NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

REPORT OF PROCEEDINGS

of

FOURTH ANNUAL AIRCRAFT ENGINEERING RESEARCH CONFERENCE

Under auspices of the National Advisory Committee for Aeronautics

Langley Field, Va.

May 14, 1929
FOURTH ANNUAL AIRCRAFT ENGINEERING RESEARCH CONFERENCE
UNDER THE AUSPICES OF
THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
LANGLEY FIELD, VIRGINIA, MAY 14, 1929

Seated, front row, left to right: Dr. George W. Lewis, Director of Aeronautical Research; *Dr. Orville Wright; *Dr. D. W. Taylor, Vice Chairman; *Dr. Charles F. Marvin; *Captain E. S. Land, U.S.N.;
*Assistant Secretary of Commerce, William P. MacCracken; Honorable W. H. Newton, Secretary to the President; *Honorable Edward P. Warner; *Harry F. Guggenheim;
Senator Hiram Bingham; Assistant Secretary of the Navy, David S. Ingalls; *Dr. George K. Burgess

(Those marked with an asterisk are members of the National Advisory Committee for Aeronautics)
The fourth annual aircraft engineering research conference between representatives of aircraft manufacturers and operators, and of the National Advisory Committee for Aeronautics was held on Tuesday, May 14, 1929, at the Committee's laboratory, known as the Langley Memorial Aeronautical Laboratory, located at Langley Field, Virginia.

The conference was attended by representatives of aircraft manufacturers, educational institutions engaged in the teaching of aeronautical engineering, aeronautical trade journals, and the press. The National Advisory Committee for Aeronautics was represented by its officers and members and also by its Subcommittees on Aerodynamics and Power Plants for Aircraft, and members of its laboratory staff.

Most of those attending the conference journeyed by boat from Washington to Old Point Comfort and were conveyed to Langley Field by automobiles. Others flew direct to Langley Field, and some of the guests proceeded by train.

The Washington steamer arrived at Old Point at 6:45 a.m. Breakfast was served at the Chamberlin-Vanderbilt Hotel at 7:00 a.m., after which the party left Old Point for Langley Field, arriving there about 8:35 a.m.
MORNING SESSION

The opening session was held at 8:45 a.m., in the Officers' Club at Langley Field, which was made available through the courtesy of the Commanding Officer of the Field. Dr. Joseph S. Ames, Chairman of the National Advisory Committee for Aeronautics, acted as Chairman of the conference.

Purposes of the Conference

The Chairman stated that the purposes of the conference were to furnish an opportunity to those who were not familiar with the work at Langley Field to see the work in progress at the Committee's laboratories and to enable the Committee to ascertain the problems which were of special interest to the industry. He stated that the primary function of the Committee was to conduct scientific investigations on the fundamental problems of flight and that up to a year or more ago the Committee's work was confined largely to the investigation of aeronautical problems relating to the military services, but that with the interest which the Department of Commerce has recently manifested in aviation and with the widespread interest in aeronautics in this country, the Committee's program of problems had broadened and extended to the problems of the manufacturer, which included the construction of airplanes and airplane parts, the operation of airplanes, etc. The Chairman stated that the Committee's laboratories were located at Langley Field, which is a flying field belonging to the War Department. He then introduced Lieutenant Colonel J. W. S. Wuest, A.C., U.S.A., Commanding Officer at Langley Field.

Colonel Wuest, Commanding Officer

Colonel Wuest's remarks were as follows:

"It is more than a pleasure to me to be able to welcome you to Langley Field. Your annual conference at this place is an event of not only great importance to all who are interested in the development of aviation, but to those of us in the Army who have this contact with you it is a matter of particular
significance and of unusual interest, because it presents to us an opportunity of learning from you directly the progress that has been made and that which we can expect in the near future toward the solution of those problems which confront us in endeavoring to improve the quality of our aircraft. And so, in welcoming you to Langley Field, I feel that we are welcoming friends who have a message of importance to bring us that we are very eager to hear, and I express the hope that your visit with us will afford you as much pleasure as it will ultimately give us benefit."

The Chairman stated that it was the purpose at the morning meeting to bring to the attention of those present the main features of the work conducted at the Langley Memorial Aeronautical Laboratory during the past year and that the men who were responsible for the work would explain by means of charts the progress of the various investigations being undertaken. He then introduced Mr. H. J. E. Reid, Engineer-in-Charge of the laboratory.

Mr. Reid, Engineer-in-Charge

Mr. Reid stated that it was a great honor and pleasure to welcome the guests attending the conference and that it was gratifying to see so many present who had attended previous conferences, as it was an indication of the value of these meetings. He said that the laboratory staff welcomed the opportunity of discussing the problems of the Committee and those of the manufacturer, with a view to serving the industry better. Mr. Reid said that some of the results of previous conferences had been very apparent during the past year and he gave as one example the N.A.C.A. cowling for air-cooled engines, which he said was the outcome of cooperation between the industry and the Committee. He said that this cowling was not the product of one small section of the laboratory but was the result of the work of all five divisions, the Administrative Division, the Technical Service Division, the Flight Operations Division, the Power Plants Division, and the Aerodynamics Division. Mr. Reid stated that in order to present as much information about the laboratory's work in as short a time as possible, the speakers at the morning session would be limited to two, namely, Mr. Elton W. Miller, chief of the Aerodynamics Division, and Mr. Carlton Kemper, chief of the Power Plants Division. He then called upon Mr. Miller.
Mr. Miller stated that by means of charts he would endeavor to give some examples of the results obtained by the various sections during the past year. He said he would first take up the work of the Flight Research Section, which is under the supervision of Mr. J. W. Crowley, Jr.

Mr. Miller's remarks were substantially as follows:

**Flight Research.** At the conference last year charts were shown giving the maximum loads on the wings and tail surfaces of a Boeing pursuit (PW-9) airplane as obtained by means of pressure distribution tests in flight. This work is regarded as one of the most important lines of investigation conducted by the Committee, as it is important for structural designers to know not only the total loads to be carried by an airplane but also the distribution of those loads over the various lifting surfaces. There is no other method of obtaining the information than by pressure distribution tests and the equipment at the laboratory for this work is most complete. This work has been continued throughout the year and the results obtained on the wings and tail surfaces have been prepared for publication. Tests are now in progress on the distribution of pressure over the fuselage of the same airplane and it is planned in the near future to start tests of pressure distribution over the wings and tail surfaces of a Douglas OSH observation airplane, which work has been requested by the Army Air Corps, and also over the various types of wing tips on a Douglas M-1.

(Mr. Miller then exhibited charts showing the results of investigations of pressure distribution over the fuselage, and over the wings for high and low incidence condition.)

The results of an investigation of the water pressure distribution over the bottom of a single float seaplane, the UO-1, were shown last year. The investigation has been continued, and during the past year the water pressure on a twin float seaplane, the TS, has been measured. In all of this water pressure distribution work special apparatus is being used which measures and records pressures which exist over periods as short as 1/50 second.

(Charts were exhibited showing the results of these investigations.)
Another interesting investigation which is being conducted by the Flight Research Section is that of the oleo and rubber cord type landing gear. One advantage of the oleo type over the rubber bungee type is the possibility that because of the dissipation of energy in the oleo type over a longer period of time, the stresses in the gear will be less, and consequently a saving in the weight of the landing gear structure can be made and possibly a decrease in weight of the fuselage. The Committee has been requested by the Bureau of Aeronautics of the Navy Department to investigate this question and the Bureau has supplied the Committee with landing gears of two different airplanes for comparative tests. To date the oleo and rubber cord type of landing gears for the F6C-4 airplane have been investigated and similar gears for the NY-2 airplane are being investigated. A demonstration of the method of testing these gears will be given at the hangar later in the morning.

One problem which is regarded by the Committee as of very great importance from the standpoint of safety is that of the "flat spin," so called because the airplane spins with its longitudinal axis at an angle close to the horizontal. It is commonly recognized that there are two separate systems of forces at work in connection with the spin, the aerodynamic and the mass or inertia forces, and the Flight Research Section has been giving some attention to the effect of mass distribution on the spin. By means of free dropping tests of airplane models, it was demonstrated that the type of spin, flat or normal, can be controlled by shifting weights on the model, and since that time mass distribution of all airplanes for which the type of spin is known, and particularly those that are known to flat spin, has been determined and studied to discover any consistent relation between mass distribution and type of spin.

(With the aid of charts Mr. Miller then described the method employed in making these tests.)

Atmospheric Wind Tunnel. The Atmospheric Wind Tunnel Section, of which Mr. Montgomery Knight is in charge, is also concerned with the problem of spinning, and that section is studying the aerodynamic forces. In fact, they are giving attention to the whole problem of control and safety in flight at low speeds, as it was thought that possibly if airplanes were made as safe aerodynamically as they can be made, a large percentage of the accidents now attributed to poor judgment on the
part of the pilot could be avoided. It was found necessary to obtain more information on the effects of such factors as gap, stagger, decalage, overhang, sweepback, and the combination of different wing sections in a biplane cellule, and a series of pressure distribution tests have been conducted, involving all of these factors. More than forty different biplane combinations have been tested and pressures have been read at sixty stations on each semi-span wing. All tests were made not only through the normal flying range of angles of attack but all the way to 90 degrees. The program was arranged partly to supply data requested by the Army Air Corps.

(Mr. Miller then exhibited charts showing the effect of changes in stagger and the effect of changes in gap.)

Another problem which has been given attention during the year by the Atmospheric Wind Tunnel Section is that of increasing the aerodynamic efficiency of airfoils by boundary layer control. Force tests were made on a wing provided with a slot which could be placed at different points along the upper surface of the wing, and means were also provided for changing the width of the slot and for varying the air pressure within the wing so that the slots might serve either as pressure or suction slots.

(Charts were exhibited showing the effect of changing the slot position along the wing, the effect of changes in slot width in terms of chord length, and the effect of variation in the pressure within the wing in terms of dynamic pressure.)

Variable Density Wind Tunnel. With regard to the work of the Variable Density Wind Tunnel Section, which is under the supervision of Mr. Eastman N. Jacobs, the tunnel has now been completed, including the reconstruction of the main balance. The tunnel has been put into operation and in comparing the characteristics of the new tunnel with the old, which was burned in 1927, it was desired to make a comparison of the turbulence of the air stream. Accordingly, a series of sphere tests were made and it was found that the new tunnel is less turbulent than the old. In these sphere tests it was possible for the first time to obtain a given Reynolds Number by varying the velocity as well as the density.

(Mr. Miller exhibited charts showing the results of these tests.)

One of the first investigations to be undertaken in
the new variable density wind tunnel was a study of the pressure distribution over an R.A.F.-31 airfoil with the Handley Page slot.

(With the aid of charts Mr. Miller gave some of the results of this investigation.)

Propeller Research Tunnel. When the conference was held last year a program of tests on the cowling of radial air-cooled engines was just being started in the propeller research tunnel. This program has been carried out as planned and all the tests have been made using a Wright J-5 engine run with wide open throttle at a tunnel speed of 80 miles per hour. The operating conditions thus represented an airplane in a continuous climb, and furthermore, the tests were made throughout the warm summer weather.

(Mr. Miller then exhibited charts showing a series of cowlings tested in connection with the closed-cabin fuselage, and also charts showing a similar series of tests with an open-cockpit fuselage.)

The reduction in drag of fifty per cent by using the N.A.C.A. type of cowling on an open cockpit fuselage has proved its value in such installations as the Lockheed "Air Express" and the Pitcairn "Mailwing," where increases in maximum speed of from 16 to 20 miles per hour have been obtained.

Tests have also been made on an AT-5 training airplane and on a Curtiss "Seahawk" airplane, which showed an appreciable increase in the maximum speed, with the use of this cowling.

This cowling has also been installed on a multi-engined airplane but the first results have been disappointing, due to interference between the nacelle and the wing. In order to study this problem a model of the wing and of the nacelle so arranged that the nacelle might be located in different positions with reference to the wing was built for tests in the variable density wind tunnel.

(Charts were exhibited showing the results of these tests.)

Plans have been made to undertake the investigation of the effect on the wing characteristics of the slip stream of the propeller when the propeller is located in different positions relative to the wing, and the effect
of the wing on the propulsive efficiency of the propeller under the same conditions.

As another method of obtaining results on airfoils at large scale, it was decided to test a number of airfoils in the propeller research tunnel. In these tests were included Clark Y airfoils, smooth and corrugated.

(Mr. Miller exhibited charts showing the results of these tests.)

Mr. Miller then discussed some high tip speed propeller tests which had been conducted in the propeller research tunnel and he stated that a demonstration would be given of one of these tests when the party visited the tunnel in the afternoon.

Mr. Reid stated that the power plant work conducted at the laboratory would next be described by Mr. Carlton Kemper, chief of the Power Plants Division.

Mr. Kemper, Power Plants Division

Mr. Kemper briefly outlined the investigations being conducted by the Power Plants Division, as follows:

The major problem of the Power Plants Division of the laboratory is the investigation of the fundamental factors influencing the combustion of fuel in high-speed oil engines. The greatly increased interest of engine manufacturers in the oil engine would indicate an appreciation of the inherent advantages of this engine which make its use attractive for aircraft engine service. In addition to the continuation of the research programs on oil engines, important investigations have also been conducted on the flight performance of supercharged engines.

Engine Cooling. In connection with the investigation made by the Propeller Research Tunnel Section to determine the increase in propulsive efficiency and decrease in drag of a Wright J-5 engine with various types and degrees of cylinder cowling, an accurate record was kept of the temperatures measured at 69 different points on the engine. Forty-seven thermocouples were located on the top, or No. 1, cylinder, and the remainder distributed at three or four
critical points on each of the other cylinders.

The cowling for which cylinder temperatures and performance measurements were obtained varied from the one extreme of no cowling on the engine to the other extreme of the engine completely cowled and the cooling air flowing inside the cowling through an opening in the nose and out through an annular opening at the rear of the engine. Each cowling was tested at speeds of 60, 80, and 100 miles per hour.

(Mr. Kemper then exhibited charts showing the temperature range for different forms of cowling, which he explained.)

Supercharger Development. In the supercharger work, conducted under the direction of Mr. O. W. Schey, extensive tests have been made to determine the effect of the capacity of a Roots type supercharger on the performance of a modified DH-4 airplane. The same supercharger was used in each case, but the capacity was changed by changing the drive gear ratio. Tests have also been made on the same airplane using a turbo type supercharger.

(Charts were then shown giving the characteristics of the two types of superchargers.)

High-Speed Oil Engine. The Committee has considered the development of the high-speed Diesel engine for aircraft use important for the following reasons: First, the use of a high-flash-point fuel should greatly reduce the fire hazard in the event of a crash; second, with the normal oil engine the compression ratios for this type engine are higher than for the carburetor engine, without doped fuels, which results in a higher thermal efficiency of the engine, the fuel consumption being less than that of the carburetor engine; and third, the use of this type of engine would result in a great economic gain, since a larger percentage of the crude petroleum can be used as fuel.

With the fuel spray photography equipment it is possible to obtain 25 consecutive photographs taken at the rate of 2000 to 4000 per second, of the start and development of a fuel oil spray from an oil engine injection valve. During the past year research has been started with this apparatus to determine the effects of various factors on the time lag of an automatic injection system. This work is of importance for the oil engine manufacturer who is forced in constructing large engines to use
long injection lines connecting the fuel pump with the fuel valve. Although the injection of fuel may be controlled at the pump, the long injection tube gives entirely different injection characteristics at the fuel valve.

(Mr. Kemper showed various charts illustrating the effect of tube length on the time lag for various injection pressures all in excess of the valve opening pressure. Charts were also exhibited showing the effect of turbulence on the penetration of fuel oil sprays in dense air.)

The Engine Analysis Section, under the direction of Mr. Harold C. Gerrish, has conducted an investigation to determine the effect of compression ratio and maximum cylinder pressure on the performance of aircraft oil engines. This investigation has covered a range of compression ratios from 8 to 18 and maximum cylinder pressures from 700 to 1200 pounds per square inch, full load fuel, and no excess air.

(Charts showing the results of this investigation were then shown by Mr. Kemper.)

Investigations are being conducted at the laboratory of the operating characteristics of two types of combustion chamber - the precombustion chamber type and the integral or direct injection type.

Mr. Kemper then described the methods of conducting power plant investigations and exhibited charts showing the results. He stated that the laboratory had recently completed the design and construction of a six-cylinder, cam-operated fuel injection pump and injection valves and that this fuel system would be used to investigate the problems of distribution and injection control of multi-cylinder fuel injection engines. He said that a Packard six-cylinder carburetor type airship engine had been converted for oil engine operation and the fuel pump and valves were being operated on this engine. Mr. Kemper stated that the fuel system would be in operation on the engine when the party visited the power plants laboratory later on in the morning.
The Chairman requested the guests to assemble in front of the Officers' Club in four groups, for a tour of inspection of the laboratory. These groups were composed of those with red tags, those with white, those with blue, and those with brown. The tags had been handed to the guests as they boarded the boat in Washington. The Chairman stated that the brown group would be under the direction of Mr. Truscott, the blue group under the direction of Mr. Victory, the white group under Mr. Lewis, and that he would be in charge of the red group. In order to avoid confusion and delay, the Chairman requested that each group keep together as much as possible. He stated that after the afternoon session he understood that a demonstration of the autogiro would be given by Mr. Harold F. Pitcairn, of Pitcairn Aviation, Incorporated.

The members of the conference then proceeded on a tour of inspection of the laboratory in accordance with the following program:

<table>
<thead>
<tr>
<th>Arrive:</th>
<th>Red</th>
<th>White</th>
<th>Blue</th>
<th>Brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Research Instruments</td>
<td>10:30</td>
<td>11:39</td>
<td>11:31</td>
<td>11:02</td>
</tr>
<tr>
<td>Atmospheric Wind Tunnel</td>
<td>10:44</td>
<td>12:13</td>
<td>11:47</td>
<td>11:17</td>
</tr>
<tr>
<td>Variable Density Wind Tunnel</td>
<td>11:00</td>
<td>10:30</td>
<td>12:05</td>
<td>11:34</td>
</tr>
<tr>
<td>Power Plants Laboratory</td>
<td>11:28</td>
<td>10:58</td>
<td>10:30</td>
<td>12:02</td>
</tr>
<tr>
<td>Flight Research Laboratory</td>
<td>11:59</td>
<td>11:29</td>
<td>11:00</td>
<td>10:32</td>
</tr>
</tbody>
</table>

At 12:30 p.m. all groups reassembled for lunch at the Officers' Club, after which a group photograph was taken outdoors.

At 1:30 p.m. the entire party proceeded to the propeller research tunnel where a Curtiss D-12 engine was set up for the purpose of testing the effect of high tip speeds on propellers.
AFTERNOON SESSION

At 2:00 p.m. the conference reconvened in the Officers' Club, with Dr. Ames presiding.

The Chairman opened the meeting with a few brief remarks, substantially as follows:

This afternoon session is intended to give an opportunity to the representatives of the industry to suggest problems in commercial aeronautics which they believe it would be desirable for the Committee to investigate in its laboratories. You have seen our laboratories, met some of the men in charge of the work in the various sections, and are familiar with the kind of work which the Committee is equipped to do. We assure you we are most anxious to help you in your problems, and would be most grateful for suggestions. A list of possible problems for discussion has been circulated among the members of the conference, but it is not desired to limit the discussion to these problems, and we sincerely hope there are some who have problems which they are willing to suggest.

In previous years it was found that the way to secure the best results was for the Chairman to call on various individuals present who he felt sure had in mind certain problems which were of general interest.

Before calling on any of the representatives of the industry, however, I would like to call on one of the new members of the Committee, one who has attended all the previous conferences, and is thoroughly familiar both with the work of the Committee and with the theory and practice of aerodynamics.

HONORABLE EDWARD P. WARNER

Mr. Warner outlined briefly some of the more important investigations which had been undertaken by the Committee and which had not yet been completely solved, and suggested the extension of some of the work already undertaken by the Committee to airplanes of commercial type, flown under the conditions of commercial operation.
A summary of Mr. Warner's remarks follows:

As a result of three years' experience with these conferences, I had prepared a list of problems which I believed it would be useful for the National Advisory Committee to undertake. On arrival this morning, I found that the Committee is already working on these problems, so far as it progressed in keeping in touch with the aircraft industry. Of the many topics for discussion, there are a few which are of particular importance, and I will voice a personal opinion by way of paving the way for others who differ with it.

One point which everyone agreed last year was most important for the improvement of the aircraft of 1928 was the study of the cowling of radial air-cooled engines, and that investigation has been undertaken with such remarkable results that we can hardly expect to go much further in that particular field. I think there can be no question as to the most important problem of 1929, and that is one on which the Committee is already working, the study of normal and abnormal spins. Although the work on spinning has been under way in the wind tunnel and in free flight for a couple of years, it appears from what I have seen in the industry, particularly in the last few months, that the most vital need is the study of abnormal spins with the object not only of learning how they can be eliminated, but also learning about their causes and how to avoid them. Obviously there is some answer to this problem, and if the Committee's staff will keep at it, it will be found.

I hope the study of taking off and landing will be carried further. This is important for commercial airplanes, especially light airplanes, which will be flown by all sorts of pilots and under all sorts of conditions. The information obtained from such a study will be useful in connection with specifications for the purchase of airplanes by private individuals and also for purchase by the Government. It is suggested that this investigation include a further study of landings at the termination of actual flights under various field conditions, with a mapping of the course of the airplane before it reaches the ground, and the breaking up of the energy absorbed on landing, that is, the determination of how much is taken up by the Oleo gear, by the rubber tires, and by distortion of the structure, etc.

Studies of airplane structures that have been
made in the last three or four years, which have reached their furthest development in the tests on the PW-9 which were set forth this morning, have borne only rather indirectly upon the majority of commercial aircraft. Commercial airplanes cannot be expected to be subjected to the kind of treatment which the PW-9 received. Information is still lacking on the structural conditions under which commercial aircraft have to work. We still lack information, which has been sought from time to time but never at great length, on the loads really imposed in flying in severe weather conditions or in rough country. It would be of considerable value to the designers of aircraft if the Advisory Committee could take up the determination of the maximum loads under which transport airplanes must work, and make measurements on multi-engined airplanes operating over difficult routes, over mountains and under the most unfavorable weather conditions, the studies to include measurements both of the total load and the load distribution, and it is desirable also that these studies should be extended to include the cantilever monoplane, on which so far nothing has been done.

There is one more point, not on the list of topics circulated. The work that has just been done and is in prospect in the wind tunnel on the placing of nacelles is of enormous importance, and its value will increase if it is extended to include the measurement of propeller efficiencies. It is suggested that it also include the study of nacelles with biplane structures. It happens that in this country most multi-engined airplanes have been cantilever monoplanes, but this is not universally the case throughout the world. It would be of value if a study could be made of multi-engines placed in various positions relative to biplane combinations.

The Chairman stated that before requesting comments on Mr. Warner's remarks, he would like someone to volunteer suggestions.

Mr. R. W. A. BREWER,

of the Aircraft Engine and Accessory Development Corporation, Jenkintown, Pennsylvania, suggested that the investigation on the placing of nacelles include the effect on the critical speed of the engine, of the propeller location relative to the leading edge of the wing, and also the ef-
fect of the proximity of these two upon propeller flutter and the critical speed of the propeller itself.

Mr. CHARLES FROESCH,

of the Fokker Aircraft Corporation of America, New York City, suggested that this information be computed in terms of propeller diameter, the investigation to include also the determination of the distance between the propeller and the leading edge not only in the horizontal plane but also in the vertical plane.

Mr. Froesch also suggested that, since the Fokker Company was planning to use a development of pusher type propeller, the study of nacelle installations include an investigation of the proper cowling for an engine behind another in a nacelle. He said his company was particularly interested in the propeller efficiencies to be obtained when a two-bladed front and a three-bladed rear propeller were used.

He also suggested a study of the effect of cockpit enclosure, especially of a monoplane, on the section of wing directly behind it, and also its interference with the tail surfaces.

The Chairman remarked that one member of the National Advisory Committee had said from the beginning of aviation that the pusher propeller was bound to come.

Mr. Froesch stated that this problem was of interest to him because the Fokker Company was building a 32-passenger airplane with dual nacelle engines in tandem.

Mr. Brewer suggested that the proposed investigation of propeller location include also the location of pusher propellers relative to the trailing edge of the wing, as well as of tractor propellers relative to the leading edge.

The Chairman remarked, for the information of those not familiar with the Committee's procedure, that all the suggestions made at this meeting were tabulated and submitted to the appropriate subcommittee of the National Advisory Committee for consideration and action.
The Chairman then called on

Mr. LESSITER C. MILBURN,

of The Glenn L. Martin Company, Baltimore, Maryland.

Mr. Milburn said that the problem in which he was most interested has already been taken up by the Committee, namely, the relation of the propeller to the leading edge, and also to the trailing edge. He said he was also interested in the continuation of the study of cowling for in-line engines and other forms of air-cooled cylinders, and for pusher engines.

When called on by the Chairman,

Mr. S. M. FAIRCHILD,

of the Aviation Corporation, New York City, said he was interested in the problems that had been discussed, and that as a general statement, he was interested in methods of decreasing the resistance of the airplane. He stated that he would like to have data on the interference of minor parts, the effect of the angle of the side of the fuselage and the wing, and the resistance of wings with various types of fillets, some of which had been obtained. He said he would also like to have information on the flow around wings - where the downwash occurs, and what effect it has on the tail - as he believed it would be of assistance in the location of many of the auxiliary parts of the airplane.

The Chairman then called on

Mr. IVAN H. DRIGGS,


Mr. Driggs complimented the Committee on its work on the cowling of radial air-cooled engines, and said he was particularly interested in the cowling of in-line air-cooled engines. He expressed the hope that the investigation of the spinning problem would be completed in the near future, as he believed that was the most important
thing the Committee could do for commercial aviation at the present time. He suggested that the work on this problem, or the study of lateral stability above the stall, be extended to below the stall, for the benefit of designers, as he believed a large portion of the present-day airplanes were somewhat laterally unstable below the stall also.

Mr. Driggs suggested that the results of the tests of biplanes with different gaps be compared with the data given by Dr. Munk not only as to aerodynamic coefficients, but also as to center of pressure, and possibly some simple formula worked out.

The Chairman called on

CAPTAIN H. C. RICHARDSON,

of the Great Lakes Aircraft Corporation, Cleveland, Ohio.

Captain Richardson stated that the spin was one of the most important problems that the Committee could take up, but he would like to give the warning in connection with it, that he was afraid that when the spin was conquered it would be found that some of the good qualities of the airplane had been taken out with it, and it should be remembered that, as far as he knew, an abnormal spin only occurred after a prolonged spin.

Captain Richardson stated he understood the Committee was considering the construction of a model basin for seaplane testing. He said that the interest in seaplanes and amphibians was growing in this country, and that the model basins were not adequate, and did not cover the range of speed required, for seaplane testing, as the models would have to be too small for the results to be useful. He said he hoped he had been correctly informed on this matter.

Captain Richardson suggested the problem of the lateral accelerations to which an airplane is subjected on landing. He said he would like to see measurements made of what occurs when a cross-wind or skidding landing is made.

Mr. G. W. Lewis, Director of Aeronautical Research, on request of the Chairman made a brief statement with regard to the Committee's plans for a seaplane channel. He said that the Committee appreciated the importance of the large flying boat, and, realizing that there is not in this country a
channel of sufficient size or with a carriage of sufficient speed to investigate properly seaplane floats and boats, had recently approved a project for the construction of a seaplane channel. He said that the largest channel in Europe was about 1400 feet long; that the channel to be constructed by the Committee would be about 2500 feet long, 24 feet wide, and 6 to 8 feet deep, and would operate at speeds up to about 40 miles per hour; and that from this channel the Committee expected to be able to get practically full-scale results in testing flying boats.

The Chairman then called on

CAPTAIN L. M. WOOLSON,

of the Packard Motor Car Company, Detroit, Michigan, and requested him to tell the members of the conference something about the Diesel heavy-oil aircraft engine which the Packard Company had developed, and which he had just flown from Detroit to Langley Field in a Stinson "Detroiter" airplane.

Captain Woolson stated that the Packard Company felt that they had merely started a job which they hoped to finish some day. He said they had been helped to a great extent by the research work of the National Advisory Committee, and that he had made the first cross-country flight with the engine to this conference as a sort of tribute to the Advisory Committee.

MR. GEORGE A. PRUDDEN,

of the Prudden-San Diego Airplane Company, San Diego, California, said that the conference had already covered practically all the important problems needing solution. He said his company was constructing an airplane with engines in the leading edge, and he would be glad to transmit the information that might be obtained from this development to those interested. He said that wind tunnel tests had just been completed, and showed good characteristics.

MR. TEMPLE N. JOYCE,

of the Berliner-Joyce Aircraft Corporation, said he was particularly interested in flat spins, having been in a
couple of them and out of a couple. He discussed the phenomenon of the flat spin, and described an incident from his own experience, which indicated that the border line between the two conditions, that is, a normal spin and a flat spin, is very fine. He said we should not call it a flat spin, but possibly an uncontrolled spin. Mr. Joyce was of the opinion that from the commercial standpoint the spinning problem would have to be conquered, but with military airplanes it was absolutely essential to be able to spin, as a pilot might be in a position, when being attacked by four or five opposing pilots, when he would have to be able to spin to save himself.

Mr. Joyce said that considerable work had been done on the study of mass distribution, but that no one had ever taken an airplane with spinning characteristics and changed its structural features, such as substituting a different wing or other part of the airplane; for example, take an airplane with spinning characteristics with a Clark Y wing and substitute an R.A.F. 15. Mr. Joyce also suggested that the effect of the disposition of the tail surfaces on spinning be investigated.

Mr. F. W. CHARAVAY,

of the Hartzell Propeller Company, Piqua, Ohio, suggested the investigation of the efficiency of propellers with geared engines. He said that most theoretical data on this subject were not borne out by practice, as, many times, the advantages of gearing far exceeded the hopes based on theory. He said it was well known that at 300 miles an hour one could afford to have direct drive and at 100 miles an hour to have a 2 to 1 gear ratio, but no definite relationship had been established, and it would be valuable to have a study of propeller and gear efficiency, to obtain information on translational velocity.

Mr. H. V. THADEN,

of the Pittsburgh Aviation Industries Corporation, Pittsburgh, Pennsylvania, when called on by the Chairman, said that most of the points on which he had made notes had been covered by recent suggestions, but proposed that, in connection with the work on corrugated sheet metal, tests be conducted with the corrugations increased to the size used in ordinary work, and if the tests were extended be-
yond the aspect ratio of 6 to include elliptical types, the data obtained would be applicable to tail surface design.

Mr. Thaden stated that in the field of aerodynamics it would be of interest to designers to have more specific data on the effect of a change in the median line of airfoils at high Reynolds Number.

He remarked that, having heard the tests of propellers at high tip speeds, he was glad to know that the efficiency drops off at speeds in excess of that of sound.

PROFESSOR C. F. TAYLOR,
of the Massachusetts Institute of Technology, Cambridge, Massachusetts, called attention to the length of time which elapsed between the completion of a research problem by the Committee and the publication of the results, and suggested that upon the completion of a research, or even a small phase of a research, of general interest, a preliminary report be issued, even though it be nothing more than a series of summarizing curves.

Professor Taylor also suggested that those in charge of aeronautical work in technical schools and universities would very much appreciate having the National Advisory Committee suggest from time to time problems which perhaps the Committee had not time to undertake or which it believed could well be undertaken under the limited conditions of technical schools. He said that this would serve a two-fold purpose: Such problems would be attacked and the solution eventually forthcoming, but, far more important, timely problems would be given to those men who were coming up to the industry from the technical schools, and such a scheme would therefore be assisting in the supplying of trained technical personnel, which is one of the most important aspects of commercial aeronautics at the present time.

The Chairman replied, with reference to Professor Taylor's second suggestion, that there was a subcommittee of the National Advisory Committee for Aeronautics, the Subcommittee on Aeronautical Research in Universities under the Committee on Aerodynamics, which had for its chief function the discussion of the problems to be taken up by technical schools.

In regard to the question of publication, the Chairman stated that the Committee was more prompt in this re-
spect than most laboratories, but was hampered by being compelled to publish its reports through the Government Printing Office, and that the length of time required for publication had been shortened as much as possible. The Chairman remarked that it was an interesting fact that the number of reports which the Committee had distributed in response to specific request had nearly doubled during the past six months, having increased from more than 25,000 to more than 45,000, and that the Committee was doing its best to cope with this increase in its work.

Professor Taylor stated that his suggestion related particularly to informal publications, and the Chairman replied by inquiring where there was a research man who was willing to have the results of his work published informally.

The Chairman said he would next call on another new member of the Committee, who was familiar especially with the practical uses to which aircraft are put,

HONORABLE WILLIAM P. MacCRACKEN, Jr.

Mr. MacCracken said he was indeed glad of this opportunity to be at the conference to see first-hand the work the National Advisory Committee was doing, and that he had come to be instructed rather than to give suggestions. He said there was one problem, however, to which those interested in the safe commercial operation of aircraft had begun to give considerable attention, which, on the surface, appeared not to be a scientific problem on which help could be given by research: namely, the problem of making it possible for a pilot to know of the proximity of another airplane. He said that, of course, on first thought this appeared to be purely a matter of the design of the cockpit and other parts of the airplane so that the pilot would have better vision in all directions, but on the other hand it might be that a solution to the problem could be found in the design and development of instruments which would advise the pilot of the approach of another aircraft and possibly the direction from which it was approaching. Mr. MacCracken said he realized this was not an easy problem to work out, and he did not know whether it came within the functions of the National Advisory Committee, but anyone interested in the development of instruments could spend time to good advantage on the development of such an instrument.
When called on by the Chairman,

Mr. W. L. LePAGE,

of Pitcairn Aviation, Incorporated, Philadelphia, Pennsylvania, said that from his standpoint, of making aviation pay its way as a system of transportation, higher speed without increase in cost of operation was one of the most serious problems, and in his opinion the work of the National Advisory Committee on the cowlng of air-cooled engines was directly in line with this problem, because it gave increased speed by means of greater aerodynamic efficiency. He called attention to the importance of investigating the possibilities of increasing the aerodynamic efficiency by reduction of the parasite drag, including the interaction of airplane parts. He referred to Mr. Miller's statement at the morning session of the conference that the research results showed that with wing engines on multi-engined airplanes the interference was sometimes twice as great as the drag of the wing, which indicated the importance of reduction of the interference, which could be investigated in the twenty-foot wind tunnel.

Mr. Reid, at the request of the Chairman, read the following telegram from

COLONEL V. E. CLARK,

of the Aviation Corporation, Buffalo, New York:

"Regret impossible attend Langley show. Suggest one problem measure of interference effects between wing and streamline struts inclined at angle of twenty-five degrees to wing as in strut-braced monoplane; strut attached to under surface of airfoil at two-thirds of half span from center line; strut attached to upper surface of airfoil at one-third of half span from center line. Suggest two struts in all cases as for a two-spar wing. Suggest testing drag of wing alone, also drag of strut alone, also drag of assembled combination with straight strut ends, also drag of assembled combination with fillets of various radii at attachment points. Best wishes for a successful party."
Mr. Reid remarked that the problem suggested by Colonel Clark could probably be very well investigated in the twenty-foot wind tunnel or the variable-density wind tunnel.

The Chairman then called on

Mr. HAROLD F. PITCAIRN,

of Pitcairn Aviation, Incorporated, Philadelphia, on whom he had previously called but who had been in the air at that time. Mr. Pitcairn apologized for not being present when first called on, but stated that he had been demonstrating the Autogiro at the request of the Assistant Secretary of the Navy for Aeronautics, who had to return to Washington early.

Mr. Pitcairn then described the Autogiro, which he had flown to Langley Field the preceding day, and which he had purchased from its Spanish designer and builder, Mr. J. de La Cierva. His remarks were in substance as follows:

I wish to express my appreciation of the opportunity given me to bring the Autogiro to this conference. The Autogiro is so interesting to me that I thought it would also be interesting to you to see it fly and hear something about it. There is so much that can be said about it, however, that I will have time to mention only a few points.

The Autogiro is not an airplane, although it is frequently called one. It has peculiarities of flying to which it takes a pilot a little while to become accustomed. In the first place, it can come straight down and remain in perfect aerodynamic balance. To my mind this removes much of the hazard of flying. With the Autogiro it does not matter how slowly you fly.

As you probably know, there is no connection at all between the engine and the rotors; the only thing that causes the rotors to move is the air. In descending vertically they operate as a windmill. Its rate of climb is not as good as that of a good airplane with a "Whirlwind" engine, but the angle of climb is better, and it is the angle of climb and not the rate of climb by which the flyer gets out of a small field.
One thing that is needed on the Autogiro is a method of getting the rotors turning at the proper speed to take off. The rotor blades maintain their proper position during flight by centrifugal force, and the speed of rotation of the blades must be sufficient to hold them in the proper position in making an ascent.

The most important recent development in connection with the Autogiro was a self-starter. If it were necessary to gear the engine to the rotors to start, this would require a heavy mechanism, and in the air such a connection would not be desired.

On his recent machines Mr. de la Cierva is placing a surface under the rotors, slanting it so that the slipstream of the propeller is diverted into the upper current of air, and in this way it is possible to obtain as many as 105 revolutions, more than enough to start. This surface is more or less comparable to the tail surfaces of an airplane. There is no practical reason why these surfaces cannot be built in such a way that it will be possible to push a lever forward in the pilot's cockpit, put the wind brakes on a minute or a minute and a half, and give it the gun and take off.

After taking off, the angle of climb of the Autogiro is better than that of an airplane. When you take off with an airplane toward an obstacle and miss your guess there is nothing to do but go straight ahead. In taking off with the Autogiro the forward speed will be less and you will have more time to think it out. If the obstacle cannot be avoided you can pull the throttle back, pull the stick back, and sit down in front of it.

As there is no wind to-day, it will not be possible to land vertically on account of the landing gear mechanism. The vertical speed is 14 or 15 feet a second and the landing gear is about 18 inches high. It will be necessary to have enough forward speed to land somewhat like an airplane so as not to bound on the landing gear. The new machine to be constructed will have a 24-inch landing gear.

I believe it will be of interest to state that it is our intention to license any manufacturers who desire to build the Autogiro. The Pitcairn Company has purchased the manufacturing rights for this country, but it is not our intention to retain these rights exclusively for ourselves. We have not yet worked out
what the royalty will be, but Mr. de la Cierva and a member of his company are coming to this country and we will work out a plan for the licensing and royalties.

There are many other interesting points in connection with the Autogiro, but I do not wish to impose on the conference by taking up any more time.

The Chairman called on

COMMANDER J. C. HUNSAKER,

of the Goodyear-Zeppelin Corporation, New York City, a former member of the National Advisory Committee.

Commander Hunsaker remarked that, being somewhat out of the airplane business he felt he could act as one of the innocent bystanders and venture to bring the Autogiro and the flat-spinning airplane together, because when the airplane is doing one of its very flat spins it is an Autogiro falling vertically at a reasonable speed, perhaps 14 feet a second; so that it may be that the flat spin is not a defect but a future asset, if the Committee can so analyze the phenomenon that it can be made use of.

The Chairman then called on another former member of the Committee,

COLONEL THURMAN H. BANE,

of the Aviation Corporation, New York City.

Colonel Bane said he was glad to be considered a former member of the Advisory Committee. He said he had no suggestions to make except to reinforce what Captain Richardson had said with reference to flying boats, and he was glad to know that the Committee was planning to construct a tank in which it would be possible to obtain information on hull lines, etc.

- 25 -
MR. HARLAN D. FOWLER,

of the Miller Corporation, New Brunswick, New Jersey, suggested that, in connection with seaplane development, an investigation be made of the effect of the landing gear, tail skids, etc., on floats; also, that the application of the Committee's high-speed cowling be extended to tandem engines. He remarked that with cabin airplanes full advantage could not be taken of the new cowling because of poor visibility, and suggested that an investigation of an arrangement of the pilot which would give the advantages of the cowling without increasing the drag would be of value.

Mr. Fowler referred to the complexity of the wing flap and other devices now being studied for the promotion of airplane safety, and called attention to the possibilities of the variable-area wing for reducing the speed of taking off and landing.

Mr. C. R. ALDEN,

of the Ex-Cell-O Tool and Manufacturing Company, Detroit, Michigan, said he thought this meeting should not close without a word in commendation of the Committee's excellent work on the fuel injection problem. He said that the work in the Committee's laboratories on this problem seemed to be far in advance of anything in any of the other phases of the internal combustion industry, and he felt incompetent to comment on it. He said that the fuel injection problem touched many phases of industry other than aircraft, and though that in itself might not be a reason for the Committee to push this problem ahead faster, nevertheless he believed that the investigation in its various phases was productive of so much useful and valuable information that it was well worth the Committee's best efforts.

The Chairman announced that the time intervening until the party left for Old Point Comfort might be spent in closer individual inspection of any part of the Committee's activities that might be desired; that Mr. Pitcairn would give a demonstration of his Autogiro from the flying field; that Captain Woolson would give a demonstration of the Diesel heavy-oil radial aircraft engine
developed by the Packard Company, and that cars for taking
the party to Old Point Comfort would be in front of the
administration building of the laboratory and at the han-
gar, the party to leave beginning at 4:50 p.m. The con-
ference then adjourned at 3:45 p.m.

Following the conference, demonstration flights were
made by Mr. Pitcairn in his Autogiro and by Captain Wool-
son in the Stinson "Detroiter" with the Packard Diesel
engine, and an exhibition of stunt flying was given by
Lieutenant A. J. Williams, U.S.N., in a Curtiss "Hawk"
airplane.

The following were present at the conference:

Members and Officers of the National Advisory Committee for
Aeronautics:

Dr. Joseph S. Ames, Johns Hopkins University, Chairman,
Dr. D. W. Taylor, Vice Chairman,
Dr. Charles G. Abbott, Smithsonian Institution,
Dr. George K. Burgess, Bureau of Standards,
Major General James E. Fechet, U.S.A.,
Brigadier General W. E. Gillmore, U.S.A.,
Mr. Harry F. Guggenheim, The Daniel Guggenheim Fund for
the Promotion of Aeronautics,
Captain E. S. Land, U.S.N.,
Honorable William P. MacCracken, Jr., Assistant Secretary
of Commerce for Aeronautics,
Dr. Charles F. Marvin, Weather Bureau,
Rear Admiral W. A. Moffett, U.S.N.,
Honorable Edward P. Warner,
Dr. Orville Wright,

Mr. G. W. Lewis, Director of Aeronautical Research,
Mr. J. F. Victory, Secretary,
Members of Committee on Aerodynamics:

1Dr. D. W. Taylor, Chairman,
Dr. L. J. Briggs, Bureau of Standards,
Lieutenant W. S. Diehl (CC), U.S.N.,
Major C. W. Howard, U.S.A.,
Mr. L. V. Kerber, Department of Commerce,
2Mr. G. W. Lewis,
Major Leslie MacDill, U.S.A.,
1Dr. Charles F. Marvin,
1Honorable Edward P. Warner,

Members of Committee on Power Plants for Aircraft:

2Mr. G. W. Lewis, Vice Chairman,
Dr. H. O. Dickinson, Bureau of Standards,
Lieutenant E. R. Page, U.S.A.,
Lieutenant Commander J. M. Shoemaker, U.S.N.,
Professor C. Fayette Taylor, Massachusetts Institute of Technology,

Representatives of Manufacturers and Operators:

Aeromarine Klemm Corporation, Keyport, N. J.:
Mr. Roland Chilton,
Mr. Ralph H. Upson,

Aeronautical Chamber of Commerce, New York, N. Y.:
Mr. Paul H. Brattain,
Mr. T. T. Hildebrand,

Aircraft Engine and Accessory Development Corporation,
Jenkintown, Pa.:
Mr. R. W. A. Brewer,

Aluminum Company of America, Pittsburgh, Pa.:
Mr. R. V. Davies,
Mr. C. F. Nagle,

Aviation Business Bureau, Incorporated, New York, N. Y.:
Mr. H. E. Hartney,

Aviation Corporation, New York, N. Y.:
Mr. L. B. Averill,
Colonel Thurman H. Bane,
Mr. F. G. Coburn,
Mr. D. E. Cox,

1Also member of the National Advisory Committee for Aeronautics.
2Also officer of the National Advisory Committee for Aeronautics.
Mr. S. M. Fairchild,
Mr. E. P. Farley,
Mr. Talbot O. Freeman,
Mr. Graham Grosvenor,
Mr. George R. Hann,
Mr. H. S. Martin,
Mr. A. E. Nesbitt,
Mr. Roland Palmedo,
Mr. R. W. Robbins,

Bellanca Aircraft Corporation, New Castle, Del.:
Mr. Frank Bellanca,

Bendix Brake Company, South Bend, Ind.:
Mr. J. R. Cautley,

Berliner-Joyce Aircraft Corporation, Baltimore, Md.:
Mr. Henry Berliner,
Mr. F. S. Hubbard,
Mr. Temple N. Joyce,

E. W. Bliss Company, Brooklyn, N. Y.:
Mr. R. W. Clark,
Mr. W. N. Deiter,

Boeing Airplane Company, Seattle, Wash.:
Mr. F. R. Canney,
Mr. J. P. Murray,

Brewster and Company, Long Island City, N. Y.:
Mr. E. N. Bertran,
Mr. R. F. Valentine,

Consolidated Aircraft Corporation, Buffalo, N. Y.:
Mr. I. M. Laddon,

Continental Motors Corporation, Detroit, Mich.:
Mr. R. S. Insley,

Crucible Steel Company of America, Baltimore, Md.:
Mr. R. W. Dietrich

Cunningham-Hall Aircraft Corporation, Rochester, N. Y.:
Mr. Theodore P. Hall,

Curtiss Aeroplane and Motor Company, Garden City, N. Y.:
Mr. Robert Johnson,
Mr. Burdette Wright,

Dripps Aircraft Corporation, Lansing, Mich.:
Mr. Ivan H. Dripps,
Ex-Cell-O Tool and Manufacturing Company, Detroit, Mich.:
Mr. C. R. Alden,

Federal Aviation Corporation, New York, N. Y.:
Mr. Thomas Carroll,

Fokker Aircraft Corporation of America, Wheeling, W. Va.:
Mr. L. H. Blankman,
Mr. Charles Froesch,

H. H. Franklin Manufacturing Company, Syracuse, N. Y.:
Mr. C. T. Doman,
Mr. E. S. Marks,

General Electric Company, Schenectady, N. Y.:
Dr. E. F. W. Alexanderson,
Mr. I. M. Day,
Mr. A. H. French,
Dr. C. F. Green,
Mr. Ray Stearns,

Goodyear Zeppelin Corporation, New York, N. Y.:
Dr. J. C. Hunsaker,

Grand Central Airways,
Mr. L. T. Cleaves,

Great Lakes Aircraft Corporation, Cleveland, Ohio:
Colonel B. F. Castle,
Captain H. C. Richardson,

Hall-Aluminum Aircraft Corporation, Buffalo, N. Y.:
Mr. Archibald M. Hall,
Mr. Charles F. Pape,

Hartzell Propeller Company, Piqua, Ohio:
Mr. F. W. Charavay,

Helium Company, Louisville, Ky.:
Mr. E. H. Courtenay,
Mr. E. G. Luening,

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

$^3$Also representing Western Air Express.
The Kimball Aircraft Corporation, Naugatuck, Conn.:
Mr. Augustus Hasbrouck,
Mr. A. L. Kimball,
Mr. Leo B. Kimball,

Grover Loening Company, New York, N. Y.:
Mr. Grover Loening,

Ludington Philadelphia Flying Service, Philadelphia, Pa.:
Mr. W. W. Kellett,

Lycoming Manufacturing Company, Williamsport, Pa.:
Mr. F. M. Bender,
Mr. V. Cronstadt,
Mr. E. D. Herrick,
Mr. J. H. McCormack,
Mr. R. S. Sempers,

Mahoney-Ryan Aircraft Corporation, Anlum, Mo.:
Mr. John C. Nulsen,

The Glenn L. Martin Company, Baltimore, Md.:
Mr. Lessiter C. Milburn,
Mr. C. A. Van Dusen,

Miller Corporation, New Brunswick, N. J.:
Mr. Harlan D. Fowler,

Packard Motor Car Company, Detroit, Mich.:
Mr. Walter Lees,
Captain L. M. Woolson,

Paragon Engineers, Incorporated, Baltimore, Md.:
Mr. Miles H. Fairbank,
Mr. Spencer Heath,

Pioneer Instrument Company, Brooklyn, N. Y.:
Mr. Victor Carbonara,
Mr. Henry F. Colvin,
Mr. Adolph Urfer,

Pitcairn Aviation, Incorporated, Philadelphia, Pa.:
Mr. E. T. Asplundh,
Mr. Agnew E. Larsen,
Mr. W. L. LePage,
Mr. MacEwan,
Mr. H. F. Pitcairn,
Mr. Ralph S. Westing,

Also representing U.S. AIR SERVICES.
Pittsburgh Aviation Industries Corporation, Pittsburgh, Pa.:
Mr. H. V. Thaden,

The Pratt and Whitney Aircraft Company, Hartford, Conn.:
Professor C. H. Chatfield,
Mr. A. Willgoos,

Prudden-San Diego Airplane Company, San Diego, Calif.:
Mr. George A. Prudden,

Radio Frequency Laboratories, Boonton, N. J.:
Mr. L. M. Hull,
Mr. R. L. Meredith,

Rome Wire Company, Detroit, Mich.:
Mr. E. A. Robertson,

Standard Oil Company, Chicago, Ill.:
Mr. R. E. Wilkin,

Stout Engineering Laboratories, Incorporated, Detroit, Mich.:
Mr. Herbert Winters,

Taylor Brothers Aircraft Corporation, Rochester, N. Y.:
Mr. C. G. Taylor,

Taylor Instrument Companies, Rochester, N. Y.:
Mr. H. Y. Norwood,

Transcontinental Air Transport, Incorporated, New York, N.Y.:
Major T. G. Lamphier,

Western Air Express, Los Angeles, Calif.:
Mr. L. H. Blankman,

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.:
Mr. H. H. Thompson,
Mr. J. W. Wagner,

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

---

Also representing Fokker Aircraft Corporation of America.
Representatives of Aeronautical Journals and Educational Institutions:

AIR TRANSPORTATION, New York, N. Y.:
Mr. Andrew Stewart,

AIRWAY AGE, New York, N. Y.:
Mr. Roy Gurley,

AMERICAN MACHINIST, New York, N. Y.:
Mr. Fred H. Colvin,

AVIATION, New York, N. Y.:
Mr. Leslie Neville,
Mr. Earl D. Osborn,

Mr. K. K. Hoyt,

SCIENCE SERVICE, Washington, D. C.:
Mr. Watson Davis,

U.S. AIR SERVICES, Washington, D. C.:
Mr. W. L. LePage,

New York University, New York, N. Y.:
Professor Alexander Klemin,

United States Naval Academy, Postgraduate School, Annapolis, Md.:
Professor Paul E. Hemke,
Professor R. E. Root,

Representatives of the Press:

Associated Press:
Mr. Allen Quinn,

Newport News DAILY PRESS:
Mr. L. D. Jester,

NEW YORK TIMES:
Mr. H. G. McCoy,

Washington DAILY NEWS:
Mr. Ernest Pyle,

Washington EVENING STAR,
Mr. Joseph S. Edgerton,

Also representing Pitcairn Aviation, Incorporated.
Additional Guests:

Honorable Hiram Bingham, U. S. Senate, President, National Aeronautic Association,
Lieutenant R. E. Blick, U.S.N.,
Lieutenant R. W. Bockius, U.S.N.,
Mr. T. B. Bourne, Airways Division, Department of Commerce,
Mr. Paul Brockett, National Academy of Sciences,
Dr. W. C. Brombacher, Bureau of Standards,
Mr. W. G. Brown, The Daniel Guggenheim Fund for the Promotion of Aeronautics,
Lieutenant Burke, U.S.N.,
Mr. Luke Christopher, National Aeronautic Association,
Mr. R. J. Cottrell,
Mr. H. K. Cummings, Bureau of Standards,
Lieutenant J. H. Doolittle, U.S.A., Mitchel Field,
Dr. H. L. Dryden, Bureau of Standards,
Lieutenant D. S. Fahrney, U.S.N.,
Mr. E. N. Fales,
Mr. W. G. Friedrich,
Lieutenant W. C. Gilbert, U.S.N.,
Mr. Charles Heywood, Society of Automotive Engineers,
Honorable David S. Ingalls, Assistant Secretary of the Navy for Aeronautics,
Mr. F. J. Keifer,
Mr. H. C. Karcher,
Mr. C. F. Marvin, Jr., Bureau of Standards,
Lieutenant Commander A. C. Miles, U.S.N., Bureau of Aeronautics,
Mr. Frederick R. Neely, National Aeronautic Association,
Honorable W. H. Newton, Secretary to the President,
Mr. C. L. Ofenstein, Washington, D. C.,
Mr. E. Powell,
Lieutenant E. R. Quesada, U.S.A., Air Corps, Washington, D. C.,
Lieutenant W. G. Tomlinson, U.S.N., Washington, D. C.,
Mr. A. J. Underwood, Society of Automotive Engineers,
Mr. C. B. Veal, Society of Automotive Engineers,
Lieutenant A. J. Williams, U.S.N., Washington, D. C.,
Mr. Laurence E. Williams, Washington, D. C.,
Lieutenant Colonel J. W. S. Wuest, U.S.A., Commanding Officer, Langley Field,
Members of Committee's Staff:

Mr. H. J. E. Reid, Engineer-in-Charge,
Mr. E. H. Chamberlin, Chief Clerk, Washington, D. C.,
Mr. John W. Crowley, Jr., head of Flight Research Section,
Mr. S. J. DeFrance, head of Full Scale Wind Tunnel Section,
Mr. Harold C. Gerrish, head of Engine Analysis Section,
Mr. Charles H. Helms, Washington, D. C.,
Mr. Eastman N. Jacobs, head of Variable Density Wind Tunnel Section,
Mr. James V. Kelley, head of Instrument Section,
Mr. Carlton Kemper, head of Power Plants Division,
Mr. Montgomery Knight, head of Atmospheric Wind Tunnel Section,
Mr. W. H. McAvoy, head of Flight Operations Section,
Mr. Elton W. Miller, head of Aerodynamics Division,
Mr. Robert E. Mixson, head of Physics Laboratory,
Mr. Edward A. Myers, head of Technical Service Division,
Mr. Addison M. Rothrock, head of Fuel Injection Section,
Mr. Oscar W. Schey, head of Supercharger Section,
Mr. Edward R. Sharp, Chief Clerk of laboratory,
Mr. John A. Spanogle, head of Engine Research Section,
Mr. Starr Truscott, Washington, D. C.,
Mr. Donald H. Wood, head of Propeller Test Section.