

# AERONAUTICS.

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## TECHNICAL REPORT

OF THE

### ADVISORY COMMITTEE FOR AERONAUTICS

FOR THE YEAR 1917-18.

(With APPENDICES.)

#### VOL. I.

General questions, Airships and model Aeroplane research.



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409	689	462	748
410	1011	470	642
411	716	471	518
412	1001	474	592
413	695	490	1190
414	252	492	712
415	132	493	621
416	219	494	710
417	174	497	15
418	51	499	1135
419	188	501	1117
420	440	502	458
421	409	503	730
423	86	505	706
424	96	507	1150
426	636	509	1134
427	430	510	974
428	90	513	1100
429	423	514	1070
430	1048	515	233
431	102	516	1080
432	192	517	1113
433	263	518	1116
434	241	520	734
435	1087	521	1154
436	1125	522	33
437	1015	527	1163
438	327	528	986
439	162	531	1137
440	229	532	653
441	702	534	1182
442	388	539	1077
443	822	563	54
444	337		

## MEMBERS OF THE COMMITTEE.

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The Right Honourable Lord RAYLEIGH, O.M.,  
F.R.S. (President).  
Sir RICHARD GLAZE BROOK, C.B., F.R.S. (Chairman).  
Major-General W. S. BRANCKER.  
Sir DUGALD CLERK, K.B.E., F.R.S.  
Mr. HORACE DARWIN, F.R.S.  
Sir E. H. TENNYSON D'EYNCOURT, K.C.B.  
Sir HENRY FOWLER, K.B.E.  
Mr. E. C. GIVEN.  
Sir G. GREENHILL, F.R.S.  
Lieut.-General Sir D. HENDERSON, K.C.B., D.S.O.  
Major B. HOPKINSON, C.M.G., F.R.S.  
Mr. F. W. LANCHESTER, M.Inst.C.E.  
Mr. H. R. A. MALLOCK, F.R.S.  
Lieut.-Colonel MERVYN O'GORMAN, C.B.  
Professor J. E. PETAVEL, F.R.S.  
Sir NAPIER SHAW, F.R.S.  
Lieut.-Colonel J. G. WEIR, C.M.G.

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Secretary, Mr. F. J. Selby, M.A.

Assistant Secretary, Mr. J. L. Nayler, B.A.

National Physical Laboratory,  
Teddington,  
Middlesex.

## REPORT FOR THE YEAR 1917-18.

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To the Right Honourable LORD WEIR OF EASTWOOD, Secretary  
of State for the Royal Air Force.

SIR,

The Advisory Committee for Aeronautics begs to submit to you its report for the year 1917-18.

The Committee was appointed in the year 1909 by the Prime Minister to "advise in matters connected with the problem of flight, whether by means of aeroplanes or dirigibles," and has in former years reported accordingly to the Prime Minister.

The Committee understands that it is desired that in future its report should be made to the Secretary of State for the Royal Air Force. In earlier years it was attempted in the report to give a brief but comprehensive review of the work accomplished in aeronautical research during the year, and to indicate the various directions in which material progress had been achieved ; in present circumstances it is possible to do no more than outline the main subjects of investigation to which attention has been devoted, and the organisation which has been provided for dealing with the new problems which constantly arise.

Some changes have taken place in the *personnel* of the Committee during the year, related, for the most part, to appointments made in the organisation of the Air Ministry. Lieut.-Colonel J. G. Weir was nominated for membership on his appointment as Controller of the Technical Department. Major-General Brancker has recently been appointed a member on taking up the post of Comptroller-General of Aircraft Equipment. Major Hopkinson, Assistant Controller (Experiments) of the Technical Department, and Mr. E. C. Given, Director of Airship Production in the Admiralty Controller's Department, have also joined the Committee. Major-General Sir Godfrey Paine and Brigadier-General D. Pitcher have retired from membership on relinquishing the positions held by them under the Air Board. The names of the present members of the Committee are given on the opposite page.

Much of the detailed work necessary to fulfil the functions assigned to the Committee is dealt with by Sub-Committees. An Internal Combustion Engine Sub-Committee and a Light Alloys Sub-Committee were formed during the year 1916-17.

An Aerodynamics Sub-Committee\* has since been constituted for the consideration in greater detail of special questions arising in connection with the aerodynamical section of the work. Other Sub-Committees are appointed from time to time to deal with particular problems. The work done by these Sub-Committees during the year under review is referred to below. The formation of these Sub-Committees and the general growth of the work has greatly increased the Secretarial duties, and an Assistant Secretary has recently been appointed.

An Air Inventions Committee and an Accidents Committee were formed during the year by the Air Board before its dissolution on the establishment of the Air Ministry. It has been arranged that these Committees shall report monthly to the Advisory Committee as well as to the Air Ministry, that the advice and assistance of the Advisory Committee shall be obtained by them when needed, and generally that the same close co-operation shall be maintained between them and the Advisory Committee as exists between this Committee and its Sub-Committees. The Chairmen of the Air Inventions Committee and of the Accidents Committee are members of the Advisory Committee, which is fully represented on those Committees. Some further particulars with regard to their work is given below.

Special attention has been directed towards maintaining and improving the close connection which is necessary between the experimental work directly controlled by the Committee and the investigations carried out on full scale machines at the experimental stations established by the various branches of the Air Services. From the time of formation of the Committee the

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

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

*Light Alloys Sub-Committee.*—Sir Henry Fowler, K.B.E. (Chairman) ; Commander C. F. Jenkin, R.N.V.R., and Professor F. C. Lea, representing the Air Ministry ; Captain H. P. Philpot, representing the Aeronautical Inspection Directorate ; Mr. A. W. Johns, Chief Constructor, representing the Director of Naval Construction ; Dr. W. Rosenhain, F.R.S., representing the National Physical Laboratory ; Professor C. A. Edwards ; with the Chairman of the Advisory Committee for Aeronautics (*ex officio*).

*Aerodynamics Sub-Committee.*—Professor J. E. Petavel, F.R.S. (Chairman) ; Mr. F. W. Lanchester, M.Inst.C.E. ; Lieut.-Colonel Mervyn O'Gorman, C.B. ; Major B. Hopkinson, C.M.G., F.R.S. ; Mr. L. Bairstow, C.B.E., F.R.S., and Wing Commander the Master of Sempill, of the Air Ministry ; Dr. T. E. Stanton, F.R.S., and Mr. E. F. Relf, A.R.C.Sc., of the National Physical Laboratory ; Captain W. S. Farren, M.B.E. ; with the Chairman of the Advisory Committee for Aeronautics (*ex officio*).

closest relations have been maintained with the Royal Aircraft Factory.\* It has been arranged that full reports on matters of interest to the Committee shall be made by the other stations under the control of the Technical Department, and by the Admiralty Stations investigating airship and kite balloon problems. Members of the staff engaged in experimental work on models will visit these stations and will consult with the officers in charge of experiments as to the investigations required to correlate the model and full scale work. Departmental officers also constantly visit the National Physical Laboratory to secure information as to work in progress, or to seek advice on current problems. The Committee has from the beginning made it a practice to visit from time to time the Service Air Stations engaged in experimental work. It is of opinion that this co-operation in experimental work is of the utmost importance, and is essential for securing continuous and substantial progress on a sound basis. The Committee receives the technical reports and papers issued by the Technical Department of the Department of Aircraft Production, as well as confidential information relative to the needs of the services and the supply of aeroplanes and engines, and these are also of great value and assistance.

Arrangements have been made with the Technical Department† for the confidential issue to an approved list of firms, as well as to departmental officers, of the reports on experimental work carried out under the control of the Committee. In order that the information thus afforded may be made available as rapidly as possible, all such reports are now printed immediately after presentation to the Committee. It will be understood that caution must be exercised in the immediate application of these reports to problems of construction, since it is clearly impossible to eliminate all sources of error in presenting, month by month, instalments of a continuous research which would ordinarily extend over a lengthened period. It is thought, however, that valuable assistance will be rendered to constructors by acquainting them with the results of current work. The reports distributed, in addition to those submitted direct to the Main Committee, include also papers contributed to the Engine and Light Alloys Sub-Committees.

Assistance has been rendered by the Committee, through the Liaison Department of the Air Ministry, to the Air Services of our Allies. A large number of requests have been received for information as to the methods of experiment employed at the National Physical Laboratory and as to data obtained, as well as generally for advice and assistance. Plans of the Laboratory channels and particulars relative to the results of experimental work have been supplied. Members of French,

\* Now the Royal Aircraft Establishment.

† These reports are issued by Section T.5 of the Directorate of Air Technical Services, Royal College of Science, South Kensington, S.W.

Italian and American Commissions have visited the Laboratory, and have discussed with the Director and the Staff numerous matters in connection with the various branches of the work.

There has been no diminution in the number and complexity of the problems with which the Committee has been required to deal. Owing to the war the technical development of aeronautics has been extraordinarily rapid. The feats that are now performed in the air, and the capabilities of modern machines, are remarkable when it is remembered that it is very little more than ten years since the brothers Wright made their first flights in Europe. It requires little imagination, however, to realise that much greater developments are to be expected, and the competition of modern warfare renders it vital that the highest possible rate of progress should be maintained and that development should be pushed forward with the utmost speed. It is by no means easy to decide upon the method of attack best calculated to win ground quickly. The needs of the moment are in many cases imperative; immediate difficulties must be solved in order that construction may not be hampered and that supplies for the services may not be held up. It is, however, not less important to take a long view, and to secure the substantial improvements that are more likely to result from systematic and continuous research. The need of systematic investigation in this or that direction is being continually impressed upon the Committee by the questions with which it is confronted. To render it possible to carry out such continuous investigation quickly and at the same time to meet immediate needs it is necessary to multiply facilities for experiment, and the Committee has had again to press for increased provision for experimental work. Happily, the fundamental importance of such research in connection with aeronautics is well established and undisputed, and as on previous occasions the needs urged by the Committee have been fully realised by the executive authorities, and their proposals have been strongly supported and carried through with the least possible delay. A channel for model tests is available at the Royal Aircraft Establishment, and this is being employed, so far as possible, for specially urgent work. The Committee are glad to note also that many firms in this country have recognised the value of experiments on models in relation to design and have constructed wind channels for their own use; a number of requests for details of the National Physical Laboratory channels have been responded to within the past year.

*Equipment for experimental work at the National Physical Laboratory.*—As above indicated, proposals for additions to the buildings and equipment for experimental work at the National Physical Laboratory have recently been made; the construction of these is in hand and will, it is hoped, be completed at an early date. Two new channels are to be provided, one similar to the

existing 7-ft. channels and one of special type. The design which has been adopted for the latter has been completely worked out by experiments on model channels, and while based on the same principle as was applied in designing the earlier channels, exhibits some interesting modifications in detail, which may be found generally valuable in future in channel construction. The buildings to be provided will contain also additional workshop and office accommodation.

Modifications of the existing equipment made during the past year embody the results of experience as regards the most accurate and the most expeditious methods of conducting the experiments. New methods have been perfected for measuring the drag on models in cases where this is very small and where consequently the highest accuracy is necessary if the results are to be of value, especially when a considerable change of scale is involved in passing from the model to the full-sized aircraft. Special apparatus has been designed for vertical force measurements, and for experiments on propellers and propeller interference. New apparatus has been constructed for the determination of rotary derivatives. Improvements have been introduced in existing methods of measurement, and every effort has been made to secure ease and rapidity of working, consistently with the maintenance of the requisite accuracy. In the Engineering Section special apparatus has been constructed for dealing with particular problems, among which may be mentioned the apparatus for impact tests at high temperatures of specimens of aluminium alloys.

*Experimental work in Aerodynamics*—In April, 1917, a Sub-Committee was appointed to consider the relation between full scale and model results and to examine into certain special questions which appeared to present difficulty. This Sub-Committee held 11 meetings and received 31 special reports. In the course of their investigations they found it necessary to arrange for a considerable amount of experimental work both at the National Physical Laboratory and at the Royal Aircraft Establishment while valuable assistance was also derived from reports made of the performance tests at other air stations. The information available was not sufficient to enable general conclusions to be reached as to scale effect for which investigation extending over a long period will doubtless be necessary but the results brought out were of great interest and to a large extent cleared up existing difficulties. The Sub-Committee reported in December, 1917, and their report will shortly be ready for issue among the confidential papers of the Advisory Committee circulated by the Technical Department (T.5). Following a recommendation made by this Sub-Committee, the Aerodynamics Sub-Committee, to which reference has already been made, was appointed in the same month and now sits regularly for the discussion of aerodynamics problems of special importance.

which arise in relation to aircraft. This Sub-Committee includes among its members representatives of the Technical Department and of the Services as well as of the National Physical Laboratory and the Royal Aircraft Establishment. Reports will be submitted to them of experimental work carried out at Service Air Stations, and arrangements have been made for securing the attendance at meetings of the officers in charge of such experimental work, in order that the Sub-Committee may have the fullest possible information on the matters dealt with.

A large amount of interesting and valuable work has been carried out during the year both at the National Physical Laboratory and at the Royal Aircraft Establishment, but it is not now proposed to give any detailed summary of investigations completed. The experiments have ranged over the whole field of practical aeronautics, including tests relating to aeroplanes, airships, kite balloons, propellers, radiators, wind screens for aircraft, aeroplane carrying ships, bomb dropping, pressure distribution, stability, &c. A considerable number of experiments have been made on models of complete aeroplanes, and the work done for the Scale Effect Sub-Committee included an analysis of the resistance of a complete model and comparison of the whole resistance with the sum of the resistances of the component parts. The investigations relating to propellers have been of special value and importance. The question of flight at high altitudes has received attention. In existing circumstances it has not been possible to concentrate attention on general aerodynamical theory, but some consideration has necessarily been given to general questions arising in connection with the experimental work, and the study of eddy motion has been advanced.

The Air Ministry has formed a special Committee to investigate certain questions relating to airscrew design. Dr. Stanton, the Superintendent of the Aerodynamics and Engineering Departments at the National Physical Laboratory, is a member of this Committee, and experiments to obtain information desired by the Committee will be carried out at the Laboratory.

*Strength of Construction.*—Continued attention has been given to questions connected with strength of construction. Early in the year a series of calculations was carried out for various enemy machines to investigate the factor of safety allowed in German design. It is of interest to note that the conclusion resulting from these calculations was that neither in performance nor in strength were the German machines equal to the British. Other things remaining the same, an increase in the factor of safety necessarily involves some reduction in performance and manœuvring power, which, not less than strength, are of vital importance for safety in air fighting; it is clear, however, that the strength factor adopted in British design, which has in earlier years been the subject of much careful consideration by the Committee, has been wisely maintained at a high level. Specific questions relating to strength have arisen chiefly in connection

with engines, and propellers in relation to engines, and have been dealt with by the Engine Sub-Committee. Valuable papers relating to methods of stress calculation and measurement have been received from both the National Physical Laboratory and the Royal Aircraft Establishment.

*Engines.*—The Engine Sub-Committee has held 29 meetings during the year 1917–18, and has received 131 reports and memoranda on various matters. The work has been of very varied character. The advice of the Committee was invited by the Air Board on several occasions with regard to the engine programme, and the selection of engines for future development. In order to arrive at a decision on questions submitted to them the Sub-Committee has visited works and inspected engines under test conditions. Among other matters which have been before them for discussion may be mentioned the methods of engine testing, engine design for high altitudes, the causes of failure of crankshafts and other parts, gearing, methods of cooling, methods of preventing freezing at high altitudes in water-cooled engines, special fuels, &c. Considerable attention has been given to matters connected with magnetos and ignition, and a large amount of experimental work in this direction has been carried out at the National Physical Laboratory and at the Royal Aircraft Establishment. At the latter also numerous investigations have been carried out for the Committee on engines and engine cylinders, which are referred to more particularly in the section of this report which deals with the experimental work done at the Establishment. A series of reports giving the results of experimental investigations undertaken for the Sub-Committee has been prepared for confidential issue, as explained.

The Sub-Committee desires to acknowledge the assistance which has been given it on many occasions, in the consideration of special matters, by the technical representatives of manufacturing firms who have attended its meetings and have communicated valuable papers and reports on questions under discussion.

*Light Alloys.*—The Light Alloys Sub-Committee was formed in February, 1917. Since that date it has held 18 meetings and has received 93 reports and communications. Experimental work has been carried out for the Sub-Committee at the National Physical Laboratory, the Royal Aircraft Establishment, Birmingham University and Manchester University, as well as by the Aeronautical Inspection Directorate and at works foundries. The result has been to secure, and to disseminate, a large amount of valuable information with regard to both cast and wrought aluminium alloys suitable for use in the manufacture of engines and aircraft parts. Experiments have been made with a number of new alloys, and every effort has been made to accumulate systematic data with regard to alloys in common use, as well as to the newer alloys, which appear to exhibit valuable characteristics.

The volume of work on light alloys dealt with at the National Physical Laboratory has been very large, and it has been necessary to ask for additional staff to enable it to be continued and extended in the future. The tests usually made of a new alloy include the tensile strength at ordinary and at high temperatures, the casting properties, contraction, &c., conductivity, coefficient of expansion, while impact, hardness and repeated stress tests at various temperatures have been made on many of the alloys. At the Royal Aircraft Establishment engine cylinders and pistons have been cast in special alloys and have been run under working conditions. Professor Lea, of Birmingham University, has worked throughout in the closest possible co-operation with the aluminium foundries, and has kept the Sub-Committee informed as to the progress made in the introduction of new alloys into practice. The wrought alloys have been investigated mainly at the National Physical Laboratory, and with these also substantial progress has been made. The Sub-Committee is indebted to Professor Edwards, of Manchester University, for much valuable assistance in the researches relating to casting alloys; and desires also to acknowledge information and help given to it by many firms and individuals.

A series of confidential reports summarising briefly the work accomplished by the Sub-Committee is in preparation; a few of these have already been issued.

*Fabrics and Dopes.*—Research in connection with this section of the work has been continued as in previous years. The work done has included tests of special fabrics and dopes, the further investigation of methods of protection of fabrics, especially airship fabrics, the testing of special materials suggested for wing coverings, determinations of hydrogen purity, and the investigation of methods of determining the purity of hydrogen and the permeability of airship fabrics. Assistance has been given to "X" Aircraft Depot in an investigation relative to the effect of tropical exposure on fabrics. Reports on other matters have been received from "X" Aircraft Depot, and the Committee is again indebted to Dr. Shakespear, of Birmingham University, for the communication of much valuable information as to methods devised by him for the testing of fabrics for permeability, and as to results obtained in various series of tests carried out under his control. Some interesting reports on experimental work carried out by them have also been received from the North British Rubber Co.

*Seaplane Research.*—Research on float models and models of flying boats in the William Froude National Tank has been actively continued. Additional apparatus has been designed and constructed for the extension of the experiments in certain directions. With regard to one section of the investigations the department has been in close co-operation with the Royal

Aircraft Establishment, to which special work had been assigned in connection with seaplane design. Some experiments in connection with airships have also been undertaken. Two reports on the work carried out in the Tank have been received by the Committee during the year.

*Other Engineering work and special investigations.*—A large amount of work has been carried out in the Engineering Department of the National Physical Laboratory, whether in connection with particular researches required by the Committee or Sub-Committees, or in response to special requests received from the Air Ministry. Among investigations of the former class may be mentioned the general research on the transmission of heat from surfaces to fluids in motion over them, experiments on engine cooling and radiators, impact and hardness tests on light alloys at various temperatures, tests of timber, struts, &c. For much of this work special apparatus has been designed and constructed.

The number of special investigations carried out for the Air Ministry and the Admiralty has been very considerable, and the work has extended to almost all departments of the Laboratory. It would appear undesirable to specify the particular matters dealt with, but it is clear that the assistance the Laboratory may be thus able to render is very valuable, and the Ministry have indicated that they desire to make increased provision for work of this character in the future.

*Airships and Kite Balloons.*—A Sub-Committee\* was appointed in August, 1917, to consider certain matters relating to airships and kite balloons on which the advice of the Committee had been requested by the Director of Air Services, Admiralty. A preliminary report was submitted in the same month giving replies, so far as was possible with the information then available, to specific questions raised. Four meetings of this Committee have been held, and experimental work has been in progress. A further report is now in preparation.

*The Air Inventions Committee.*—This Committee was formed by Lord Cowdray in August, 1917. As originally constituted it consisted of six members of the Advisory Committee, with eight others, chosen either for their special scientific experience or for their connection with the Flying or Anti-Aircraft Service. The Chairman is Mr. Horace Darwin, F.R.S. It reports monthly to the Advisory Committee, and important inventions are referred, when considered desirable, to that Committee. On

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\* The members of this Sub-Committee are as follows :—

Sir Napier Shaw, F.R.S. (Chairman); Mr. A. Mallock, F.R.S.; Lieut.-Colonel Mervyn O'Gorman, C.B.; Professor J. E. Petavel, F.R.S.; Mr. C. T. R. Wilson, F.R.S.; Wing Commander the Master of Sempill and Lieut. W. H. Rose, of the Air Ministry; Wing Commander Cave Brown Cave; Mr. F. E. Smith, O.B.E., F.R.S., of the National Physical Laboratory; with the Chairman of the Advisory Committee for Aeronautics (*ex officio*).

the other hand it is now under the general supervision of the newly-appointed Chief of the Air Staff, and its meetings are attended, when necessary, by representatives of the G.H.Q. Home Defences and of the Technical Department of the Department of Aircraft Production. The Committee has also been authorised to invite the attendance of aircraft manufacturers (through the Society of British Aircraft Constructors) when this is thought to be desirable.

With this constitution the Committee hopes to be able to keep in close touch with the most recent experience at the front, as well as with all new methods and manufacturing developments, and thus to ascertain the most pressing needs of the moment as regards inventions.

The *personnel* is completed by a Secretary and Examiners. The work is done largely through Sub-Committees, of which there are five. The number of inventions received since the formation of the Committee is about 4,000; these are placed on receipt in two categories—(A) those requiring further consideration: (B) those which can be rejected at once.

Class A inventions are further considered either by individual members of the Committee or by one of the Sub-Committees. In some cases they are referred for the opinion of other experts, and when thought desirable experiments and trials are carried out before a final decision is made. Funds are at the disposal of the Committee for the development of an invention when considered to be of value.

There is a good deal of inter-communication with the two other Inventions Committees, *i.e.*, the Munitions Inventions Department, and the Board of Invention and Research, and duplication is prevented mainly by overlap of membership and the cordial relationship between the three Committees.

Information regarding the appliances and methods in use in other countries has hitherto been obtained chiefly through the *liaison* officers, but arrangements are in contemplation for inviting representatives of the Allies to attend meetings of the Committee when subjects of mutual interest are being discussed.

*Accidents Investigation Committee.*—The Committee has, on a number of occasions, been asked by the Department concerned to undertake investigations in connection with accidents. The information derived from such investigations is often of the very greatest value. Recently an Accidents Department has been formed under the Air Ministry, and a special Committee, of which Lieut.-Colonel O'Gorman is Chairman, has been appointed to advise as to questions arising in relation to accidents, and as to investigations required to ascertain the causes which have led to them, and the measures desirable to provide a remedy. It has been arranged that this Committee shall report to the Advisory Committee, which will give assistance, when required,

in the carrying out of special investigations and experiments which the Accidents Committee may desire to have made. As in other instances, this co-operation will be of great advantage to both Committees, and the work may be expected to lead to important improvements in construction and design. The value of the investigations undertaken in relation to accidents has been strikingly illustrated in a case which has recently been under consideration by the Committee.

*Other special matters.*—Reference may be made briefly to a number of other special matters.

The Committee was requested by the Aeronautical Society in October, 1917, to nominate a representative to serve on the Technical Terms Committee of the Society. The Committee nominated their Secretary, Mr. F. J. Selby, to serve on their behalf. Lieut.-Colonel O'Gorman is Chairman of the Technical Terms Committee, which has now been constituted also a special Committee of the Engineering Standards Committee, in the section dealing with Aircraft Standardisation.

Special arrangements have been made for the continuation and extension of the series of abstracts of technical papers relating to aeronautics formerly prepared by the Secretary, and printed in the Technical Reports of the Committee. In this matter the National Physical Laboratory is acting in co-operation with the Aeronautical Society and with the Intelligence Department of the War Office. This Department will undertake the printing and circulation of the abstracts, while it is understood that they will be printed also in the Aeronautical Society's Journal.

Under a scheme arranged by the Aeronautical Society, lectures on aeronautics have been given, with the Committee's permission, by members of the staff of the National Physical Laboratory at a number of centres throughout the Kingdom. It is understood that these have been found of much value, and they will, it is hoped, stimulate and quicken interest in the general study of the subject by those who are engaged in aircraft production.

In July, 1917, a request was received from Professor G. H. Bryan that the Committee would give him assistance to enable him to obtain such data as he might need in connection with researches on the stability of the aeroplane on which he was engaged. The Committee were informed that a grant had been made to Professor Bryan by the Department of Scientific and Industrial Research to enable him to devote himself, for a period, to the prosecution of his investigation relating to the stability of the aeroplane, and they willingly offered to render such assistance as was within their power. It is understood that Professor Bryan has already arrived at results of considerable interest.

The Committee desire to express their thanks to the many firms and individuals who have given them assistance in various ways, by personal attendance at meetings, by the contribution of papers giving valuable information, or by assistance in experimental work. The cases in which such help has been rendered are too numerous to be referred to in detail; but acknowledgment must be made of the co-operation given by Professor Sir James Dewar, at the Royal Institution, in experiments on light alloys at low temperatures. An interesting communication relative to a matter which was under consideration by the Committee was received from Professor A. E. H. Love, of Oxford University.

**EXPERIMENTAL WORK AT THE ROYAL AIRCRAFT ESTABLISHMENT.**—As in previous years the Committee are much indebted to the Staff engaged in experimental work at the Royal Aircraft Establishment for their valuable contributions to the general progress made in aeronautics research. These contributions, which are most fitly characterised, in general, by the term “full scale work” which has been applied to them in the past, cover a very wide field. In addition to experiments on aeroplanes in flight, which in themselves are of a very extensive and varied character, they include a most important and comprehensive series of investigations relative to engines, and engine parts and accessories, a large amount of experimental work on alloys for engine construction, including foundry work and the manufacture and testing of numerous trial cylinders and pistons in various alloys, as well as of complete engines, investigations relative to fabrics and dopes, the study of instruments of all kinds for use on aeroplanes, and many other matters.

The measurements on aeroplanes in flight are an important and essential complement of the model experiments, and have led to many valuable and interesting results. The co-ordination of the full scale and model work effected by the “Scale” and Aerodynamics Sub-Committees has been of definite advantage in controlling the conclusions to be drawn from the two classes of experiments, and the special investigations called for by these Sub-Committees, while entailing a large amount of experimental work, have left the ground clear for more rapid progress in the future. A considerable part of the full scale work at the Royal Aircraft Establishment on aeroplanes in flight during the past year has been done for these Sub-Committees in confirmation and amplification of the observations on models. In addition to calculations based on determinations of “performance,” and on force measurements, much work has been done on the measurement of actual loading and its distribution on wings in flight, and some remarkable results have been obtained. Among other matters to which much attention has been given may be mentioned the careful study of the conditions which accompany “spinning,” and the investigations of controllability, including the design of

the necessary instruments for making the observations in flight required for this work.

A large number of investigations in relation to engines have been carried out at the request of the Engine Sub-Committee. These include the design and construction of plant for testing engines under high altitude conditions, the investigation in actual flight of the variation of engine power with height, the continuation of experiments on air cooled cylinders and engines, as well as researches relative to engine temperatures, methods of cooling, magnetos and other accessories, and a number of other problems. In close connection with this work, a large amount of research has also been carried out for the Light Alloys Sub-Committee, including the study of special alloys, the casting of cylinders and other engine parts, in alloys of different composition, and the examination of their behaviour under running conditions. Important conclusions have been reached from the comparison of cylinders of different materials.

Investigations have been made on various substitutes for materials difficult to obtain in the quantities necessary for the largely increased production of dope. As a result of this work it has been possible to reduce considerably the quantity of doping material required.

Improvements on the standard aeroplane instruments have been made, and the methods of testing them with rapidity and accuracy have been advanced. Instruments have been constructed for the full scale measurements, and the work on bomb sights has been continued.

**METEOROLOGICAL WORK.**—A considerable number of meteorological enquiries have been answered and a number of papers relating to meteorological problems have been presented to the Committee. A comparison of the observations of wind velocities in the upper air by means of pilot balloons with those obtained by other methods has given satisfactory results.

The special experimental work in meteorology carried out for the Committee at the Branch Meteorological Office at South Farnborough has been mainly concerned with the methods for noting and recording lightning. The work was carried on by Captain Cave, R.E., with the assistance of Mr. R. A. W. Watt, until June 30, when Captain Cave was transferred to the Office at South Kensington in order that he might bring the experimental work into daily practical relation with the forecast service. Part of the work was transferred with him, and he retained the Superintendence of the enquiry. Mr. Watt became meteorologist in charge of the Branch Office and the experimental work at South Farnborough. He was joined temporarily by Mr. N. Tunstall, assistant in the Laboratory of Sir Ernest Rutherford at Manchester, and later by Mr. E. L. Hawke, as professional

assistant. After a few months work at the Office, Captain Cave was invalided, and on his recovery was placed in charge of one of the units of the Meteorological Section R.E. His services are therefore no longer available for the experimental work.

The experimental work has included the design and construction of the apparatus necessary for the equipment of two other stations to act with South Farnborough. Plans have been prepared for the erection of the necessary apparatus, but progress is arrested for the time being for want of assistants who have been or can be trained in the special work. The provisional trials made with the stations available elsewhere have shown that an effective answer to the enquiry is quite within the capacity of the instruments at three properly equipped stations in suitable positions.

Interesting results have been obtained in connection with the study of eddy motion, with an anemometer of special design exposed on a tall chimney, and a contribution has been made to the difficult subject of the variation of wind velocity near the ground.

*Signed on behalf of the Committee,*

**RAYLEIGH,**

**PRESIDENT.**

*August, 1918.*