POSITION AND PROSPECTS OF AVIATION.

BY L. BAIRSTOW, F.R.S.

THE present phase of scientific development of aviation may be said to date from the period 1890-1900, and to have its most definite form given by the researches of Langley and Maxim. From Langley's book were taken the early data on which pioneer designs were prepared, and a protracted controversy arose between Blériot and Farman as to the relative merits of the biplane or the monoplane as a result of a statement by Langley which has since proved to need considerable modification.

The first notable flight in public appears to have been that of Santos Dumont in 1906, for which he was granted the Deutsch de la Meurthe prize; this was little more than a long hop, and for the next two years it was clear that one of the larger difficulties of flight was the control of aircraft in the air.

Flying with reasonable certainty dates from the exhibition flights of the Wright Brothers in France during 1908, and may fairly be ascribed to the introduction by them of wing warping for the purposes of lateral control. Since then progress, both scientifically and industrially, has been very rapid.

In 1909 the Advisory Committee for Aeronautics was formed by the then Prime Minister, Mr. Asquith, with the late Lord Rayleigh as its president. The Committee controlled the activities of the Aeronautical Research Departments of the National Physical Laboratory, and was closely informed of the full-scale research work carried on at the Royal Aircraft Factory.

The development of the best shape of aeroplane had approached finality somewhat closely in the years 1913-14; on the other hand, owing to the death in an aeroplane accident of Mr. E. Busk, preliminary experiments on the industrial application of the theory of stability came to a premature end. During the war the attention of scientific workers in aeronautics was devoted to the many applications of existing knowledge rather than to its extension, and it was pointed out by them that the performances of aeroplanes could be predicted approximately with little effort, and that these predictions could be made the basis for an appeal for new designs to meet the increasing exigencies connected with fighting in the air.

On the other hand, no such simple generalisation has been found possible for dealing with stability, with the unfortunate result that designs made to give the necessary speed and rate of climb have been put into use before their condition as to stability was fully understood. Defects of stability made themselves felt by a series of accidents peculiar to each type. The analysis of these accidents and suggestions as to remedies came from the existing scientific work on stability. Examination of the categories into

which accidents fall gives, perhaps, the clearest idea as to the technical development possible in the next decade. Some 80 per cent. of the total accidents during training are due to loss of speed of the aeroplane and an attempt on the part of the pilot to turn his aeroplane towards suitable alighting ground. The remaining 20 per cent. are in large part accounted for by failure of the engine to continue to develop power and so to compel descent on unsuitable landing ground. The latter point scarcely needs more than passing comment, for the general history of development in machinery shows that many years are necessary after main ideas have been established before details are satisfactory. Progress made in understanding the phenomenon connected with fatigue suggests that a moderate reduction of the power expected from existing aeroplane engine designs would lead to an enormous increase in the length of their life. It may therefore be expected that the ordinary precautions taken in the development of an engine will lead to the practical elimination of accidents under the heading of forced landings; here, again, progress will be accelerated by use of the known scientific data.

The larger group of accidents mentioned above needs a consideration of design intimately associated with the pilot's power of control of the aeroplane and its inherent stability. It should not be forgotten that the relation between these two quantities in an aeroplane designed for fighting in the air may have little or no connection with the corresponding relation of the properties desirable for civil aeroplanes. This field is as yet comparatively unexplored, and there are strong grounds for believing that an aeroplane can be so designed that the dangerous consequences of error of control by the pilot are greatly reduced; it is not improbable that the accidents on the score of loss of flying speed can be reduced to some 5 or 10 per cent. of their present magnitude when the necessary skill in design has been acquired.

The most important of the many difficulties which make it impossible to forecast the future of aviation are not technical, but commercial. Development under the stress of a great war has left an industry capable of producing an enormous number of aircraft. Attention has been given solely to military uses, and aeroplanes are therefore not specifically designed for civil purposes. At the same time, the civil uses are not clear; how far aviation will be good for the purposes of carrying mails, passengers, or merchandise is at present almost wholly a matter for conjecture.

Pre-war experience was gained in the development of aircraft which could be flown with a moderate degree of ease and safety, and no lines of commercial communication had been inaugu-

rated. The main asset of both the aeroplane and the airship is speed, and here the importance of long distances will be evident on little consideration. In a country like England, with well-organised railway trunk lines and journeys of the order of 500 miles, the saving of time in the carriage of mails is small, particularly since the mail trains travel by night, whereas aeroplanes wait for the dawn before commencing the journey.

Where the route includes a sea passage the advantages are much greater, and the enterprise of our two leading transport companies has shown the possibility of a remarkable degree of certainty in the service between London and Paris. It is, however, on much longer journeys than these that

the saving of time by aerial transport presents its most attractive possibilities.

On the other hand, the initial outlay and running expenses are roughly proportional to the length of journey, and the inception therefore represents a formidable undertaking. The returns are problematical, and from the nature of the case it will be obvious that until the special facilities have existed for some time no estimate of value can be made as to the charges which will prove remunerative to an operating company and sufficiently attractive to the users of the new form of transport.

Civil aerial transport is therefore still in its infancy as an addition to our industrial life.

THE LIQUEFACTION OF GASES.

BY PROF. C. H. LEES, F.R.S.

IN 1869, when the first number of *NATURE* appeared, Andrews had just completed his experiments on carbonic acid, and established the fact that for each gas there is a critical temperature above which it is impossible to liquefy the gas by pressure. Faraday, by using low temperatures and considerable pressures, had liquefied chlorine, sulphurous and hydrochloric acids, cyanogen, and ammonia in 1823, by 1844 had added eight other gases to the list, and had solidified sulphuretted hydrogen, ammonia, and nitrous oxide. Cailletet, in 1878, by suddenly reducing the pressure on oxygen, nitrogen, and carbonic oxide compressed to 300 atmospheres, obtained mists which he ascribed to fine drops of the liquefied gas. Pictet, about the same time, by employing greater pressures and cooling his apparatus with other liquefied gases, succeeded in obtaining a small quantity of liquid oxygen which was of a slightly blue colour.

In 1883, at Cracow, Wroblewski and Olszewski succeeded in obtaining small quantities of liquid oxygen, nitrogen, and air, which evaporated in a few seconds. By 1887 Olszewski could obtain a few c.c., and by 1900 100 c.c., of liquid oxygen before an audience of his students. Dewar had been able to produce quantities exceeding 20 c.c. since 1886, and had already made determinations of the properties of substances at the low tempera-

tures thus attainable. In 1892 he introduced the double-walled vacuum vessels with a little mercury within to convert the internal surfaces into mirrors, now known as Dewar flasks. These reduced the rate of evaporation of a liquid gas stored in them to about a thirtieth of the rate for ordinary vessels. The utilisation of the Joule-Kelvin cooling effect by Linde and by Hampson in 1895 enabled each to produce a machine capable of liquefying air, oxygen, and nitrogen on a commercial scale. In 1898 Dewar produced for the first time liquid hydrogen, using the Joule-Kelvin effect in the gas pre-cooled to 68° A. by a bath of liquid air evaporating *in vacuo*. Next year he solidified it, and determined its melting point to be 14° A. In 1908, at Leyden, Kamerlingh Onnes liquefied helium and determined its boiling point to be 4° A. In the meantime, Olszewski had liquefied and solidified argon in 1895, and Ramsay and Travers had by 1900 liquefied krypton and xenon.

The commercial production of liquefied gases gave facilities for the examination of the physical properties of substances at low temperatures, and in this work Dewar and Kamerlingh Onnes and his pupils have played prominent parts. It is to the Leyden professor we owe the discovery of the disappearance of the electrical resistances of many metals at temperatures a few degrees above absolute zero attained by the use of liquid helium.

PROGRESS OF METEOROLOGY.

BY W. H. DINES, F.R.S

THE progress of meteorology during the last fifty years has been very marked, as may be seen by a casual reference to the current meteorological literature of the period 1865-75; to a great extent, it resembles the emergence of

astronomy as an exact science from the old astrology, but it must be confessed that the Newton of meteorology has not yet appeared.

Fifty years back the student of meteorology spent much of his time in a vain hunt for weather

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