AERONAUTICS.

TECHNICAL REPORT

OF THE

ADVISORY COMMITTEE FOR AERONAUTICS

FOR THE YEAR 1914-15.

(WITH APPENDICES.)

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REPORT FOR THE YEAR 1914-15.

To the Right Honourable H. H. Asquith, M.P., First Lord of the Treasury.

Sir,

The work of the Advisory Committee for Aeronautics has been continued during the past year on the same lines as previously.

The names of the members of the Committee during the year 1914-15 are given on the opposite page. During the absence of Major-General Sir David Henderson on active service, Colonel Brancker, Deputy Director of Military Aeronautics, has acted as the representative of the War Office on the Committee.

Continued progress has been made during the year in the consideration of the conditions affecting the stability of the aeroplane. The exact knowledge furnished by these investigations relative to stability has led to definite improvements in safety and ease of handling without loss of speed and efficiency. It is satisfactory to learn from the reports of officers in the field that this work has resulted in advantages which are appreciated by our fliers.

A large amount of attention has also been given during the past year to improvements in the aeroplane in detail, both from the aerodynamic and constructional points of view.

Under the circumstances at present existing, it has not been thought necessary in this Report to describe so fully as in previous years the nature of the investigations carried out and of the conclusions reached. A detailed account of the work done is in preparation.

Equipment for experimental work at the National Physical Laboratory.—Important additions have been made to the equipment for experimental work at the National Physical Laboratory. The large air channel, 7 ft. square in section, has been completed, and is now in use. In this an air speed of 65 ft. per second can be reached, with a consumption of about 60 horse-power. The balance for the measurement of the forces and moments on the models tested was constructed by the Laboratory Staff, and the accuracy with which the observations can be made has been found satisfactory. Three air channels are now available for investigations on models, and provision has been made for the necessary increase in the staff to enable advantage to be taken of the facilities thus afforded. The volume of work to be carried out continues to grow, and all the channels are at present in practically continuous use.

In connection with the researches on light alloys, and the investigation of improvements in the methods of mechanical treatment employed in their manufacture in the forms required for practical purposes, a sum was included in the estimates for 1914-15 for the provision of a rolling mill at the National Physical Laboratory, to

enable the practical working of light alloys to be studied under suitable conditions. The necessary buildings and apparatus have now been erected and the work has commenced. It is hoped that by the opportunities thus afforded, the practical importance of variations in the conditions attendant on manufacture can be more closely examined, and that results of very general value may be attained.

A number of smaller items of equipment have been provided. The more important of these are an apparatus for tests of air-screws in the wind channels, new gear and attachments for tests of seaplane floats in the William Froude National Tank, and apparatus for strength tests of large samples of aeroplane and airship fabric. The equipment generally has been maintained in good order.

Air channels.—The work done in the air channels has included tests on models of airships, and airship appendages, aeroplane wings, bodies, fins and rudders, tail planes and elevators, struts, wires and other aeroplane parts, and on models of complete aeroplanes. As previously, a large amount of this work has been carried out in response to requests received from the Admiralty and the War Office, to supply information needed for constructional purposes, and for improvements in the design of machines. At the same time systematic research has been continued with a view to securing increased aerodynamic efficiency in all parts.

The investigation relating to the stability of the aeroplane, which has been a prominent feature of the work of the National Physical Laboratory, has been continued and extended. The previous work related to the effect of disturbances from steady rectilinear motion. The case of steady curvilinear motion, *i.e.*, of a machine effecting a turn, whether moving in a horizontal plane, or in a spiral path, has now been considered. The analysis involves the solution of algebraic equations of the 8th degree, and the methods applicable to the solution of such equations have been developed with a view to the reduction of the labour involved. The machinery thus provided will, it is hoped, be of assistance to other workers on the subject. Interesting results have been obtained as to the influence of turning on the longitudinal stability, and on the tendency to the form of instability known as the "spiral dive." Some of the experiments on complete models in the air channels have been directed to obtaining data required in connection with these investigations relating to stability, and for the design of the controls.

Air-screws.—A research relative to certain questions in connection with air-screws was completed early in the year, the tests being made in one of the air channels with apparatus specially designed for the purpose. Further tests on air-screws have been made on the whirling arm, both for the Admiralty and for the War Office. These tests have brought out points of interest and importance, and experiments are proposed with a view to the improvement of the methods of calculation applicable to air-screws and to securing a means of predicting more accurately the performance of an air-screw under various conditions of use. This question has been dealt with by a member of the Committee from a theoretical standpoint in some recent papers.

Strength of construction.—In continuation of the enquiry conducted earlier into questions connected with the strength of construction of aeroplanes, methods have been devised for the calculation of the stresses in the wings and bracing of aeroplanes, and have been applied to the determination of the stresses occurring in special types of machine. The methods of calculation applicable to more rigid structures require appreciable modification in relation to so flexible and elastic a structure as that of an aeroplane, and the method of "strain energy" has been developed and applied for this purpose. It is hoped that the results of this work will be of assistance to designers.

Reports relative to the strength of machines have been presented to the Admiralty and the War Office, and recommendations have been made with a view to securing, wherever possible, increased strength in the construction of aeroplanes.

At the request of the Superintendent of the Royal Aircraft Factory, experiments have been made on the fatigue strength of stranded cables, passing over pulleys of relatively small diameter.

By desire of the War Office an investigation has been undertaken with regard to autogenous welding, and the precautions to be observed in relation to its employment in the manufacture of aeroplane parts.

Fatigue tests of a wing spar which have been in progress over a considerable period have recently been completed.

Investigation of breakages.—During the past year a large number of cases of fracture of aeroplane parts, especially of parts of engines, have again been investigated at the request of the Admiralty and of the War Office. The importance and value of this work is considerable. It has led in many cases to suggestions for improvements in design which have been brought to the attention of manufacturers, and has in some instances revealed undesirable variations in the composition of the materials employed in manufacture. The continuation of this work thus tends uniformly towards the elimination of defects of design and towards improvement in the strength and reliability of the materials employed.

Seaplane floats.—Tests have been continued in the William Froude National Tank on models of floats for seaplanes, and improvements have been made in the methods of test and the apparatus employed. Useful information has been obtained from experiments carried out by the Admiralty on machines fitted with floats designed in accordance with the results obtained in the model tests, and the report made to the Committee by the officer who carried out these experiments emphasizes the value of the investigations made in the tank. Provision has been made for the continuation of the work in the current year.

Fabrics.—An increased volume of work has been dealt with relating to airship and aeroplane fabrics, methods of proofing, dopes, &c. New apparatus has been constructed for carrying out strength tests on larger specimens of fabric, and for reproducing in the laboratory the conditions of weathering tests. In accordance with arrangements

to which reference was made in last year's report, special attention has been given to a number of questions relating to the strength required in aeroplane fabrics, especially under the conditions of service and exposure. The stresses which may occur in the fabric on the wings of aeroplanes under various conditions have been more fully investigated, and a series of bursting tests on aeroplane fabrics has been carried out for comparison with the results obtained from tensile tests. The Committee desire to thank Mr. T. Jackson Greeves, of the Portadown Weaving Company, Limited, for assistance rendered in connection with these tests, and in other ways.

The investigation which was undertaken with a view to deciding upon standard conditions to be observed in tests of fabrics, especially undoped fabrics, has now been completed, and it has been possible to specify conditions for the contractual testing of aeroplane fabrics which conduce to increased rapidity of test and greater uniformity in the results obtained. These conditions have been adopted as standard for the purpose of War Office specifications.

Other matters.—Among other matters which have been under consideration by the Committee may be mentioned the question of sighting appliances for use on aeroplanes, and accuracy in bomb-dropping. A number of special investigations have been undertaken for the Admiralty and the War Office, including the analysis and examination of deposits on airship envelopes, and tests of magnetos forming part of wireless installations to determine their liability to ignite explosive mixtures of gases.

A report on Gyroscopic Theory has been prepared by Sir G. Greenhill, as stated in the previous report, and was issued in December last as a Stationery Office publication.

Full scale work at the Royal Aircraft Factory.—The investigations undertaken during the year at the Royal Aircraft Factory with a view to the design of new or modified types of aeroplanes, and the improvement of existing types, have necessarily been closely related to military requirements. The importance of the research carried out on the full scale machine is, however, so great that there has been no relaxation but rather an increase of effort in the continuance of the investigatory work with the aid of which the conclusions drawn from the model tests are applied and adapted to practice. In particular, as already indicated, the value of the theoretical study of the conditions affecting stability, and the experiments on models in the wind channels associated therewith, has been fully tested and demonstrated in its application to the full scale aeroplane, and much has been done in extending the knowledge derived from the work on models, and in determining the manner in which the information obtained can be most fully utilized in the design of the numerous aeroplane types now employed.

Strength of construction.—The reports received from the Expeditionary Force have clearly indicated the advantage of attention to strength and good construction in all details of the aeroplane,

and the superiority in durability and useful life thereby attained. It is felt that the results thus achieved fully justify the care which has been devoted to these matters and the special precautions taken.

In all machines now designed the recommendations made by the Committee are closely followed, and the margin of strength allowed for exceeds that specified as required from considerations connected with the effect of flattening out after a steep dive. The increase in weight due to the modifications made has to some extent been compensated by other improvements, and by increased aerodynamic efficiency. In military use further increase in strength has to be considered in relation to other factors affecting safety; in particular the merit of rapid climbing tends to safety of a different kind, to which great consideration must be given, and limits the increase in strength and weight which might otherwise be adjudged desirable.

In accordance with suggestions put forward in reports made by the Committee to the War Office, the use of autogenous welding has been dispensed with in parts under stress. Many other matters of detail in design and construction as affecting strength have also received attention.

Design and construction of machines.—The modifications required to conform with the considerations arising, as explained above, in connection with stability and strength of construction, have led to the complete re-design of certain existing types of machine, involving alterations to wings, body, tail, fin area, wires and controls. Tests of the new designs have shown that it is possible, without sacrifice of controllability, to make the aeroplane inherently stable and capable of flying satisfactorily without use of the controls. Improvements have been introduced in the shape of the body and engine covering, in tank capacity, in the section and attachments of wires and in many other ways. Experiments on alighting gear have been continued, and two standard types adopted as suited to special requirements.

New types of machines have been designed embodying special features which recent military experience has shown to be desirable. In all of these it has been found possible to secure stability under ordinary flight conditions.

Wireless and other signalling apparatus has been designed, and bomb-dropping gear has been fitted and investigated. In these matters assistance and advice has been given by individual members of the Committee.

Engines.—Experiments with engines have been continued, and four types of engine for different purposes have been designed, and are being produced by various manufacturers for use in standard aeroplanes. Much work has also been carried out in conjunction with makers of other types of engine in this country, and the experience gained in the testing and repair of engines used on service machines has thus been rendered of material assistance in the improvement in detail of existing types. Additional engine testing plant has been installed, and arrangements made for running extended tests; information derived from such tests has already resulted in increased reliability.

Instruments.—Increased accommodation has been provided for the instrument department. The work of the factory in this respect involved a considerable amount of routine testing of instruments for use on aeroplanes, which can now be dealt with more rapidly. Improvements have been made in the standardization of dimensions and methods of attachment of instruments, so that those of different makers can be readily attached to standard instrument boards or supporting panels. Attention has been given to the clear marking and to the lighting of instruments, and a dashboard lighting set has been produced. A thorough investigation has been made into the sources of compass error on the aeroplane, and a full report on the work has been presented to the Committee. This matter has been under consideration by the Committee on several occasions and members of the Committee have rendered much assistance in dealing with the difficulties which have been found to occur.

Whirling arm.—The dynamometer and recording instruments for tests of full-sized air-screws on the whirling arm have now been fitted, and tests have been in progress. Owing to shortage in the power supply it is not yet possible to obtain full speed conditions, but with some air-screws forward speeds of 50 to 55 miles per hour have been reached, corresponding with the climbing speeds of certain aeroplanes. It is hoped shortly to increase the speed attainable.

Wind channel.—The wind channel which was installed at the Royal Aircraft Factory over seven years ago has recently been greatly improved on the lines indicated by the experience gained at the National Physical Laboratory, and by the courtesy of the Laboratory a balance is being provided similar to that employed in the 3-ft. channel at Teddington. With the aid of this channel it will be possible to carry out preliminary tests which will enable the enquiries and requests for detailed investigations addressed to the Committee to be presented in a more complete and useful form. It is hoped that this may assist in relieving the Laboratory from some of the less general questions constantly arising, and leave it somewhat more free to continue researches planned on broader lines, thus tending to expedite the work and to facilitate progress both at the Factory and at the Laboratory.

Naval work.—As in previous years close co-operation has been maintained between the experimental department at Teddington and the Air Department of the Admiralty. The Committee is indebted to the Air Department for assistance rendered and information furnished with regard to matters connected with the work on airships and aeroplanes, in relation to the experimental investigations carried out on models. Valuable information has been afforded by the full-scale tests, already referred to, carried out by the Air Department with floats made to the designs based on the experiments in the William Froude National Tank. The Laboratory has also received much assistance from the Admiralty in connection with the tests of airship and aeroplane fabrics.

The Committee has received from the Air Department a large number of requests for investigations involving experimental work

at the Laboratory, among which may be mentioned tests of aeroplane and airship models, the determination of the air pressure on airship sheds, tests of wind screens, investigations relative to fabrics, and to the material and design of parts of aeroplanes and of engines.

In July, by invitation of the Air Department, the Committee visited some of the Naval Air Stations, when opportunity was afforded of inspecting the naval airships, aeroplanes and seaplanes, and of examining into certain questions on machines in flight.

METEOROLOGICAL WORK.—At the end of 1913 the experimental work in meteorology was moved from Pyrton Hill to new quarters in the Royal Aircraft Factory at South Farnborough. The Meteorological Office at South Farnborough is administered as a branch of the Office at South Kensington, and its normal staff consists of a meteorologist provided by the Meteorological Committee, a professional assistant provided through the Advisory Committee, and a boy provided by the War Office. The establishment of the new office engaged the attention of the staff during the early part of the year under review. This involved the organisation of an observing station for obtaining continuous records of pressure, temperature, humidity, rainfall and sunshine, with regular observations for the purpose of control, of frequent observations of air currents at different levels by means of pilot balloons, and of arrangements for the supply of charts, forecasts and other information to the Aircraft Factory, and to the naval and military wings quartered at South Farnborough.

With one notable exception, that of the provision of an anemograph at the Office itself for the important purpose of enabling the Meteorologist-in-charge to watch the changes in the direction and force of the wind, all these points had been attended to by July last, and the Superintendent of the Royal Aircraft Factory had given facilities for the use of records from an anemograph on the golf course about half-a-mile distant from the office. An understanding had also been arrived at with the Commandant at Upavon for the reciprocal checking by the meteorologist at each station of the special aircraft forecasts issued by the other. The results of this checking show that so far as wind is concerned the forecasting is good.

This organisation, which was an essential preliminary to effective experimental work, was barely completed when the outbreak of war made it necessary for the staff to turn their attention to helping the Central Office in meeting the special war requirements of the air services. Further progress with the experimental work in meteorology has thus, for a time, been unavoidably postponed.

Signed on behalf of the Committee,

RAYLEIGH,

President.

June, 1915.