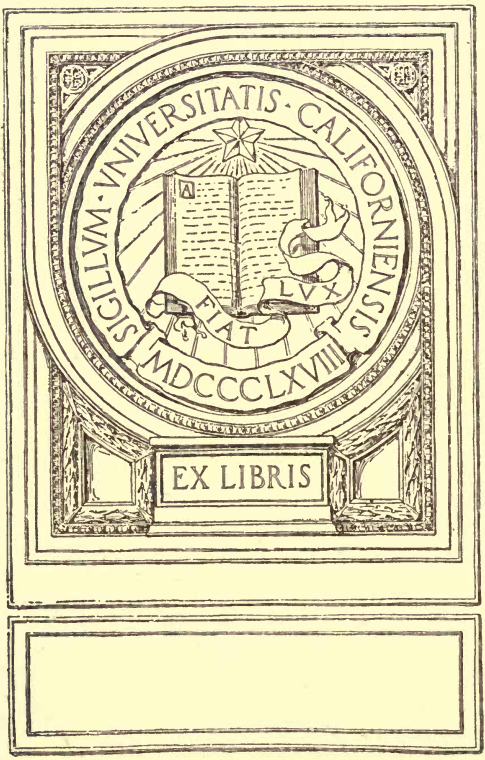
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OUR FIRST AIRWAYS

BY THE SAME AUTHORS

THE STORY OF THE AEROPLANE

THE AEROPLANE; PAST, PRESENT, AND FUTURE

HEROES OF THE AIR

WITH THE AIRMEN

THE AEROPLANE IN WAR

AVIATION

THE AIR KING'S TREASURE

THE AEROPLANE

AIRCRAFT IN THE GREAT WAR

HEROES OF THE FLYING CORPS

LEARNING TO FLY

THE INVISIBLE WARPLANE

AIR POWER, ETC.

Photo by Elliott & Fry

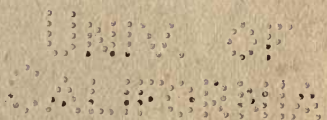
CLAUDE GRAHAME-WHITE

OUR FIRST AIRWAYS

THEIR ORGANIZATION, EQUIPMENT, AND FINANCE

By CLAUDE GRAHAME-WHITE
AND HARRY HARPER . . . .

WITH ELEVEN SPECIAL ILLUSTRATIONS BY
MR. GEOFFREY WATSON.



LONDON: JOHN LANE, THE BODLEY HEAD
NEW YORK: JOHN LANE COMPANY MCMXIX

WILLIAM CLOWES AND SONS, LIMITED, LONDON AND BECCLES, ENGLAND

INTRODUCTION

THE aircraft industry, now and in the future, must receive not only the financial support of the Government, but also the moral support and encouragement of the entire nation.

No cry for retrenchment, however desirable in other directions, must be allowed to retard the progress of aeronautics.

Money spent on aircraft is a form of national insurance—an insurance against our peril should some enemy, attacking us by air, endeavour to strike a blow so sudden and so paralysing that the whole nation, crippled and disorganized, would be compelled to sue for an immediate peace.

The same energy, determination, and

grit which Britons everywhere have put into the titanic struggle that has ended in a victory so glorious for our arms, must now be devoted to securing, and then maintaining, the aerial strength and power on which the future safety of our Empire will most assuredly depend.

Aeronautics is, indeed, a subject which is something very much more than merely commercial. It is not only national but also Imperial; and it is something even more than both of these: it is a subject which affects the development, happiness, and peace of the entire world. When, with the growing speed of aerial transport, a business man will be able to dine in New York one evening and in London the next; when no part of the earth's surface, however remote, is more than a week's journey away from London by air, then we may surely say that the coming of this aerial age —at the dawn of which we now stand— will do more for the world than any other

invention or discovery man has ever made.

What we must contemplate is that the whole of the high-speed traffic of the world will be transferred gradually from land and sea to air. This is no longer a novelist's dream: it is a change which will now come about within a definite period of years; and just how long this will be depends mainly on the initiative of the public in making use of the aerial services which we shall now so soon be organizing.

Our main task, in the immediate future, is to accustom people to the idea that when they are called on to make an urgent journey, or when they wish to send an important letter or parcel, an aerial service, in preference to the railway service, is now at their disposal. We want to make people think about these new air services; to envisage what they really mean. We want them to become familiar in their minds with the idea of travelling by air,

just as they are familiar with the idea of travelling in a motor-car or train. And here the Press, if it will do so, can help us very greatly. By keeping commercial and pleasure-flying constantly before the public, and by showing people how safe and practical it has become, the newspapers can render our movement the greatest possible assistance; and we are not likely to appeal to them in vain. Prominent men, also, can help the movement very materially if they will now begin to use the aeroplane as a vehicle when they require to make an urgent journey. Mr. Bonar Law, among others, has set an admirable example in this respect by flying to France and back to attend the deliberations preceding the armistice, and also by using the aeroplane to visit his constituency. It is gratifying also to find that business houses, as well as private individuals, are already beginning to place orders for machines which are to

be used for rapid journeys or pleasure flights.

The spirit of reconstruction with which we enter on the era of peace now dawning, the desire to make the fullest use of our time, to scrap old, outworn ideas and welcome new ones, will help very greatly in the development of commercial flying. The whole atmosphere is propitious. Time is money; and with huge tasks now facing us, and with every minute meaning more to us than it ever did before, we shall find people only too ready to travel from London to Paris in two-and-a-half or three hours by air, instead of spending seven or eight on the journey by land and sea; to say nothing of the discomforts of a bad sea crossing, which is dreaded so greatly by many travellers.

Here we are confronted, however, by three questions which we are so often asked. These are:—

(1) Can an air service be made safe?

(2) Can it be made reliable?

(3) Can it be made to pay?

These are the essential questions, and all we ask is that readers should approach them with an open mind. They should bear in mind what has been accomplished in aeronautics within a comparatively few years. It was only eight years ago that we were told repeatedly that it would never be possible to fly an aeroplane in bad weather; while a good deal more recently even than that it was contended that an aeroplane, owing to its frailness and alleged unreliability, would never play any really useful part in war. Well, facts can speak for themselves, now, in both these respects. Aeroplanes fly quite safely even through gales of wind. They have just exercised a vitally important influence on the greatest war in history; and when we describe, as we shall in this book, the vastly important part they are now to play in developing the commerce of the world, we think that,

on the actual achievements which aeronautics now has to its credit, we are fully entitled to an attentive and open-minded hearing.

The aeroplane is the fastest vehicle in the world, and is likely to remain so; the air is our ideal speedway. But speed alone is not enough. If it cannot be combined with safety, and with an ability to fly regularly to a daily time-table, then the use of the air will always be irregular, and air services will be unable to compete with other methods of transport. Nor must we ignore the important question of finance. The operation of an airway must be commercially sound: in short, it must be made to pay.

Another matter of extreme importance is this: we in the aircraft industry desire to start commercial flying with the fewest possible restrictions so far as the law is concerned, because we foresee quite well how rules and regulations might, if

they were burdensome, retard progress. But when we ask for such freedom, and for confidence to be shown us, we on our part must recognize our serious duty towards the public. We must not only carry in safety the people who travel by air, but we must do everything in our power to prevent the use of the air being a danger or an annoyance to those who occupy the land over which our aerial routes will pass. In war-time everybody has been willing to take a lenient view of any invasion of their property by a suddenly-descending aircraft, but now when private purchasers buy machines, and wish to use them as they would a motor-car, it will be very necessary for us to prevent any friction between those who use the air and those who remain on the ground.

In a compulsory descent, made suddenly on private land, we must be prepared to face the fact that damage might be done.

During the war, in fact, a number of such cases have occurred; and it would be a thousand pities if in the early days of commercial and pleasure-flying the public attitude showed any tendency to become hostile. How, mainly by organization and by forethought, this risk may be avoided, it will be one of our main purposes in this book to explain.

CLAUDE GRAHAME-WHITE.
HARRY HARPER.

LONDON,
February, 1919.

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LIST OF ILLUSTRATIONS

By Mr. Geoffrey Watson

NOTE.—The pictures showing commercial and pleasure-type machines were produced by Mr. Watson from drawings prepared by the designing staff of the Grahame-White Company.

OUR FIRST AIRWAYS

PART ONE

CAN AN AIR SERVICE BE MADE SAFE?

I

WE shall have multi-engined aircraft, immediately, which will carry twenty or thirty passengers from London to Paris in less than three hours, as compared with seven or eight by land and sea; and the passengers who travel by air will not only do so in perfect comfort, but will be spared the inconvenience of changing from train to boat, and also the ordeal of the sea-crossing, which is often so unpleasant. In regard to such aircraft as we have mentioned, there is now no question of uncertainty or doubt; they can be made available now for a passenger service as soon as this is authorised by the Air Ministry, which has adopted the very wise attitude that, until an adequate

organisation has been prepared, and conditions generally are favourable, it would be unwise to embark upon public services by air.

From machines carrying twenty or thirty passengers we shall progress to those which will accommodate fifty and a hundred. It is perfectly feasible, now, to ensure the comfort of passengers. They will be seated in enclosed saloons, protected completely from any rush of wind; and the motors which drive the machines will be so silenced, and so isolated from the saloons, that nothing but a low drone, which will be the combined sound of motors, propellers, and a rush of air, will reach the passengers' ears. Space will be provided also in which they can move about, should they desire at any time to leave their seats; while from observation windows they will be able to look down, whenever they care to do so, on a wide panorama of land or water, according

to the position of the machine in its relation to the earth.

All this is not only possible, but is now to become an accomplished fact. A London-Paris route, or a New York-Chicago route, will merely be two out of many. The whole of Europe, the vast territory of America, and by degrees the entire world, will be covered by a network of aerial ways; while air speeds will so increase that before long we shall have commercial craft which will attain, and exceed, a rate of 200 miles an hour. The "air age," foreseen for centuries by men of imagination, will at last dawn upon the world.

II

Under the stimulus of four-and-a-half years of war, the aircraft industry has made more progress than it would have done in twenty years of peace; and it should be

consoling and encouraging to us to remember that these wonderful weapons, which have carried destruction for hundreds of miles, can in the days of peace be converted just as readily to the constructive and useful task of quickening the world's communications, and enabling us the more speedily to repair the damage which has been caused by war.

In this respect, truly, the aircraft industry is in a unique position. Born, one may say, under the stress of war—because there was practically no industry, at any rate in this country, before the war—it will carry all the weight of its experience, all the value of the lessons learned, into those splendid days of peace towards which the eyes of the world are now directed. The warship is a warship, even in days of peace; and the millions we have spent on shells, guns, and the whole vast impedimenta of land warfare, are little better than so many millions thrown into the sea once

hostilities have ceased. But several types of aircraft we have used in the war may be converted at once, and at no great cost, to purely commercial work. The big bomber, for example, with certain alterations in its fuselage, and in other minor directions, may be turned into a passenger or goods-carrying craft; though, of course, it will not be so efficient as a machine built specially for commercial purposes. The high-speed fighter or scout can, with small modifications, be used in an express mail service. There are other war machines, also, which can be put to commercial use. Therefore the money we have expended on war aircraft is far indeed from being wasted; and this quite apart, of course, from the immense importance of the purely military work on which the machines have been engaged.

With the war over, we not only have service machines which can be used immediately for peaceful tasks, but we have

something else which will be more valuable even than this. We have a vast amount of data, as to the use of aircraft under the most exacting conditions, which, though it is true that it is war data, will be invaluable all the same, when it is collated, to the designer of a purely commercial machine. It should be the policy of the Air Ministry, therefore, bearing this important point in mind, to make readily accessible to the industry all this mine of knowledge which now exists, not only in regard to aircraft, but also as to their piloting. The severe strains of war flying, not only on pilots but on machines, should indeed provide us with data which will be of the utmost possible service.

The design of a war machine, which is expected to climb rapidly, to travel extremely fast, and to fly for long distances without alighting, and to carry at the same time a heavy load of fuel, instruments, guns, and bombs, is a far more difficult

task than the design of a commercial machine, which will not be required to climb fast, which will effect a reasonable compromise between the speed attained and the load carried, and which will not, as a rule, require an excessive weight of fuel, seeing that on many commercial routes a descent will be made after a few hours' flying, not so much on account of the machine as for the comfort of passengers, who, at first, at any rate, will not desire to remain in a craft for many hours on end. This being so, the success of the designer of commercial craft should be appreciably greater than that of the designer of war machines; and, as the designers of war machines have already done far more than some experts thought they would ever be able to do, it is safe to assume that the progress made with commercial craft will be very surprising and very significant, more especially to those who still pose as sceptics.

III

Apart, however, from speculations as to the future, and reckoning only the machines we shall actually have, it will be possible, as we have shown, to carry passengers at more than twice the speed of an express train; and it will be possible in addition to carry urgent letters, or light express goods, at approximately three times the speed that is possible by train. And such speeds, even when they are attained, represent no more than a quite moderate performance. Scientific opinion, as expressed in the light of knowledge which has been gained during the war, sees no reason, now, why a speed through the air as great as 240 miles an hour should not be attained, and this merely by a reasonably simple development of existing-type craft: and when this speed has been reached, and we are passing through the air at the rate of four miles a minute, it should be possible

to effect improvements in wing construction, to which we shall refer later, which may quite conceivably lead to increases up to as great a speed as 300 miles an hour. When we reach these days, and they may not be far distant, the business men of New York and London will be separated not by a journey of days, but merely of hours.

It is not our intention though, here, to carry the reader into realms of imagination, but to ask him rather to consider those readily accessible craft which we shall be despatching immediately on mail and passenger flights. The obvious interest of the ordinary citizen in commercial flying is as to what benefits it may bring him personally, either in business or as a vehicle for pleasure. Of course if he is a thoughtful citizen he will recognise that there is another and an even greater aspect of the development of flight; the aspect which proves that it will be imperative for us,

if we are to retain our position as a great world-power, and sleep securely in our beds at night, to take our rightful place upon the highways of the air. But for the moment we prefer to deal with strictly commercial aspects, and to regard matters from the point of view of the business man.

There will, as we have suggested, be two main users of the air, those who fly for business and those who fly for pleasure; and it is with the first we shall now concern ourselves. It is clear, of course, that no business men at all would be induced to leave the earth, and take to the air, unless some very definite advantage could be offered them—an advantage they could not gain in any other form of travel. And the advantage of airways, when in competition with railways, will obviously be their greater speed. This should always remain so. Even with accelerations in railway transit, such as may now be expected, the airway should always be

considerably faster than the railway; and this superiority, clear as it will be even with the first air services, should grow more marked as time goes on, and as air speeds continue to increase. There is, of course, electrical traction, combined perhaps with the use of mono-rail tracks, which may offer considerable accelerations in land speed. But even assuming that the speed of an express train can be increased from 50 miles an hour to 100, it may be taken for granted that, by the time any such improvement has been effected, the speed of the airways will have been more than doubled, and that passengers will be carried by air at a rate of 200 miles an hour.

That the public demand greater speed is proved again and again by the patronage which is extended instantly to any land or sea route which can offer some new advantage in time-saving, as compared with the performance of its rivals. This demand, sufficiently keen before the war, and

leading as it did to railway races, and the fierce competition of Atlantic transport lines, should now be even more insistent, because the world will be busy with schemes of reconstruction, and there will be so much high-pressure work to be done that the axiom "time is money" will have a significance even greater than was the case in former days. The man of affairs, with many business interests to supervise, who strives to crowd a maximum of his own personal work into any given period of time, welcomes always the extra hour he may gain by travelling the quickest way; and if, when he wants to go from London to Paris, he finds he can get there in three hours by air, saving a clear four hours over land and sea transit, then he should most certainly be ready to go by airway and pay a special fare for the privilege of doing so—provided he feels sure he will be carried with safety.

IV

Here one reaches the crux of the question. If one were to write for hours, or talk for days, one would come back inevitably to this fundamental question: "Can flying be made safe?" On the answer rests the whole future of commercial aeronautics. Speed alone will not be sufficient. Airways must be capable of being operated with reasonable safety; and, as a point of almost equal importance to the business world, they will require also to be operated reliably. Before a regular stream of land traffic can be diverted from earth to air these two questions will have to be answered satisfactorily; and not merely in the form of written words, but in the actual records of the first services. These air services must, in a word, show not only that they can carry passengers safely, but that they can adhere to their time-tables for a large number of days in

the year, and that business men who start by air say from London to Paris may reckon they are as reasonably certain to reach their destination, at the time specified, as they would be if they travelled by land and sea.

Though many people refuse to believe that an air service can be conducted safely until this has been proved by the daily records of an actual service, there are many others, we hope, who, while reserving judgment to a certain extent, are at the same time sufficiently interested to wish to be told how, by the careful organization of an airway, it will be possible to give aerial travelling just as much safety as when travelling by land or sea. Such readers we now address.

It would be an injustice, in the first place, to form the opinion that flying is unsafe, and always must remain so, merely on the records of what has been done up to the present day; and for the simple reason

that flying has not yet been organized, and that no regular commercial routes have yet been opened up. One should remember, too, when instancing railways, and the safety they have attained, that it has been organization, combined with experience, and improvements in construction and operation, which have given them this high factor of safety. The same applies to sea travelling, or any other form of locomotion; and it will be the same in the air.

V

The mere fact that a machine is passing through the air, without any earth contact, introduces nowadays no particular element of danger. Provided the machine maintains forward speed—and inherent stability now ensures this—its planes have sufficient lift to maintain it in flight, and there is no possible fear of its falling; while as for risks arising say from sideslip, or the action of

violent wind-gusts, feared so greatly by the pioneers, it is now a fact that inherently stable machines, no matter what position they may be forced into, will themselves recover, and resume normal flight, without any intervention from the pilot.

The effect of adverse winds, when encountered by the large multi-engined machines we are now using, are relatively unimportant. Small boats are tossed about even by a moderate sea, but a large vessel will force its way through turbulent water with very little oscillation; and while the small, low-powered aeroplane of early days, with its lack of momentum, made very bad weather in a gusty wind, the larger modern-type machine will thrust through adverse gusts with scarcely a pitch or roll; and this even when conditions prevail which would have been declared impossible for flying only a few years ago. With the large commercial craft we shall soon use, their engines developing thousands of horse-power, the

effect even of a gale will show itself only in the time occupied by a flight, and will in no way imperil the machine.

Readers may ask why, if the safety of flying has become so great, they should have read so often lately of an aeroplane accident. The answer is simple. Evolutions have been made in the air, and purely warlike feats attempted, which have often involved pilots in considerable risk. These evolutions were necessary as long as we were at war, and pilots accepted them, philosophically, as a war risk; but they are unnecessary in commercial flying. In this direction alone, in the ceasing of dangerous manœuvres, there should be a marked reduction in the number of accidents recorded. In peace, also, when there is not the same urgent demand for pilots as in war, we can extend the period during which an aviator is being taught. He will acquire knowledge more gradually, and gain a greater actual experience, before

he attempts any important flight. And so he will be less likely, obviously, to make mistakes.

VI

It should be stated that even with craft which are automatically stable, capable practically of flying themselves when at a sufficient altitude, there still remain circumstances in which a pilot may come to grief, and in which he may wreck his machine, and perhaps lose his life. The greatest risk is always when a machine is very near the ground. If an error is made at a low altitude, the pilot may be unable to rectify it before he has come in heavy contact with the ground. Even with automatically stable craft, which will dive and recover their flying speed should a pilot have committed the error of "stalling" them—bringing them, that is to say, to a standstill in the air, and thus depriving their planes of sustaining power—a certain

clear air-space below them is required before they can re-establish lift; remembering always that lift is due solely to the forward movement of the plane, and fails directly a machine is deprived of this forward motion. The craft has, in effect, to dive forward and downward for a short distance, after being brought to a standstill, before it can restore this lift to its planes. If, therefore, a pilot should have "stalled" it near the ground, say by endeavouring to climb too fast, the machine may be unable to recover itself before it is in contact with the ground. The same may apply to other errors in pilotage, if they are made at very low altitudes. Should, however, they occur at anything like a reasonable height, then either the machine itself, or the pilot by his own exertions, will repair the error before there is any danger of striking the ground. But the risk is always there, and it may be a serious one should men be foolish enough

to attempt dangerous manœuvres at low altitudes; the risk, that is to say, of a machine which is flying near the ground passing suddenly out of control, through some error of its pilot, and, before control can be restored, coming into contact with the ground.

The continuance of this risk under peace conditions is the point with which we are most concerned. It may be said, at once, that a completely "fool-proof" aeroplane cannot be expected; the human element can never be wholly eliminated. A man who has been badly or hurriedly trained, or is incapable of taking precautions, will always be a menace to himself—and to others; but still it should be remembered at the same time that, even while aeronautics remain in their infancy, and assuming of course the use of a well-designed and properly-adjusted machine, travelling at a sufficient altitude, there is no more danger in flying than there is say

in motoring. This is no over-statement of the case: it is the literal truth. And as to the specific risk which arises from an error of judgment near the ground, we should be able materially to reduce this. The very carefully trained pilots we can now produce; the greater reliability we can impart to machines, and particularly to motors; and the even greater natural stability which can be given to aircraft now the demand for an extreme war performance no longer exists: these are among the factors which will ensure safety.

The public should not labour under the delusion that, even in abnormal war times, the risks of flying have been really great. Though accidents have been recorded frequently, it must be remembered that a very large number of machines are now in use; that they are numbered, indeed, in thousands rather than in fifties and hundreds—as they used to be. As a matter of fact, when one takes into account the

amount of daily flying which is now done, and when one realizes that hundreds of thousands of miles are now being travelled by air, the actual mishaps which take place, in comparison with the vast total distance which is flown in safety, makes it sufficiently clear that, when we have still better machines and more perfectly trained pilots, and when we have organized "airways" leading from point to point, it will be possible to reduce the risks of flying until they are no greater, and in some respects even less, than those of any other form of high-speed transit.

VII

We devote space to this question because it is one, as we have said, of outstanding importance. Not only must flying be made safe, but the mass of the people must assure themselves that it is safe, if we are to reap the full fruits of this great

conquest. It is essential also, in the early days of commercial flying, when the public will look critically upon this new form of travel, that there should be no heavy record of accidents. It is here that so much can be done by investigating carefully all accidents which do take place, and by eliminating promptly the defects, human or mechanical, which have been their cause. The Air Ministry has now a Committee which investigates very thoroughly all the accidents of a serious nature which befall Service craft. This is an extremely valuable work; and it should be interesting, and also instructive, before we turn from the question, to indicate quite briefly the principal causes of accident at the present time.

First comes engine failure. It is, records show, an engine failure which takes place when a machine is near the ground, and perhaps over bad country from the point of view of a forced landing, that

ends most often in a crash. Ordinarily, the failure of its engine while a machine is in flight implies merely that the pilot must glide to the ground; and if he can alight on anything like a suitable surface no harm at all is done. But it happens sometimes that a sudden failure takes place at a moment when the pilot is not in a position to reach any suitable spot. And if he comes down in a field which is too small, or on a very rough surface, he may either collide with some obstruction or his machine may be overturned. It may also happen that, should a motor stop suddenly, and disconcertingly, at a moment when a pilot is not sure of any safe alighting point, the mental shock will lead him to some error of judgment by which he minimizes whatever chance he may have had of coming safely to ground.

It is gratifying, in a sense, that the first and most fruitful cause of accident should be engine failure, because there is now

every promise of being able practically to eliminate this risk. Every day, one might almost say, the aero-engine is becoming more reliable; and as soon as we can reap the full benefit of war experience the prime mover of an aircraft should give no more trouble than that of a well-built motor-car.

VIII

It is now the intention—as we shall describe presently in detail—to have perfectly-equipped aerial routes, with chains of emergency alighting grounds so arranged that, provided a pilot is at a reasonable height, he will be able always to reach one or other of them in a glide, and so be absolutely certain, at any moment, of making a smooth landing on a properly-prepared surface.

That the cost of any such alighting grounds would be prohibitive, even on a long route, is not a valid objection. The

purely emergency ground will be merely a suitable field or fields, marked so that it can be seen from the air, and containing nothing more as a rule than a shed, a telephone box, a store of fuel under the care of an attendant, and an apparatus for night signalling or use in fog. At the present time it is reckoned that an emergency ground should be of about sixty acres in extent.

To a company intending to lay down an organized aerial route, several hundred of miles in length, and desiring to place an emergency ground at a distance of every ten miles, the actual expenditure involved, as indicated by its place in overhead charges, would add only a few pence a mile to the cost of running a service. The annual rental of an emergency ground should not, on an average, be more than about £120 a year, even in developed countries. So that even when one reckons upon the cost of these emergency grounds, as being

a wise and very necessary outlay, the actual amount expended upon an airway, as compared say with a railway, should be really very small indeed, and for the reason that aircraft, unlike trains or other surface vehicles, require no permanent-way.

Assuming the provision of emergency landing grounds—which it is now thought might quite reasonably be a Government undertaking—it is possible to say that accidents following engine failure, such as occur at the present time, would be almost completely obviated. Pilots would almost invariably make a safe landing; and it is in landing after engine failure, when no suitable place can be found, that the chief cause of accident is found to-day. It should not be forgotten, either, that with large passenger craft, driven by several motors, any case of a descent through engine failure should be rare, because, if a single unit failed, or even two, the machine would still continue in flight with its

remaining engines. There will, however, be single-motored mail craft, and also single-engined machines for touring and pleasure flying; and to these a chain of alighting grounds will, from the point of view of the security they offer, prove specially valuable. In night flying, also, which will be necessary in the carriage of mails, the existence of an organized route, which can be lighted suitably and thus act as a guide to the pilot, will be essential to a reliable service.

IX

A frequent cause of accidents, at the present time, is a pure error of judgment on the part of a pilot, with the result that a crash follows for which the machine itself cannot be blamed at all. Here, again, under peace conditions a much greater security should be obtained. Instead of producing pilots under conditions of high pressure, it should be possible to organize,

and operate under the best conditions, a scheme of instruction which will ensure that every man who takes a certificate of proficiency is really competent in the broadest sense, having been through a period of cross-country flying, and knowing perfectly well what to do should an emergency arise. By the utmost care in tuition, and by making sure that men who are unsuitable are not allowed to qualify as pilots, it should now be feasible to reduce to very small proportions indeed the risk of an accident taking place through any mistake, or rash action, on the part of a pilot.

Every day, we must bear in mind, men are more accustomed to navigate the air. And the men who are becoming familiar with this newly-entered medium, through their constant navigation of it, are imparting their knowledge to those who follow them, and this all tends, naturally, to a greater safety.

X

Another cause of accident lies in the faulty design or construction of a machine, with a consequent breakage while in flight. Here, though, one has a risk which is enormously less than it was a few years ago; and it should be reduced until it is almost non-existent now we have reached the days of peace flying. There exists already a sufficient knowledge of construction, and sufficient experience on which to draw, to ensure that with the use of suitable materials, and with a proper care in their assemblage, an aircraft should be no more likely to collapse than any other vehicle. Even under the abnormal conditions of war, which subject craft to enormously heavy strains, it is possible to maintain a high factor of structural strength; and in peace flying, when commercial machines are subjected only to

what one may call reasonable strains, and with high-grade steels entering more into processes of manufacture, there is every ground for stating that the collapse of any part of a machine in flight, thereby causing an accident, will be encountered so rarely that it will become a risk that is negligible.

Apart from such principal risks of flying, as they stand revealed to-day, there are several other minor causes of mishap. One lies in the sometimes dangerous manœuvres which pilots have had to make when training for war service. This, however, as we have already suggested, is a risk which will be eliminated in peace flying, at any rate among civilian pilots.

Another danger is found in abnormal weather conditions; a pilot may be caught, that is to say, in mist, rain, fog, or low-lying clouds, and a bad landing may result; or he may encounter a violent disturbance, or find himself suddenly in a dangerous

trend of wind, when he is flying quite close to the ground.

This introduces a subject which is now realized to be vastly important, that of the study of meteorology as it affects aerial navigation. Much has been done during the war, but very much more should now be possible. The main object must be to have a complete system of meteorological stations, not only along the line of the main flying routes, but also at suitable points on either side of them, the aim being that the weather should be forecasted so accurately, for any given route and time, that a pilot before starting will know exactly what conditions he is likely to encounter, and will be able to avoid areas in which the weather is bad. In connection with long flights, such as the trans-Atlantic, where prevailing winds may either help or hinder navigation, according to the course steered and the height attained, a study of the meteorology of the upper

air has become most necessary; while there are other questions, as to the existence at certain times of abnormal conditions, which also need investigation. The main fact, however, which already emerges, and which should be strongly emphasized, is that an efficient and well-financed service of meteorology, working solely in the interests of commercial flying, will add very greatly not only to the reliability of any service, but also to its safety; and the establishment and maintenance of such a service would be one of the directions in which State assistance would be of extreme value.

Another minor cause of accident, but a peculiarly distressing one, is the outbreak of fire on a machine. This risk, due to the ignition of petrol, takes place sometimes in the air, but more often as a rule after a machine has been damaged in a bad landing. It is a risk which is now being studied most carefully, and, under the improved conditions of peace, it should be possible to

reduce it very greatly. It is most desirable to keep the main petrol supply well clear of any of the heated parts of a motor, and also as far as possible from the magneto. It is necessary, also, that exhaust pipes should be clear of petrol pipes, and that the exhaust discharge should be arranged in such a way that a spark cannot set fire to any petrol vapour which may be coming from exits or leakages. In other ways, too, though their technicality precludes mentioning them here, the risks of fire in commercial or pleasure machines should be so minimized that they are almost non-existent.

One other type of accident needs mention—that which is caused by the sudden illness of a pilot when he is in charge of a machine. He may lose consciousness, perhaps through being in bad health, or over-fatigued, while undergoing the strain of piloting a fast war machine. War flying has imposed a very much greater strain, naturally, than will flying in times of peace,

but it will be necessary, always, and more especially with pilots of public service craft, to make certain that a man is fit, physically and temperamentally, before he is given charge of a machine. Medical attention is being directed to the effect on a pilot of ascending rapidly to high altitudes, and then perhaps descending again with equal rapidity. Such organic strains, though they must be incurred in war, will not be necessary in civil flying. Moderate flying heights will, as a rule, be most suitable, and also most pleasant; and in comfortable machines, moving at a reasonable altitude and speed, the physical effect of flying, on either pilot or passengers, should be exhilarating rather than in any way harmful. The pure air one breathes, when thousands of feet high in an aeroplane, has all the invigoration of a climb to a mountain-top. Touring by air, as compared with touring by motor-car, is infinitely more enjoyable, because in the air the tourist is free from

the dust and heat of roads and from the vibration which is inevitable with any vehicle travelling on land, but which is so surprisingly and delightfully absent from the movement of an aeroplane.

XI

We have dealt at an early stage with the question of safety, because it lies at the root of the whole problem; and the review we have made of present-day risks, and our comments on them, may we hope lead a reader to view this general question as it should be viewed, and not to do flying the injustice of assuming, before organization has been applied to it, that it possesses forms of danger which are irremediable. Emphatically, it does not. The modern aeroplane is supported by its wings, when in the air, just as surely as a train on its metals. Its design is now so scientific, so certain, that there is practically no risk at all, while it is in flight,

of any abrupt fall to the earth through a loss of balance or control. Scientifically-designed machines, with stability which is inherent, may be compared to a lifeboat in their power to recover from any and every abnormal position into which they may be forced. An inherently stable machine, if taken to a height in the air, and then launched upside-down, would turn over automatically, and glide down right-side-up. If, when piloting it, you tried to bring it to a standstill in the air, and so cause it to fall by taking away the support of its planes, it would tilt its bow downward, again automatically, and begin at once a dive which would restore its flying speed.

We have run a risk of labouring such points because the actual facts of flying to-day are so different from what people imagine them to be. Many onlookers, when they see an aeroplane in flight, imagine its occupant sitting at levers

which he must move constantly in order to keep his machine balanced. They look upon him, in fact, as a sort of aerial tight-rope walker, who may overbalance at any moment and crash to the ground. Such impressions are completely wide of the mark. With an inherently-stable machine, once you have taken it to the required altitude, it is quite possible, without any risk at all, to lock the controls and let the machine fly itself; which it will do for as long as you desire, righting itself automatically should it be tilted sideways by a gust, and maintaining perfect stability, also, in a fore-and-aft direction. A touch on the rudder occasionally, to keep the machine on its course, is all the human assistance it requires, and there is not even a remote chance of the machine losing its balance suddenly and falling. Its stability is absolutely automatic, absolutely perfect, depending not on mechanism which may get out of order, but on the design and

position, in their relation to the air, of its supporting, controlling, and stabilizing surfaces. When one pictures a large machine built on such lines, weighing with its load as much as ten tons, and being driven through the air in perfect safety at a speed of 100 miles an hour, and when one remembers in addition that flying is still at the dawn of its real development, one should be willing to concede that the future now has possibilities so great that they are practically illimitable.

XII

Our concern, however, is with the immediate questions which arise in the establishment and operation of the first air services. We know, now, that such services are in process of organization. We know, too, that we shall have the pilots and machines required. And so one returns inevitably to the three prime questions—

"Will such services be safe?" "Will they be reliable?" "Will they pay?"

On safety we have dwelt carefully, seeking to remove from a reader's mind the almost inevitable prejudice which must exist against a new form of travel that is conducted not by the known and familiar mediums of land and water, but which passes high through the air. There is, in many minds, the same timorous feeling as to man's invasion of this new element as there was in those far-off days when men first ventured on the sea, and when a crossing of oceans, now undertaken as a matter of course, would have appeared an adventure too desperate even to be thought of. Yet sea travel has been made so safe, at normal times, that men feel as free from anxiety in a large steamship as they would in an hotel on land. And as an organization is created, and experience gained, travel by air will be made as safe as travel by sea, and people will cross above an

ocean with just as little thought of danger as they would if they were moving on its surface. Familiarity with aerial travel, such as we shall have now that peace has come, will produce a change in our mental outlook. The old picture of a lonely airman, balanced perilously in an element which he was foolish to invade, will give place to a picture of the large multi-engined craft, cleaving its way through the air with a swiftness, dependability, and absence from danger, which will make it the ideal machine for high-speed travel.

PART TWO

CAN AN AIR SERVICE BE MADE RELIABLE?

I

NOW, having gone so far, we come face-to-face with the question whether, granted that an air service can be conducted safely, it can also be operated with regularity. From the point of view of the Post Office, which will now desire to send by air any mail-matter which is specially urgent, this question of dependability is obviously most important. The essence of the contract, in carrying mails, is that they should be carried reliably, and that business should not be jeopardized by the delay or non-arrival of important letters.

It is no secret, now, that an official decision has been made, as between ourselves and the French, to institute a mail-service between London and Paris

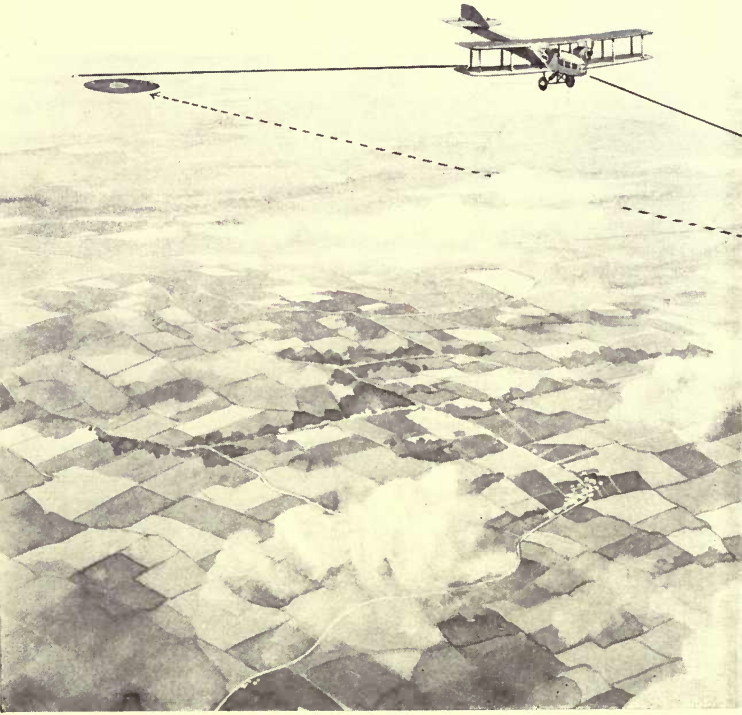
immediately pilots and machines can be spared for the purpose, and a suitable ground organization prepared. It is hoped, also, to continue the route from Paris to Rome, and other great continental cities. If, for example, mails could be carried by air from London to Italy, instead of by land and water, their delivery could be expedited to the extent of a whole day, which would be of extreme value from a business point of view. To obtain the full advantage from such a service, however, night flying would be entailed; therefore the organisation, and particularly the lighting of the route, would be of great importance. For mail-carrying, in fact, a large amount of night flying must be contemplated; but there is no reason, given organization, why it should not be carried out successfully. At night the conditions atmospherically are usually more suitable for flying than by day, while the actual navigation of machines, and the prevention of errors in

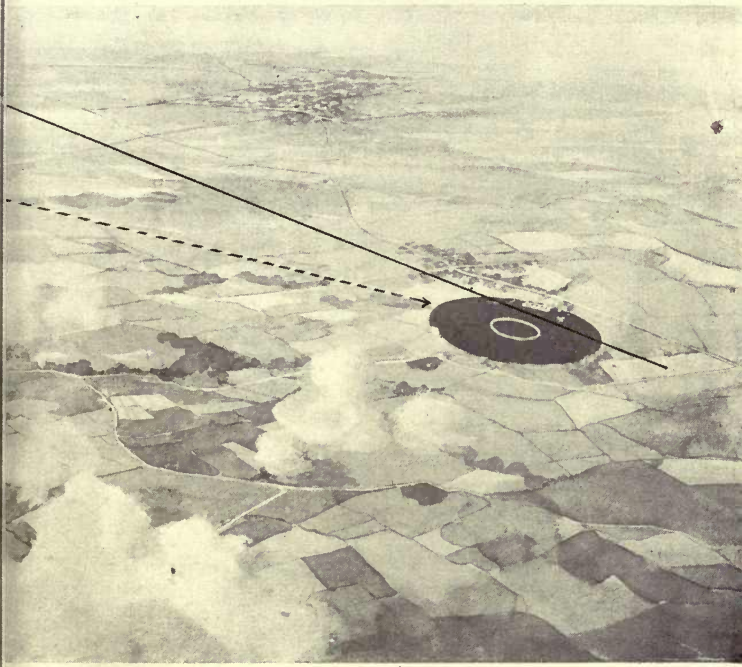
steering, should offer no difficulties that organization cannot remove; particularly when we remember the enormous advantage now conferred by the development of directional wireless.

II

Once a prepared route is in existence the rest becomes a matter of organization and of experience. We will assume that a direct London-Paris airway has been surveyed—a task which must be undertaken by air as well as by land—and that emergency alighting grounds have been provided at intervals of ten miles on both the English and French sections. It may be asked why such a specific distance as ten miles should be chosen as the distance separating the landing grounds. The answer is given, graphically, in the illustration which will be found overleaf. Here you see two emergency grounds. Exactly midway

between them is an aeroplane. This machine we calculate to have a gliding angle of one in six. That is to say, when its motor stops, and it has to use the force of gravity to maintain it in forward motion, it will move forward six feet for every foot it descends. When he is flying such a machine, therefore, a pilot will maintain a height of about 4000 or 5000 feet in order to be certain of reaching a landing ground, even if his motor stops when he is exactly midway between two grounds. It may be asked why, if machines are used which have several motors, and breakdown is unlikely, it should be necessary to make an elaborate provision for forced landings. The answer is that many single-motored machines will be flown over such a route. There will develop, for example, a specialised form of express mail service, in which the machines used will be speed-craft pure and simple. They will contain only one man, the pilot, who will carry a small bag of





GV LANDING GROUNDS

mails, weighing perhaps 100 lbs., and containing only letters for which a high fee has been paid. With such a machine—a suggested design for which will be found facing page 54—if a chain of landing grounds is in existence on the route over which it flies, this fact alone will affect its whole design. Here, although one verges on technicality, a simple explanation is still possible. These machines, flying probably at a rate of 170 miles an hour, will require to make their contact with the ground, on alighting, at a comparatively high speed. Their wing surface, that is to say, will be so small that it will not support them unless they are gliding fast.[1] If, therefore, such a machine has engine failure, and a forced descent is necessary, the risk of the machine overturning, or of running into some

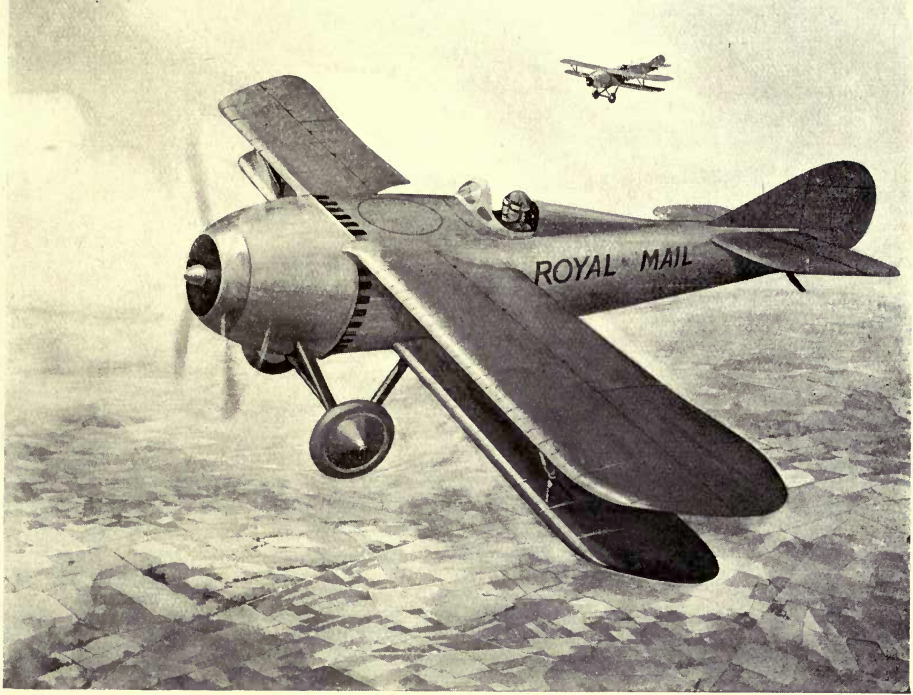
[1] By fitting various forms of air brakes, operated by the pilot, it should be possible to reduce, to quite an appreciable extent, the speed at which such machines make their contact with the ground.

obstruction, is likely to be considerable when the pilot has to choose some point quite haphazard, and in a hurry, and do the best he can to alight on it safely. But if he is flying along an organised route, with a smooth-surfaced ground always within reach, then even if engine failure does bring him down, he will be practically sure of a safe landing, and of not damaging either himself or his machine. The existence, therefore, of an established route, with landing facilities everywhere, will permit the use of craft with high alighting speeds, such as it would be unreasonable to employ were no prepared grounds available.

Here, also, one reaches an important fact. The Italians, who have the distinction of being pioneers in this field, established early in the war a chain of emergency grounds, approximately ten miles apart, between their manufacturing centres and headquarters at the front. These grounds

were merely large fields, each bearing a distinguishing mark in whitened stones, and with a boy scout stationed on it who could carry messages for any airman who might descend. Along these routes the Italians sent each new aeroplane as it was ready for delivery to the front; and the value of the landing grounds was so clearly proved that it was found, even in the first year, they had more than paid for themselves by saving the breakage of machines which had to descend involuntarily. The pilot who had engine trouble simply made his landing on the nearest alighting ground, obtained assistance if he needed it, and was quickly in flight again, with no damage at all done. Aerial transport companies should, as a matter of fact, regard the landing-ground system as a form of insurance; it is one which should pay for itself quickly in the saving of damage to machines, quite apart from the safety which it would provide for human life.

Emergency landing grounds will be specially valuable in saving delay on an express air-mail service, should any craft descend through engine failure. Each of these grounds will be numbered; and it will also, as we have mentioned, have a telephone; while here and there, at suitable points along a route, relief machines will be stationed, with their pilots ready to take the air. Therefore, should a machine which is carrying mails have to descend before its journey is completed, its pilot will bring it down on the nearest emergency ground, and will telephone at once to a relief point, stating that he has just descended on ground number so-and-so. Whereupon a relief machine will be quickly on the spot, the mail-bag will be transferred to it, and it will continue the flight. If there were not such a system of landing grounds, a pilot might be forced to descend, involuntarily, at a point miles from the nearest telephone; with the result that



AN EXPRESS MAIL MACHINE

there would be a long delay before he could get a message through describing what had happened to him, and an even longer delay before the pilot of a relief machine had found the exact point where he had descended. It might even be found impossible for the relief pilot to alight in the same field in which the first machine had descended; and this would mean a further delay in the transference of the mails. From whatever point of view one regards the question, in fact, the provision of a chain of landing grounds, each of them numbered and connected by telephone, appears vital to the operation, on anything like a commercial or reliable scale, of the first air services. Without them, in the case either of mails or passengers, one would be in the position of just sending off a pilot across country, without organization or prevision, and if he made a forced landing at any spot which was not readily accessible, there might be hours' delay;

whereas in a similar contingency, on organized routes, the delay should be very small indeed.

In the case of wide districts oversea, when aerial journeys have to be conducted over uninhabited country, and hundreds of miles have to be flown across land where there are no conveniences in the shape of telegraphs and telephones, the laying down of a proper route, with a chain of grounds connected by wire or 'phone, will be indispensable. No reasonably safe service could, in fact, be run without them. In a journey, for example, across some wide and very thinly populated territory, a pilot might have to descend, involuntarily, a long way from any point where he could communicate with his base; and this would cause delay, and perhaps even danger. It is not improbable that in very remote country, with hundreds of miles of forest-land over which flights had to be undertaken, that, in the absence of organization,

a machine might descend at some wild and inaccessible place, and never be heard of again. An organised route, desirable as we have shown it to be in developed countries, is likely indeed to be absolutely essential in large and undeveloped lands; and the cost of such an undertaking, even when carried out on the fullest scale, would be small when compared with the expense of laying a railway across a wide tract of undeveloped country. In clearing and preparing an alighting point for aircraft in the heart of forest land, or in precipitous or hilly country, a fairly considerable outlay might of course be involved; but this should be more than made up for by the low cost of establishing other grounds on an undeveloped stretch of country.

III

It is argued sometimes that an emergency landing ground system, which would

naturally entail expense, has now become almost unnecessary because of the reliability we can obtain even with machines driven by only one motor. It is also argued that it is not wise to tie an air service down to one fixed route, like a railway. In doing so, it is stated, one robs it of the superiority which it possesses over a land service; of its ability, that is to say, to do without a permanent way, and fly by any route on which weather conditions happen to be most favourable. Personally, we think there is much in favour of this argument. We certainly should not envisage an air service as passing always along one fixed line of country. If we did so, and when the time comes for meteorology to tell us from day to day just those areas and altitudes where flying conditions are best, we should not be in a position to avail ourselves of such assistance, which will be of the utmost value.

This, however, to our minds, is no

argument for abandoning the principle that in the early days of commercial flying, and on main routes, we should have landing grounds so disposed that at any moment we are sure of making a safe descent. We must legislate not for the exceptional occasion but the general rule; and the general rule in commercial flying, when speed is everything, will—weather permitting—always be to go the shortest way. Therefore on the London-Paris route, to take a practical example, we think it will be found that traffic will, in the majority of cases, pass along a fixed and well-defined track.

We are not prepared to argue that we shall always want a ten-mile chain of landing grounds. Personally we think that we may not; but we agree heartily that we should have them to start with, and we are perfectly convinced that if we have them at all they should be arranged carefully on a well-devised scheme.

IV

The cost of establishing an airway, in remote and thinly-populated districts, would not only be far cheaper than a railway, but the comparatively small cost of its maintenance, when established, and its ability to adapt itself exactly to fluctuating loads, should render it quite ideal. The train as a traffic unit is large; therefore loads have to be allowed to accumulate, and this is apt to spell delay, a drawback which is likely to be aggravated when there is intermittent traffic with which to deal. But with the aeroplane, thanks to its mobility, and to the fact that it is a small traffic unit, it is as easy to handle a small load as a large one, or to carry twice as much to-day as you did yesterday without any confusion or delay.

This is where an airway will be so valuable in serving any young and growing community, overseas, which has been

established, say, a hundred miles or so from the nearest rail-head. In such a case, on any given morning, if only enough traffic presented itself to fill one aeroplane, then that one machine would be got away promptly, without having to wait for any further load; while, if mails and passengers should arrive in sufficient quantities and numbers to fill several machines, instead of only one, then these could be brought out and dispatched with an equal promptitude. Provided only the existence of a sufficient number of machines, you can carry three people on any given morning, or as many as fifty, without any confusion or delay.

The adaptability and mobility of an air service should be of value in developed as well as in undeveloped countries. It would be perfectly feasible, for example, to organize between cities which are conveniently situated a half-hourly service of aircraft; and in this way the business man, in addition to being carried by air at twice the speed

that would be possible by land, would not have to wait hours, as he often does now, after missing one train and before catching the next. It should be possible, indeed, to organize a regular stream of aircraft between populous districts, each machine carrying a small number of passengers and a bag of mails and express parcels; and if the total volume of traffic proved large, as distributed over a network of aerial ways, and even when broken up as suggested into small loads, the operation of such routes should be made profitable.

Not only in the matter of speed, therefore, but also in its capacity to deal quickly with a small and constantly-arriving stream of traffic, an airway should be able to give facilities which would be impossible to obtain on a railway. Take, for example, two cities such as London and Birmingham: a fast aircraft carrying a few passengers and a bag of mails could make the journey between them in, say, a little over an hour.

An express air service on a route like this, with machines leaving at frequent intervals during the whole of the business day, should facilitate greatly not only the movements of busy men, but also the exchange of urgent letters, and other documents of importance. And such a route would, of course, join up with services in other directions. One assumes, in fact, a service linking up all the large business centres of the country. Therefore a business man, leaving London at an early hour in the morning, and travelling throughout by airway, should be able in the future to visit a number of cities during the course of a day, staying only just as long as is required in each, and always finding, when he goes again to the aerodrome, that some machine is starting which will take him another stage upon his journey.[1]

[1] A frequent and rapid service of motor-cars, linking up aerodromes and cities, would be an essential feature of such a scheme.

In a country like America the scope for quick-service air traffic is practically limitless. The essential fact indeed to be remembered is that the establishment of airways should permit a constant flow of passengers and mails between important cities, and that this flow should go on practically all day long, and not at certain fixed intervals, as is the case with trains.

V

This new facility, when it is in full working order, should be revolutionary in its effect on business letter-writing. The fixed principle, hitherto, has been to write letters during the day and allow them to accumulate until the evening, when they are dispatched by the night mails and distributed the next morning. This, so far, has proved generally satisfactory to the business world, and none but very important letters have been sent by express

post at special fees. But the great tasks of reconstruction which now face us, and the need which exists to make good as quickly as possible some of the most obvious ravages of war, should make us willing to adopt any new method which will expedite business transactions. The habit of allowing letters to accumulate should be replaced by a system of posting them at once, and having them transmitted by air so that they reach their destinations within a few hours of being written. It is true that, at first, a fairly high fee would have to be charged for the carriage of a letter by air; but once an organization has been built up, covering the whole country, and assuming reasonably large loads to be forthcoming, there is no reason why the charges should not be reduced until they are no more, or very little more, than those charged at normal times for land transport.

If the air-mail system is adopted universally, and if the majority of business

letters are dispatched by air practically as soon as they are written, reaching their destination in some cases almost as quickly as a telegram does now, the effect on the whole world of commerce should be extremely important. A letter dispatched in the ordinary way from London to Manchester, on the evening of one day, reaches its delivery-point next morning, being replied to during the course of that day, the answer arriving in London on the third morning. But the establishment of an express air-mail will permit a letter posted in London during the morning to reach its destination in Manchester about midday; and, assuming the letter to be replied to at once, the answer will be received in London well before the close of that same business day. An extension of this system throughout the country would, in most cases, ensure the saving of a clear day in the exchange of business correspondence, as compared with the present system.

A great point to be considered by any company operating an express air-mail is the possible delay on land connections. One must assume that, for a time at any rate, aerodromes will be on the outskirts of cities: therefore the mail must be taken out to the aerodrome of departure and brought in again from the aerodrome of arrival; and unless this is done expeditiously, some of the advantages of a high air-speed may be lost. In the New York-Washington service fast motor-cycles are employed; and these, or light motor-vans, have obviously much to commend them. In time, however, we should find that aerodromes are connected with main Post Offices either by pneumatic tubes or by some such system of miniature electric railway, carrying mail-bags in small trucks, as our Post Office authorities have been constructing under London from east to west, and which should now soon be in operation. By an extension of this system,

in which mail-bags are transmitted at high speed, the G.P.O. in London might be connected directly with a dispatching aerodrome; in which case the air-mail could be sent from the Post Office right out on to the flying ground in less than half-an-hour.

VI

At this juncture readers may be inclined to ask: "What about the question of bad weather? What will be the use of your being able to carry an express mail one day, and then being prevented, perhaps for several days, from running a service owing to weather conditions? Look at the inconvenience this might cause, and the confusion which might arise when letters consigned by their senders to the aerial route could not at the last moment be carried." This question raises clear issues, with which we shall deal.

Firstly, in organizing an aerial transport service, we must lay our plans on

the basis of adverse weather. We must organize, in fact, for bad weather flying. A pilot on a fine day needs practically no organization at all. He can leave London and fly to Paris, finding his way by map and compass and visual observations, and being almost completely independent of any assistance from the ground. But when there is cloud, mist, or fog, or when he is flying at night, his success in travelling to schedule, as a train does to its time-table, must depend mainly on the patience and the perfection of the organization of the airway. Here there is one very important fact which we, in the industry, must never lose sight of. It will be in the early days of commercial flying, when the public will be watching results with a critical eye, that no single detail of organization, however small, can be omitted from the general scheme of safeguards.

It is always best, if one can, to bring a question like this to a practical issue;

and so we propose to take a multi-engined passenger craft, of the type now obtainable, and to see how weather conditions would affect the flight of such a machine. Fine weather, naturally, we rule out of the question; we do not legislate for that, because it represents a condition in which organization is least required.

VII

Now to combat bad weather. Here it is necessary to define what we mean by bad weather. Ordinarily, and on such a route as that between London and Paris, we mean high and gusty winds or heavy rains, or perhaps a combination of both. When we talk of bad weather, indeed, we usually mean a wet day or a windy day, or a day on which it is both wet and windy. How would such conditions affect a big passenger machine such as we have indicated? The answer is that neither

wind nor rain would have any detrimental effect at all on the flight of the machine. What we mean, when we say this, is that neither wind nor rain, nor both, would imperil in any way the safety of the machine, or of its passengers, or prevent its reaching its destination. Of course, in a high wind, if it is a head wind, the flight of a machine would be somewhat prolonged; or in rainy weather, when there are banks of low-lying cloud to be contended with, time might be lost in ascending to a higher altitude than would ordinarily be necessary. But the point is that neither wind nor rain, unless the former attains the velocity of a hurricane, will have the power to suspend the running of an air service, provided that it is being conducted with suitable multi-engined machines.

Naturally there is the question of delay to be considered, when a machine has to fly against a strong head-wind. But even should it be so delayed, it would, in almost

every case, still show a very marked saving of time over land and sea travel.

Taking a big machine driven by motors developing 1800 or 2000 horse-power, which should be capable of maintaining a speed of 100 miles an hour, this would mean that under favourable conditions, and reckoning the distance by airway at 250 miles, the journey between London and Paris would be made in two hours and a half. And even assuming a head-wind as strong as 40 miles an hour, blowing directly against the machine during the whole course of its flight from London to Paris, the journey would still be made in four hours instead of in about seven or eight by land or sea. One must not forget, either, that in the reverse direction from Paris to London, a strong following wind might make it possible to shorten the normal journey by an hour or more; with the result that passengers might on occasion make their journey between the two cities in as short

a time as an hour and a half, or even less.

The point, however, is that neither wind nor rain—which are the two most common forms of bad weather—will have anything more than a partially adverse effect on the flight of such powerful machines as we are now able to build. Of course when the wind attains the violence of a full gale, and the cross-Channel steamer services have to be abandoned temporarily, we must expect, at any rate for a time, that our aerial services may have to be abandoned also. There are indeed absolutely abnormal weather conditions in which any form of service must expect to suffer some temporary interruption. But it might be quite possible to fly to Paris on occasions when the Channel conditions make it not only extremely unpleasant, but also dangerous, to cross by water. And it is surely a most encouraging fact that, even within so short a space of

years, the aeroplane should have ceased altogether to be a fine-weather machine, and should be capable of being navigated safely even through violent winds.

VIII

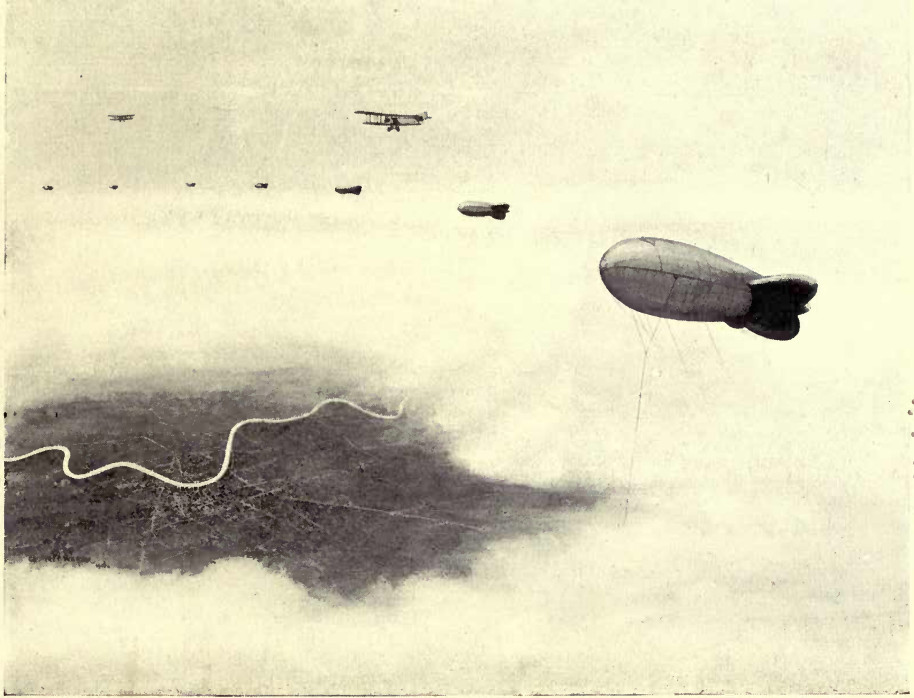
Now we come to our real weather enemy—fog. Here, however, we need to make quite certain how far fog is really a menace; and this brings out at once the fact that, assuming there is the organization we shall describe, fog should not trouble us very much, except at the moment of alighting after a flight. This is a great feature in favour of an airway, as compared with a railway. A railway train, in fog, has to grope its way constantly through an obscured air; it cannot, as can an aircraft, climb quickly through the fog-belt until it is above it, and then move ahead in perfectly clear air. On a foggy day, for instance, even if the fog should extend over a wide area on the London-Paris

route, it would mean absolutely no delay at all in the actual travel of an aircraft, once it had cleared the fog-belt after leaving its starting-point. It must be remembered also that fog is almost always low-lying, and that in a thousand feet or so, as a rule, a machine would be in clear air. And on a properly organized airway, with special fog regulations in force as to the inward and outward traffic at main aerodromes, there should be no risk of collision while a machine was climbing through the fog; and, when it was above the fog, flying would, as we have indicated, be perfectly normal. Nor would a pilot be embarrassed at all during the time he was climbing. His instruments would tell him all he wanted to know as to the inclinations of his machine; while wireless and other signals would inform him whether his course ahead was clear.

It may be asked: "Doesn't he run a risk of losing his way, or of deviating from

his course, if he flies for several hours without being able to see a landmark?" The answer is that he would not, provided he was aided by organization. By sending up kite balloons along an aerial route, which will fly conspicuously above the fog-belt—as shown by the illustration facing this page—and also by the aid of directional wireless, it now becomes perfectly feasible, even if a pilot has to fly for hours without seeing any landmark, to keep him with accuracy on any given course.

The chief risk lies in the alighting of a machine should an aerodrome be obscured by fog. Here the problem for an airway, as for a railway, is to illuminate the fog. What we must have is a system of illumination which will throw light beams upward through the fog and which a pilot can see as soon as he passes down from clear air into the upper layers of the fog. The main question here, with rays projected from searchlights showing vertically

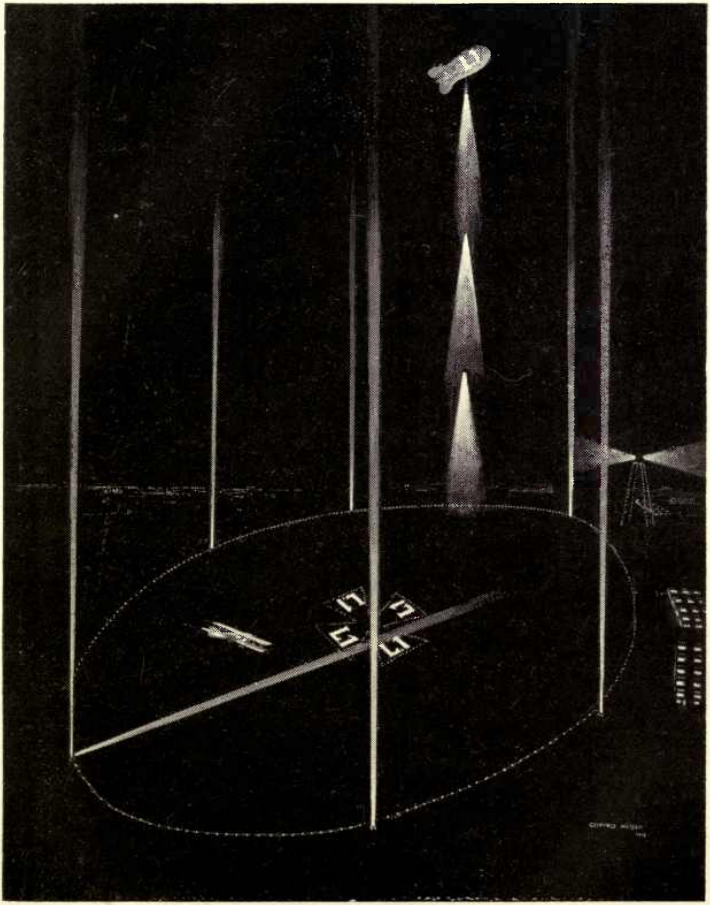


COMBATING FOG ON AN ORGANISED AIRWAY

upward, is one which is familiar to students of such problems—the difficulty being to obtain a ray which will penetrate through a fog, and will not be dispersed and dissipated when it impinges on the thick masses of the fog. Assuming, however, that we have the best form of light available, it should be possible to indicate the contour of the aerodrome by means of half-a-dozen of these searchlight rays, each pointing vertically upward. Then a pilot, having flown above the fog until he reached the aerodrome on which he had to descend, and being able to locate its position by means of the guiding balloon riding above it, would descend gradually into the fog until he caught sight of the searchlight rays. Round these he would then circle, reducing his altitude by degrees, and estimating his height above ground level by means of his instruments. Then, when he had got low enough, he would turn in between any two of the searchlights and make his descent

something in the middle of the aerodrome —a manœuvre he might accomplish quite safely, when he had become familiar with the general lie of the ground, without even having caught a glimpse of the actual surface on which he was alighting. A general impression of such a scheme of lighting is to be obtained from the picture facing this page, which suggests also how a pilot might be helped in his descent through the upper layers of the fog by searchlights shining downward from the kite balloon, and also at intervals from a cable suspended from the balloon. This whole question of fog is, as a matter of fact, fairly simple. The only real problem which still remains is to assist the pilot when he requires to make a landing through heavily-obscured air.

What we should like to represent very strongly is that, on a well-organized airway, we should in some respects be in a better position to combat fog than is a railway; and we do not believe that, except in



ILLUMINATING AN AERODROME IN FOG

extreme cases, an air service should be interrupted seriously by fog. It should be pointed out, also, that there is a possibility with an air service of doing something which is quite impossible with a railway; and that is to make a detour completely round any localized belt of fog. It might happen that, whereas one aerodrome was shrouded in fog, another only a few miles away would be in comparatively clear air; and in such a case it would be perfectly feasible to transfer traffic temporarily from one aerodrome to another.

We have now dealt with wind, rain, and fog; but there still remains snow. Should there be a heavy snowfall over an aerodrome, traffic might certainly be suspended temporarily; but here again, having regard to what one may call the elasticity of an air service, there should be no difficulty about transferring the arrival and departure of machines to some neighbouring ground, where conditions were less adverse.

IX

An interesting point, arising in connection with fog, is that research might now be directed to attempting the dispersal of a fog over the limited area of a flying ground. Railways have considered this matter; but their problem is, of course, much more difficult. They have great areas which they must clear of fog; whereas on an airway it would be necessary only to clear just the spaces where machines have to land. If some such system can be evolved, and if it is not too expensive, it should be possible to keep main aerodromes free from fog, and so remove, at a stroke, practically all the drawbacks so far as an air service is concerned.

It has been stated, more than once, that the fog which lies so often on the American side of the Atlantic would be a serious drawback in any trans-ocean air service; and so indeed it might be, were

it not for the power which wireless telegraphy now confers upon the aviator. With this marvel of science to help him, he will be directed across the 3000 miles of the Atlantic just as readily, and just as accurately, as from London to Paris. Probably, in a trans-ocean service, it will be found advisable—at any rate at first—to establish one or two sea-stations en route. These will be very large ships of special design, with deck-room sufficient for a machine to alight upon them. It may be found desirable, in commercial working, even though a machine can carry sufficient petrol and oil, in addition to the weight of its passengers and crew, to do the entire trans-ocean journey without alighting, to make perhaps two stops en route to pick up fuel, and for the reason that this would enable a machine to start its flight with fuel say for 1000 miles flying, instead of for over 3000, and this saving of weight could be

employed usefully in the extra accommodation of passengers, mails, or baggage.

With directional wireless, still further perfected as it will be, there should be no difficulty at all for a pilot in steering accurately across the Atlantic to each of the sea-stations provided for him. He would be in constant touch with them by wireless, and they could indicate to him their position so accurately that he would be able to fly directly on a line to them, even if he had to rely on these signals alone, and had no other means of correcting his course. And when approaching the American coast, say under conditions of fog, the pilot would take his machine well up into clear air and would then rely entirely on wireless to bring him along to the end of his journey.

It is a wonderful tribute to science to be able to say, as is possible now, that if one anchored a ship right out in the middle of the wide Atlantic, and then sent

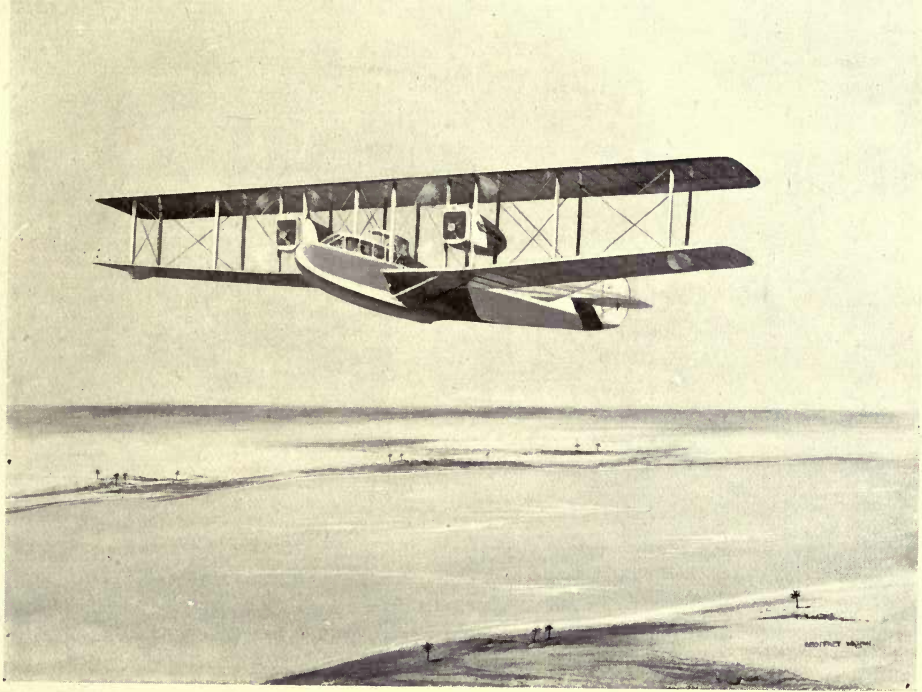
up an aeroplane say from London, that this ship, by means of wireless signals, and by nothing else, could guide that aeroplane across a vast track of water and bring it with absolute accuracy just to that one tiny spot on the ocean's surface; and this even in spite of fog, mist, cloud, or wind. It would seem miraculous to any occupant of the machine who did not understand the method employed; but it can be done, and will be done, not merely as an interesting experiment, but as a matter of routine.

Directional wireless, so far as long non-stop, commercial flights are concerned, will provide just the one thing needed to overcome the difficulty pilots may encounter through the fact that they are high in the air and may be unable—perhaps for some time—to make any visual observation of the earth below such as would help them to correct their compass course, and warn them of any

deviation they had made. With this new wonder of science to aid him, a pilot need no longer grope his way uncertainly above a belt of cloud, or embark with any uneasiness on a long flight across water: practically at any moment, and as often as he likes, he will be able to pick up these invisible signals which come to him out of the air; and, by means of special receivers in his machine—which by a variation in the strength of the signals received tell him when he is veering from his course—it will be possible for him immediately to divine his position in relation to the earth below.

X

These two great inventions, then, when they are used in combination—that is to say wireless and the conquest of the air—will be sufficient in the years to come to revolutionize all our notions of distance and of time. We shall find ourselves in a new



A TWIN-MOTORED FLYING BOAT

world so far as travel is concerned. To-day it is possible to transmit words for immense distances in an extraordinarily brief space of time; but when men themselves travel they still find it a tedious business, even in a fast ship or an express train. Now, however, as we enter on the age of aerial transport, we shall find that what telegraphy did for the transmission of the written word, with all the developments which followed it, so flying will do in regard to the transit of the human body from place to place.

The extraordinary speed of aerial travel, with all that it will imply, will have a greater influence on the world, probably, than any of the eras which have preceded it; and it is again a comfort to think that this influence will be so entirely for good, and that the more flying can be developed the less grave will become the menace of any future struggle between nations.

XI

By degrees, we hope, as a reader follows the stages of our book, his scepticism—assuming that he started with any—will begin gradually to leave him. Our whole aim, in fact, is to pave the way for civil aerial transport; to go straight to the root of those objections, and prejudices, which it is only natural the ordinary citizen should entertain, remembering that what we now suggest is that he should desert land and sea, the mediums of his travel for centuries, and soar up into this new element, the air, which, owing to its sheer unfamiliarity, appears to him to be filled with dangers which do not in reality exist. "Propaganda" is a word which some now declare to be very much overdone; but we are prepared to say, quite frankly, that this book is a deliberate piece of propaganda, and nothing else; but even after having made such a confession,

we are hopeful that it may be found to be interesting propaganda, and that therefore it will be read and discussed—an ambition which is not realized, always, in regard to other forms of propaganda.

When we range on the side of an airway all those factors which can now be brought to bear in its favour—large multi-engined machines; a complete system of landing grounds; a perfected system of illumination and of meteorology; not forgetting the aid of directional wireless—then we see how one thing will fit into another, and how a pilot, who might be in difficulties if he had none of these aids, will be able with their combined help to make flights in conditions which have up to the present been considered hopeless.

One of the most valuable aids to commercial flying, and also one of the greatest safeguards, will be an efficient meteorological service. The exact conditions of the weather should, for example, be known

not merely in the vicinity of London but also along every mile of the journey from London to Paris; and on all other main routes as well.

One should always bear in mind in this connection, as we have suggested, that the pilot of a passenger aircraft, when he encounters bad weather, will have the opportunity as a rule of flying either above, below, or round a storm, and so escaping the worse of its effects. And when he has to go high, with storm-clouds obscuring his view of the earth below, he can have both kite balloons and wireless to guide him on his course; while, when he comes down low, and flies underneath a heavy bank of cloud, his own visual observations will be sufficient to guide him, seeing that each of the landing grounds upon a route will be marked, and that this sign will be visible from the air.

In addition to the meteorological stations which are placed directly along a flying

route, there will be others at some distance on either side of it. There will, in fact, be such a network of stations created, by degrees, that the movements of any storm-centre will be easily traced, and reported, from hour to hour. Already, in this regard, we should pay tribute to the admirable meteorology which has so assisted the work of our R.A.F. pilots during the war.

XII

One assumes that a pilot will usually have an alternative route when it is a question of bad weather. In going say from London to the north, there will no doubt be an east-coast route, and also one more or less up the centre of England. As time goes on, in fact, it should be possible to select a route almost in any direction, and still find below one an organized system of alighting grounds. The possibility of choosing an alternative

route will often be of very great importance when a series of weather reports are being examined. It might be found, for example, on any given morning, that the weather along the east-coast route was quite unsuitable for flying; that there was a high and contrary wind which would delay very considerably any machine proceeding by this route say from London to Newcastle, Edinburgh, and Glasgow. This being so, and after the weather reports from the midland and west-coast routes had been considered, it might be decided to divert the Scotch air-mail from the east-coast route to the west, or perhaps to run it up through the midland route.

If the bad weather was shown by the reports to be quite local, and confined to certain districts, as in the case of areas of heavy rain, it will be quite easy to divert the main air traffic for a time from those particular areas; and the adverse result

of so doing, as revealed by the time taken on any particular journey, would be far less felt in the air than on the land, having regard to the very high speeds attained by air, which will make the adding of a few miles to any given journey by no means as serious a matter as it would be to lengthen the mileage of a train. Besides, the mobility of an air service, and the fact that an alteration in a route could be made at a moment's notice, and without upsetting the whole time-schedule of the day—as would be the case with a railway—will make it easy for pilots not only to avoid bad weather but to profit also by a favourable wind.

XIII

In very long commercial flights, and more especially in those made across oceans, it will be of the utmost importance to be able to take advantage of a prevailing wind.

Here, once more, there is an immense field for meterological research. The trend of winds at fairly moderate altitudes has already been studied; but where we now require data is as to the movement of those great bodies of air which are found in the upper altitudes.

About trans-Atlantic winds there is much already on record, though here again it does not tell us what is taking place at very great heights. During a number of months of the year, for example, and in a flight made from Newfoundland to the west coast of Ireland, the pilot of an aircraft would find that he had the wind behind him, varying of course in strength, and sometimes a little in direction, but generally assisting him and adding to the speed of his machine. As to a journey made the other way across the Atlantic, it is considered that a machine flying much further south, and taking the Azores on its route, would often have the advantage of

a following, or partially favourable, wind. The great wind-tracts of the world, when they are more clearly understood from the point of view of aeronautics—that is to say in their higher altitudes—should play an enormously important part in quickening journeys, and in reducing the amount of fuel consumed. We are all familiar with the trade winds which are of so much importance to the sailing ship; and in the days of the long-distance aircraft, with a journey of thousands of miles to be made, it will mean all the difference in the commercial operation of a service, and in the reduction of running costs, if a stratum of air can be entered which will favour instead of retard the flight of a machine.

What can be done by a careful study of meteorology the Germans showed us in one of their daylight raids on London. By flying at one altitude when approaching London, and by ascending into a higher zone when they returned, they achieved the

apparently impossible feat of having a wind behind them both ways, which materially increased the speed of their machines. What actually happened, on this particular day, was that one stratum of air was moving from the coast towards London, while another stratum, at quite a different elevation, was in motion in almost an exactly opposite direction. These varying wind-currents, of immense importance to the aviator, are frequently tested and made use of by the balloonist. There was a case, for instance, only the other day, of a balloon pilot who left an aerodrome at a fairly low altitude and passed away some distance across country; and then, by manœuvring his balloon into another and a higher current, he managed to drift back again until he alighted almost exactly at the point from which he had ascended.

When the meteorology of the upper air is more completely understood, and can be applied with precision to the

commercial use of aircraft, we shall find that the express air-mail from London to Marseilles, while proceeding one day overland via Paris, may on another day find it advantageous to sweep out wide towards the Bay of Biscay, in order to make use of some high and powerful trend of wind. The day may quite easily come, indeed, when the rapid movement of the air, which was so dreaded by the early pioneers, may be made to help, rather than retard, the flight of our big mail and passenger machines. The wind, instead of being an enemy, may indeed become a friend, adding many miles an hour to the speed of any machine which maintains just the right altitude when it is moving from point to point.

XIV

Now, perhaps, one may make something in the nature of a summary. Winds we have dealt with in their relation to a

commercial service; also mists and fogs, and such conditions as are caused by snow and rain; and we hope we may have thrown light on these matters from the point of view of a purely non-technical reader.

The fact which emerges insistently, which is indeed predominant, is that there is all the difference in the world between launching a machine on a flight with a carefully-devised land organization to help its pilot, and in just sending that same machine away across country with nothing existing in the way of assistance or direction. In fair weather, of course, a pilot could make a journey of hundreds of miles from point to point with nothing more to aid him than his compass and an occasional glance at the earth below. Naturally he is dependent on his engine, but if this runs well he will reach his goal safely, even without the help of alighting grounds or land signs, or indeed of any organization at all.

But to start a regular commercial

service under such conditions would merely be to court an ignominious failure. And here it is that such a clear distinction must be drawn between purely experimental commercial flights, such as have already been made, and the really serious and practical work which we must now be ready to attempt. When one reads of an aviator having flown from the continent across to London, carrying a bag of official mails, and having done the journey in so many hours, the whole thing appears a simple and easily-accomplished fact. But what must be remembered is that the pilot waited probably until he had just the weather conditions he wanted; and then of course the flight presented no difficulties at all. Perhaps on the following day, had he attempted the feat again—and remembering that he had no land organization to help him—he would quite likely have lost his way in mist or cloud, damaging his machine

in a bad landing; or engine failure might have brought him down in some quite inaccessible spot. It is not fair-weather flying, as we have suggested, that one has to reckon with in planning a commercial service. When conditions are suitable there is, indeed, no question at all now about a flight being made. It will be made just as surely as any other journey would be.

What one *has* to reckon with, before one begins to operate an airway, is the number of days in the year when one will have to maintain a service in adverse weather conditions. And so it is that an occasional flight between London and the continent, though it may be made very rapidly and with complete success, and may gain considerable attention in the Press, does not prove in the least what we shall now soon be called upon to prove; and this is that we can start off an air-mail from London at a fixed time every day and night, and for this service to be

maintained, in bad weather as well as fine, with the same reliability as is ensured by land and sea transport. This is the question which must be faced; and it is a vastly different one, and a vastly more complex one, than running any intermittent service just to indicate generally what the possibilities may be.

XV

A heavy responsibility rests upon those who, acting say as contractors to the Post Office, set themselves the task of running a regular commercial air-mail service between London and the Continent; and the same responsibility rests on those in America, or anywhere else, who attempt a similar task. The public will watch these services very critically; business men will hesitate in regard to sending their letters by air. And if these first services are marred by frequent breakdowns, and if unreliability is due to the fact that the

contractor has not taken every possible step to perfect his land organization, then he will lay himself open to the very serious charge that he has brought commercial aeronautics into disrepute, and has spread in the public mind an impression which it will be difficult afterwards to dispel.

It was regrettable, for instance, that in an otherwise interesting experiment which was tried recently in America, the very first day's service should have been marred by a delay which appears as though it might quite easily have been obviated. As the reader is doubtless aware, the idea has been to run one machine each way daily, carrying a bag of mails, between New York and Washington, with a stop en route at Philadelphia, the pilots being Service men, and the experiment being considered justified, even during the war, by the fact that the cross-country flying entailed would form part of these pilots' training.

A great publicity was given to this

proposed service; much was written about it in the Press; and therefore the public was in a frame of mind to regard it critically. On the first day, May 15, 1918, the mail-bag from New York was carried through to Washington without a hitch; though owing to the type of machine employed, the average speed fell lower than had been anticipated, and the total time of the journey by air did not show as great a saving as should have been possible over land transport.

Of course the whole service was experimental, and the aeroplane used was not a particularly fast machine: still it is a pity that it was not possible, at a time when the papers were devoting columns to the test, to have shown more strikingly the speed which is possible by air. The type of aeroplane which should have been used for such an important demonstration was a very fast high-powered craft doing about 130-miles-an-hour instead of the

95-miles-an-hour which was the maximum speed of the actual machine used. With such a fast machine the time should have been cut down very considerably, and the public would have been correspondingly impressed. It must never be forgotten that speed is the very keynote of the whole undertaking when one is carrying mails by air in competition with a highly organized system of railways; and, when one has a chance of showing the public what the possibilities really are, every nerve should be strained to make the time of flight as short as possible.

Naturally, in the experiment we are describing—and it is far from our intention to criticize it at all severely—the promoters suffered from the fact that they were attempting it in time of war, when the very latest and fastest machines, such as would have astonished the public by the speed they attained, could not be diverted from their purely warlike use.

This is really an argument in favour of not advertising any air services, or of calling wide attention to them, until you are in a position to show what really can be done, and are not obliged to apologize for mishaps and delays, and to tell people that everything will be much better on some future occasion. The public, nowadays, is not prepared to make any such allowances: if you start a service, they expect quite naturally that you have made adequate preparations.

There is, however, no need to labour the point; and one must of course make some beginning with a service before experience can be gained. But what we submit, none the less, is that it would be better as a rule to carry out one's preliminary experiments more or less in privacy, and not to solicit any wide attention, or regular public patronage, until it was possible to operate a service with at any rate a reasonable amount of dependability,

and also with a sufficient speed to justify the transference of mails and passengers from a railway to the airway.

XVI

It would be obviously unfair, at the present time, to criticize too harshly any practical experiment such as we have just mentioned. Our American friends might, if we did so, be stung quite naturally to the retort that it was a case of "sour grapes"; that we were finding fault with a practical test when we ourselves had done so little in a similar direction.

As to this, the fact that at the time of writing there has been no air-mail experiment in England is due not to the lack of enterprise of individuals but to the official mandate of the Air Ministry, which has laid it down quite clearly that, until there has been time to study, and determine upon, certain very fundamental

questions affecting civil aerial transport, not only in its international but also in its domestic aspects, no public services can be permitted. This ban, which has a great deal to commend it, may, however, before these lines are read, have been removed.

Our Allies, the French, have been particularly anxious to establish an air service between London and Paris, and stated even during the war that they were in a position to spare a certain number of pilots and machines for this purpose; but, though flights have been made by French aviators to demonstrate what can be done, there has been nothing, at the time of writing, in the nature of an organized effort.

It is satisfactory, as far as it goes, to note that the British Post Office has shown a practical interest in the question of carrying mails by air, and is quite prepared, when the responsible authorities give permission, to inaugurate first services, and to make a comprehensive test

of this new high-speed method of transmitting urgent mails. The French authorities, it is understood, propose to run their own pilots and machines as a Government service; but we, on our part, seem more likely to adopt the system which is in vogue with the rail and motor transport of mails, and invite tenders from responsible firms in the industry, thus leaving the actual carriage of the mails in private hands, the Post Office paying so much per ton for the loads carried.

XVII

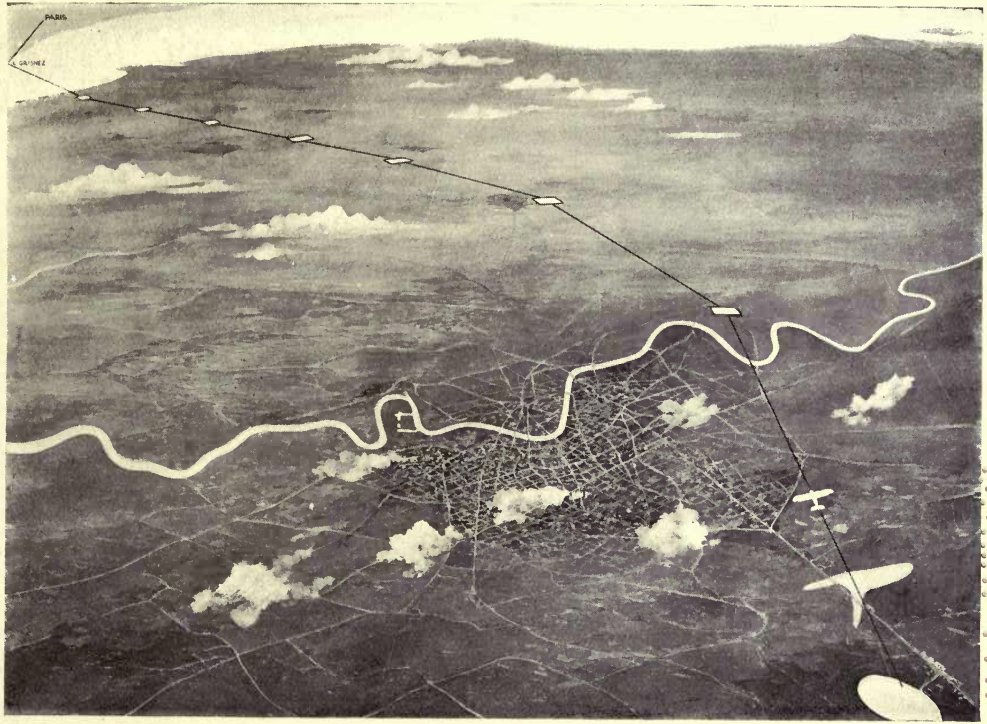
It is a consideration of such points as we have made, with the obvious desirability of starting a service under the most favourable conditions, which makes one hope that in Great Britain, as well as in other Allied countries, as much as possible will now be done to build up in advance the general organization of certain specified

and important routes; and here of course the international aeronautical conference in Paris, which may be sitting by the time this book issues from the press, should lay the foundation-stone of all future progress.

One may take as a convenient example in this regard, the vital traffic route between London and Paris, which will be the first link of many services extending farther into the Continent. We now have pilots and machines for these services; but it would be a thousand pities if a public service was instituted, and flights to a daily time-schedule attempted, without the help of all the ground organization which it has been our purpose to describe. It is true, of course, that military alighting grounds exist already on this route; but what will be required, if the full value of aerial speed and reliability are to be revealed, is a line of emergency grounds forming a regular and precise chain with a specified distance between each. Any

serious irregularity—the absence that is to say of a ground just at a point where a pilot might require one day to make a forced descent—would invalidate the whole idea of the scheme, which must be carried out systematically or not at all. A panorama view of a London-Paris airway is shown facing this page.

This leads one to the very definite point that there is a vast amount of organization to be undertaken; and the question of the laying down of definite routes, with the selection and marking of emergency grounds, and the preparation of an organization for night flying, and also for flying in mist and fog, is one which is of the utmost urgency. Unless adequate preparations are made, it will mean either that services will have to be attempted without proper organization, which will be inviting failure and a loss of confidence in the public.



PANORAMA VIEW OF THE LONDON-PARIS AIRWAY

XVIII

Our Government, and more particularly the Air Ministry, have been waiting no doubt for the advice of the Civil Aerial Transport Committee, which was appointed in May, 1917, and which has recently made its report to the Ministry—this report being now obtainable by the public, from any bookseller, for a fee of 9*d*.

With this report in hand, and with the obvious necessity it indicates for a great amount of organization, it is hoped that no time will now be lost by the Ministry, the war being at an end, in doing all that can be done in paving the way for the running, during all weathers, of a commercial air service. It is regrettable here to note that, even among practical men, the necessity has not been fully realized for all that work of organization which we have been advocating. Doubts have been expressed, for example,

as to the need for a chain of alighting grounds, and pilots even of experience have stated that they thought they could do without them. Because they have flown frequently between London and G.H.Q. in France, and because they have not often been brought down by engine failure, and because they have learned by their familiarity with natural landmarks to find their way with ease so long as conditions are favourable, they are rather apt to scorn the idea of an elaborate ground organization, and to be impatient at the suggestion that so much should be done to obviate an accident which may never take place.

What they should realize, however, is that there is all the difference in the world between making an occasional flight from London across to France, generally at some convenient hour, and usually under favourable conditions, and pledging oneself to maintain a service, day in and day out, starting at a fixed hour, and contracting

to carry and deliver safely, within the shortest possible space of time, a bag of His Majesty's mails; to say nothing of a certain number of passengers. And one has only to see the actual records even of present-day flying to realize how impossible it would be to ensure anything like full reliability unless one had an organized route, with every possible aid in the way of relief machines and emergency grounds, the whole system being linked by telephone and wireless, and providing a complete and homogeneous aerial way.

Engines fail, as a rule, just at the very moment when they are not wanted to do so; pilots lose their way when weather is obscure; and forced descents have still to be made at all sorts of inconvenient places. This does not matter so much when an hour or more's delay is a matter chiefly of personal inconvenience, and is regarded merely as part of the day's work. Even when an exceptionally skilled pilot,

encountering mist and rain, has to descend several times between London and G.H.Q. in order to find out where he is, the matter is looked upon more or less as a joke. But when a business man in London entrusts an urgent letter to the morning air-mail, paying a fee say of 2*s.* 6*d.* for its rapid transmission, and being given to understand that it will be in Paris very shortly after lunch, he will feel extremely disgusted if, simply through failure to organize the service properly, the pilot is allowed to lose his way, or make a descent miles off his route, with the result that the letter does not reach its destination until hours after the promised time. After one or two experiences of that kind, the business man would decide to continue the old-fashioned method of sending his letters by train.

To put this matter very plainly, it seems to us extremely foolish, when one is embarking on such a new and untried task as the carrying of mails and passengers

by air, to disdain any possible aid which may render flying more reliable and also more safe. In the future, perhaps, we may not require emergency landing grounds; but in our first air services, if they are to escape condemnation by the public for a lack of dependability, we shall not be able to dispense even with the smallest piece of forethought or organization which may guard us against the risk of breakdown, or minimize the effect of any breakdown should one actually occur.

XIX

If such precautions as we have advocated were to entail heavy expense, that might be a weighty argument against them; but they would not do so. They would imply only a very small addition, in the matter of overhead charges, to the actual running costs of a service; and so

far at any rate as emergency landing grounds are concerned, these would be a form of insurance against the damage or breakage of machines, and would more than pay for themselves under this heading alone.

Besides, quite apart from any question of expense, the sensible way of looking at the question is surely this: nothing must be neglected, in the early days, which will increase the reliability of an air service, or the safety of those who use it. That is the crux of the question, and there is no getting away from it. We must provide for every possible contingency; we must err, if error has to be made, on the side of over-precaution. It is a very poorly-conceived policy which suggests the discarding of safeguards even before we have been able to realize what the actual difficulties of running an air service will be.

XX

There is a very much larger aspect of this question than is covered by any purely commercial or individual view. What we have to consider is the safety of the public; and we have also to remember that the reputation of the whole aeronautical movement, and the confidence or lack of confidence that the public has in it, will be bound up very largely in any such schemes for air services as are now being mooted. It is not a case, indeed, of individual preferences or individual opinions. If there is any possible step which can be taken at first, no matter how small, to increase either the safety or the reliability of a service, then that step should be taken; and the science and industry as a whole, through its accredited bodies—and also of course with the support of the Air Ministry—should place an absolute ban on the starting of any service, or the

promotion of any route, unless it is shown clearly that the organization is complete, that the control of the undertaking is in the hands of those who know their business, and that every precaution has been taken to ensure safety.

In this aspect of the question lies a very wide problem of policy, which it must be the task of the industry to study with the utmost care. We must, above all, profit by the experience of the past; and we must avoid more than anything else the rousing of hostility in the mind of the public. In the early days of the motor-car, through the inconsiderate driving of a minority, the whole movement was for a time thrown into disrepute. In commercial flying, if pilots are guilty of any action which prejudices the public safety, they must be dealt with at once and with a very firm hand. The rights of earth-folk must be respected as well as the rights of those who use the air.

Here it is that a well-devised system of airways will play so important a part. If a pilot has always an emergency ground on which he can alight, should anything go wrong with his machine, there will be no need for him to descend unexpectedly on private property. A picture has been drawn, by those who profess to fear the coming of "the air age," of machines alighting in all sorts of inconvenient places, causing damage on private land, and perhaps injuring helpless wayfarers; nor do they fail to draw attention, in this regard, to certain regrettable accidents which have taken place during the war.

Such accidents, however, when flying is fully organized, should be almost wholly avoided. The pilot who flies along a chain of landing grounds should scarcely ever find it necessary to alight anywhere except on a suitably provided spot. It will also be possible, and indeed advisable, to avoid flying directly over thickly populated

neighbourhoods. Aerodromes will be established on the outskirts of cities; and although in the future, when we have more perfect craft, it will no doubt be quite safe to bring an air-mail machine right into the heart of such a city as London, it will not be worth while, in the very early stages of commercial aeronautics, to run any risk of accident by manœuvring machines at low altitudes over a wide area of streets and buildings.

XXI

The laying down of regular aerial highways, and the confining of the general body of traffic to such routes, should obviate very largely any complaint, on the part of private people, that machines are flying constantly over their residences and grounds, with the allegation of nuisance to which this might give rise.

Naturally there must be a certain

amount of give-and-take, more especially when commercial flying is in its infancy. This new movement will be all for the benefit of mankind; it will establish for the general public a new means of high-speed travel which will become an increasing convenience as time goes on. Therefore we must hope that the public, so long as it is assured that every reasonable precaution is being taken, will not adopt any too critical or captious attitude. After the war we shall be able to silence the motors of aircraft; therefore their passage overhead will not be noisy as it is to-day. And if pilots adhere as far as possible to defined routes, and fly always in a way which shows they are studying the public convenience, it should be quite easy to avoid any ill-feeling between them and those who remain on the ground.

XXII

There has been a good deal of discussion, recently, as to prescribing some definite altitude at which commercial aircraft should fly, this height being made the subject of legal enactment, and pilots being prosecuted for any infringement of the regulation.

Expert opinion, however, has been all against any such suggestion; and quite rightly so. The idea underlying the proposal is that by keeping machines at a certain height there is less risk of nuisance for those on the ground; but in a climate like that of England, with its constantly varying conditions, it is essential that the aviator should be given full freedom of the air. Let us take a concrete example. On a morning when there were heavy banks of cloud, above which it was not practicable to ascend, the pilot of a London-Paris

air-mail might require, at certain points of his journey, to fly as low as only a few hundred feet above the ground. And if he could not do this, if the regulations compelled him to ascend and fly at a height which forced him right into the thick of the clouds, then it would be impossible for him to continue his journey, and the whole service would be interrupted.

It should be stated that such low-flying as we have mentioned would only very rarely be necessary; but, at the same time, the pilot of a commercial service must be given the fullest right to choose the altitude which suits him best. If he could not be given this right there would be quite a number of days in the year when he would be unable to fly at all. Normally, that is to say in average weather, the height at which a commercial machine flies will be governed by the distance apart of the emergency landing grounds. Assuming, for example, that these are ten miles apart

—the system which is generally advocated—then a pilot would be flying as a rule at somewhere about 4000 feet. And this rule would hold good on the majority of the days of the year. A skilled pilot, one who knows his business, always likes to have as much air space as possible below him; his tendency is not to fly low but rather to fly high. And in commercial or pleasure flying, should complaints be received that a machine had been passing at an unnecessarily low altitude over private property, then the pilot concerned would be asked for an explanation; and, if the weather conditions did not justify him in doing what he had done, action could easily be taken against him by the proper authorities.

XXIII

How, it may be asked, are machines to be identified when in flight? The answer is that each aircraft will be licensed,

and numbered, and will carry its identification number in a very conspicuous position. Furthermore, it is probable that pilots will be required to keep a log of their flights, and of their departure from, or arrival at, any aerodromes which lie on their route. Different types of aircraft should soon become familiar in their appearance; and, of course, the lower a machine flies the more easy it will be to read its number.

Thus, with the organization of routes, and the numbering of machines, and the general record which will be kept of the flights made, it should soon become difficult for an "air hog"—as for a "road hog"—to escape the penalty of any foolish or inconsiderate act. It is improbable, as a matter of fact, that flying to the danger of the public will be in the least prevalent; and for the very simple reason that the pilot who does anything foolish in the air will risk injuring himself far more than he

will imperil those on the ground. Self-preservation, the strongest of instincts, will prevent all save the most reckless from playing the fool with an aeroplane.

For the absolutely reckless pilot, the man who is a menace not only to himself but to others, a simple and very efficacious treatment can be found. Every man who flies will have to be duly certificated, and without this initial certificate he will be unable to fly at all. Therefore the "air hog," the man who is such a fool that he cannot be trusted with an aeroplane, will simply have his certificate taken away, and will be unable to fly any more. In actual practice, moreover, it will probably be found that the man who is quite unsuitable as an aviator will disclose his faults and weaknesses during the period when he is under tuition; and this will mean that, in the majority of cases, he will never even become possessed of a certificate at all.

It is the fixed intention of those who

have the best interests of flying at heart that no man shall be certificated as an aviator unless he is in actual fact a competent and reliable man, capable of handling an aeroplane efficiently under all the varying conditions which may present themselves while he is in flight. Bad driving, in the early days of the motor-car, did that movement more harm than anything else; and bad flying, so far as the development of aeronautics is concerned, would be even more deplorable in its results. If the safety of his own skin will not deter a man from foolish flying, then he must never be allowed to fly at all.

There are a good many people who express timidity when they are told of the coming of this aerial age which we have been describing. They not only expect that accidents will befall those who fly, but they conjure up visions of the air above them being black with craft, and of the ordinary man becoming almost afraid to

venture out of doors for fear that some unmanageable machine may descend upon him.

Such fears should prove utterly groundless. It will be possible to develop commercial aeronautics, granted that reasonable precautions are taken, and that pilots and machines are equally dependable, without any prejudice at all to public safety.

PART THREE

CAN AN AIR SERVICE BE MADE TO PAY?

I

IT is now possible to approach a question of the greatest possible interest, concerning which there is a wide diversity of opinion. Put plainly, the question is this: assuming that an air service can be made safe, and assuming also that it can be made sufficiently reliable to meet business requirements, *can it be made to pay?*

Before dealing directly with this matter, there are one or two points which, though they are fairly obvious, need at the same time to be placed on record. To begin with, there is the very obvious point that, no air service having as yet been attempted on anything like commercial lines, figures which are mentioned as to running costs, or any general statistics which may be

arrived at as to the balance-sheet of an aerial transport company, must be matters very largely of speculation. Any accountant knows of course that, in the case of new undertakings, where no practical experience has been gained, it is possible to make figures say very much what you like. Therefore, in connection with any speculative balance-sheets as to the running of aerial services, it is wise to examine these not necessarily with suspicion, but certainly with a very critical eye. There are, of course, figures which can be ascertained, and which it may be assumed will survive the test of actual experience; but there are others which are far less capable of estimation. Some in fact can scarcely be estimated at all.

There is a disposition, which is reasonable, not to go too much into details, at the present time, as to the running costs of a service, and for the reason that some quite wrong impression might

quite possibly be given, and also for the reason that any problematical figures, as put forward now, might be disproved entirely by actual experience. But, even with this being so, there are certain very definite issues, as to the finance of an airway, which it can do no harm at all to discuss. They rest on a perfectly sound foundation, and are not likely to be upset even when we are confronted by the figures of an actual service. Besides, as an encouragement to candour, it must be remembered that the business man, who is naturally interested in the question whether an air service can be made to pay, and would like to have it discussed, would probably gain a very bad impression if the subject was ignored, or if he was simply told that it cannot as yet be discussed with advantage. Such an attitude would lead him to think that there was something wrong; he would suspect that there was "a skeleton in the cupboard" in regard to

this question of finance: whereas, in actual fact, there is nothing of the kind. The only elements of doubt are as to certain very specific items in overhead charges and running costs. Apart from these it is possible, even to-day, and before the statistics of any actual service can be drawn upon, to present certain data which are not only interesting, but which should throw quite a clear light on the financial prospects of an aerial service.

II

The question of vital importance with an airway, as with a railway, is the volume of traffic it will obtain. When you have established an aerial route, and have provided alighting grounds, staffs, and all the organization we have described, this expenditure on land facilities represents an item in overhead charges which may be said to be very much the same whether

only one or two machines, or a much larger number, pass over the route in any given time. This means that if a fully organized route is laid down, and only a very small volume of traffic can be obtained for it, then the purely establishment charges, as represented by the rental and up-keep of aerodromes, the provision of ground staffs, and other similar expenses, may take so high a place in the general expenditure, as compared with the traffic receipts, that it will be extremely difficult to avoid showing a loss.

One might imagine, as an extreme instance of what we mean, that after a complete railway line had been laid between London and Glasgow only just sufficient traffic was forthcoming to fill one train each way daily. With the overhead charges which would be incurred in maintaining the route it would be only possible to make both ends meet, under such circumstances as these, by the fixing of

an extraordinarily high fare for passengers, and a proportionately high fee for letters and goods. Of course the cases of an airway and a railway are by no means parallel, because the cost of establishing and maintaining the former is almost infinitesimal, as compared at any rate with the railway; but the illustration may serve in a general sense; and it is of course a fact that with an airway, as with a railway, the greater the volume of traffic that can be obtained the better is the chance not only of making a profit for the operating company, but of moderate charges to the travelling public.

What this means, in effect, is that if the public can be induced to travel freely by air, and also to send their urgent letters by express air-mail, it should be possible to carry a load through the air at quite a reasonable charge, having regard of course to the very much greater speed attained. But if very few people travel by air, and

if the mail-bags carried contain only a very small number of letters, then the charges which will have to be made, if any profit at all is to be shown, will obviously be high; it will be impossible to make them otherwise.

III

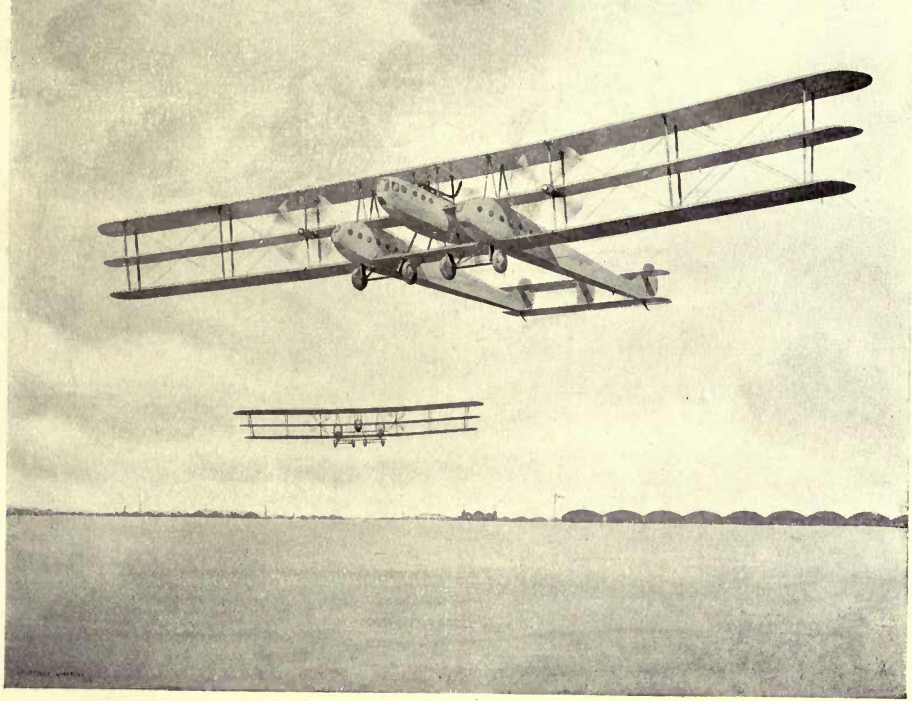
One of the most interesting ways to approach the question of finance, so far as the actual operation of an airway is concerned, is to take some specified aerial way, such as that between London and Paris, and then to estimate, so far as one can, what the expenses would be in running a certain number of machines daily over such a route.

Two of the most important points, to begin with, are to decide how many trips shall be made daily, and also by what types of machine they shall be conducted.

For our purposes here we assume that,

even at the outset of a London-Paris service, it will be possible to obtain a load sufficient to run two machines each way daily on this route, each machine carrying twenty-four passengers. This would mean that every day there would be forty-eight passengers flying from London to Paris, and forty-eight travelling in the opposite direction; a total of air-borne traffic, per day, of ninety-six passengers. When one remembers the large volume of train and boat traffic on this route at normal times, and when one assumes, as it is fair to do, that this volume of traffic will be increased during the period of reconstruction on which we have now embarked, then to take about one hundred people from among these many hundreds, and to calculate that approximately this volume of traffic will be diverted each day from land and sea to air, seems on the face of it fairly reasonable.

Of course it is understood that for aerial transport, as we shall show, a higher fare



A LONDON-PARIS PASSENGER MACHINE

will be charged than for land and sea travel. Therefore this implies that the hundred people who travel by air will all have some reason which makes their journey specially urgent, and which will induce them to pay more in the way of fares than they would normally be prepared to do. The assumption seems justified, however, that there actually will be a daily volume of air-borne traffic, particularly when we show, as we shall, that the difference in fares between air and land travel is not likely to be unreasonable, having regard to the fact that the traveller by airway will make his journey between London and Paris in appreciably less than half the time that would ordinarily be required.

Before going into actual details of finance, it should be explained that we assume the company which operates a first air service will have certain equipment and facilities already in existence; such for example as an aerodrome near London

which is suitable as a terminal alighting point, and also equipment in the way of a factory, with sheds and a skilled staff. This assumption made, and it being understood that the service maintained will be one of two flights each way daily between London and Paris, one each way in the morning and another in the afternoon, the next point to determine is as to the size of the air fleet it will be necessary to provide in order to be certain of maintaining such a service. Here it seems reasonable to assume that six machines would be sufficient—three being stationed in Paris and three in London.

In actual operation the service would work thus. A machine which left London in the morning, on its 250-miles flight to Paris, would wait for an hour or two at the Paris aerodrome and would then make the return journey to London; and the same would apply to the machine starting from Paris. Therefore, in the ordinary

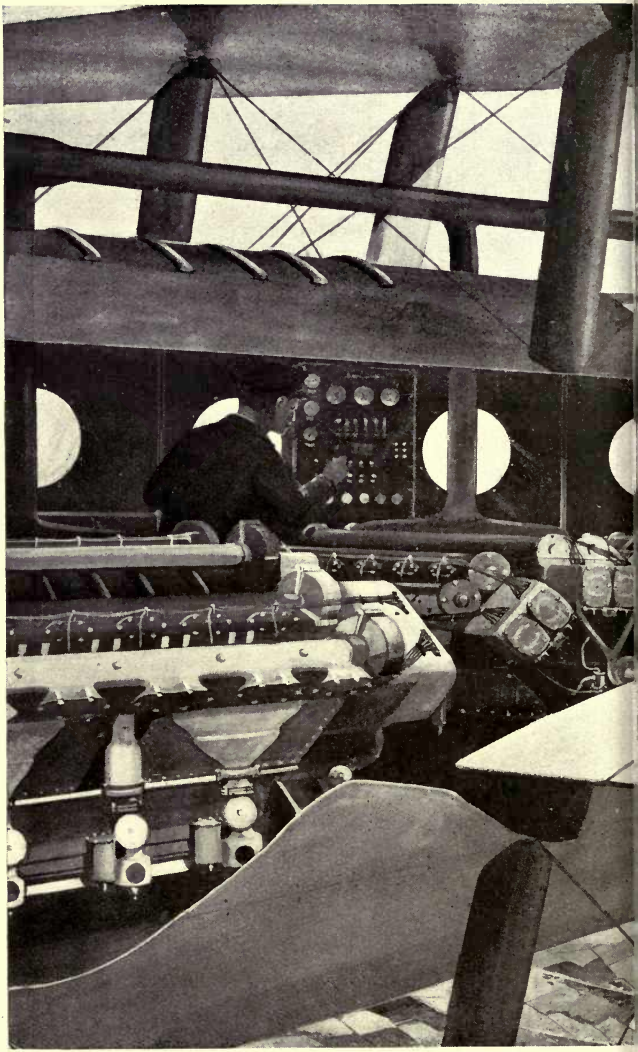
way, two machines would be sufficient to carry out any given day's service, each making a double journey. This would allow for two machines at each end to stand daily in reserve, which would be a necessary safeguard, in view of the fact that machines might be incapacitated temporarily by some mechanical trouble. Normally, by such an arrangement as this, any one machine would make two trips say on Monday and would then lie off until Wednesday, when it would again take up the service. This would give ample time for all necessary overhauls and small repairs, and would not mean that any of the machines were being overworked. Nor would there be any risk of running a machine when it was not quite in trim.

The machine contemplated, so far as our purpose here is concerned, is of the type illustrated facing page 136. This is a triplane, driven by a total of

1800 horse-power, and designed to maintain a speed of 100 miles an hour when carrying twenty-four passengers, a crew of five (pilot, navigator and wireless operator, mechanic and two attendants) and 500 lbs. of express parcels, together with fuel sufficient for a four-hours' flight. When fully loaded such a machine would weigh about 8½ tons.

A picture showing the interior of the engine-room, in the machine we are describing, will be found overleaf. In front, separated from the mechanical plant by a bulkhead, is the cabin containing the navigating officer and the pilot. The former is right out forward in a position where he can obtain the best possible view. It will be his task to set the course of a machine and then to see that she adheres to it. This he will do by his maps and compass, and he will also have the assistance of directional wireless.

Behind the navigator sits the pilot of



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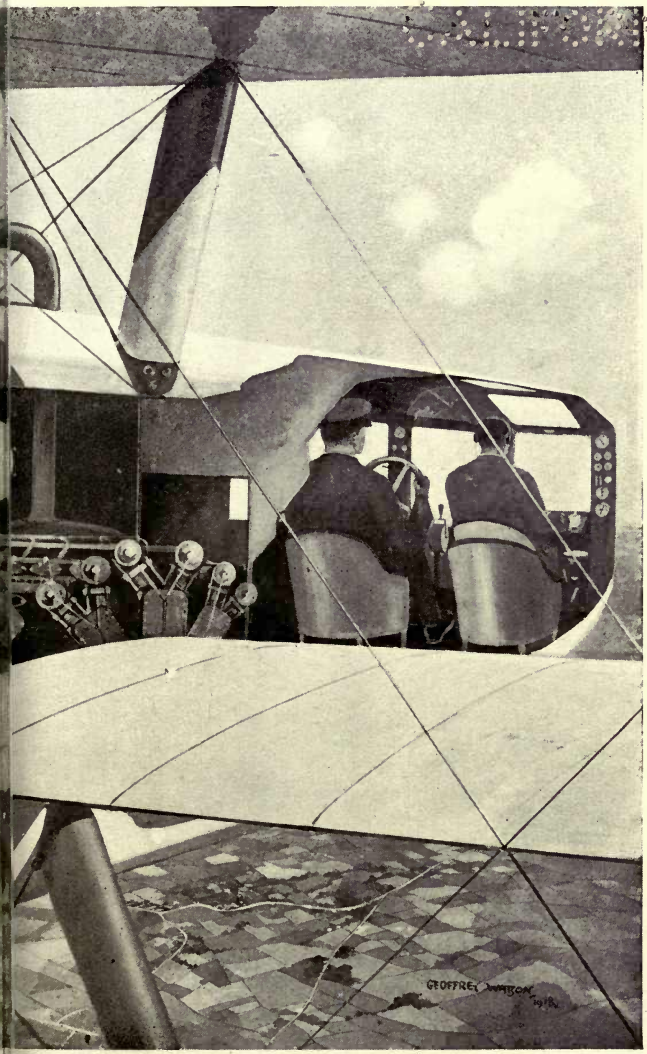


DON-PARIS MACHINE

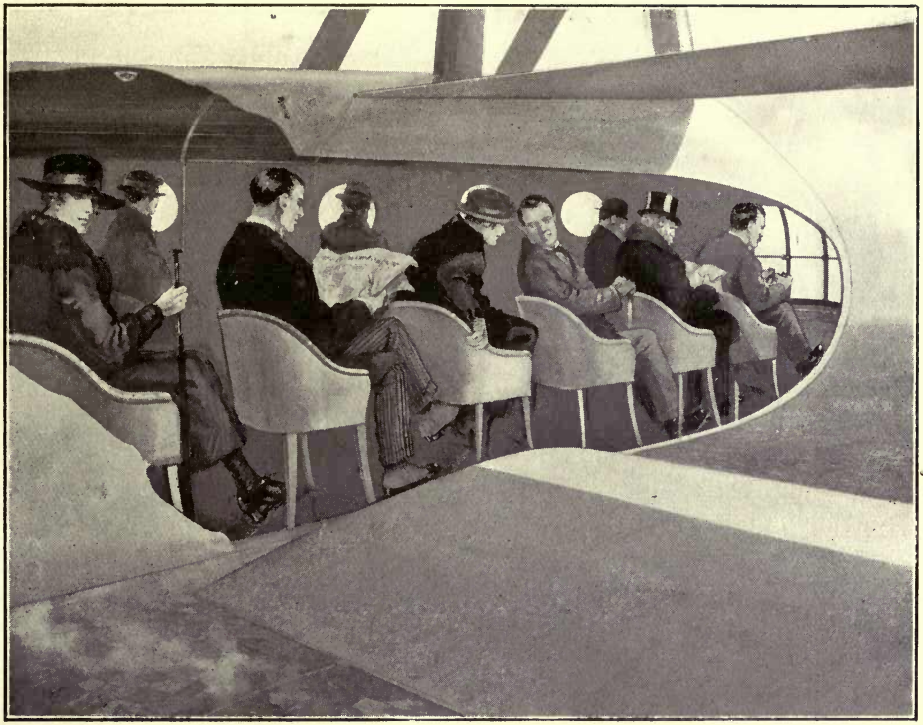
his machine. In the early days of commercial flight it will be particularly necessary for both the navigating officer and pilot of passenger aircraft to be men of absolutely first-class ability, with perfectly sound judgment and steady nerves. Reckless or careless pilots, no matter how skilled they may be, will not be suitable for commercial work. What we shall require are men who have a deep feeling of responsibility, and who realize how much depends upon their constant vigilance and care in the handling of their machines.

Behind the navigator and pilot, and separated from them by a bulkhead, is the engine compartment.

On either side of the central engine-room is a nacelle or hull which is intended for the use of passengers. The interior of one of these nacelles is illustrated in the plate facing page 142. In each it is intended that there should be accommodation for twelve passengers, six being seated,

as shown, on each side of a small central gangway, and with portholes on either side of the hull, from which they can obtain a view outward while the machine is in flight. In the front of each car there is also a small "look-out" platform, with observation windows, which passengers may reach by walking up the gangway, and from which they can see outwards and downwards and also on either side. It should be noted, here, that there is no longer any question, with these big machines, of their balance being affected in any way by passengers moving about in them. It will be perfectly feasible, in fact, for passengers to walk about in the car just as much as they please.

At the rear of each car there will be a compartment for an attendant, in whose charge will be the dozen passengers in his section of the machine, and who will be able to serve light refreshments during the progress of the flight. We shall be



ONE OF THE PASSENGER NACELLES OF THE LONDON-PARIS MACHINE

able quite easily to find room, in each of these cars, for a certain weight in the form of light refreshments, and also for other conveniences of modern travel. It would be pleasant on the afternoon air service from Paris to London, or vice versa, to serve tea, say at about mid-channel; while on the morning services there is no doubt that a cocktail, some time during the flight, would be appreciated by many passengers. We must not forget the amenities of life, even when in the air.

Behind the attendant's compartment, in each nacelle, will be space for the storage of 250 lbs. of express parcels, making a total of 500 lbs. for the two nacelles.

Separated as they will be from the engine-room, and freed from any troublesome vibration or noise, the occupants of the passenger nacelle will find that they can make a journey by air not only in absolute comfort but also with complete safety.

It should be mentioned that the motors of a machine of this type, and also of the machines used for touring and pleasure flying, will be silenced. They will in fact be so well silenced that they will not merely cease to be an annoyance to those who are in a machine but also to those who remain on the earth. At anything like a fair flying altitude, a well-silenced commercial or pleasure aircraft should be practically inaudible from the ground.

Even when loaded with twenty-four passengers and its crew of five, and with 500 lbs. of express parcels and fuel sufficient to take it from London to Paris without alighting, such a machine as we have described, attaining a speed of 100 miles an hour, will do the journey between London and Paris in two-and-a-half hours as against seven or eight by land and sea; and if passengers can be carried remuneratively at a fare of 6*d.* a mile—that is to say just twice what is the normal

first-class railway fare—this should surely prove attractive to the public, remembering that although they are paying only twice as much, they are being carried appreciably more than twice as fast. How it may be possible to do this from the point of view of finance, we shall now explain.

IV

Assuming again that a company with existing facilities embarks on such a service, it is necessary to decide on the capital required for the enterprise. It is reckoned that a sum of £200,000 would be sufficient, and the first expenditure entailed would be in obtaining a fleet of aircraft. Six machines should, as we have indicated, prove sufficient for the operation of two services each way daily. As to the price of these aircraft—assuming they are of the twenty-four passenger type just described—it may be estimated that the cost of each

machine would be £20,000. This figure is based on construction in the immediate post-war period, when the cost of engines and other material still remains very high. Of course, should a large number of machines be acquired the price would naturally be lower; but for the first fleet of six the figure of £20,000 apiece is one which experience in such construction would appear to make quite reasonable. The acquisition of six machines would thus represent a total expenditure of £120,000.

Other items would be a sum of £30,000 representing plant and machinery at the terminal aerodrome for repairs and maintenance, also shed accommodation there. As to emergency alighting grounds en route, it is now assumed that the Government, as represented by the Air Ministry, will provide this facility as a State undertaking, and that aerial transport companies and the private tourist will pay fixed fees for the use of such grounds. It is thought

that Government support of flying could be more usefully given in this direction than in any other. With a proper landing-ground system in operation not only in this country but also throughout Europe, there would be every encouragement for the development of regular daily flying.

The working capital necessary for the operation of the service is estimated at £50,000, this, with the previous items, accounting for the sum of £200,000 which has been mentioned as the total capital of the undertaking.

One of the most difficult problems, in framing any estimate of expenditure and income on the first year's working of a service, is to make a suitable allowance for the depreciation of machines. Here, at present, there is little data upon which to rely. Certainly one can obtain figures as to the war life of big bombing machines. Such craft are not as a rule subjected to the very severe wear-and-tear, in

the shape of violent manœuvres, which the fighting machines have to undergo. They set out on a flight with a given load and proceed steadily to their destination, dropping their bombs and then returning to their base. Their flights, indeed, approximate more nearly than do those of any other war machines to the making of regular commercial journeys. But a point to be reckoned with is that with the war machines it has not been possible, as a general rule, to look after them so carefully as should be the case with a commercial machine. It may in fact be calculated that the life of a commercial machine, flying say one day and then having a day or so's rest, during which it can be thoroughly overhauled, would be considerably longer than the life of a war machine. What has been decided, in the case of the balance-sheet being considered now, is to assume that the first fleet of machines would have depreciated to the extent that

they were no longer suitable for their purpose after a period of only twelve months' working: that is to say, one writes off the whole fleet at the end of the first year. This has been considered by some experts as too drastic: they would give a machine of the type we are describing an eighteen months' or two years' life. But it is obviously best, when an uncertain factor like this has to be considered, to take a conservative rather than an optimistic view; and to write off the whole of one's fleet at the end of the first year is clearly to err on the safe side.

Treating depreciation on this very drastic scale means, of course, that one must enter the whole sum of £120,000—the purchase price of the six machines—on the adverse side of the profit and loss account; and this makes it by far the heaviest item.

The next largest item is that for fuel. To drive a machine such as we have

described at a speed of 100 miles an hour, when she is fully loaded, requires, of course, a large expenditure of power. It would, indeed, cost probably from £30 to £35 to provide the petrol and oil which would be consumed by the three 600 h.p. motors on the 250-miles flight from London to Paris; while the annual fuel bill for maintaining two services each way daily on this route would, in round figures, be something like £50,000. This is the price which must be paid for speed. If we were content with a speed lower than 100 miles an hour, the cost of running the machine would be appreciably less: but on a route like that between London and Paris, where the air service would be in direct competition with a well-organized land and sea route, it is obvious that the highest speed possible must always be attained.

The next largest item in the year is one of £25,000 for the maintenance and repair of machines. That our balance-sheet

has been framed conservatively is indicated by the fact that this item has been included in it, even in view of the fact that the whole fleet is considered to be worn out at the end of the year. What maintenance and repairs would imply, generally, is the replacement of motors and small working parts, and also the changing of planes. With this allowance, and also with the very liberal attitude adopted towards depreciation, the operators of the service should be guarded fairly effectually against any unpleasant surprise, even remembering that the whole undertaking would be purely experimental.

Another figure of some magnitude is that of £23,125 for management. This would include London and Paris offices for dealing with both passenger and parcel traffic, also the payment of aerodrome staffs.

Next comes an allowance of £10,000 for insuring the fleet of six machines against

total loss and also against third-party risks. It is not assumed that the transport company would insure its passengers, though arrangements might be made to add the cost of insurance to the price of the tickets issued. Aircraft crews would have such liberal salaries that they would be expected to take steps to insure themselves. The item of salaries for the crews of the machines is indeed the next largest—representing a sum of £7000. It is assumed that the pilot and the navigator, being men of exceptional skill and experience, would receive salaries of £500 a year each, and there would also be an expert mechanic to provide, and in addition too a couple of cabin attendants, one in each of the passenger nacelles.

An item of £6000 is represented by the expenditure incurred on the motor-van services which it is assumed will be established both in London and Paris to expedite the collection and delivery of

the express parcels which the machines would carry.

Two other entries of £5000 each, one for landing-ground fees and the other for advertising, complete the annual statement of expenditure.

V

Now as to the profit side of the year's balance-sheet. Here there are two sources of revenue; the first being passengers and the second express parcels. Previously we have mentioned a fare for passengers of £6 5*s.* 0*d.* for the single journey: this being at the rate of 6*d.* per mile. With seating accommodation for twenty-four passengers, and assuming that the machine had every seat occupied, this would represent a revenue of £150 a trip. But the argument may be raised that during the period when the public is being educated to make use of an air service there would be many days when all the seats were not filled—when a machine

might have only fifteen or sixteen passengers instead of twenty-four. This question is extremely important. A balance-sheet based on carrying always of a full load may be altered completely, and a profit turn into a considerable loss, if the requisite number of passengers are not forthcoming.

What has been done in this case, by way of a sound compromise, is to assume that on an average, and on the first year's working, the machines will only carry a three-quarter load of passengers—that is to say eighteen instead of twenty-four; and the same method has been adopted in reckoning parcels traffic. The machine would be able to carry a maximum weight of 500 lbs. of parcels on each trip in addition to her passengers, crew, and fuel; but on a three-quarter load basis the volume of parcels per trip would be only 375 lbs., and this is the figure, therefore, which has been taken here.

On the year's working, calculating four

trips per day, and assuming always a three-quarter instead of a full load, the total revenue for passengers would be £164,250; while as to the parcels traffic, assuming a three-quarter load at 5*s.* per lb., this would represent a sum of £136,875. The rate of 5*s.* per lb. for parcels would include, it should be mentioned again, the collection by motor-van of all parcels from the London office of the operating company and their delivery by motor, at the other end, to the receiving office of the company in Paris, and vice versa.

The two totals of revenue, £164,250 for passengers and £136,875 for parcels, give a grand total for the year of £301,125. This, when set against the expenditure of £251,125, shows an annual profit of £50,000 —that is to say 25 per cent. on the capital involved.

The statistics previously quoted, and explained, are set forth below, in tabular form, to render them more explicit:—

AIR SERVICE LONDON AND PARIS.

(Distance 250 miles.)

TWICE DAILY EACH WAY.

(1000 miles a day.)

Four Single Trips per day equals 365,000 miles per annum.

A fleet of six machines fitted with 1800 h.p. engines accommodating 24 passengers, crew of five, and 500 lbs. express parcels.

Capital required : £200,000.

Annual profit after writing off total cost of fleet at the end of the year—£50,000; equals 25 per cent. on the capital.

	£		£
Capital .	200,000	Six aeroplanes at £20,000 each cost . .	120,000
		Plant and machinery at terminal aerodrome (for repairs and maintenance) and shed accommodation	30,000
		Working capital	50,000
	£200,000		£200,000

PROFIT AND LOSS ACCOUNT.

First Year.

	£	Income based on three quarters of load capacity.	£
Fuel	50,000	18 passengers at a fare of £6 5s. Four journeys per day	164,250
Wages (crew)	7,000		
Repairs	25,000		
Parcels Delivery	6,000	375 lbs. of express parcels at 5s. per lb. Four journeys per day	136,875
Landing Fees, etc.	5,000		
Insurance	10,000		
Advertising	5,000		
Depreciation	120,000		
Management	23,125		
	251,125		
Profit	50,000		
	£301,125		£301,125

Such figures should not, of course, be taken too literally. Only the practical experience of actually running a service will clear up certain points which are at present obscure. But, all the same, such a balance-sheet as we have mapped out should prove both interesting and suggestive. A great deal of information can

in fact be obtained merely by studying the details of such a project, which has certainly been worked out on none too optimistic a basis. Two points, especially, need emphasis. The first is the drastic step of writing off the whole fleet of machines at the end of the year. The second is the fact that even though only two machines each way are assumed to be running daily—an extremely small volume of traffic, having regard to the importance of the route and the facilities which an air service will offer—the further adverse assumption has been made that even this small daily service will not carry its full load, but that on the average the machines will be only three-quarter full. If, at the very beginning of such an air service as this, when few of the factors are favourable, and the volume of traffic is small, it is possible to indicate a profit on the capital invested, then it seems fair to assume that later on, when operating

experience has been gained and the public patronage of a service makes it possible to fill a number of machines daily instead of only a few, it should be possible to run an airway not only as a convenience to the community, but also as a financial success.

A point which may occur to the reader is that no allowance has been made for the number of days in the year when a service would be suspended owing to abnormal weather conditions. That there will be days when a service is interrupted, especially in winter, and during the period when operation is experimental, goes without saying; it is estimated indeed, that an allowance of ten per cent.—that is to say of approximately a month—should be made for such interruptions; and under such circumstances the transport company would have all its overhead charges to pay, and would be obtaining no revenue. In this particular estimate we have not allowed for weather interruptions for the reason

that we have already made the adverse assumption that our machines will carry no more than a three-quarter load. As a matter of fact, however, and more particularly during the summer months, it is fairly certain that each machine would carry its full load of passengers from day to day. If, therefore, on top of estimating a three-quarter load for the whole year, one also makes a ten per cent. deduction for weather interruptions, the resulting figures become unnecessarily adverse, and are apt to show the finances of a service from an unduly pessimistic point of view; which is almost as great a mistake, of course, as being too optimistic.

VI

Though there are many routes, not only in England and on the continent, but also in such a country as America, where an air service should be able to enter into

direct and successful competition even with high-speed railways, the fact is none the less true, so far as the immediate future is concerned, that the most insistent demands will be for the institution of airways not in developed countries, where travel is already easy, but in those great tracts of land oversea where progress is being hampered continually by a lack of adequate communications. Here one may say without exaggeration that the field is illimitable; and from the point of view of operating an air service at a profit many of these proposed routes oversea have a greater attraction, and are less likely to cause their promoters anxiety, than would a fierce competition with highly organized European railways. For one thing the competing methods of transport will be nothing like so formidable. When an airway service in some remote part of the world has nothing more serious to compete with than a primitive railway, averaging

about fifteen miles an hour, then the problem for the designer of the aircraft for such a service will be far less onerous than would be the planning of a machine which would compete successfully against an express train on some main European or American line. And it should be appreciated that very high speeds in the air, even though the air is an ideal medium for speed, can only be bought at a definite price: which means that high-speed machines, with the problems in construction they involve, can only—at the present time—be made to give results, and to come up to the promise of their designers, by some sacrifice in general utility, as compared with a machine which is only required to fly at a moderate speed.

VII

The problems involved are mainly those of head resistance and structural weight,

though there are others too technical for discussion here. The chief point which emerges is that if you say to the designer, "I want a fairly slow machine, which need not climb very fast," he can build you a craft which, not only in general airworthiness and comfort, but also in its capacity to carry a big load, will outstrip very considerably the machine in which almost everything has been sacrificed to obtain speed. In the course of time, naturally, the discrepancy between weight-carrying and speed will be more reduced. There are structural problems in regard to high-speed commercial machines which are at the moment not merely unsolved, but a solution of which has scarcely even been attempted. The structural weight of the large machine such as we have been using for bombing is at present far too great; while the disposition of its power-plant, and the whole loading and arrangement of the machine, now require the most careful study

in order that improvements may be made. Nobody would in fact suggest that the large weight-carrying machines such as have been evolved during the war, useful though they have been for their specific purpose, represent in any way the ideal from a commercial point of view. With the war machine, for example, results have been obtained as a rule simply by augmentations of engine power, irrespective of any such questions of fuel economy, or cost per mile of running, as must be considered very seriously in the operation of a commercial service. The system also of placing motors out on the wings of a machine, as adopted in most multi-engined aircraft of existing types, is not likely to survive when a real commercial-type machine is built—even though it has the advantage of giving a direct drive to the propellers, without any system of transmission. An engine out on the wing, apart from the head-resistance it offers, has the disadvantage that, should

it break down during flight, it is not practicable to repair it: that is to say, its exposed position makes it impossible for a mechanic to do anything more than the most trivial repair. In the commercial machine, when on a long flight, it will be most necessary to repair effectually any unit which has broken down. Even though the machine might be able to continue in flight after a breakdown of one of the motors its speed would of course be reduced, and this would in itself be a serious matter. What is considered an ideal, if it can be achieved, is to group all the motors of a big machine into one central engine-room. Here mechanics could tend them constantly while the machine was in flight; and if any one motor developed trouble it could be dealt with promptly and under quite favourable conditions. There are two problems, however, which have to be considered in this connection. The first is that with an aeroplane—as say with a

bridge—it is imperative from the point of view of structural strength to distribute as much as possible over the supporting surfaces the load that the machine is called upon to carry. If all motors are grouped in a central hull it may become inexpedient, therefore, to place all the passengers, and all the fuel load, in this same compartment also.

The contemplation of such difficulties has already given designers the idea of a large commercial machine which shall have two fuselages or hulls, instead of one. Machines embodying this principle have, indeed, already been used as bombers. In a central nacelle, which is a short one, projecting a little way in front of the main planes, and terminating rearward at a little distance behind the planes, where it carries an engine and pusher air-screw, are carried for warlike purposes a pilot, bomber, fuel supply, machine-gunners, and the general impedimenta of war equipment. On either

side of the central nacelle are the two fuselages, which run right back till they carry the rear stabilising planes, elevators, and rudders. At the front of both of these two fuselages are motors operating tractor air-screws ; and, in the war machine, gunners are placed also at certain positions within them.

From the point of view of building a purely commercial craft, these twin-fuselage machines are considered to open up a very important field for development. It is already suggested, for example, that large biplanes, triplanes, or quadruplanes, might be built on these lines, the centre nacelle being occupied solely by the multi-engines which drive the machine : that it should be equipped, in fact, as an engine-room, in which mechanics would work under conditions such as are found in a ship's engine-room, and in which any repair could be carried out while the machine was in flight. As to the two fuselages, it is suggested

that these should be equipped as passenger saloons, which in a machine of large dimensions might quite readily be done; the seats for the passengers being placed, for example, on either side of a narrow central passage-way, and with suitable outlook windows in front and on either side of the nacelle. In the rear sections of these fuselages, where they taper towards the elevator and rudders, might be arranged compartments for the storing of luggage and mails.

The idea underlying such a method of construction is, as we have explained, mainly to effect a distribution of load, and this it would obviously do. A design for a large machine of this type is illustrated externally and internally in the illustrations facing pages 136, 140, and 142. The problem which is met with, and it is one which is engaging very careful attention, is in regard to the transmission of the power from a central engine-room to air-screws

which might be fitted out on the wings of a machine. With the big bomber this question has not become insistent, because it is not yet the custom to group engines in any central compartment. The system adopted, as we have explained, is to place motors out on the wings of a machine, away from the central hull, and to couple these direct either to tractor or pusher air-screws, with the result that no system of transmission is required. One might also avoid gearing with two say of four motors in any central engine-room. One motor, placed in front, might drive a tractor air-screw fixed right at the bow of the engine-room structure, while another, situated on the rear end of the car, might drive a pusher air-screw placed directly behind the engine-room. But in addition to these two screws others would be required to take up the power of the two remaining engines in the car—assuming for the sake of argument that there are four.

These two remaining motors would be required to operate screws placed out on the wings of the machine. Hence the necessity for a system of gearing. This problem is apt sometimes to be regarded too seriously. The questions involved are mainly those of weight, loss of power in transmission, and possibly head resistance. In all these respects there is not only a wide field for useful experimental work but every chance of a satisfactory result. Even with a simple form of hollow steel shafting and gearing, provided that it is suitably constructed of the right materials, there should be no difficulty, or undue weight or waste of power, at any rate in transmitting such horse-powers as we shall require to do immediately. And as progress is made in the direction of increases in power, so progress ought to be made also in regard to the question of transmission.

VIII

Another interesting field for experiment is in regard to a machine which shall have a variable wing area. As we are not concerned here with technique, it is only necessary to describe this system in general terms; which can be done, fortunately, without much difficulty. The idea, briefly, is that when a machine is ascending for a flight, or when it is descending, it should be able to present to the air a relatively large amount of wing surface—thus facilitating its rapid ascent, and also ensuring that it shall alight slowly and come to a standstill quickly. When, however, the machine has gained its required height, say for a long commercial flight, and is using the full power of its many motors, then it would be advantageous, if this could be done, to reef or dispense temporarily with a certain amount of its wing surface; which becomes superfluous when it has ceased to climb and

is flying horizontally at a high altitude and at a rapidly-increasing speed. The problem of varying wing area in the way suggested does not, nowadays, present anything like such difficulties as it did a year or so ago. An increased knowledge of construction, and of what can be done with improved wing structures, now show clearly how certain troubles may be overcome. But we must be prepared none the less for a period of very careful experiment before success can be attained; and these experiments, like others, will involve considerable expense. The main point to be remembered, in regard to the large multi-planed machine, is that no very great amount of surface would have to be reefed, so far as each individual wing is concerned, in order to gain the effect required. One short section, for example, at the extremity of each wing, if it could be made to telescope into the next, would probably do all that is necessary: that is to say, even if there was only

a small reduction of surface on each wing, the total reduction, when all the wing extremities of a multi-plane machine were thus reefed, would represent quite a considerable variation of surface. With steel tube construction, and other methods for gaining internal strength which now suggest themselves, it should be possible in these movable end-sections to do away altogether with interplane struts or wires: to have in fact a short section, at the extremity of each wing, which would have no fixings or attachment at all such as might hinder the operation of telescoping. The section would, indeed, be of such strength as to be completely self-supporting; and being of a slightly smaller camber and chord than that of the section immediately next to it, would, when required, and when operated by suitable gearing from the engine-car, slide completely inside this other section. Such a variable-surface machine, if its operation was successful, would not

only rise quickly from the ground, thus requiring no great space for starting, but would alight if necessary in a comparatively small space, and would also come promptly to a standstill after it had alighted; and these would be desirable features not merely in the purely commercial machine, but also in pleasure and touring craft. A variable-surface machine, attaining very high altitudes when on long flights, and using also variable-pitch propellers, in addition to a series of motors so adapted that they will develop their required power even when working in rarefied atmosphere, offers probably the solution of the problem of maintaining greater speeds, when on trans-ocean or trans-continental journeys, than is possible to-day. At present, if, say, two extra motors are added to a twin-engined machine, making four in all and doubling its power, the resulting increase in speed is apt to be disappointing; the head resistance of the machine—that is to say the

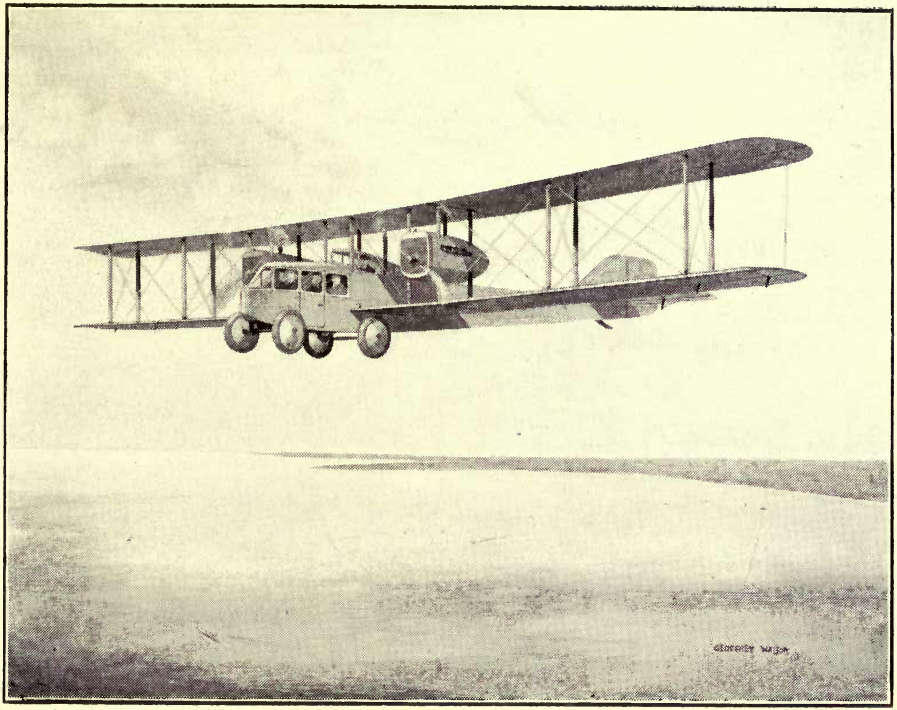
resistance set up by its own passage through the air—being a factor which tends very seriously to reduce speed. But with variable surfaces and special motors, and with the attaining of great altitudes where head resistance falls away, it should be possible to overcome these drawbacks, and to maintain, with large multi-engined machines, speeds very much greater than are possible under existing conditions. As to the comfort of passengers when moving through the air at great speeds and at very high altitudes, this could be ensured quite well with specially-designed, totally-enclosed cabins, in which the air supply could be made independent of the changes in atmospheric pressure outside.

IX

The only way flying can be popularized is by inducing people to fly. Therefore it will be most important to encourage

aerial touring and all forms of pleasure flying. The more uses that can be found for aircraft the more quickly will the public realize that we have entered at last upon the air age, and that this new craft is now at the practical service of mankind. For the same reason we must encourage international air racing, competitions, and displays. It should be remembered that races and sporting contests, when they are properly organized and carried out, not only stimulate the interest of the public, but also tend very greatly to improve, by the severity of the conditions they impose, the whole design and construction of the commercial-type machine. Thus they serve two purposes, both eminently desirable.

To men who now wish to buy and use an aeroplane as they would a motor-car, the cost of flying, even immediately, should not be prohibitive. A well-equipped touring machine, seating four passengers and a driver, may cost, say, from £5000



A FIVE-SEATER AERO-LIMOUSINE

to £6000 so long as the cost of materials is abnormally high, and until standardization becomes possible. The life of such a machine, when well cared for, should be almost as long as that of a motor-car; but its upkeep, at any rate for some little time to come, will cost more probably than that of a car. Eventually, however, the maintenance of an aeroplane should cost appreciably less than that of a motor-car. The tyre bill of the aeroplane will, for instance, be negligible.

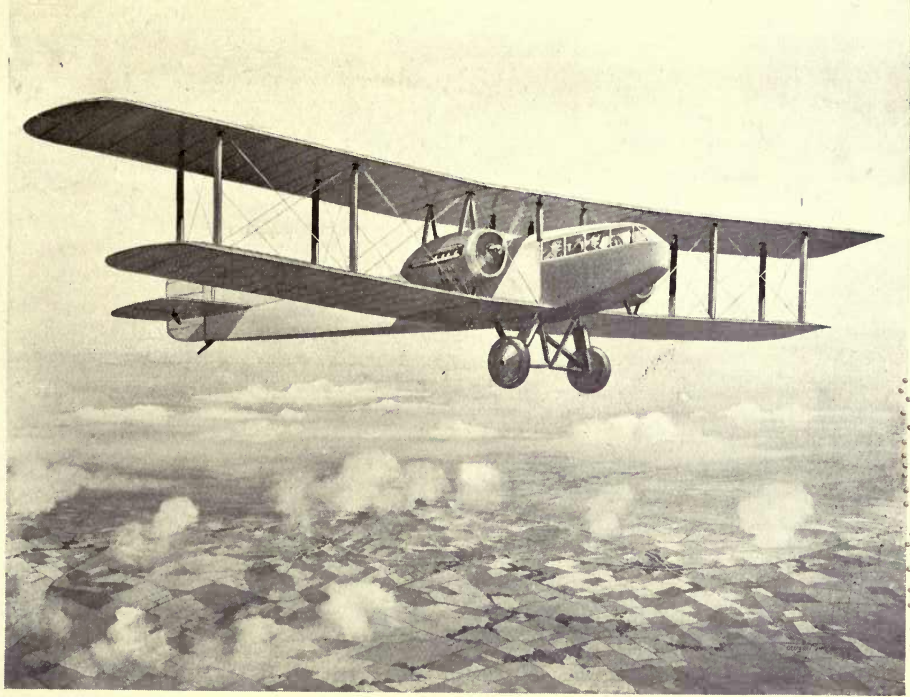
A touring machine, which can be made so comfortable that one can describe it as an aerial Rolls-Royce, is illustrated facing page 176. Internally it is just as roomy and luxuriously equipped as a Rolls-Royce motor-car; it provides indeed almost exactly the same amount of space. The four occupants are seated as they would be in a car, with the driver in a separate compartment behind them. The body is completely enclosed, as in an interior-drive car, the

windows being of unsplinterable glass, both wind and draught proof. Two engines—each of them a 270-h.p. Rolls-Royce—are fitted, one on either wing, and in case one of them broke down the other would continue to maintain the machine in flight.

Both motors are silenced, and even when flying near the ground the machine would be practically inaudible; while its occupants would be spared altogether the din and clatter which is the accompaniment of a flight in a machine with an unsilenced motor. A journey in such a machine will, indeed, represent travel in absolutely its most luxurious form.

X

The private owner who wishes to erect in his own grounds a garage for the housing of an aeroplane will find probably that a



A FOUR-SEATER AERO-LIMOUSINE

building which has a pleasant appearance, is electrically lit and heated, and has a water supply, will cost him from £1000 to £1500; though it might be quite possible to erect a less pretentious building for about £500. It will be a great advantage to build pleasure-type aircraft with folding-wings, which will mean that they can be garaged in a shed of quite moderate size. The machine just described is of such construction, and, when its wings are folded, the span of the machine is reduced to only 29 feet.

It will be very necessary, in cases where the private owner wishes to ascend from, and alight on, his own private park or field, that this should be of a size sufficient for the safe manœuvring of a machine. A smooth open space 400 or 500 yards long, and about 300 yards wide, will be required, with no seriously high obstacles, such as trees or chimneys, in the immediate neighbourhood.

The wages of a pilot-mechanic, a man competent to fly an aeroplane and also to keep it in trim, should be somewhere in the neighbourhood, say, of £6 a week, and if this man could obtain occasional help from other workers on an estate he should be able to do all that is normally required. One or two men might, however, be needed to help in getting a machine in or out of a shed, but gardeners or others could be quite competent to render such assistance as this. And when electric or other forms of power-winches can be obtained for hauling a machine, even such extra help as this might be dispensed with.

As to the actual cost of running a five-seated machine such as that described—taking petrol and oil at their present prices, and assuming "give-and-take" weather conditions—this should work out at about 2*s.* a mile. Another item which the private owner would need to consider is

that of insurance, and here a policy covering the machine, owner, and driver in Great Britain, and providing also against third-party risks, might represent an annual expenditure of something like £200.

As to the pleasures an aerial tourist will enjoy, to rhapsodize on these would be to paint the lily. Every novice when he descends from his first aerial trip invariably demands another, which he asks should be longer and higher. There is in navigating the air an exhilaration which cannot be described in words; the mind, even when actually experiencing it, does not register more than confused impressions. The smooth and seemingly effortless speed; the absence of jolting or vibration such as of wheels passing along a road, which are the accompaniment of journeys by motor-car; the magnificent panorama that is unrolled of the land below—slow-passing, far-distant, but revealed in marvellous detail; above

all, the complex, triumphant sensation of riding, surely and swiftly, through an unseen element—these combine to produce a joy so deep that it is dumb.

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