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REPORT OF PROCEEDINGS

Of

SECOND GENERAL CONFERENCE

Between

Representatives of

AIRCRAFT MANUFACTURERS AND OPERATORS

And

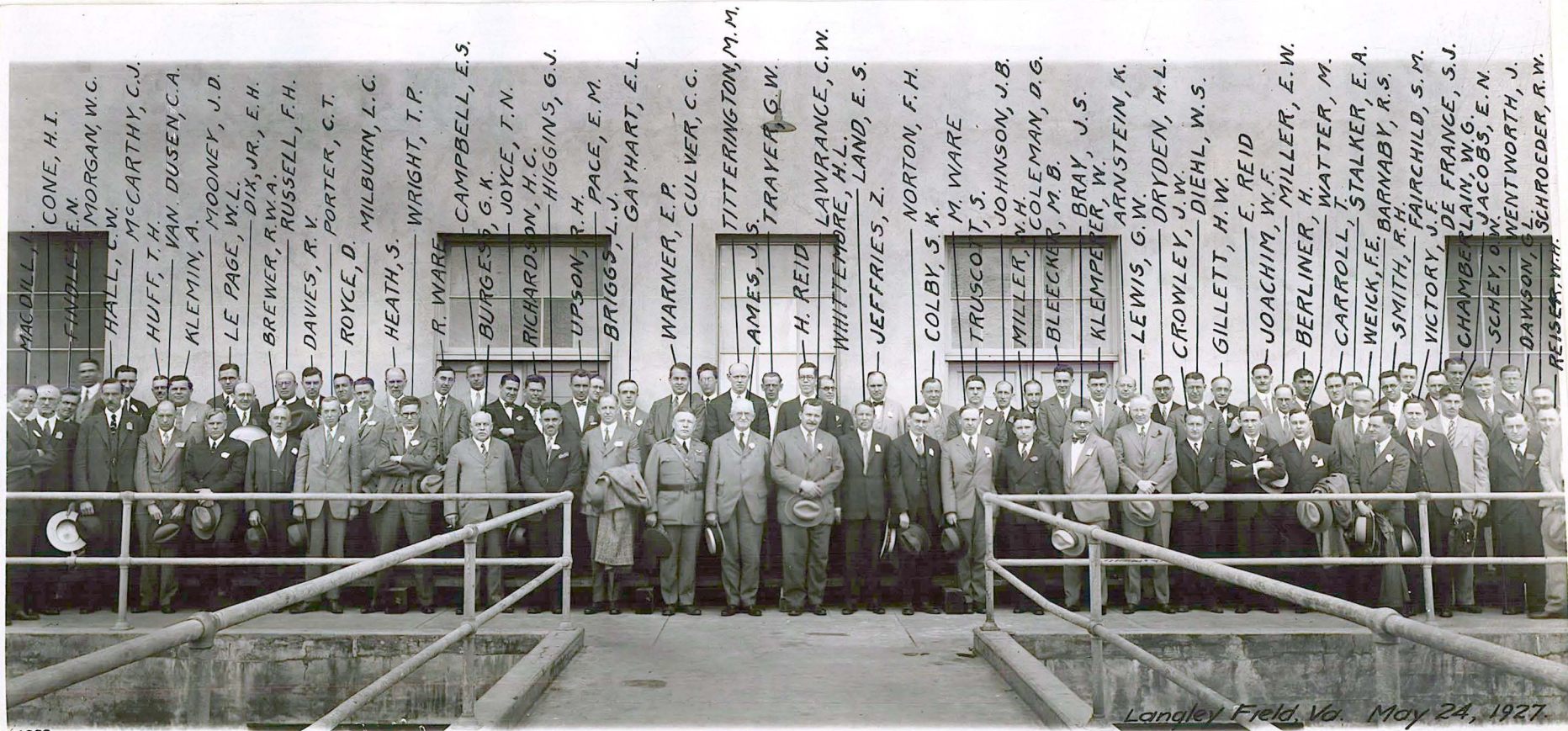
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Held at

LANGLEY MEMORIAL AERONAUTICAL LABORATORY

Langley Field, Va.

May 24, 1927



1852

Langley Field, Va. May 24, 1927.

Second Annual Aircraft Engineering Research Conference
 May 24, 1927.

JOSEPH S. AMES, PH. D., CHAIRMAN
DAVID W. TAYLOR, D. ENG., VICE CHAIRMAN
GEORGE K. BURGESS, SC. D. REAR ADMIRAL WM. A. MOFFETT, U. S. N.
WILLIAM F. DURAND, PH. D. MAJ. GEN. MASON M. PATRICK, U. S. A.
BRIG. GEN. W. E. GILLMORE, U. S. A. S. W. STRATTON, SC. D.
CAPT. EMORY S. LAND, U. S. N. ORVILLE WRIGHT, B. S.
CHARLES F. MARVIN, M. E.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

3341 NAVY BUILDING, 17TH AND B STREETS NW.

WASHINGTON, D. C.

TELEPHONE MAIN 1056

IN REPLY
REFER TO NO.

REPORT OF PROCEEDINGS

Of

SECOND GENERAL CONFERENCE

Between

Representatives of

AIRCRAFT MANUFACTURERS AND OPERATORS
and
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

The second general conference between representatives of aircraft manufacturers and operators and of the National Advisory Committee for Aeronautics was held on Tuesday, May 24, 1927, at the Committee's research laboratory, known as the Langley Memorial Aeronautical Laboratory, located at Langley Field, Virginia. This conference was attended by representatives of aeronautical trade journals and of educational institutions engaged in the teaching of aeronautical engineering, in addition to the representatives of the industry. The National Advisory Committee for Aeronautics was represented by its Subcommittees on Aerodynamics and Materials for Aircraft and members of its laboratory staff.

The members of the subcommittees and most of the invited guests journeyed by boat from Washington to Old Point Comfort and were conveyed to Langley Field by automobile, while others of the party flew direct to Langley Field and some proceeded by train.

The Washington steamer arrived at Old Point at 6:45 a.m. Breakfast was served at the Sherwood Inn at 7:00 a.m. At 8:00 a.m., the party left Old Point in Army automobiles and arrived at the Officers' Club at Langley Field, at 8:25 a.m.

Opening Session

The opening session was held at 8:30 a.m. in the Officers' Club at Langley Field, Virginia. Dr. Joseph S. Ames, Chairman of the National Advisory Committee for Aeronautics, acted as Chairman of the conference. A list of those present is appended.

Doctor Ames stated that the conference had been called by the National Advisory Committee for Aeronautics upon action of the Executive Committee, and that the primary purpose was to secure a discussion of problems involved in the design and construction of aircraft, with special emphasis upon the problems growing out of the needs of commercial aviation, with a view to the incorporation of such problems into the research programs of the National Advisory Committee for Aeronautics for the ensuing year. Before going into the problems, however, the Chairman stated that he would like to introduce Colonel C. C. Culver, Commanding Officer at Langley Field, to whom the Committee felt very much indebted for his interest and cooperation.

Colonel Culver welcomed the guests, saying that not only the research laboratories but the military authorities at Langley Field felt honored by their presence. His remarks were substantially as follows:

The research laboratories are studiously working on the problems leading up to to-morrow's production, while on the other hand the ultimate consumers, the military services, are working with the products of yesterday's manufacture. It is therefore fitting that members of the aircraft manufacturing industry and allied interests should be present to make the conference complete. It is also very appropriate that the conference should be held on the tenth anniversary of the laying out of Langley Field.

Langley Field owes its inception very largely to that great scientist, Doctor Charles D. Walcott, late Chairman of the National Advisory Committee for Aeronautics, whose memory is revered by all.

In 1916 a survey was made of a number of sites to find a suitable one for the U. S. Government Aviation School and Experimental Station. The present location was selected and in 1917 the first buildings, a string of temporary hangars, were hastily thrown together and the field launched on its career to win the war.

During the war great activity prevailed at Langley Field. Foreign airplanes were rushed there for demonstration in order that this country might learn what foreign war developments had brought forth, military and civilian pilots were finished off and sent as instructors to other schools then just starting, the development of airplane radio telegraph and telephone was transferred to Langley Field from San Diego and intensive work carried on by a large number of scientists, and numerous other activities were carried on which would take too long to mention.

In 1919 Langley Field was represented in the first Transcontinental Airplane Reliability Test, sometimes spoken of as the Transcontinental Race, which was won by Lieutenant Maynard. This test was the first of a series of remarkable long-range group flying. Langley Field was also represented in the Alaskan Flight, under Captain Streett, the Porto Rican flight under Major Lamphier, the Round-the-World Flight under Major Martin and Captain Smith, and the Pan-American Flight under Major Dargue.

Langley Field is the base of the bombardment activities for national defense. The Second Bombardment Group recently left for Texas with 16 bombers, 8 transports, and approximately 100 officers and men, to take part in the Air Force Maneuvers at San Antonio.

The Air Corps Tactical School for field officers is also an important Langley Field activity.

In the plans for the future, on the military side, Langley Field seems destined to be the home of the Second Bombardment Wing, with two of its component groups, the Bombardment Group and a Pursuit Group.

On the research side it is hoped that Congress will give greater consideration to the National Advisory Committee's requirements, in order that the research personnel now at these laboratories may have enlarged opportunities to lead the producer and the ultimate consumer.

From time to time everyone has no doubt given thought in a kaleidoscopic way to the bewildering ramifications of this "air game" and has wondered whither it is leading.

Colonel Culver then stated that he had recently found an old official paper which would show the great progress which aviation has made. The paper was the first invitation to the

public to submit proposals for a heavier-than-air flying machine which did not carry a gas bag. Colonel Culver said that he wished especially to call Admiral Cone's attention to this paper in his plans for the Safety Competition which is under way, in which one of the essential elements for success is slow speed.

Colonel Culver then read some extracts from Signal Corps Specification No. 486, dated December 23, 1907, and signed by Brigadier General James Allen. The extracts were as follows:

"Sealed proposals, in duplicate, will be received at this office until 12 o'clock noon on February 1, 1908, on behalf of the Board of Ordnance for furnishing the Signal Corps with a heavier-than-air flying machine.

* * * * *

"Unless the bidders are also the manufacturers of the flying machine they must state the name and place of the maker.

"Preliminary.- This specification covers the construction of a flying machine supported entirely by the dynamic reaction of the atmosphere and having no gas bag.

* * * * *

"General Requirements. The general dimensions of the flying machine will be determined by the manufacturer, subject to the following conditions:

1. Bidders must submit with their proposals the following:
 - (a) Drawings to scale showing the general dimensions and shape of the flying machine which they propose to build under this specification.
 - (b) Statement of the speed for which it is designed.
 - (c) Statement of the total surface area of the supporting planes.
 - (d) Statement of the total weight.
 - (e) Description of the engine which will be used for motive power.
 - (f) The material of which the frame, planes, and propellers will be constructed. Plans received will not be shown to other bidders.

2. It is desirable that the flying machine should be designed so that it may be quickly and easily assembled and taken apart and packed for transportation in army wagons. It should be capable of being assembled and put in operating condition in about one hour.

3. The flying machine must be designed to carry two persons having a combined weight of about 350 pounds, also sufficient fuel for a flight of 125 miles.

4. The flying machine should be designed to have a speed of at least forty miles per hour in still air, but bidders must submit quotations in their proposals for cost depending upon the speed attained during the trial flight, according to the following scale:

40 miles per hour,	100 per cent
39 miles per hour,	90 per cent
38 miles per hour,	80 per cent
37 miles per hour,	70 per cent
36 miles per hour,	60 per cent
Less than 36 miles per hour	rejected
41 miles per hour,	110 per cent
42 miles per hour,	120 per cent
43 miles per hour,	130 per cent
44 miles per hour,	140 per cent

5. The speed accomplished during the trial flight will be determined by taking an average of the time over a measured course of more than five miles, against and with the wind. The time will be taken by a flying start, passing the starting point at full speed at both ends of the course. This test subject to such additional details as the Chief Signal Officer of the Army may prescribe at the time.

6. Before acceptance a trial endurance flight will be required of at least one hour during which time the flying machine must remain continuously in the air without landing. It shall return to the starting point and land without any damage that would prevent it immediately starting upon another flight. During this trial flight of one hour it must be steered in all directions without difficulty and at all times under perfect control and equilibrium.

7. Three trials will be allowed for speed as provided for in paragraphs 4 and 5. Three trials for endurance as provided for in paragraph 6, and both tests must be completed within a period of thirty days from the date of

delivery. The expense of the tests to be borne by the manufacturer. The place of delivery to the Government and trial flights will be at Fort Meyer, Virginia.

8. It should be so designed as to ascend in any country which may be encountered in field service. The starting device must be simple and transportable. It should also land in a field without requiring a specially prepared spot and without damaging its structure.

9. It should be provided with some device to permit of a safe descent in case of an accident to the propelling machinery.

10. It should be sufficiently simple in its construction and operation to permit an intelligent man to become proficient in its use within a reasonable length of time."

Colonel Culver asked the manufacturers present to take notice of the next item.

"13. The price quoted in proposals must be understood to include the instruction of two men in the handling and operation of this flying machine. No extra charge for this service will be allowed."

After reading these extracts Colonel Culver asked the members of the conference to bring their thoughts up to the present day when the world has just witnessed the wonderful flight from New York to Paris of Captain Charles A Lindbergh.

The Chairman thanked Colonel Culver for his warm welcome and interesting address. He stated that a great deal of the success of the Langley Memorial Aeronautical Laboratory depended on the cooperation of the Commanding Officer at Langley Field, and that Colonel Culver had done everything possible in this respect, because of his knowledge and appreciation of the Committee's work.

The Chairman said that before the members of the conference visited the various laboratories he wished them to understand clearly the character and scope of the Committee's activities and the facilities and methods employed.

The Chairman then introduced Mr. H. J. E. Reid, Engineer-in-Charge of the Langley Memorial Aeronautical Laboratory.

Mr. Reid welcomed those attending the conference and said that he was glad of the opportunity of meeting the represent-

atives of the aircraft industry and obtaining from them suggestions as to what further work the Committee could do that would be of assistance to the manufacturers in their work. He announced that after the heads of sections had spoken, an inspection of the laboratories would be made in three groups, to be known as the red, white, and green groups according to the color of tags issued to members of the conference at the time of registration. He stated that those with red tags would be under the direction of Mr. Lewis, those with white tags would be under the direction of Mr. Truscott, and those with green tags would be under the direction of Mr. H. J. E. Reid.

Mr. Reid, Engineer-in-Charge, then introduced Mr. Elliott G. Reid, the engineer in charge of the atmospheric wind tunnel.

Mr. E. G. Reid stated that during the past year his section had been studying three major problems, which consisted of a series of pressure distribution tests on models of wings of the Boeing PW-9, an investigation of spinning in general with particular reference to the rather new problem of flat spinning, or autorotation, and an investigation of airfoil characteristics as affected by control of the boundary layer flow. In the course of his remarks, Mr. E. G. Reid displayed a series of charts relating to the various items. These included charts showing the pressure distribution over the upper and lower wings of the PW-9, a chart showing the autorotational characteristics of different wings and wing sections, and charts showing the effect on the air flow around a wing of sucking in air and discharging air, respectively, through slots in the wing surface.

Mr. George J. Higgins, the engineer in charge of the variable density wind tunnel, was next introduced and he gave a brief outline of the work being done in that wind tunnel. He stated that tests had been made on British models with three different wing sections and the results correlated with those that had been obtained in England by tests of the same models in an atmospheric tunnel and with a full-sized airplane in flight. He said that tests had also been made on an airship model with different fineness ratios. He exhibited charts showing the effect of "scale" on the R.A.F. 15, 19, and 30 airfoils, and the effect of scale on the drag coefficient of a model of an airship.

Mr. Reid then introduced Mr. Elton W. Miller, the engineer in charge of the Propeller Research Equipment.

Mr. Miller described the Propeller Research Equipment as a large wind tunnel of the Eiffel type, in which a full-sized airplane fuselage may be mounted. He said the purpose is to test full-sized propellers under flight conditions and measure the forces. He stated that the air velocity is 100 miles an hour at the throat and decreases to about 12 miles an hour at the opening to the entrance cone. He exhibited diagrammatic charts of the Propeller Research Equipment and added that it would be operated for the first time to-day.

Mr. George L. Dawson, the engineer in charge of the Instrument Section, was next introduced and stated that the work undertaken by that section consisted mainly of the development of special instruments to be used by the Aerodynamics and Power Plant Divisions in their various investigations. He showed on various charts the optical system used on many of the N.A.C.A. instruments and the principles of the accelerometer and of the pressure measuring instruments.

Mr. John W. Crowley, Jr., the engineer in charge of the Flight Research Section, described the pressure distribution tests that had been conducted during the past year. He said that there was in progress at the present time an investigation of pressure distribution over the wing and tail surfaces of the PW-9 airplane, the pressure being measured at 250 points over the whole airplane. By charts he showed the accelerations obtained at the center of gravity, the wing tip, and at the tail of a PW-9 Boeing pursuit airplane in a "pull-up"; the pressure distribution on the wings of the PW-9 airplane; and the pressure distribution on the hull and tail surface of the U.S.S. LOS ANGELES.

Mr. Reid then introduced Mr. Thomas Carroll, Chief Test Pilot of the Committee, who is in charge of the Flight Operations Section.

Mr. Carroll gave a brief outline of the work that has been done by the Flight Operations Section during the past year. He said that an investigation had been conducted on the characteristics of airplanes and seaplanes in taking off and landing and also that a study of ground effect had been made.

Mr. Marsden Ware, the engineer in charge of the supercharger development at Langley Field, was next introduced.

Mr. Ware described the N.A.C.A. Roots supercharger and stated that while it is similar in principle to the Roots supercharger that has been used commercially, it differs in many important respects. He then brought out the points

wherein the two types differed, and exhibited charts showing the characteristics of the supercharger and the effects obtained by fitting it to airplane engines.

Mr. W. F. Joachim, the engineer in charge of fuel injection research, was then introduced and stated that the National Advisory Committee, realizing the importance of the development of aircraft in general and especially the importance of increasing the safety from fire hazard, and also increasing the distance of flight, undertook the study and development of the high-speed oil engine for aircraft in 1920. Since that time considerable progress has been made in the development of this engine and Mr. Joachim outlined briefly the investigations that had been carried on. He further stated that it took four years to perfect the Committee's present spray photography equipment with which high-speed moving pictures are taken of oil sprays at rates up to 4,000 pictures per second.

Mr. Reid then requested all those who had not registered please to do so.

The Chairman announced that Mr. Reid would like to have the names of all those who intended to return by the Cape Charles route, so that reservations could be made. He further added that Mr. Reid had several announcements he wished to make.

Mr. Reid stated that at 4:00 p.m. there was to be a demonstration in the hangar of the Katzmayer effect as applied to a TS airplane and also a flight of a Vought airplane with a cut-out center section. He said that transportation would be furnished by Army cars and by members of the laboratory staff. Mr. Reid invited attention to the programs which had been distributed and asked the cooperation of all in adhering to the schedule.

The members of the conference then stepped outside the Officers' Club and posed for a group photograph, after which they divided into three groups and proceeded on a tour of inspection of the Committee's laboratories, in accordance with the following schedule:

Arrive:	<u>Red</u>	<u>White</u>	<u>Green</u>
Atmospheric Wind Tunnel	1 9:45	4 11:20	2 10:25
Variable Density Tunnel	2 10:02	5 11:37	3 10:42
Instruments Section	3 10:20	1 9:45	4 11:00
Power Plant Laboratory	4 10:45	2 10:10	5 11:25
Flight Research Airplanes	5 11:20	3 10:45	1 9:50
PROPELLER RESEARCH EQUIPMENT	6 11:55	6 11:55	6 11:55

At 12:30 the members of the conference reassembled in the Officers' Club for a buffet luncheon.

Joint Conference

At 1:30 p.m. the conference reconvened in the Officers' Club with Dr. Ames presiding as Chairman.

The Chairman stated that before beginning the formal proceedings for the afternoon he would like to announce that Mr. Lewis had telephone to the Washington office of the Committee to get the latest news in regard to the Italian officer, de Pinedo, who was flying from New York to the Azores, and that the latest word received was that he had been picked up near the Azores. This report was unconfirmed but the press regarded it as authentic.

The Chairman then stated the object of the joint conference, his remarks being substantially as follows:

The National Advisory Committee for Aeronautics called the meeting primarily for its own benefit, as it is the duty of the Committee to furnish advice to everyone interested in aeronautics and to determine by scientific experiments the information on which this advice is based.

The primary purpose of the conference is to secure a discussion of problems involved in the design and construction of aircraft, with special emphasis upon the problems growing out of the needs of commercial aviation, with a view to the incorporation of such problems into the research programs of the National Advisory Committee for Aeronautics for the ensuing year.

In the past, the efforts of the Committee have been concentrated mainly on problems which have arisen in the military services, but, owing to the passage of the Air Commerce Act of 1926 and the consequent growth of commercial aviation, it seems desirable for the Committee to consider also problems relating particularly to civil and commercial aviation. The Committee, therefore, is anxious to have brought to its attention the problems growing out of commercial aviation which its laboratories are equipped to study.

Having visited the laboratories of the Committee and having met the members of its technical staff, those at-

tending this conference probably have in their minds a picture as to what the Committee can do. The Committee stands ready to do anything it can. It is not interested in problems relating to any one particular type of aircraft, it is interested in fundamental problems; but there is no fundamental problem which does not have a practical bearing. The Committee would welcome any suggestions which would guide it in the problems to be undertaken.

The Chairman then stated that he thought it best to call upon a few men individually, because he believed they would be able to start a discussion and to offer suggestions which would be helpful. He first called upon Mr. Frank H. Russell, who represented the Aeronautical Chamber of Commerce.

Mr. Russell stated that the problems of commercial aviation, and the building of airplanes particularly, as distinguished from the problems of military aviation, were coming before the manufacturers of this country with increasing force, and that Doctor Ames' remark that the Committee is ready to assist the industry along this line came as a very welcome one. Mr. Russell said that after an inspection of the laboratories of the Committee he thought the growth over last year was almost phenomenal. He said no one could spend a day at Langley Field and see the work that was being done, meet the engineers, and see the wonderful equipment without going away inspired and enthused.

The Chairman then called upon Honorable E. P. Warner, Assistant Secretary of the Navy for Aeronautics.

Mr. Warner stated that so far as the relation of the services to the National Advisory Committee for Aeronautics is concerned, he was reminded of a wonder that had often crossed his mind as to how human beings ever existed without electric lights, automobiles, and other conveniences that are now accepted so much as a matter of course. He said it seemed now, after seven or eight years of intensive aeronautical research at Langley Field and elsewhere, difficult to conceive how any use of the airplane or any branch of aeronautical operation or aeronautical engineering could have got along without that research, and obviously difficult to conceive how much poorer would have been our knowledge of the data upon which the progress of aeronautical engineering rests had there been no National Advisory Committee for Aeronautics and no laboratory at Langley Field. He stated that it was well known that the Army and Navy have been receiving constant assistance from the National Advisory Committee and that the services had learned to lean upon the Committee. He

added that the services have from time to time been able to give assistance by furnishing equipment on loan. Mr. Warner said that, speaking to some degree on behalf of the services, he could say that the services recognized their interest in the development of commercial aviation, in the strengthening of the industry by the expansion of its commercial market; and as a very important means to the consequent strengthening of the industry, the Navy would be glad to do everything in its power to assist the National Advisory Committee in any work that might appear likely to be useful to that end.

Mr. Warner then stated that, speaking as an individual engineer, who like all the other members of the conference had been interested in visiting the laboratories of the National Advisory Committee, there was one suggestion he would like to renew from last year's meeting. He said at that time the Air Mail routes were just getting under way and that the future of commercial aviation seemed rather uncertain, but that now after an additional year of experience it was quite clear that the carriage of passengers was going to become important as well as the carriage of mail, and he thought a study should be made of some of the factors that bear on the comfort and convenience of the passengers of the airplane, and especially on the question of noise and the means of eliminating those sounds which produce unpleasant effects upon the ears of the occupants of the cabin.

The Chairman then called upon Admiral H. I. Cone, Vice President and Treasurer of the Daniel Guggenheim Fund for the Promotion of Aeronautics.

Admiral Cone stated that, judging from his long experience as an engineer, he believed that there had never been in the history of engineering any branch that depended more on laboratory work, and on the fundamentals of mathematics, physics, and other sciences, than aeronautics. He said that we in this country were particularly fortunate in having available the laboratories of the National Advisory Committee.

He said that members of the industry and all who are interested in commercial aviation could congratulate themselves that there is a body of distinguished scientists, physicists, mathematicians, and engineers like the members of the National Advisory Committee for Aeronautics who give their time and attention to helping in the solution of the problems of aeronautics.

He said that the Guggenheim Fund was anxious to assist in every way possible and was looking for ways to aid in the

development of aeronautics. He said he wished to report that when the Guggenheim Fund was first organized, and had no definite ideas as to how to accomplish its purpose, it had been helped more by the National Advisory Committee, and especially by Dr. Lewis, than he could say.

Admiral Cone said that there was probably no one who knew more the difficulties of carrying on the work of an establishment like these laboratories than he himself. He said that such an establishment is hampered at every turn, no matter how eager it may be to respond to requests, by regulations of all kinds, by "red tape" with reference to the expenditure of funds, etc., and that everyone, in dealing with the Committee, should bear this in mind and be patient, being ready to assist in every way, as well as demand of the Committee.

Admiral Cone thanked the Chairman for the privilege of speaking.

The Chairman called upon Mr. T. P. Wright, Chief Engineer of the Curtiss Aeroplane and Motor Company, stating that last year Mr. Wright had given the conference helpful suggestions.

Mr. Wright said that in connection with the preparation of the rules for the safety competition recently instituted by the Guggenheim Fund, a great deal of study was given to the factors that went into the safety of the airplane and it was found that one of the important requirements was that the airplane must have controllability at low speeds. He suggested that this is the feature along the line of safety which calls for more attention on the part of the Advisory Committee than any other. He pointed out that the Committee is working on this problem in connection with the investigation of slotted wings, and he hoped this would lead to greater knowledge of the effect of slots and of combination of slots with aileron action, which would lead to greater improvement than can be realized now. He added that he hoped the study of controllability at low speeds and at high angles of attack, and the control of the burbling of the wing would be carried as far as practicable in the next year or two.

The Chairman said that at last year's conference a question was asked by Mr. Charles Ward Hall, of Charles Ward Hall, Incorporated, which led to an investigation taken up by the Committee. He called upon Mr. Hall for further suggestions.

Mr. Hall expressed the opinion that there was one element of investigation which has not been carried as far as

it might be, namely, the study of the effect of minute protuberances here and there on an otherwise faired streamline body. He said that such information was important in connection with the use of radial engines.

The Chairman remarked that in the testing of models in the variable-density tunnel, it is essential to reproduce on the model every point on the full-sized airplane. He said that in an atmospheric wind tunnel such detail is not necessary, but in variable-density, to get results free from the scale effect, it was necessary to use models accurate in every detail.

The Chairman said that the question of sound was a very difficult one, and it was hoped to obtain some information along this line from the operation of the Propeller Research Equipment.

The Chairman said he would now call upon a man who had particular reason to be proud of the product of his factory, Mr. Charles W. Lawrance, President of the Wright Aeronautical Corporation, which built the engine used in the airplane in which Mr. Lindbergh recently crossed the Atlantic.

Mr. Lawrance said he would like to enlarge a little on Mr. Hall's remarks. He said that the question of the cowling of air-cooled engines was one about which very little is known, as can be seen from examination of different kinds of airplanes. He described two entirely different conditions of cowling, and pointed out that no definite knowledge was available of the resistance conditions in the two cases. He said it would be very valuable if in the new large sized tunnel an engine could be equipped with various kinds of cowling and experiments conducted on the effects of the different types.

The Chairman said that the remark had been made that two or three wind tunnels like the Propeller Research Equipment were needed on account of the large number of problems which needed to be solved in such a tunnel. He said that the question of the cowling of the air-cooled engine was one of the first which the Committee had resolved to take up with the new equipment.

The Chairman then called upon Mr. S. M. Fairchild, President of the Fairchild Aviation Corporation.

Mr. Fairchild said that he had made many contacts at this conference, and suggested that it might have been well to have the conference two days. He said that the problem in

which he was particularly interested was the use of low-speed propellers and that so far it has not been possible to get very accurate data along this line from flight tests. He pointed out that the new propeller research equipment would be most valuable in this connection, as tests may be carried on which take into consideration the effects of the fuselage and other factors which are apparently very hard to calculate.

Mr. Fairchild also pointed out the desirability of a study of the resistance of cylinder heads sticking out of the various forms of cowling.

The Chairman next called upon Dr. Karl Arnstein, of the Goodyear-Zeppelin Corporation.

Dr. Arnstein said that those interested in lighter-than-air development had reason to be very grateful to the National Advisory Committee for Aeronautics for the wind tunnel tests of airship models in the high-pressure wind tunnel. He said that the new balance was a marvelous achievement, and would insure great accuracy. He said that another important development by the Committee was the work being done toward the solution of the high speed oil engine and remarked that it was unnecessary to say that the development of the oil engine would increase the safety and economy of airship operation.

He said he was greatly impressed by the Propeller Research Equipment and hoped airship tests would be conducted in it with full-sized airship cars.

The Chairman said he would call on the representative of the company responsible for the development of a great deal of aircraft material in this country, Mr. S. K. Colby, a representative of the Aluminum Company of America and President of the American Magnesium Corporation.

Mr. Colby said that the question in which he was particularly interested was that of materials, and that the display he had witnessed that morning was one that he could not completely comprehend. He was impressed particularly with the scope of the laboratory, with the wind tunnel and flight research carried on. He said that if there were two or three such laboratories the answers to the questions of commercial aviation would come a great deal sooner.

He said that the particular detail in which he was interested was magnesium. He said it had been thought the development of this metal would grow rapidly, but it had not grown as rapidly as was expected; that the difficulties would be

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solved, but had not been solved yet.

The Chairman said that he had called upon a number of the people present whom he happened to know personally and who knew something about the Committee. He then requested that others in the conference suggest fundamental problems for investigation by the Committee.

Mr. R. W. A. Brewer of Pitcairn Aviation, Incorporated, said he was interested in the question Professor Warner had raised, the question of noise, to which he had referred at last year's conference. He said that another thing on which he would like to have information which was tied up with the question of cowling, and that was the most suitable way of handling the exhaust in the radial air-cooled engine, whether by ring manifolds, short stacks, or what. He would like to be advised as to some way of handling manifolding not only from the viewpoint of silencing, but of the comfort of the passengers and of the durability of the product itself.

He said he was also interested in the question of materials from which cylinders can be made and he believed the development of an improved method of cylinder construction would be a great advance in the commercial air-cooled engine at the present time.

Mr. R. H. Upson, of the Aircraft Development Corporation, referred to the great dependence of lighter-than-air design at the present time upon the Committee's laboratories at Langley Field. He said that the problem of scale effect, which is a serious one even with heavier-than-air craft, becomes a very dominant problem with lighter-than-air craft, on account of the fact that not only are the scale differences actually so much greater but also the types of full-sized lighter-than-air craft are of such a delicate character that they seem to be peculiarly sensitive to changes in scale. He pointed out that the National Advisory Committee had the only two tunnels in this country, if not in the world, which are suited to the solution of the difficulty of scale effect, particularly with reference to lighter-than-air craft, and that the problems of airship resistance can be studied nowhere else as thoroughly as in either the high pressure tunnel or the new large tunnel. He said that there were countless problems which might be studied with very good advantage, including the shape, form, and disposition of tail surfaces; and that the investigation of varying fineness ratios had already been started. He said that a thorough study of this problem involves study not only of the various curves for various fineness ratios but of the variations in the curve of results for the same fineness ratio.

The Chairman stated that the British Aeronautical Research Committee has been studying the problem of a suitable design for a wind tunnel similar to this Committee's variable-density tunnel, and had sent to this Committee confidential reports prepared by British scientists on the merits and demerits of our tunnel. He said that the British were skeptical of our tunnel because they were convinced that the character of flow in our tunnel was turbulent, and that a tunnel of the Eiffel type was preferable. The Chairman pointed out, however, that the results obtained by the Committee on models tested in the variable-density wind tunnel checked closely with actual flight tests made in England on full-sized airplanes of the same type, whereas these two sets of results were at variance with the results of tests in the wind tunnel of the National Physical Laboratory on the same models as were tested in the variable-density wind tunnel.

The Chairman further stated that the National Advisory Committee has in mind its responsibility with reference to investigations on lighter-than-air craft.

Dr. Zay Jeffries, of the Aluminum Company of America, pointed out that perhaps the only field in aeronautics in which all aircraft people are interested is that of aerial navigation, which involves the questions of suitable landing facilities, and flight in fogs, snowstorms, bad winds, and other conditions of bad weather. He said that anything the National Advisory Committee for Aeronautics could contribute in this field would be applicable to the whole aircraft industry and would probably hasten the development of commercial aviation. He suggested that someone outline for the conference the status of aerial navigation in bad weather.

The Chairman called upon Dr. L. J. Briggs, of the Bureau of Standards.

Dr. Briggs stated that the experience of the Bureau of Standards had been entirely in the laboratory, in the development of instruments, which, when developed, never meet the full requirements of the flyer. He said he thought it would be much more to the point if someone who had spent long hours in the air under the conditions referred to would recount his experiences, and suggested that Lieutenant Shoemaker be called upon.

Lieutenant Shoemaker said that his experience was limited to operations with the battle fleet in West Indian waters this winter, involving flights of 700 or 800 miles. He said it had been found necessary to abandon the wind-driven earth inductor compass because it was not dependable, and that an excellent British aperiodic compass had been substituted, which gave magnetic north at all times and was not affected by the turning of the airplane.

Referring to Mr. Lindbergh's New York-to-Paris flight, Lieutenant Shoemaker said he did not understand how he had done it. He described the drift indicating device used by the round-the-world flyers, and said that in his own experience in seaplane flying he had found that, knowing the force of the wind when he took off and judging its direction from the streaks he could see in the water, he could set his course to allow for the drift. He said that the electrically driven earth inductor compass and the aperiodic compass were the best instruments now in use to indicate direction, and stated that Mr. M. M. Titterington, of the Pioneer Instrument Company, was thoroughly familiar with these instruments, and also knew what navigation instruments were used by Lindbergh in his flight.

Mr. Titterington said that the problem of air navigation was a very difficult one. He said that it would be possible to fly entirely blind as long as a couple of stars or the sun can be seen, and the fact that long flights have been carried out would seem to show that even with the present equipment this can be done. He said that the problem of taking off and landing in fogs was important.

The Chairman inquired whether any instrument had yet been developed to indicate actual height above the ground as distinct from the indication of pressure of the atmosphere. Mr. Titterington replied that there was promising development along this line, and it was felt that the problem would eventually be solved.

In answer to inquiry as to the instrument equipment carried by Lindbergh, Mr. Titterington said that his instruments were those ordinarily carried by the pilot, and included two small magnetic compasses of the ordinary type, an earth inductor compass, and a drift indicator, as well as a turn and bank indicator, air-speed indicator, tachometer, and engine instruments of the standard types. He said that Lindbergh had all the instruments that he could readily use, but had no way of reading his position by astronomical observations.

The Chairman remarked that when Alcock and Brown made their transatlantic flight in 1919, he had asked Commander Richardson how they had succeeded in reaching Ireland, and the Commander had replied that they "hit Ireland by the grace of God."

Mr. Fairchild remarked that he had been told when he was in Europe last summer that the British are using an automatic rudder control for directional flying, and that the results obtained were very accurate. He asked whether any information

was available on this instrument.

On inquiry of the Chairman, Mr. Lewis said that the Committee had no information regarding this instrument.

Major Leslie MacDill, U.S.A., of the Materiel Division of the Air Corps, after apologizing for introducing the matter at this meeting, called attention to the question of standardization of Army and Navy requirements for aircraft materiel. He said that letters were being sent to the manufacturers asking them what differences between the Army and the Navy requirements caused them difficulty, and which they preferred, and why. He appealed to everyone to give this letter careful consideration and to go into the matter in as much detail as possible, prior to the standardization conference to be held at McCook Field within the next few months.

At this point the Chairman stated that he would turn over the meeting to Dr. George K. Burgess, Chairman of the Committee on Materials for Aircraft of the National Advisory Committee for Aeronautics, for a public session of the Materials Committee.

Public Session, Committee on Materials for Aircraft.

The Committee on Materials for Aircraft then met in joint session with the other members of the conference, Dr. Burgess presiding.

Dr. Burgess announced that the main feature of the meeting would be the presentation of a paper by Dr. E. H. Dix, Jr., of the Aluminum Company of America, on "'Alclad,' a New Corrosion-Resistant Aluminum Product," but that prior to the presentation of this paper there were one or two items of routine business of the Materials Committee to be taken up. After these were disposed of, Dr. Burgess made a brief statement regarding the importance to aeronautics of the light alloys of aluminum, the chief points he brought out being as follows:

Aluminum alloys, and especially duralumin, have been studied for a number of years, and attempts have been made to develop an alloy better than duralumin, but have been unsuccessful. The chief difficulty in the use of duralumin is the intercrystalline embrittlement of the material, and there are two problems involved in the study of this embrittlement, namely, that of determining and eliminating

the cause of the embrittlement, and that of interposing a protecting layer of material between the duralumin and the atmosphere. In connection with the study of these problems, the cooperation of the producing companies with the Government organizations interested has been excellent in all respects. The Aluminum Company has developed an arrangement of metal which is called "Alclad," and which Dr. Dix will describe to the conference.

Dr. Burgess then introduced Dr. Dix.

Dr. Dix presented a detailed discussion of the new product. He said that, while in comparison with steel aluminum offered high resistance to corrosion, nevertheless the strong alloys, when used in thin sections, required some protection, especially if exposed to mist or salt air. He stated that for the past four years the research laboratories of the Aluminum Company of America had been studying resistance to corrosion, and had developed this new product, which consists of a core of 17ST alloy (duralumin) with a surface of pure aluminum.

Dr. Dix exhibited a number of lantern slides showing the internal structure of this material, and submitted a number of samples, which were examined by the members of the conference at the close of the meeting.

Dr. Burgess asked Dr. Jeffries to comment on Dr. Dix's paper.

Dr. Jeffries said it might be interesting to know that the coating of pure aluminum on the surface of the duralumin entailed a slight loss of tensile strength, somewhere in the neighborhood of 5,000 pounds per square inch, but it was possible that with further study of the material this could be regained. He said that it was not possible as yet to state definitely what could be expected from this material from the point of view of protection from corrosion. He stated that the Aluminum Company was making every effort to develop this product as a material to be desired by the aircraft industry.

Dr. H. W. Gillett, of the Bureau of Standards, said that from tests at the Bureau of Standards it had been found that pure aluminum was especially resistant to the intercrystalline type of corrosion, and it was expected that tests of the new product at the Bureau would corroborate the belief as to its high resistance to corrosion.

Lieutenant R. S. Barnaby, U.S.N., of the Bureau of Aeronautics, Navy Department, raised the question of the protec-

tion of rivets used with the new material. Dr. Dix replied that from tests made by the Aluminum Company it seemed certain that the pure metal would form an electrolytic protection for the rivets.

Dr. Burgess stated that the Committee on Materials for Aircraft was organized with four subcommittees, namely: Metals; Woods and Glues; Coverings, Dopes, and Protective Coatings; and Aircraft Structures. He asked whether any members of the conference had any suggestions to offer relating to the work of these subcommittees.

Mr. B. C. Boulton, Chief Engineer of the Loening Aeronautical Engineering Corporation, said that one thing in which his company was interested, and on which the Army and Navy were not in complete accord, was the question of zinc plating for certain types of tubular structures. He said that there were certain airplane parts which the plating process could not reach but which were subjected to the acid, and he believed it was injurious to attempt to zinc plate such fittings or parts. He said there was controversy between the Army and the Navy on this point, and he thought the matter would be a suitable subject for further investigation.

Dr. Burgess replied to Mr. Boulton that the Committee would be glad to keep his suggestion in mind.

As there were no further suggestions, Dr. Burgess thanked the members of the conference for their attendance at the meeting of the Materials Committee, and the meeting adjourned.

Following the meeting, the members of the conference made a further inspection of various activities of the laboratory which were of particular interest to them. Demonstrations of the effect of blowing air through transverse slits in the wing, known as the Katzmayer effect, and of a wing with the front portion cut away and equipped with flaps, for improvement in visibility, were conducted at the Committee's hangar and in the air and were witnessed by many members of the conference.

The following were present at the conference:

Members of Subcommittee on Aerodynamics:

Dr. Joseph S. Ames, Johns Hopkins University, Chairman,
Dr. L. J. Briggs, Bureau of Standards,
Lieutenant W. S. Diehl, U.S.N.,
Professor Alexander Klemin, Department of Commerce,

Mr. G. W. Lewis, Director of Aeronautical Research,
National Advisory Committee for Aeronautics,
Major Leslie MacDill, U.S.A.,
Professor Charles F. Marvin, U. S. Weather Bureau,
Captain H. C. Richardson, U.S.N.,
Honorable Edward P. Warner, Assistant Secretary
of the Navy for Aeronautics.

Members of Subcommittee on Materials for Aircraft:

Dr. George K. Burgess, Bureau of Standards, Chairman,
Professor H. L. Whittemore, Bureau of Standards,
Vice Chairman and Acting Secretary,
Lieutenant R. S. Barnaby, U.S.N.,
Mr. S. K. Colby, American Magnesium Corporation,
Dr. H. W. Gillett, Bureau of Standards,
Dr. Zay Jeffries, Aluminum Company of America,
Mr. J. B. Johnson, Materiel Division, Army Air Corps,
*Mr. G. W. Lewis, Director of Aeronautical Research,
National Advisory Committee for Aeronautics,
*Captain H. C. Richardson, U.S.N.,
Mr. G. W. Trayer, Forest Products Laboratory,
*Honorable Edward P. Warner, Assistant Secretary
of the Navy for Aeronautics.

Representatives of Manufacturers and Operators:

Aeronautical Chamber of Commerce, New York City:
**Mr. Charles L. Lawrance, Wright Aeronautical
Corporation, Paterson, N. J.,
**Mr. F. H. Russell, Curtiss Aeroplane and Motor
Company, Garden City, N. Y.,
**Mr. S. M. Fairchild, Fairchild Aviation Cor-
poration, New York City,

Aircraft Development Corporation, Detroit, Mich.:
Mr. R. H. Upson,

Allison Engineering Company, Indianapolis, Ind.:
Mr. J. S. Bray,

Aluminum Company of America, New Kensington, Pa.:
Mr. R. V. Davies,
Dr. E. H. Dix, Jr.,

Auto Engine Works, St. Paul, Minnesota:
Mr. J. D. Mooney,

-
- * Also member of Subcommittee on Aerodynamics
** Also representing his own company

Henry Berliner Company, College Park, Maryland:
Mr. Henry Berliner,

Boeing Airplane Company, Seattle, Washington:
Mr. E. S. Campbell,

Curtiss Aeroplane and Motor Company, Garden City, New York:
Mr. F. H. Russell,
Mr. T. P. Wright,
Mr. W. H. Miller,
Mr. T. N. Joyce,
Mr. M. B. Bleecker,

Fairchild Airplane Manufacturing Corporation, New York City:
Mr. S. M. Fairchild,

Goodyear Tire and Rubber Company, Incorporated, Akron, Ohio:
Dr. Karl Arnstein,
Dr. Wolfgang Klemperer,

Charles Ward Hall, Incorporated, New York City:
Mr. Charles Ward Hall,

Keystone Aircraft Corporation, Bristol, Pa.:
Mr. C. T. Porter,

Loening Aeronautical Engineering Corporation, New York City:
Mr. B. C. Boulton,

Glenn L. Martin Company, Cleveland, Ohio:
Mr. C. A. VanDusen,
Mr. L. C. Milburn,

Paragon Engineers, Incorporated, Baltimore, Md.:
Mr. Spencer Heath,

Pioneer Instrument Company, Brooklyn, New York:
Mr. M. M. Titterington,

Pitcairn Aviation, Incorporated, Philadelphia:
Mr. R. W. A. Brewer,

Pratt & Whitney Aircraft Company, Hartford, Conn.:
Mr. William G. Chamberlain,

R. W. Schroeder, Glencoe, Illinois:
Mr. R. W. Schroeder,
Mr. John Wentworth,

Thomas-Morse Aircraft Corporation, Ithaca, N. Y.:
Mr. Raymond Ware,

Chance Vought Corporation, Long Island City, N. Y.:
Mr. C. J. McCarthy,
Mr. Michael Watter,

Wright Aeronautical Corporation, Paterson, N. J.:
Mr. Charles L. Lawrance.

Representatives of Aeronautical Journals and Educational
Institutions:

AVIATION, New York City:
Mr. W. L. LePage,

U. S. AIR SERVICES, Washington, D. C.:
Mr. Earl N. Findley,

University of Michigan, Ann Arbor, Michigan:
Mr. Edward A. Stalker.

Additional Guests:

Lieutenant Colonel C. C. Culver, U.S.A.,
Commanding Officer, Langley Field, Va.,
Admiral H. I. Cone, The Daniel Guggenheim Fund
for the Promotion of Aeronautics,
Captain Emory S. Land, U.S.N.,
Dr. F. L. Browne, Forest Products Laboratory,
Dr. H. L. Dryden, Bureau of Standards,
Commander E. L. Gayhart U.S.N., Washington Navy Yard,
Lieutenant Lloyd Harrison, U.S.N., Bureau of Aeronautics,
Mr. T. H. Huff,
Mr. F. H. Norton, Cambridge, Mass.,
Commander E. M. Pace, U.S.N., Bureau of Aeronautics,
Mr. H. S. Rawdon, Bureau of Standards,
Lieutenant Commander D. Royce, U.S.N., Bureau of
Aeronautics,
Lieutenant J. M. Shoemaker, U.S.N., Bureau of Aeronautics,
Mr. R. H. Smith, Washington Navy Yard,
Dr. L. B. Tuckerman, Bureau of Standards,

Mr. J. F. Victory, Assistant Secretary of the National
Advisory Committee for Aeronautics.

Members of Committee's Staff:

Mr. Thomas Carroll, Chief Test Pilot,
Mr. Donald G. Coleman,
Mr. John W. Crowley, Jr., head of Flight Research
Section,
Mr. George L. Dawson, head of Instrument Section,
Mr. Smith J. DeFrance,
Mr. George J. Higgins, head of Variable-Density
Wind Tunnel,
Mr. Eastman N. Jacobs,
Mr. William F. Joachim, head of fuel-injection
engine development,
Mr. Elton W. Miller, head of Propeller Research
Section,
Mr. William C. Morgan,
Mr. Elliott G. Reid, head of Atmospheric Wind
Tunnel,
Mr. Henry J. E. Reid, Engineer-in-Charge,
Mr. Walter H. Reiser,
Mr. Oscar W. Schey,
Mr. Edward R. Sharp, Chief Clerk of Laboratory,
Mr. Marsden Ware, head of Power Plants Division,
Mr. F. E. Weick.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Joint Conference of
Committee on Aerodynamics;
Committee on Materials for Aircraft;
Representatives of: Aircraft Industry;
Educational Institutions; and Aeronautical Trade Journals.

At

Langley Memorial Aeronautical Laboratory,
Langley Field, Va., May 24, 1927.

The following is a list of persons attending the conference, other than those stationed at Langley Field:

- ⊕ Dr. Joseph S. Ames, ⊕ Chairman N.A.C.A. and Chairman of the conference.
- ⊕ Dr. Karl Arnstein, ⊕ Goodyear Tire and Rubber Company, Akron, Ohio.
- ⊕ Lieut. R. S. Barnaby, ⊕ U.S.N., Bureau of Aeronautics, Navy Department.
- ⊕ Mr. Henry Berliner, ⊕ Henry Berliner Company, College Park, Md.
- ⊕ Mr. M. B. Bleecker, ⊕ Curtiss Aeroplane & Motor Company, Garden City, L. I., N. Y.
- ⊕ ~~Mr. B. C. Boulton~~
~~Mr. B. C. Boulton,~~ Loening Aeronautical Engineering Corp., New York City.
- ⊕ Mr. J. S. Bray, ⊕ Allison Engineering Company, Indianapolis, Ind.
- ⊕ Dr. L. J. Briggs, ⊕ Bureau of Standards.
- ⊕ ~~C. J. Brown~~
- ⊕ Dr. F. L. Browne, Forest Products Laboratory, Madison, Wis.
- ⊕ Dr. George K. Burgess, ⊕ Member N.A.C.A.; Chairman of Committee on Materials for Aircraft; Director, Bureau of Standards.
- ⊕ Mr. E. S. Campbell, ⊕ Boeing Airplane Co., Seattle, Wash.
- ⊕ ~~Mr. S. K. Colby~~ ⊕ ~~Mr. S. K. Colby~~ American Magnesium Corporation, Niagara Falls, N. Y.
- ⊕ Admiral H. I. Cone, ⊕ Daniel Guggenheim Fund for the Promotion of Aeronautics.
- ⊕ Mr. R. V. Davies, ⊕ Aluminum Company of America, Washington, D. C.
- ~~Lieut. Ernest W. Dichman~~, U.S.A., Material Division, Air Corps, McCook Field, Dayton, Ohio.

- ⊕ Lieut. W. S. Diehl, U.S.N., Bureau of Aeronautics, Navy Department.
- ⊕ Mr. E. H. Dix, Jr., ⊕ Aluminum Company of America, New Kensington, Pa.
- ⊕ Dr. H. L. Dryden, ⊕ Bureau of Standards.
- ⊕ Mr. S. M. Fairchild, ⊕ Fairchild Airplane Mfg. Corp., New York, N. Y.
- ⊕ Mr. Earl N. Findley, ⊕ U. S. AIR SERVICES, Washington, D. C.
- ⊕ Comdr. E. L. Gayhart, ⊕ U. S. Navy Yard, Washington, D. C.
- ⊕ Dr. H. W. Gillett, ⊕ Bureau of Standards.
- ⊕ Mr. Charles Ward Hall, ⊕ Charles Ward Hall, Inc., New York City.
- ⊕ Lieut. Lloyd Harrison, U.S.N., Bureau of Aeronautics, Navy Dept.
- ⊕ Mr. Spencer Heath, ⊕ Paragon Engineers, Inc., Baltimore, Md.
- ⊕ (Mr. T. H. Huff,) ⊕
- ⊕ Dr. Zay Jeffries, ⊕ Aluminum Company of America, Cleveland, Ohio.
- ⊕ Mr. J. B. Johnson, ⊕ Materiel Division, Air Corps, McCook Field, Dayton, Ohio.
- ⊕ Mr. T. N. Joyce, ⊕ Curtiss Aeroplane and Motor Company, Garden City, L.I., N. Y.
- ⊕ Prof. Alexander Klemin, ⊕ Daniel Guggenheim School of Aeronautics, New York University, N. Y.
- ⊕ Dr. W. Klemperer, ⊕ Goodyear Tire and Rubber Company, Akron, Ohio.
- ⊕ Capt. E. S. Land, U.S.N., ⊕ Member N.A.C.A.; Assistant Chief Bureau of Aeronautics, Navy Dept.
- ⊕ *Ruth Brewer* ⊕ Pitcairn Aviation, Inc., Philadelphia, Pa.
- ⊕ Mr. ~~A. E. Larsen~~, ⊕
- ⊕ Mr. Charles W. Lawrance, ⊕ Wright Aeronautical Corporation, Paterson, N. J.
- ⊕ Mr. W. L. LePage, ⊕ AVIATION, New York City.

⊕ Mr. G. W. Lewis, ⊕

Director of Aeronautical
Research, N.A.C.A.

~~Mr. G. C. Loening~~

Loening Aeronautical Engineering
Corporation, New York City.

⊕ Major Leslie MacDill, ⊕ U.S.A., Materiel Division, Air Corps,
McCook Field, Dayton, Ohio.

⊕✓ Mr. C. J. McCarthy, ⊕ Chance Vought Corporation, Long
Island City, New York.

⊕ Prof. Charles F. Marvin, ⊕ Member N.A.C.A., Chief, U. S.
Weather Bureau.

~~⊕~~ Mr. L. C. Milburn, ⊕ Glenn L. Martin Company, Cleveland,
Ohio.

⊕✓ Mr. W. H. Miller, ⊕ Curtiss Aeroplane and Motor Co.,
Garden City, Long Island, N.Y.

⊕✓ Mr. J. D. Mooney ⊕ Auto Engine Works, St. Paul, Minn.

⊕ Mr. F. H. Norton, ⊕

⊕✓ Comdr. E. M. Pace, ⊕ Jr. U.S.N., Bureau of Aeronautics, Navy
Department.

~~(Mr. H. F. Pitcairn)~~

Pitcairn Aviation, Inc., Phila-
delphia, Pa.

⊕ Mr. C. T. Porter, ⊕ Keystone Aircraft Corporation,
Bristol, Pa.

⊕ ~~Mr. H. C. Richardson~~
⊕ Capt. H. C. Richardson ⊕ U.S.N., Bureau of Aeronautics,
Navy Department.

⊕ Lieut. Comdr. D. Royce, ⊕ U.S.N., Bureau of Aeronautics, Navy
Department.

⊕ Mr. F. H. Russell, ⊕ Aeronautical Chamber of Commerce,
New York, N. Y.

⊕✓ Mr. R. W. Schroeder ⊕

⊕ ~~Lieut. James M. Shoemaker~~
Lieut. James M. Shoemaker, U.S.N.

⊕✓ Mr. R. H. Smith, ⊕ Navy Yard, Washington, D. C.

⊕✓ Mr. Edward A. Stalker, ⊕ University of Michigan, Ann Arbor,
Mich.

~~Mr. W. B. Stout,~~

Stout Metal Airplane Co., Dearborn,
Mich.

- ⊕ Mr. M. M. Titterington, ⊕ Pioneer Instrument Company,
Brooklyn, N. Y.
- ⊕ ✓ Mr. G. W. Trayer, ⊕ Forest Products Laboratory,
Madison, Wis.
- ⊕ ✓ Mr. Staff Truscott, ⊕ National Advisory Committee
for Aeronautics.
- ⊕ Dr. L. B. Tuckerman, Bureau of Standards,
- ⊕ ✓ Mr. Ralph H. Upson, ⊕ Aircraft Development Corp.,
Detroit, Mich.
- ⊕ ✓ Mr. C. A. Van Dusen, ⊕ Glean L. Martin Company,
Cleveland, Ohio.
- ⊕ Mr. J. F. Victory, ⊕ Assistant Secretary, N.A.C.A.
~~Mr. Chance Vought,~~ Chance Vought Corporation,
Long Island City, N. Y.
- ⊕ ✓ Mr. Raymond Ware, ⊕ Thomas-Morse Aircraft Corp.,
Ithaca, N. Y.
- ⊕ Hon. Edward P. Warner, ⊕ Assistant Secretary of the
Navy for Aeronautics.
- ⊕ Mr. Michael Watter, ⊕ Chance Vought Corporation,
Long Island City, N. Y.
- ⊕ ✓ Mr. John Wentworth, ⊕
- ⊕ Prof. H. L. Whittemore, ⊕ Bureau of Standards.
- ⊕ Mr. T. P. Wright, ⊕ Curtiss Aeroplane and Motor
Company, Garden City, Long
Island, N. Y.
- ⊕ (Dr. A. F. Zahm,) Construction Department, Navy
Yard, Washington, D. C.
- ⊕ Wm a Hayward 1st Lt. Av., Langley Field, Va.
- ⊕ B. mason Hill Petersburg, Va.
- ⊕ Col. C.C. Culver. ⊕