AERONAUTICS.

TECHNICAL REPORT

OF THE

ADVISORY COMMITTEE FOR AERONAUTICS

FOR THE YEAR 1916-17.

(With APPENDICES.)

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REPORT FOR THE YEAR 1916–17.

To the RIGHT HONOURABLE D. LLOYD GEORGE, M.P.,
FIRST LORD OF THE TREASURY.

SIR,

The experimental investigations carried out under the control of the Advisory Committee for Aeronautics into the many problems affecting the development of aircraft have been continued and extended during the past year.

Some additions to, and changes in, the personnel of the Committee have been made. Dr. Dugald Clerk was appointed a member in June, 1916. Mr. Henry Fowler became a member on taking up the post of Superintendent of the Royal Aircraft Factory. Commodore Murray F. Sueter has lately retired from membership, after serving for seven years, on receiving a new appointment, and has been succeeded by Commodore Godfrey Paine. General Pitcher, Controller of the Technical Department of the Air Board, has recently been nominated an additional member of the Committee. The names of the present members are given on the opposite page.

Owing to the growth of the work of the Committee in certain directions, Sub-Committees have been formed to advise in regard to special matters. An Internal Combustion Engine Sub-Committee has been appointed under the chairmanship of Dr. Dugald Clerk; Mr. Fowler is acting as chairman of a Light Alloys Sub-Committee.* Other Sub-Committees have been constituted from time to time to investigate particular problems.

Many changes and developments in the design and construction of aircraft have taken place as the result of the continued and varied experience gained from their use in warfare under modern conditions. An increasing number of special problems is thus

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* The members of these Sub-Committees are as follows:—

Engine Sub-Committee.—Dr. Dugald Clerk (Chairman); Mr. F. W. Lanchester; Lieut.-Colonel Mervyn O'Gorman; Mr. Henry Fowler; Dr. T. E. Stanton, representing the National Physical Laboratory; Wing Commander W. Briggs, R.N., Lieut.-Commander T. B. Barrington, R.N.V.R., and Captain G. W. A. Brown, representing the Air Board; Lieut.-Colonel R. K. Bagnall Wild and Captain R. H. Verney, representing the Aeronautical Inspection Department; with the Chairman of the Advisory Committee for Aeronautics (*ex officio*).

Light Alloys Sub-Committee.—Mr. Henry Fowler (Chairman); Lieut.-Commander C. F. Jenkin and Professor F. C. Lea, representing the Air Board; Captain H. P. Philpot, representing the Aeronautical Inspection Department; Mr. A. W. Johns, Chief Constructor, representing the Director of Naval Construction; Dr. W. Rosenhain, representing the National Physical Laboratory; with the Chairman of the Advisory Committee for Aeronautics (*ex officio*).

constantly presented for investigation, and these have very closely occupied throughout the year the attention of the staffs engaged in experimental work both at the National Physical Laboratory and at the Royal Aircraft Factory. In addition to aerodynamical research, much attention has been given to questions relating to engines, materials of construction, strength of construction and design, instruments and accessories, as well as to methods of attack from aircraft, and other matters.

Equipment for Experimental Work at the National Physical Laboratory.—Reference was made in the report for last year to the additional equipment provided for experimental work. The wind channels now available comprise two 7-foot channels, two 4-foot and one 3-foot. The new 7-foot channel was completed and brought into use early in the year 1916–17. No important departure has been made in its design from that of the earlier 7-foot channel, but some minor modifications have been introduced which experience had indicated as tending to greater convenience in working. An air speed of 85 feet per second can be reached in this channel with an expenditure of 160 h.p. It is doubtful whether further increase in size of channel or in speed of air current would advance existing knowledge to an extent sufficient to outweigh the greatly increased cost and other disadvantages involved. If it should prove necessary, for certain purposes, to conduct experiments on a larger scale and at higher speeds, it would appear, therefore, to be necessary to employ a method in which the model is moved through the air. As is well known, this procedure presents various difficulties, and the securing of even moderately accurate data in this manner is, at the best, extremely laborious. Probably the least troublesome way of applying this method is by installing measuring apparatus on the aeroplane itself, and it seems probable that only in this way can an accurate comparison be obtained between model and full scale conditions. The matter is of importance, and attention is being given, so far as existing circumstances permit, to the devising of suitable measuring apparatus.

Improved methods of supporting the models under test in the channel have been devised for use in special cases. The effect on the measured resistance of the method of holding the model is often surprisingly large, and without the necessary care and experience in avoiding effects due to interference with the air flow, very large errors may result. The difficulty is of course in general greatest in measurements on forms of small head resistance, *e.g.*, aeroplane bodies and airship envelopes. Earlier measurements on airship models of stream-line shape were made to determine the form of least resistance, and were, in the main, comparative; from the cause mentioned, it is probable that little reliance can be placed on the absolute values then obtained. With the new methods of support the possible error has been greatly reduced, and when full scale values have been determined

with accuracy. the prediction of full scale resistance from the model experiments will be established on a satisfactory basis. The new method of support is employed also in tests of models of complete aeroplanes.

Experimental Work in Aerodynamics.—It is not proposed at present to enter in detail into consideration of questions on which experiment has been in progress. Fliers and designers have, of course, given close attention to matters in which improvement would be of value, and this has led to the repetition and re-examination. from a somewhat modified aspect, of many earlier investigations. The experiments have been of very varied character, and have included tests of models of, probably, all types of aircraft at present employed. A large part of the work has arisen from specific enquiries proceeding from the service departments, but progress has been made with some investigations of more general character.

A number of experiments have been carried out relative to the resistance of airship shapes, and further observations on the distribution of pressure in such cases have been made.

The investigation into the stability of the aeroplane has been continued. A number of special cases have been examined, and results of importance have been reached. The theory of airship stability has also been investigated.

Research into the nature of the flow of fluids round obstacles has been continued.

A number of investigations relating to airscrews have been carried out, with a view to increasing the accuracy of prediction of performance, and thus facilitating the design of airscrews for special purposes. Tests on screws to be used as windmills for the production of power have also been made.

The work has included a complete series of tests on more than one complete aeroplane model. The information thus derived is of considerable importance for practical purposes in aeroplane design.

Strength of Construction.—A number of questions relating to strength of construction have been investigated, and some general conclusions have been reached tending to simplification of strength calculations. The basis to be adopted in design to secure adequate strength in high speed machines, with the power of rapid manœuvring essential in aerial fighting, is a matter demanding the most careful consideration. To secure the highest possible speed it is necessary to keep down the weight to a minimum, and the best compromise between these two opposed conditions does not admit of precise determination. This question has received attention, and the manner in which strength varies with increase of dimensions has also been made the subject of investigation. Cases in which vibration has been set up have been examined, and calculations relating to the strength of the body structure have been made.

Engines.—A number of questions relating to engines and engine design have been submitted by the Air Board for consideration by the Engine Sub-Committee. These have required very careful investigation, and the Sub-Committee has been closely occupied since its formation with the various problems which have arisen. Experimental work has been carried out, by request of the Sub-Committee, at the Royal Aircraft Factory; and the Sub-Committee has received much assistance in the examination of special questions both from the Royal Aircraft Factory and from manufacturing firms whose works have been visited.

An extensive series of experiments on radiators has been carried out at the National Physical Laboratory, and other investigations relative to the transfer of heat from surfaces to fluids flowing over them are in progress. These have an immediate bearing on the design of the cooling systems in aeroplane engines. Experiments relating to the performance and efficiency of magnetos have also been made.

Light Alloys.—The use of light alloys in the construction of aircraft and aircraft engines is becoming of rapidly increasing importance, and improvements in the production of light alloys will have great effect on future development. The investigations relating to light alloys which have been in progress for many years at the National Physical Laboratory have been continued, and results of special interest have been achieved during the past year. Suggestions have been made to the Air Board by the Committee which may, it is hoped, help to secure the best conditions in manufacture for the development of such alloys. The formation of the Light Alloys Sub-Committee will be of great assistance in co-ordinating the work on light alloys which is being done in various quarters, and in collecting the information resulting from experimental investigation and manufacturing experience. Experimental work has been carried out for the Sub-Committee at the Royal Aircraft Factory, the University of Birmingham, the National Physical Laboratory, and elsewhere, and arrangements have been made for placing the information obtained at the disposal of manufacturers.

Fabrics, Dopes. &c.—A number of special questions have arisen for investigation in relation to airship and aeroplane fabrics. A large amount of attention has been given to materials for use as dopes, varnishes, &c., and the Laboratory has collaborated with the Military Air Department in an investigation into the behaviour of fabrics, dopes and protective coatings under the conditions of tropical exposure. The results of exposure to ultra-violet radiation have been studied in relation to the effect of sunlight, and conclusions of importance have been reached. The Committee is indebted to Dr. Shakespear, of the University of Birmingham, for information he has placed before them as to the methods developed by him for determining the

permeability of fabrics by hydrogen; comparisons have been made with the results obtained at the National Physical Laboratory. Methods of determining the purity of hydrogen have been investigated.

Investigations Relating to Seaplanes.—Tests on models of seaplane floats in the William Froude National Tank have been continued and extended. The provision made last year for an increase in the staff available for carrying out this work has enabled more rapid advance to be made, and a number of important questions have received attention. The methods employed have been improved and elaborated, and new apparatus has been designed whereby additional measurements can be obtained and further information secured relative to special conditions arising in practice.

Special Matters.—As usual, a large number of special questions have been referred to the Committee for advice or investigation. The experiments relating to bombs have been continued, and valuable communications relative to the flight of bombs have been received from the Air Department of the Admiralty and from the Central Flying School. The Committee is indebted to Professor Karl Pearson, F.R.S., for communicating to them the results of his calculations of bomb trajectories. This question has also been the subject of investigation at the National Physical Laboratory.

Questions relating to the attack of aircraft from aircraft have been examined. Problems in connection with the aeroplane compass have been further considered. Other instruments and apparatus for use on aircraft have been investigated.

As previously, a number of enquiries have been received from the Board of Invention and Research and the Munitions Inventions Department, and investigations have been carried out at their request at the National Physical Laboratory and at the Royal Aircraft Factory.

Reports from the Experimental Stations of the Air Services.—A number of communications have been received during the year relating to experimental work carried out by the R.N.A.S., and by the Testing Squadron of the Royal Flying Corps. Many of these have been of great interest and value, and of much assistance in the application of the results obtained from the model experiments and in the estimation of aeroplane performance.

The Committee visited on various occasions during the year military and Naval Air Stations, as well as the Royal Aircraft Factory and the National Physical Laboratory, and witnessed many interesting experiments and trial flights.

Experimental Work at the Royal Aircraft Factory.

Engine Experiments.—Much research has been made into various methods for improving the output and the reliability of aeroplane engines. A large number of radiators of various types have

been tested, and an efficient type has been standardised. Great progress has been made in the development of the air-cooled engine. Work has been done on the compensation of carburetters for variation of air density and a device for improving the performance of engines at great heights has been tested on several engines.

Full Scale Aeroplane Experiments.—The measurement of the resistance of aeroplanes in flight has been continued with the object of confirming the model experiments and an instrument for measuring the resistance directly has been developed. The distribution of air pressure over the surface of the wing of an aeroplane in flight has been measured and further experiments on these lines are in progress. Experiments have been made on longitudinal and lateral stability of aeroplanes in flight, and much theoretical work on the same subjects has been done. Measurements have also been made of the disturbance of the air behind a propeller to obtain data which are required in the design of new machines.

Instruments.—The behaviour of various types of magnetic compass in an aeroplane in flight has been investigated. Two new types of bombsight have been developed, and are now being tested. The improvement of the standard aeroplane instruments has been continued, and a number of special instruments have been devised for use in connection with full scale experiments on aeroplanes. The means of communication between pilot and observer have been improved.

Fabrics, Dope, &c.—Weathering tests on fabrics and experiments on the influence of humidity on their strength have been made. The development of a calendered fabric has received attention. The deteriorating effect of various agents (bacteria, light, &c.), has formed the subject of considerable research. The experiments on the composition of dopes, varnishes, and pigments and on fluxes, paints, and oils have been continued.

Light Alloys.—Much experimental work has been done to arrive at the most suitable aluminium alloys for engine parts. Experiments have also been carried out in the application of the alloys which have been developed at the National Physical Laboratory.

Meteorological Work.—Experimental work in meteorology has been mainly in connection with the inquiry into the location of distant thunderstorms and the tracing of their progress across the map by means of a properly organised system of observations at various stations.

In this inquiry valuable assistance has been rendered by various officers of the Admiralty, Royal Engineers and Royal Flying Corps. The Meteorological Office Observatories at Richmond and Benson have also been in co-operation, and apparatus has been lent by Professor Peddie, of University College, Dundee.

A portable hut has been installed for the accommodation of the assistant, close to the receiving station.

On some occasions the progression of thunderstorms across the map has been satisfactorily identified, although the identification on other occasions was uncertain.

Further attention is necessary in order to develop an apparatus which is more directly suitable for the purpose than that which is at present in use, in consequence of the variability of the sensitiveness, which with the present form of apparatus is unavoidable.

In addition, an inquiry into the variation of the gustiness of wind between day and night has been provided for by the erection of an anemometer with its vane at 140 feet above the ground; and for the purpose of this enquiry Captain Cave, R.E., officer in charge, has lent two thermographs in order to determine the corresponding variation in the temperature of the air.

Observations have also been made of the variation of the wind with height close to the ground; and a large number of observations of pilot-balloons have been made and duly reported.

Signed on behalf of the Committee,

RAYLEIGH.

President.

June, 1917.