to educate the public mind in this country will send any information they can to our Secretary at the Royal Colonial Institute, we will do all in our power to popularise this question throughout the whole British Empire, particularly in the overseas Dominions; we may be able to collect information that may assist them through our communications in

a way that they may not have the opportunity to do.

On the question of subsidies, this good old country has a distinct objection to subsidising things; but in the overseas Dominions new industries are encouraged to develop by subsidies; the sooner this old mother country takes a lesson from some of her children the better for the country and the Empire as a whole. You cannot carry on and establish expensive new industries by which the nation is going to benefit without some backing and assistance from the Government; if private enterprise is going to spend money on national services, then it is up to the nation to support them and help them to pay for some of those services, especially in the early stages of development.

General Bagnall-Wild referred to the question of timber supplies. I suppose throughout the British Empire we have a greater variety of supplies of timbers, and certainly a greater variety of conditions under which timbers can be produced, than any other nation. It may have been already considered, but I offer this suggestion: that the authorities here should get into communication with all our oversea Governments, give them full information with regard to timbers required, supply them with the necessary data as to the best classes of timbers wanted, and try and get them to see if there are any native timbers growing in those different dominions already which might be suitable, or get every class of tree tried in the different oversea dominions as well as here. Other nations are producing timbers which are suitable, and of which they are constructing aeroplanes and airships; General Bagnall-Wild referred to Canada and a certain class of spruce; it may be found that under varying conditions, climatic conditions and conditions of soil and so on, a tree which may not be a success in one place may be a great success in another. I think that is a matter in which Governments might co-operate with very great advantage. The need for looking ahead must not be forgotten; timbers take 40 years to grow and reach the stage at which they are useful for commercial purposes. Now is the time to begin; we will not know for another 40 years probably whether certain timbers are suitable, but we may find that there are very many more than is generally considered.

Major W. T. Blake: My Lords and Gentlemen: I do not want to keep you long, but there are one or two points not on the papers so much as on to-day's discussion that I would like to make a few observations on. In the first place there is air-mails; General Williamson told us of the work that is being done with regard to air-mails, and he seemed to think that they were efficient; somebody else—I have forgotten who it was for the moment—has told us they were not efficient. I am sure everybody who has attempted to use the air-mails will agree they are about as inefficient as may be. I will give you one or two instances; in Poland this autumn I tried to send urgent messages back to London; I sent them in duplicate by the ordinary post and by air-mail, and handed them in and saw them depart in the aeroplane from the aerodrome at Warsaw myself; when I arrived home between three and four weeks afterwards, not one of those letters had turned up; all the letters sent by ordinary post had turned up, but the air-mail express letters, on which I had paid a comparatively high fee, arrived three weeks after I got home. I have had the same experience from and to Berlin and Paris.

I have taken a great deal of trouble to inquire into the matter, and the reason appears to be due to this fact. As regards London and Paris, the aeroplanes do not fail and the letters arrive promptly enough; then having arrived on the other side they stay there the night for the mail to come by the ordinary method, before they are delivered. If it is the foreign postal authorities who are at fault, possibly the British authorities can find some means of "bucking" them up a bit.

With regard to air-mails, I suggest that if a guaranteed daily load of air-mails could be given for any of the air routes, all need for subsidies would be eliminated.

As regards internal routes, I know the majority are of opinion that internal routes could not be run successfully in England, but I think there are many cases where they could be run. The argument is apparently that where you have a good train service an air service is no use—in other words, you want an air service where there are no trains; according to this argument you might take Siberia, but I am sure that no aircraft service would be of any use there. You want an air service where there are large populations, and I am sure there are many cross-country routes in England where air services could be successfully run. I think the year before last new mail arrangements for the carriage of mails to Ireland were made. Aircraft would be eminently suitable for carrying mails from England to Ireland; they could save a tremendous amount of time, and do it at a far cheaper rate than the subsidy that is being paid to the railway company to carry the mails. The question was raised in the House of Commons at my suggestion, and the answer given was that when the Postmaster-General thought aircraft were any good he would think about it; I think the contract has been given for the next ten or twenty years to the railway company.

As regards the sending of mails by night, I believe that soon it will be possible to organise a night service to Paris. That I do not want to go into.

Somebody else raised the question of goods. I can tell you definitely that I have had brought to me an offer for the carriage of definite loads of goods on definite days for as low a charge as 6*d.* a lb. That, I think, is getting in the neighbourhood of a commercial proposition.

Then with regard to Captain Hill's statement about the danger of flying, and that 300 people a day would be killed in the tubes if tube travelling was as dangerous as travelling on the airways, for the six months

ending September this year the number of passengers killed on the airways was nil—when I say the "airways" I mean the British air services from London to the continent—there were no casualties; so that how Captain Hill makes out his figures of 300 per day killed on the Underground I cannot understand. In England itself during that period there was one passenger killed and one passenger injured; both accidents on joy-riding. I say that during the last six months no single passenger has been killed or injured on the airways, and I do not think you can have safety higher than that.

I had certain other things to say, but I am told they are not in order, so will content myself with saying that in common with most other members of the Conference I am very sorry to find that the Secretary of State for Air holds the views he does. I think it is a pity that a man in his position should express such views.

Mr. F. Handley-Page, C.B.E., F.R.Ae.S., Director of Messrs. Handley-Page, Ltd.: My Lords and Gentlemen: I would like to speak a few words on research and design more particularly with regard to civil aviation. At the present time in the Air Ministry there is a system of competitions which are held for machines more particularly for military purposes; I would like to see the same system instituted for civil machines. Air transport companies when they come to make their choice are necessarily very restricted in the field that they have before them; if it were possible that they had a choice of five or six types selected out of a number by competition, they would be able then to choose better machines more suited for the particular type of work that they have to undertake.

There is quite a divergence between what is required for civil machines and what is required for military machines; what is necessary is economy as distinct from performance, which is the essential of the military machine. We must at all costs, consistent with due safety for passengers and regularity of the service, ensure that the machines can be run as a paying proposition; therefore one wants machines with less horse-power per pound of load (passenger or freight) carried than in a military machine where you must have high speed and good climbing capacity. I would therefore urge if possible that more attention in the Air Ministry might be devoted to the provision of competitions for such machines so that the transport companies might have a better choice.

The next point on which I wish to say a few words is the point raised in General Bagnall-Wild's paper where he deals with the question of civil aviation and says that the aero-engine is the hard problem; on the next page he goes on to say that "it is a matter for surprise that, with the many years of experience of the high speed petrol engine for motor cars, it has not yet been possible to develop a high-speed petrol engine of equal freedom from the necessity for frequent overhaul for aircraft." If you have an aero-engine under the same conditions as a motor-car engine you will have the same reliability; a motor-car engine very rarely runs at its top speed; invariably it runs at a very small proportion of its power. If you do run a motor-car engine at its top speed it necessitates very high speeds on the road; I have made such tests, and the results have been recorded by what is called a "competent authority" on a proper document; but I have generally found that continuous trials of that nature, apart from the financial cost being rather high, invariably lead to breakdown of small parts in the engine or in its installation. The trouble that one suffers from in aircraft is that the aircraft takes too much horse-power for too long a time, and I therefore feel rather that the improvement in reliability is more likely to come from improving the aircraft and making it take very much less horse-power, so that for a large proportion of the time, unless one has a short journey, not more than, say, 25 per cent. of the total horse power installed is used. I think then that you have to make a definite choice between taking two engines, one of which by itself, according to Captain Hill, will drive the machine with 80 per cent. of its power, or together will only take 40 per cent., and running one engine at 40 per cent. of its power all the time. Personally, I would rather have the one running at 40 per cent. of its power, or better still have the two running at 40 per cent. of their power.

There was one point on which Major Green touched to which I should like to refer, and that is this. He said in his paper: "The research already suggested in connection with control at low speeds is possibly the most important factor of landing in small aerodromes and probably more advantage will be gained by a knowledge of this subject than by the use of wings of an abnormally high lift coefficient." The question of landing on small aerodromes depends on the control that one has over a machine. With wings of high lift coefficiency there is this great advantage, that the machine becomes quite small, and one can visualise the possibilities of making machines more durable and more robust, and taking much smaller horse-power; at one time I had the temerity to suggest you might get such a small machine in a coal shed. I think it is some such line of development as that that is like to be successful, rather than searching for high efficiency in the engines and very great durability. The engine itself must be costly if so developed, and as economy forms one of the most important points to which we have to look, it is rather in the aircraft itself than in the engine that we have to make improvement.

Major-General Sir W. S. Brancker, K.C.B., A.F.C.: My Lords and Gentlemen: I just want to make a few definite suggestions to the technical expert from the practical point of view, or rather from the operator's point of view, as a means of helping him to lower his expenses and increase his reliability. I think the first and most important item to be pushed on as much as possible is stability. Without it we cannot run reliably, in really bad weather or at night; with it I guarantee

that aircraft can fly on any day or night that a ship can put to sea. General Bagnall-Wild yesterday said that an inherent stability would be sufficient, and put automatic stability out of court altogether. I am not quite sure; I think inherent stability means that aircraft must move about before the stability begins to work, that is, that you have to get into an uncomfortable position before you are pushed back right; on the other hand, automatic stability can stop the movement at its start, which means that the automatically stabilised machine will be a more stable platform for the use of guns and bombs, and also may eliminate air sickness to some extent.

The second most important item in connection with aircraft is metal construction, particularly as regards propellers. I am just back from the East, and I was very much impressed there with the necessity of getting over the question of metal construction as soon as possible to save wear and tear and useless expense. I have made a good many inquiries since I came back, and I am rather with the speaker who said that the expense is not so great. I believe with quite a small order of, say, at the very most 50 machines, you can make metal machines just as cheaply as wood, and I am not at all sure they will not work out lighter as we make further progress in design.

The third item of importance for technical people is the introduction of a really reliable air-cooled engine. It seems to me ridiculous that we, in this stage of development of aviation, have to fly about with many gallons of water in a very fragile and delicate radiator and employ a system which alternately freezes and boils just whenever you do not want it to do so.

The fourth item which strikes me as being important is to abolish rubber entirely from the structure of the machine. I see from General Bagnall-Wild's paper that that is already being done with regard to petrol connections which is a very great step. I believe in hot climates—and I think most of our aerial transport will be in our oversea dominions in future—we shall have to get rid of the rubber tyres as well if we want to be really reliable.

I would like to say I am absolutely word for word in accordance with Professor Jones's remarks, but with regard to Captain Hill, although he makes me feel very brave, I think he has only proved that statistics are very dangerous things to play with.

I agree with Mr. Handley-Page that what we have to aim at is a really reliable engine running below its power, and having got that one engine is quite sufficient. If you have a good engine, a sound installation, and a really good mechanic you should never have engine trouble.

There is one more point I should like to refer to and that is to ask that the proceedings of the Conference may be published before the 1st April. I think the proceedings of the last Conference took more than twelve months to produce. I am not sure about that; I am open to contradiction.

Major-General Sir W. S. Brancker.

Sir HENRY WHITE-SMITH, C.B.E., Chairman of the Society of British Aircraft Constructors: [In the first place I should like to congratulate Lord Gorell and Colonel Bristow on the excellent papers they have laid before the Conference. There is very little in their papers with which I find reason to disagree, although I should like to have seen Colonel Bristow lay more emphasis on the need for the development of goods traffic by air. In my opinion there is a great scope for development and I believe the air transport companies will find it well worth their most careful attention.

Captain Guest's remarks at the opening of the Conference appeared to me to be unduly pessimistic and I can only think that we have received a wrong impression of his views.

Whatever the future holds for civil aviation I consider that it is highly desirable that the Air Ministry and the transport companies should address themselves to the question of "through-routes." Great Britain, by reason of its geographical situation on the North-West of Europe, bids fair to be crabbed, cabined and confined unless a broad vision is brought to bear on the possible outlets for her air traffic. At the present time France and other countries are laying out services which go far beyond their borders, and I would suggest that this country should consider, at once, how the "through-routes" from Great Britain to her Colonies are to be conducted.

By the International Convention, whilst we are permitted to land in and fly over other countries, every country has the right to say that we shall not pick up new traffic within her borders. It follows, therefore, for instance, that if we were running services to Malta that the only traffic we could cater for would be that of passengers or goods who were to be transported over the whole of the journey. The aircraft would not be permitted to take passengers as far as Paris and then pick up further passengers there for the rest of the journey.

I would suggest, therefore, that the position be considered, firstly, geographically as to the routes to be taken, and, secondly, what arrangements can be made with other countries, either with the Governments or air transport companies, by which services could be so inter-connected that we may have our fair share of the traffic to be carried and in the conduct of the main trunk-routes. Unless this subject is considered at an early date we shall find that other countries have so established themselves on the main lines of traffic that we shall be left out in the cold.]

Dr. H. C. WATTS, A.M.I.C.E., a director of Messrs. Ogilvie and Partners, Ltd.,: [The discussion so far has been confined to two types of aircraft—aeroplanes and airships. It appears to have been overlooked that there is yet a third type, namely, the helicopter. Both the Secretary of State for Air and General Bagnall-Wild have quoted it as an instance of the research on which the Air Ministry is spending time and money. So far, the Conference has not suggested to the Secretary of State for Air any means of economising. On the whole, criticism has

been directed against economy on research and against the decision to close down work on airships. The research which is now being carried out on helicopters is a research which, in the interests of economy, might well be stopped, without involving any serious loss of Great Britain's position in aviation. I am sure that in making that statement I shall carry with me most of the technical men in this room.

Generally speaking, in deciding its policy of research the Government have been guided by its Advisory Committee in the past or the Aeronautical Research Committee in the present, or by its own technical advisers in the Air Ministry itself. I make bold to say that the research on helicopters which we are told is now proceeding has never been suggested or asked for either by the past Advisory Committee or by the present Aeronautical Research Committee. I would go further and say that the research was started against the advice of the Air Ministry's own technical advisers. I speak with some knowledge of of the facts since I was myself one of those technical advisers at the time when this research was initiated.

I do not wish to enter into technical details, but there seems to be a large amount of misunderstanding concerning the difficulties to be overcome in the evolution of a helicopter of any commercial or military value. Both at this Conference and in the newspapers of other countries we have heard it almost triumphantly announced that a helicopter has succeeded in rising a few feet under its own power. This result seems in the minds of many to justify the thousands of pounds which have been spent. The Director of Research has suggested to this Conference that it is an encouraging result.

The helicopter is nothing more or less than a propeller exerting a thrust vertically instead of horizontally, and I confidently assert that for many years we have had sufficient knowledge of propellers to have predicted this result without the expenditure of money which has taken and is still taking place. The technical men of this country have not asked for research on helicopters, not because they doubted whether such a machine could rise vertically from the ground, but because they could not see of what use it would be, or how it could be controlled and rendered stable when it had done so. I do not, as I have said, wish to go into technicalities, but I would suggest that the Secretary of State for Air should seek the advice of his Aeronautical Research Committee or any other external authority on the question whether research on helicopters is justified in the present stringent financial circumstances.]

Mr. CHAO-HSIN CHU, Chinese Chargé d'Affaires in London: [Although I am not a scientific man, having no connection with research in aeroplane work, I feel I should like to take a few moments of your valuable time in expounding to you the opinions of my country—a country which up to the present, has not taken the initiative in aeroplane work, but is only following your footsteps. I intervene to point out that all the research work you are doing in this country and all the progress you are making must be of immense advantage to you and to your manufacturers. I say without hesitation, it will be a long time before we in China create aeroplane factories of our own, or indulge in the serious business of manufacture. This is not due to backwardness on our part in appreciation of the importance of research work and manufacture, but it is attributable solely to the fact that for the next decade or two, we have so much on hand that it would not be possible to expect that our activities could extend to this branch of scientific development. We are, and shall remain, purchasers and users of aeroplanes, and we shall always be so to an increasing extent, and I would therefore point out to all those engaged in research work in this country, that they should not look on us for the moment as competitors, but merely as good, keen potential customers. You will find that we shall come into the market to buy, and buy no doubt on a large scale, and we shall choose undoubtedly the best market for the purpose, because I can at least claim that we appreciate in any branch of life and work, the best obtainable article.

You, therefore, who are carrying on research work, one of whose objects is, I see from the Agenda, "To make the safest and most economical aeroplanes," are certain to reap the reward of your labours. No doubt the industry at the present time is in a state of flux, and it is a little difficult to say what it may be in the future, but it is the industry of the future, and I can assure you that we in the East will be found among those nations which will be the first to profit to our advantage and to your financial benefit by the progress you make.

I make these remarks so that you can feel that commercially, as well as scientifically, British research in aeroplane work will have a great future before it.

I should also like to say something on the subject of airships which undoubtedly interest China. We are in favour of all forms of aerial development, but obviously we look at the practical nature of inventions, and it has therefore not escaped our notice that, prior to the War, the Germans undoubtedly used with considerable success airships for purely commercial purposes.

We should like to see airships a commercial proposition, and though I am quite aware you may say we look at the matter rather selfishly since we leave you to do all the experiments and ourselves only benefit from what you do, I can assure you that the scientific innovator is nowhere more honoured than in China. In years to come, we may build ourselves, but frankly, for the moment, we have too much on our hands to enable us to do so. I notice that the view is generally held that the most economical method of development is along civil lines. I strongly endorse that view. We in China, despite what you may hear from some of our so-called friends, have always welcomed the practical application of scientific work and research. We consider that in the hands of the Government—of any Government— no effective and large-scale development of aerial work can be

expected. A Government can rightly point the way, and ought to do so, but all subsequent progress should be in private hands. We do not take any interest in airships from military purposes; I doubt whether in view of the lessons of the war they have one. They ought to have great value as passenger and goods carriers, and especially in countries like China, where you cannot expect the country to be fully developed with the same rapidity as smaller ones—in size—which possess dense aggregations of populations. I modestly suggest that the makers of airships might do worse than turn their attention to the commercial possibilities of China. They will, if they interest Chinese commercial men in their venture, find a ready welcome and great possibilities. With us there should be room for both the aeroplane and the airship, though, perhaps, in constructing the latter the more popular and useful size would be the smaller type of vessel, at all events initially. I notice the airship has its critics nowadays. Maybe it has to prove that in the long run it can compete against the aeroplane from the financial and commercial standpoints. Still, if this can be done, it can be done best in China, where the possibilities are so great. Hence I can assure you my Government would like to see the experiment tried, and there ought to be enough commercial confidence in this country to make the attempt.]

The CHAIRMAN: We have now come almost to the end of our programme for the day, and I think you will agree with me when I say we are all delighted to have the Secretary of State for Air back with us again in Conference. Captain Guest has not sent in his name as a speaker, but nevertheless I call on him.

The SECRETARY OF STATE FOR AIR (Captain the Rt. Hon. F. E. GUEST, C.B.E., D.S.O., M.P.): Lord Weir and Gentlemen: I feel somewhat like the prisoner in the dock, but after all someone had to start the ball rolling, and it appears in ventilating my views at the commencement of the Conference I have come up against some very strong contrary opinions. Surely that was the object of the Conference. It is of no value at all if we all sit round and pat each other on the back and do not ever disagree. To the best of my ability, I put before you formally and as shortly as possible my views on this great movement, as far as I have yet been able to appreciate it, with the object of helping it, not with the object of interfering with it; and I want if I can to persuade, convince, and carry with me those who are as enthusiastic as I am myself along the lines which I believe will lead to ultimate success. A Conference of this nature is just the very opportunity for thrashing out divergent views, and I think, although I have not been able to attend the whole of it—because, as you know, there have been other calls upon me outside this hall, including Parliament and the Levée this morning—I have yet been able to keep pretty well in touch with what has been said by the chief speakers.

I, therefore, if I may, will refer to one or two of the controversial points, but before doing so I would like to say how much the Ministry and how much the public in the end, I think, will be indebted to all of you for taking part in this Conference and expressing your opinions so clearly. In the first place, the attendance has been remarkable; it is a busy time of the year when business and politics are drawing people in other directions, yet so keen are the sentiments of so many on this subject that they have come and spent two laborious hard-thinking days in this hall on this subject. The suggestions made have been carefully recorded. The speeches have been listened to by high officials in the Ministry, and everyone of the suggestions made will come up for the closest consideration and investigation in the Air Ministry.

There are a few names—although it is invidious ever to mention names—which I should like to thank for their contributions. Colonel Bristow's paper gave us yesterday morning immense pleasure. Professor Jones's speech this afternoon contained valuable matter. A particular recommendation of Sir Richard Glazebrook's, about which I have had an opportunity to discuss with him privately, in connection with airships and further experiments will receive the most serious consideration. Colonel O'Gorman has on this occasion, as on previous occasions at the Ministry, brought to our attention an idea that is in his mind and in the minds of others as to a suggested method by which scientific research might be freed somewhat from the interference and overlapping of *ad hoc* experiments. That is a suggestion which is going to be most closely investigated. General Brancker, in his well known breezy manner, has proved himself a valuable friend to the whole movement by his breezy ventiliation of so many important points. The Conference is indebted also to the Chairman this afternoon, the late Secretary of State for Air. He is one of the busiest men in the Kingdom, and bears upon his shoulders business propositions and probably business difficulties of tremendous magnitude, but such is his belief in the movement that he has sacrified two days to come and give us here his constant attention and his enthusiastic support.

In this connection I would like to mention to you that I have to make the regrets and apologies for absence of two other ex-Ministers of the Air Ministry, both of whom would have been here but for the fact that Parliament called them to Westminster—Lord Londonderry, the late Under-Secretary for Air, and also General Seely. They both ask me to convey to the Conference their apologies for non-attendance.

Before coming to the two or three points to which I have undertaken to reply, I want also the Conference to be appreciative of the immense difficulties under which the Controller-General of Civil Aviation has laboured since the last Conference. The amount of effort, time and trouble that he has put into a work which he has been forced to see dwindling under his very hand is very great—dwindling through no fault of his own, but

simply dwindling from the fact that from every side, quite apart from the famous "axe" which you see depicted in the picture papers every day, we are being urged and forced to contract. On that point I would like those interested in this movement to know that during the last four months the Ministry has been engaged in a life and death struggle, and wrapped up in the life of the Ministry is the life of civil aviation. Those of you who read of the economic difficulties from which the country is suffering—and I know most of you do so very closely—will appreciate from whence our attacks have come. We are the "baby" of the Services, and there is the elder generation who would destroy us root and branch if we did not fight to keep our end up.

It is upon the scientific and technical side of our movement that we depend for our existence, and therefore when we get a Conference of this kind it rejoices me to hear and to see how complicated are the subjects which are in the minds of those who support the movement and upon which the life of the Ministry depends, because no one has the courage to say that the Air Ministry and all that aerial development may mean both in war and in peace, can be put on one side, or can be placed in a position from whence there is a risk that it may not continue to maintain its premier position in the world. I mention that only to indicate to you the difficulties under which we have suffered financially in the last four months.

Coming more particularly to the point which the Conference has shown is somewhat at issue between myself and subsequent speakers, without departing one iota from the point of view which I have taken up and which I tried to explain, I would like to add one or two additional sentences. It turns, I gather, chiefly on the expression that the prospects of commercial success in aeroplane services in Britain and in Europe are not in my opinion likely to achieve great success in the near future. Taken by itself, out of its context, I can quite understand that sentence is liable to some misinterpretation. I do not deny that it is my opinion. I should be as ready as anyone to see it disproved. But the real significance is the comparison with the fields of enterprise to which we might devote our efforts, the question being whether we should with expectations of commercial success devote our enterprise to a European effort or to an Imperial effort; and it is in that direct alternative that I submit it is necessary to keep up a cross-Channel service. You have noticed that we have succeeded in obtaining from the Treasury a sufficient subsidy to make it a success. I consider that if that is proved to be a success—apart from a commercial success, a flying success —we should without delay transfer our efforts, our brains and our capital to the development of our Imperial air communications. Taken in that form I think it means a great deal more than the limited interpretation that has been put upon it by some in this Conference.

Now, I said one word about economy. If it hits us hard on aeroplanes, it hits us harder still on airships, and the point raised a few minutes ago by a speaker gives me the opportunity of replying. I said that I thought that the trade recovery necessary to carry airships, which in the first instance, until proved, are bound to be a commercial luxury, is remote; it is a matter of many years; and if we try by means of a subsidy to support such an experimental service over a great many years—over seven, eight or ten years—it would cost us just as much as if we started *de novo* when the better times come. The loss of the staff is deplorable, but I am doing my utmost by one means and another to preserve such of the pivotal factors of the designing staff as is possible by finding them work in other places.

To return to the more general subject, the Conference has from many sides of the hall called upon the Ministry to do more, one way or another. Would they devote the same amount of attention and the same amount of energy to calling upon the British Public to do more? You are speaking to the converted when you are speaking to the Air Ministry. There is not a man in the Ministry who is not a daily and hourly enthusiast in this cause, and we cannot do more on the money we have got than what we are doing. If you could use the energy and effort that you have put into your thoughts on this occasion, to popularise the subject with the British Public our problem is solved. Money comes from them; it is better that it should come voluntarily than in the form of taxes, and I feel that I shall get more support outside than perhaps I get in this room in making that suggestion to you. Public support is essential. The advertisement of our movement, of course, is vital. No good business is run, or can be run with success, without a reasonable, but not exaggerated, advertisement. That I think we try to do without trespassing upon the fringe of vulgarity. We in the Ministry I assure you, thank you all very much for having come, for having spoken so freely, and for having given us so much counsel and friendly advice. We will get the report published before the 1st April if we can collect it together in time, and we hope that the next Conference will find us in happier times.

The CHAIRMAN: Gentlemen, before declaring the Conference closed, I think you will agree with me as to two duties we have still to discharge. The first is to express our appreciation of the support and encouragement extended to the work of the Conference by the Press. We owe them our thanks for their help in making our proceedings widely known. Then next I have to ask you to extend to the Lord Mayor and the Corporation of the City of London our great appreciation of the help and assistance they have extended to us by enabling us to have the use of this magnificent chamber for our Conference. We are deeply indebted to them, and I ask you to pass them a very hearty vote of thanks (Carried.)

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