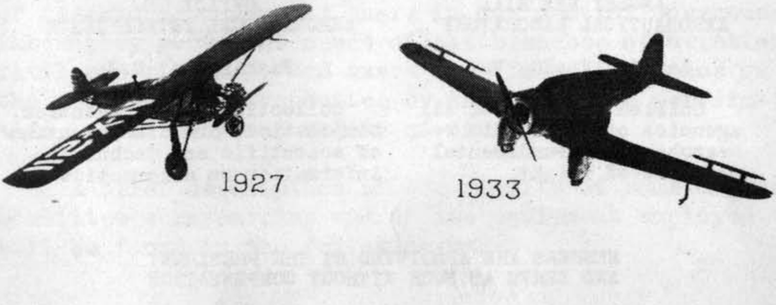
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

N.A.C.A.

A GLIMPSE OF SCIENTIFIC RESEARCH ON FUNDAMENTAL PROBLEMS OF MILITARY AND CIVIL AIRCRAFT

WASHINGTON
1933



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SUPERVISION AND DIRECTION OF SCIENTIFIC STUDY OF THE PROBLEMS OF FLIGHT

ESTABLISHED BY ACT OF CONGRESS APPROVED MARCH 3, 1915

SUBCOMMITTEES

Aerodynamics	Problems of Air Navigation
Power Plants for Aircraft	Aircraft Accidents
Materials for Aircraft	Invention and Design

Coordination of Research Needs of Military and Civil Aviation

Preparation of Research Programs

Allocation of Problems

LANGLEY MEMORIAL AERONAUTICAL LABORATORY

Langley Field, Va.

Unified conduct for all agencies of scientific research on the fundamental problems of flight.

OFFICE OF AERONAUTICAL INTELLIGENCE

Washington, D.C.

Collection, classification, compilation, and dissemination of scientific and technical information on aeronautics.

MEMBERS ARE APPOINTED BY THE PRESIDENT AND SERVE AS SUCH WITHOUT COMPENSATION

THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Among the outstanding accomplishments of the last century is man's conquest of the air. That conquest began in 1903 when the Wright brothers made the first successful flight of an airplane at Kitty Hawk, North Carolina.

Five years later the United States Government purchased its first airplane for the use of the Army, and began the training of officers for military flying. During the years immediately preceding the outbreak of the World War the Government and a meager aircraft industry had made important progress, but the Government, practically the only customer, had purchased less than one hundred airplanes.

In the meantime, leading European nations, sensing acutely the potentialities of aircraft in warfare, had made greater progress and had begun laying the foundations for the new science of aeronautics. The World War gave a remarkable impetus to the development of aeronautics and emphasized the need for organized research on the fundamental problems of flight.

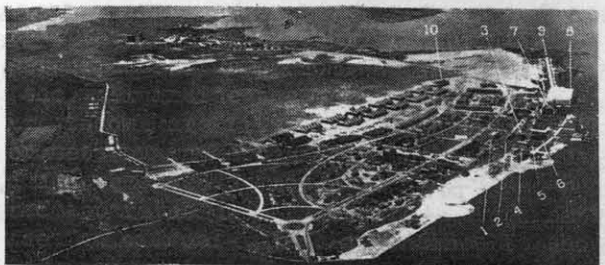
By Act of Congress approved March 3, 1915, the National Advisory Committee for Aeronautics was created and charged with the duty of supervising, directing and conducting fundamental scientific research and experiment in aeronautics. With the farsighted support of the Congress the Committee has developed at Langley Field, Virginia, the largest and best equipped aeronautical research laboratory in the world. The results of researches conducted there in one central Government laboratory serve the needs of all branches of aviation, civil and military, and exert a profound influence on the progress of aeronautics by improving the performance, efficiency and safety of aircraft.

A brief description of the results of some of the Committee's researches and of the equipment employed will be found in the following pages.

N.A.C.A. LABORATORIES
Langley Field, Va.

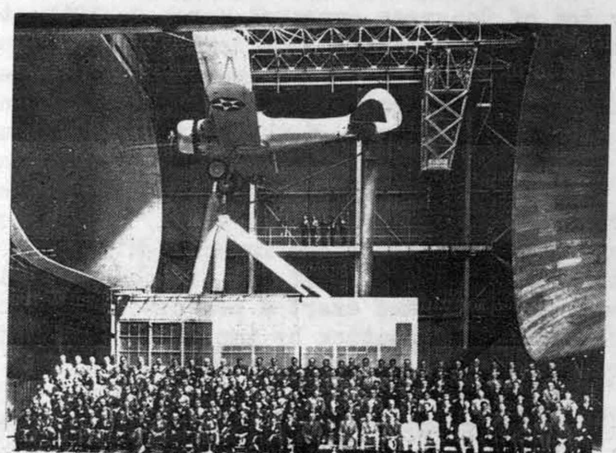
ESTABLISHED IN 1918. COMPRISES 10 BUILDINGS, HOUSING THE AERODYNAMIC, POWER-PLANT, HYDRODYNAMIC, AND PHYSICAL LABORATORIES, AND VARIOUS SUPPORTING SHOPS AND OFFICES. THE STAFF OF 260 EMPLOYEES IS ABOUT EVENLY DIVIDED BETWEEN THE TECHNICAL AND NON-TECHNICAL PERSONNEL.

MAIN BUILDING, HOUSING THE ADMINISTRATIVE OFFICES, LIBRARY, OFFICES OF CHIEFS OF DIVISIONS, PHOTOGRAPHIC SECTION, AND PHYSICAL-RESEARCH LABORATORY



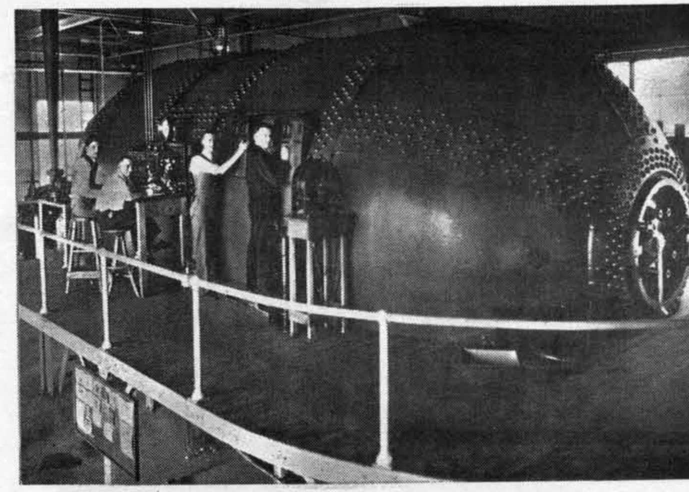
GENERAL VIEW, LANGLEY FIELD, SHOWING N.A.C.A. LABORATORY ACTIVITIES

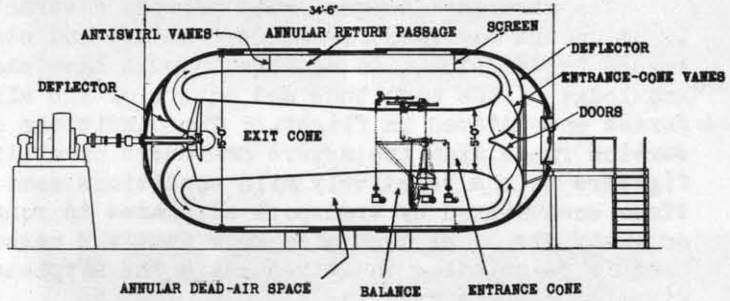
1 ADMINISTRATIVE OFFICES
2 SERVICE BUILDING
3 MAINTENANCE BUILDING
4 ATMOSPHERIC WIND TUNNELS
5 VARIABLE-DENSITY TUNNEL
6 POWER-PLANT LABORATORY
7 PROPELLER-RESEARCH TUNNEL
8 FULL-SCALE TUNNEL
9 N.A.C.A. TANK
10 FLIGHT-RESEARCH LABORATORY



EIGHTH ANNUAL ENGINEERING RESEARCH CONFERENCE IN TEST CHAMBER OF FULL-SCALE TUNNEL, MAY 4, 1933

VARIABLE-DENSITY WIND TUNNEL

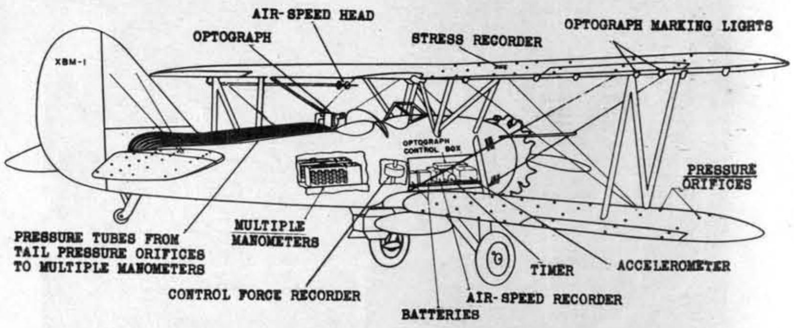




DIAGRAMMATIC LONGITUDINAL SECTION OF THE VARIABLE-DENSITY WIND TUNNEL

This is the only type of wind tunnel in which small models may be used to obtain full-scale results. This wind tunnel is built within a steel tank, and compressed air is used to test the models, the purpose being to have the same mass of air passing the model per second as would pass the airplane in flight. If, for example, a model 1/20 the size of an airplane is tested, the air is compressed to 20 times its normal density or to 300 pounds per square inch. In the determination of the lift and drag characteristics of wing sections the results obtained with this equipment are accepted as standard.

A FLYING LABORATORY



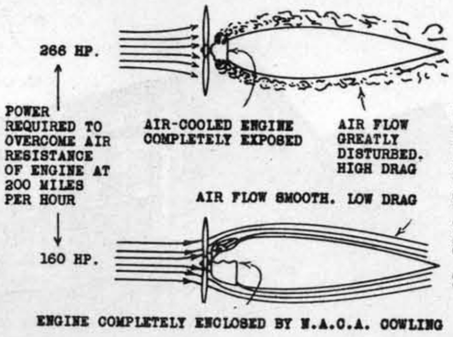
INSTALLATION OF INSTRUMENTS FOR MEASURING THE AIR FORCES, STRUCTURAL DEFORMATIONS, AND STRESSES IN FLIGHT.

The airplane designer must provide a structure light enough for good flying performance and strong enough for safety. To do this he must have exact knowledge of the magnitude and nature of the air forces encountered in flight. The conditions of service range from the severe maneuvers of military fighters to the relatively mild conditions sometimes encountered by transport airplanes in rough or gusty air. He must also know that the methods used in calculating the stresses in the airplane give the correct results.

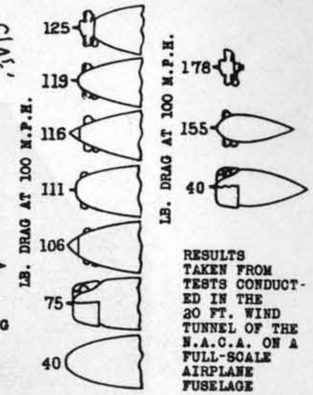
To provide the exact information required for the improvement of future designs, studies of the forces on airplanes in flight have been and are being carried out by the aid of elaborate installations of recording instruments such as are illustrated above.

The instruments shown record a complete story of the air pressures on the wings and tail, the air speed, the force exerted by the pilot on the control stick, the acceleration of the airplane, the stresses in the structure at a number of important points, and the deformations at various parts of the structure. Other instruments not shown provide data from which the flight path of the maneuver can be determined.

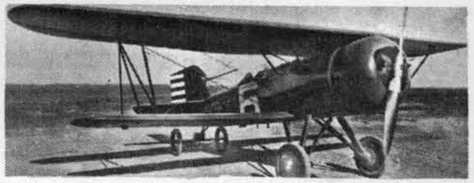
N.A.C.A. COWLING



THE REASON FOR THE LOW RESISTANCE OF THE N.A.C.A. COWLING

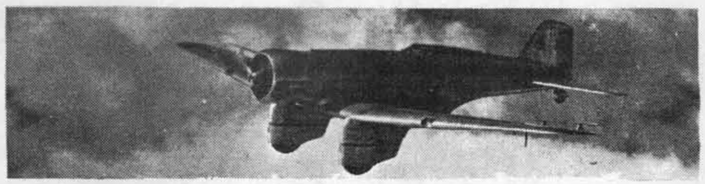


UNCOWLED ENGINE
HIGH SPEED 118 MILES PER HOUR



COWLED ENGINE
HIGH SPEED 137 MILES PER HOUR

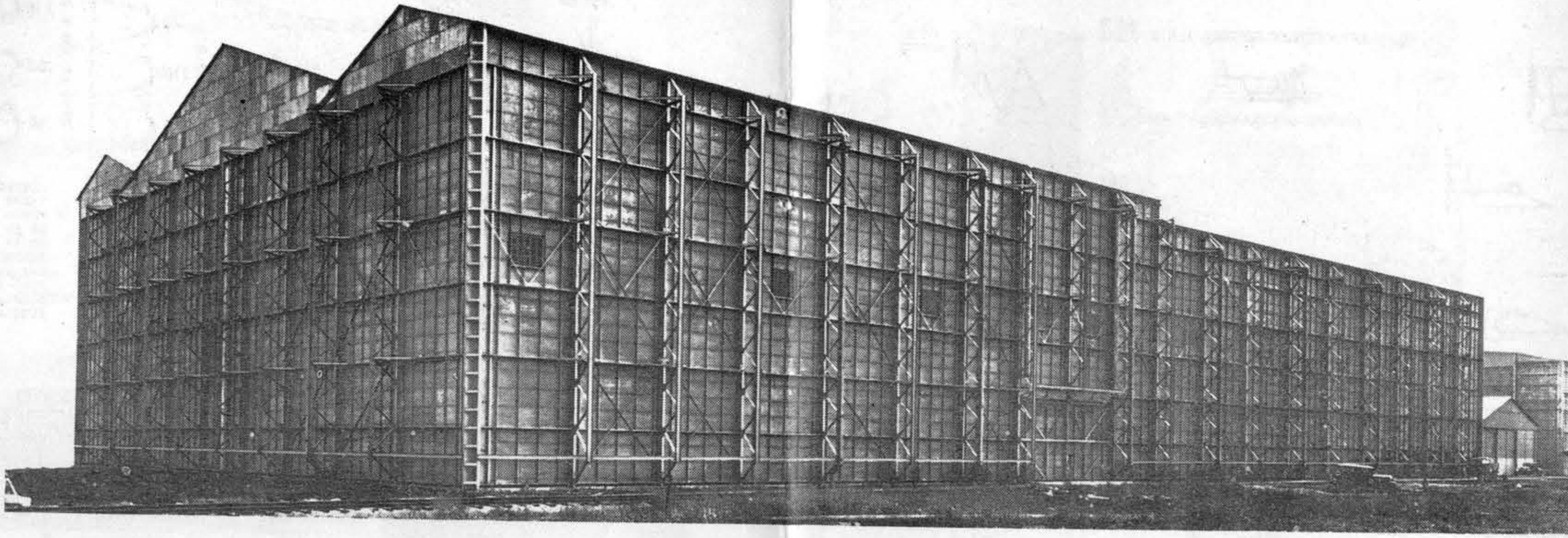
FIRST APPLICATION OF N.A.C.A. COWLING TO A COMPLETE AIRPLANE
LANGLEY FIELD OCT. 12, 1928



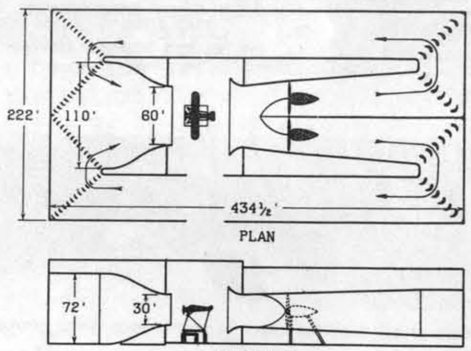
APPLICATION OF N.A.C.A. COWLING TO A MODERN HIGH-SPEED AIRPLANE

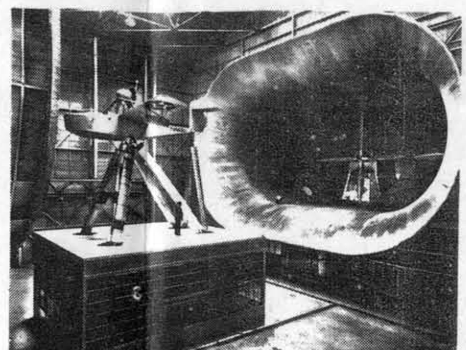
The low-drag N.A.C.A. cowling for air-cooled engines is recognized the world over as an outstanding achievement in aeronautical research. The potential value of the N.A.C.A. cowling to United States aircraft for 1932 exceeds $5,000,000. The saving to the Government and to commercial operators from this one research would exceed the total cost of all the researches by the National Advisory Committee for Aeronautics in the past eight years.

FULL-SCALE WIND TUNNEL

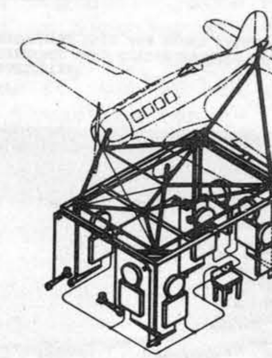


ARRANGEMENT OF WIND TUNNEL





NAVY SEAPLANE MOUNTED ON BALANCE



SCHEMATIC DRAWING OF BALANCE OF N.A.C.A. FULL-SCALE WIND TUNNEL

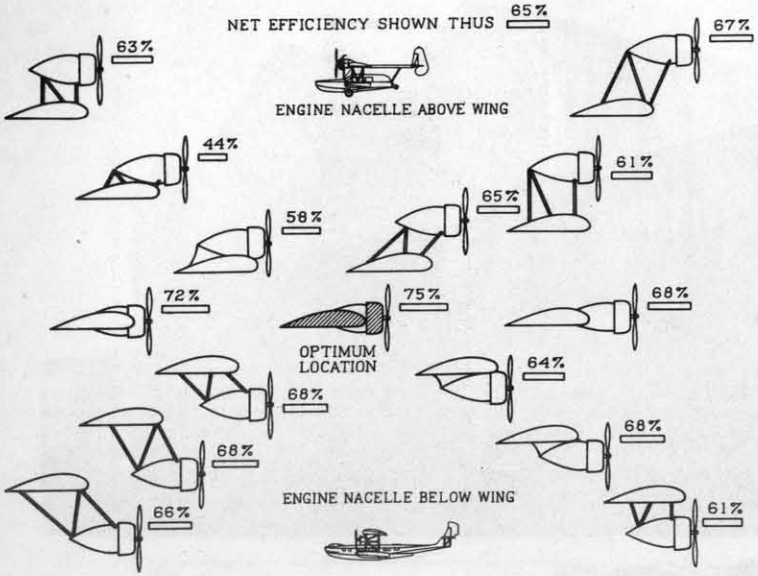
The characteristics of a small model as determined in a small wind tunnel cannot be used directly in designing full-sized airplanes without making empirical corrections. Therefore, the most satisfactory method of obtaining the aerodynamic characteristics of an airplane is to conduct a full-scale investigation. Heretofore such investigations have been conducted only in flight. For a number of reasons this method is not altogether satisfactory. In order to provide a means for full-scale investigations not subject to the limitations applying to tests made in flight, the National Advisory Committee for Aeronautics has erected the full-scale wind tunnel.

This wind tunnel is the only one in the world in which tests can be made on a complete airplane.

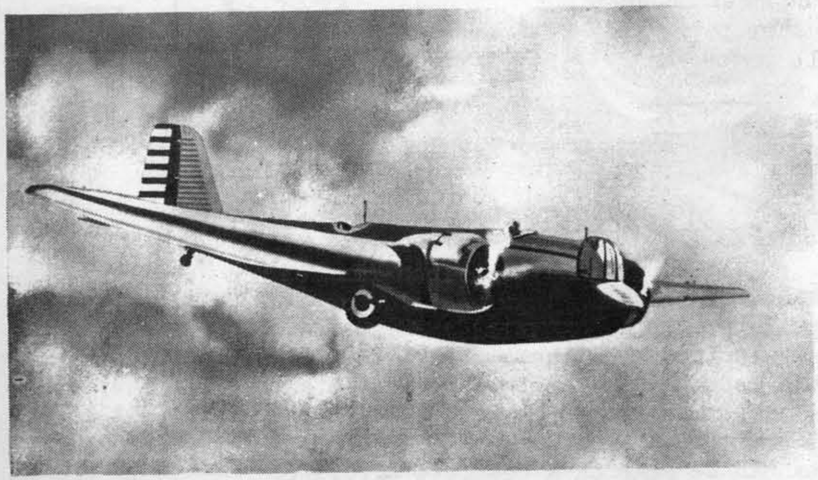
Dimensions of tunnel: Height, 97 ft.; Length, 434½ ft.; Width, 222 ft. Dimensions of air stream, 30 by 60 ft. Velocity of air stream, 25 to 118 m.p.h. Diameter of propellers, 35 ft. 5 in. Horsepower, 8,000.

WING-NACELLE INVESTIGATIONS

NET PROPELLER EFFICIENCY FOR AN ENGINE NACELLE IN VARIOUS POSITIONS WITH RELATION TO AN AIRPLANE WING



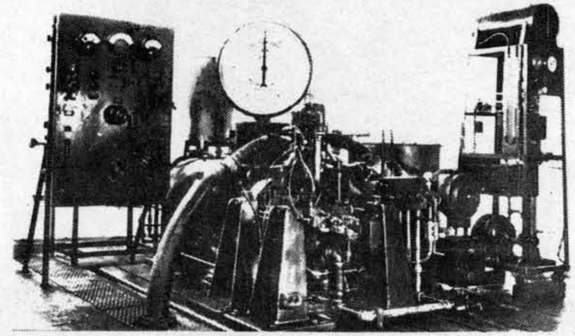
ENGINE NACELLE MOUNTED ABOVE THE WING INCREASES THE LIFT; BELOW THE WING REDUCES THE DRAG. ENGINE BUILT INTO OR FAIRED INTO THE WING IS IN THE BEST LOCATION FOR OVER-ALL EFFICIENCY.



PRACTICAL APPLICATION OF N.A.C.A. COWLING AND N.A.C.A. WING-NACELLE POSITION.

NEW MARTIN ARMY BOMBER, WINNER COLLIER TROPHY 1933

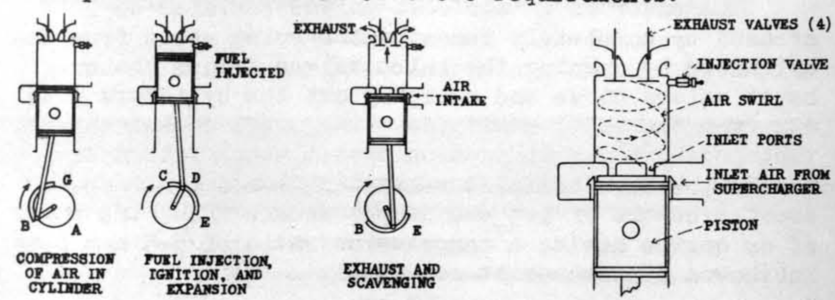
AIRCRAFT ENGINES
Compression-ignition; Two-stroke-cycle



N.A.C.A. TWO-STROKE-CYCLE TEST ENGINE

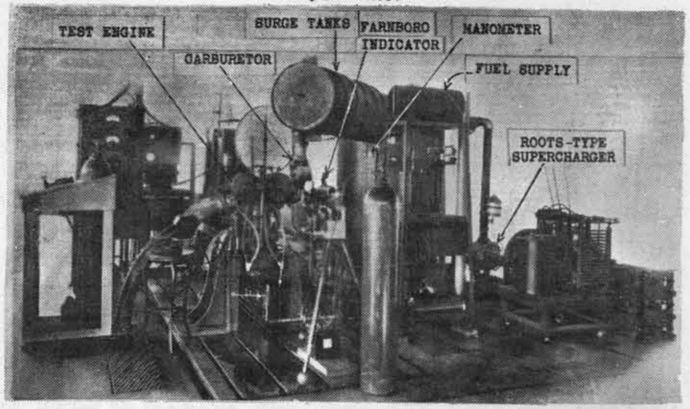
Researches into the problems connected with the improvement of the performance and the reliability of aircraft engines and engine accessories are conducted by the power-plant division of the laboratory. The general problem in connection with aircraft engines is to increase power, to decrease fuel consumption, and to increase the reliability of engines. This work has been carried out in large part on a number of specially designed single-cylinder Universal test engines. With these engines very accurate control can be had of all the conditions desired in the investigation.

The power plant should provide the greatest possible power from the smallest possible bulk and weight, and should also use as little fuel as possible commensurate with the other requirements. Recent investigations made with the N.A.C.A. two-stroke-cycle single-cylinder Diesel engine, pictured above, warrant the belief that this type of engine promises to provide an acceptable combination of these requirements.



INCREASING THE POWER OF AIRCRAFT ENGINES

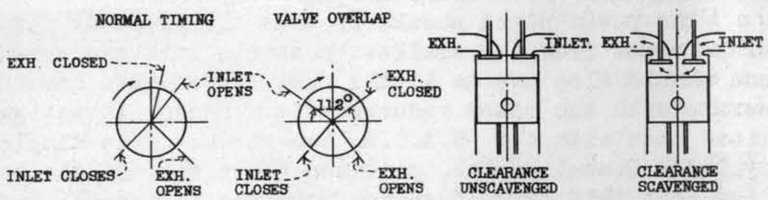
BOOSTING



ENGINE AND ACCESSORIES USED IN BOOSTING TESTS

The power of aircraft engines can be increased by using an air pump to boost the weight of the mixture delivered to the cylinders. An investigation to determine the effect of boosting on the engine performance indicates that the increase in power is directly proportional to the increase in the weight of the air mixture. That is, to double the weight of the air inducted into the cylinders is to double the horsepower of the engine.

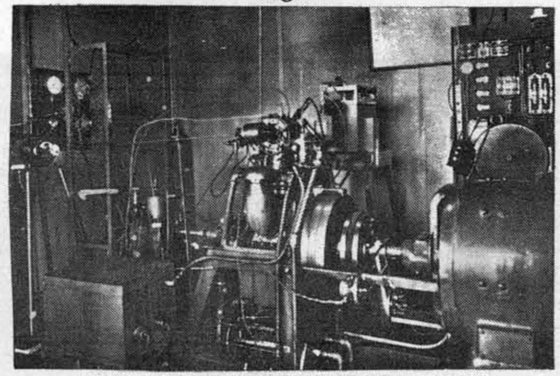
VALVE OVERLAP



IMPROVED SCAVENGING WITH VALVE OVERLAP

The power of an aircraft engine can also be increased by completely removing the burnt gases from the cylinders by opening the inlet valves before the exhaust valves close and sweeping out the cylinders with air from the inlet manifolds. The usual carburetor is replaced by a fuel-injection system which introduces the fuel after the inlet valve has closed. Using a boost pressure of 1.5 pounds per square inch, the power of an engine having a compression ratio of 5.5 has been increased 18 percent at sea level.

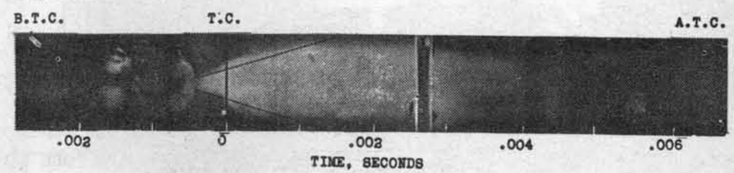
SPRAY-COMBUSTION RESEARCH



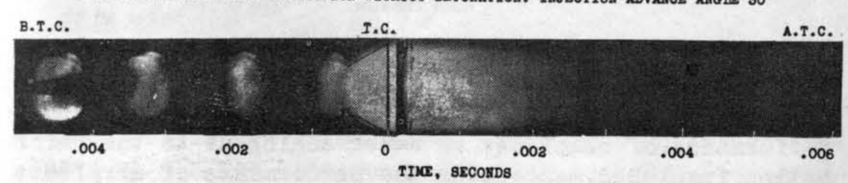
ASSEMBLY OF N.A.C.A. SPRAY-COMBUSTION APPARATUS

To effect the greatest economy in weight with efficiency in performance, the phenomena connected with the burning of the fuel inside the engine must be studied. Accordingly, windows are fitted in the cylinders through which the process of injecting and burning the fuel can be observed and recorded by means of high-speed photographs. The apparatus used in obtaining information for the better design of fuel-injection engines is shown above.

Below are two typical records. The upper one shows that without detonation the fuel is auto-ignited around the spray, and the combustion is progressive, which is of the desired type. The lower record shows that with detonation the mixture of fuel and air explodes, lighting the whole combustion chamber at once. This type of combustion is not desired, because it produces severe shock loads on the engine.

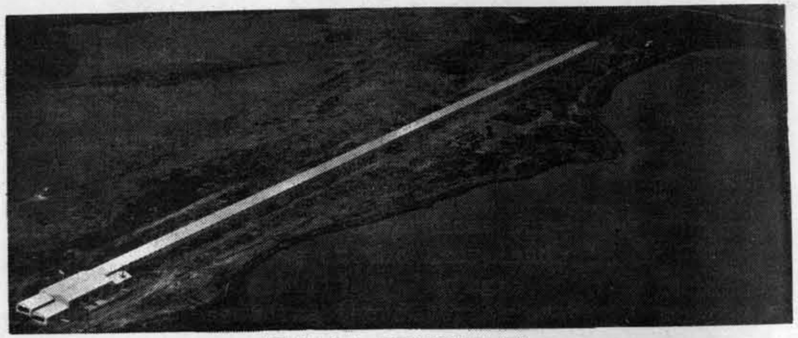


SPRAY PENETRATION AND COMBUSTION WITHOUT DETONATION. INJECTION-ADVANCE ANGLE 30°

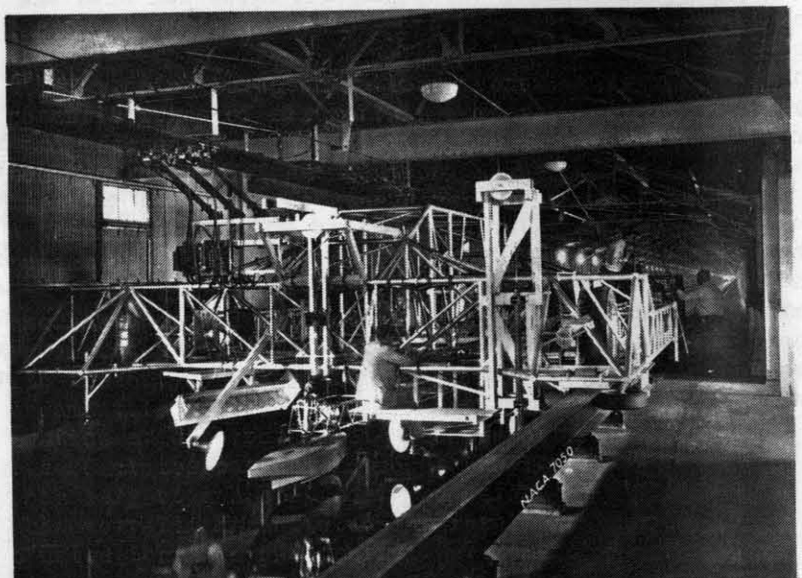


SPRAY PENETRATION AND COMBUSTION WITH DETONATION. INJECTION-ADVANCE ANGLE 60°

N.A.C.A. TANK



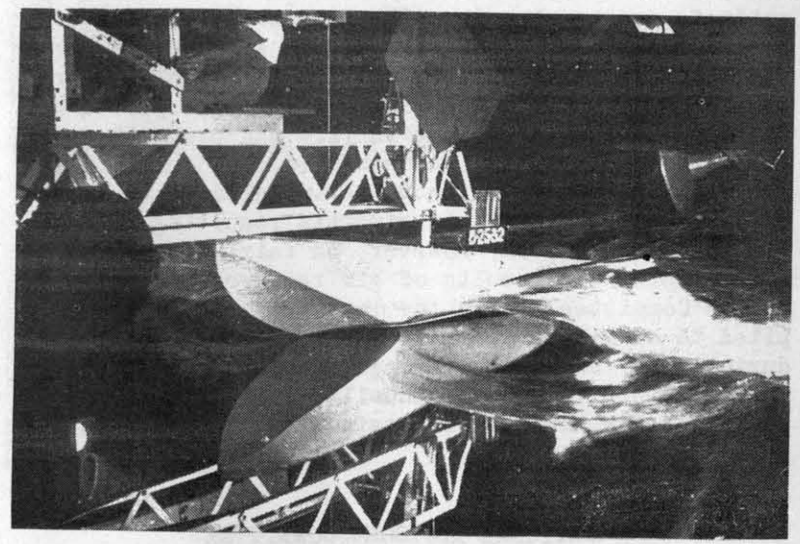
THE N.A.C.A. TANK FROM THE AIR



INTERIOR VIEW OF TANK, SHOWING TOWING CARRIAGE WITH MODEL OF FLYING-BOAT HULL MOUNTED READY FOR TEST.

The purpose of the N.A.C.A. tank is to enable the Committee to provide information and data regarding the performance of seaplanes on water analogous to the information furnished concerning the performance of airplanes in the air. In this tank large models of seaplane hulls

N.A.C.A. TANK
Typical models of flying-boat hulls.



may be towed at high speeds and accurate information obtained for designers as to the resistance and other features of the performance. The tank is 2,000 feet long, 24 feet wide, and 12 feet deep, and the maximum speed of the towing carriage is 60 miles per hour.

The National Advisory Committee for Aeronautics has fifteen members appointed by the President and serving as such without compensation. They include two representatives each from the Army and Navy air organizations, the heads of the Smithsonian Institution, the Weather Bureau, and the Bureau of Standards, and eight members appointed from private life. There are technical subcommittees similarly organized, the members of which also serve without compensation.

The Committee coordinates the research needs of aviation, and conducts fundamental investigations the results of which are made available to the Army, the Navy, the Department of Commerce, the aircraft industry, and others concerned. The researches of the Committee lead to material improvement in the performance, efficiency, and safety of aircraft. No money estimate can be placed on the immeasurable value of superior performance of aircraft in warfare, for aerial supremacy is quite likely to be ultimately decisive of a war; nor can a money estimate be placed on the indeterminable savings in life and property due to improved safety in the operation of both military and civil aircraft. The value in dollars and cents of improved efficiency in aircraft resulting from the Committee's work can, however, be fairly estimated. For example, the results of six researches completed by the Committee within the last few years, when applied to airplanes equal in number to those in use during 1932, show that savings in money alone will be made possible in excess annually of the total appropriations for the Committee since its establishment in 1915.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS,
Navy Building,
Washington, D.C.