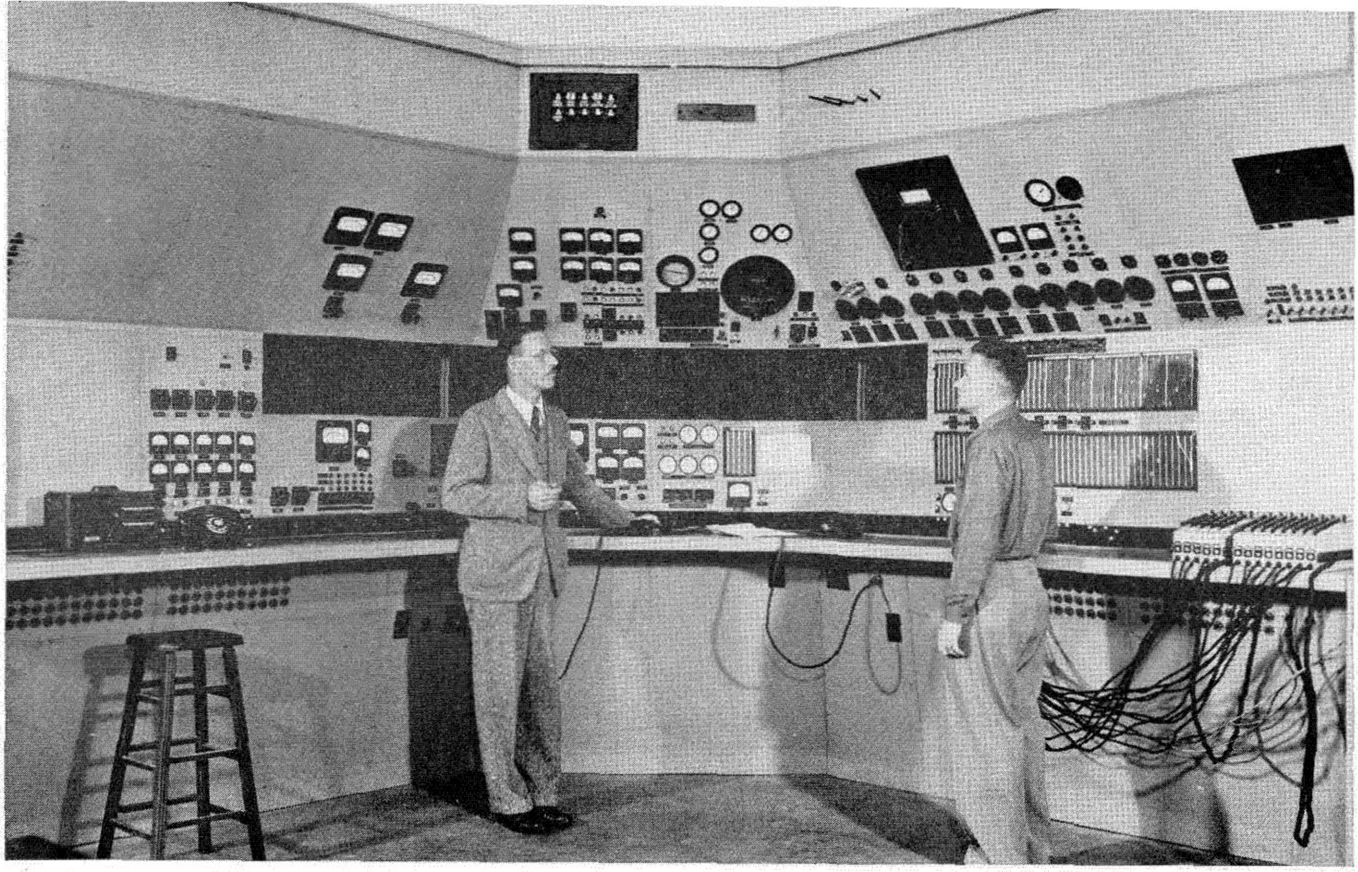

FIG. 2. Console of control room, which provides centralized operation by means of remote control and indication circuits.

INTRODUCTION

THE Southern California Cooperative Wind Tunnel is an achievement remarkable not only for its technical features, but perhaps even more significantly for the concept of cooperation upon which it is based, and which is emphasized in its name. Under the impetus of wartime necessity, the traditionally highly competitive aircraft industry, through joint and closely cooperative action, astounded the world by "achieving the impossible." With the coming of peace, the competitive spirit, with its emphasis on individual initiative, will return to the industry.

Even under peacetime competition, however, there are certain fields of activity in which joint action is so intrinsically desirable as to justify its permanent incorporation in the aeronautical industry. One of the most important of these fields is that of research and development, involving particularly the highly complex facilities required for the analysis and solution of the difficult problems encountered in the development of modern, high-speed aircraft.

The Cooperative Wind Tunnel provides such a facility. It is a $2,500,000 project, financed and owned by four Southern California aircraft companies—Consolidated Vultee Aircraft Corporation, Douglas Aircraft Company, Inc., Lockheed Aircraft Corporation and North American Aviation, Inc.—and operated by the California Institute of Technology. Under the cooperative arrangement, these four aircraft companies thus continue in peacetime to employ the most important elements of wartime cooperative development, while retaining the advantages of the flexibility and initiative of private ownership and management. The Cooperative Wind Tunnel represents a highly significant and valuable experiment in cooperative organization on the part of one of the nation's great industries.

The wind tunnel was originally conceived as a design instrument for use by airframe manufacturers in carrying out the aerodynamic development of current and new aircraft. The design was jointly supported by the cooperating Southern California companies and the Curtiss-Wright Corporation, which is constructing an essentially identical wind tunnel. It had to satisfy a number of very special requirements: Size had to be such as to make the construction of complete airplane models relatively simple. Operating conditions had to cover speeds up to the velocity of sound, and also scales, or Reynolds Numbers, as large as possible. Accuracy had to be extremely high, and the time required to make the tests and obtain complete data had to be held to the absolute minimum. Wide flexibility was required in the type of test which could be conducted, and the transition from tests on one project to those on another had to be rapidly and easily made. The tunnel, therefore, has many new features which are justified by and can only be understood and appreciated in the light of these very special requirements.

GENERAL FEATURES

THE general arrangement of the Cooperative Wind Tunnel is shown in *Fig. 1*. The heavily reinforced steel tube, seven-eighths inches in thickness, is of circular cross-section and is sheltered by a reinforced concrete and frame building. The maximum inside diameter of the tunnel is 31½ feet, while the working section is 12 feet wide and eight and one-half feet high. A bank of vanes is provided at each corner to guide the airflow smoothly around the turn. This is shown in the cutaway of the turn at the right of *Fig. 1*. The control room is on a mezzanine above the second floor, shown in the lower left portion of *Fig. 1* and in *Fig. 2*.

At the upper left of the control room in *Fig. 1* are shown two partitioned model rooms with wood and metal shops immediately adjoining. The engineering offices, drafting room, photographic laboratory, technical library and other work rooms are on the first floor. The model is mounted within the decompression sphere shown at the

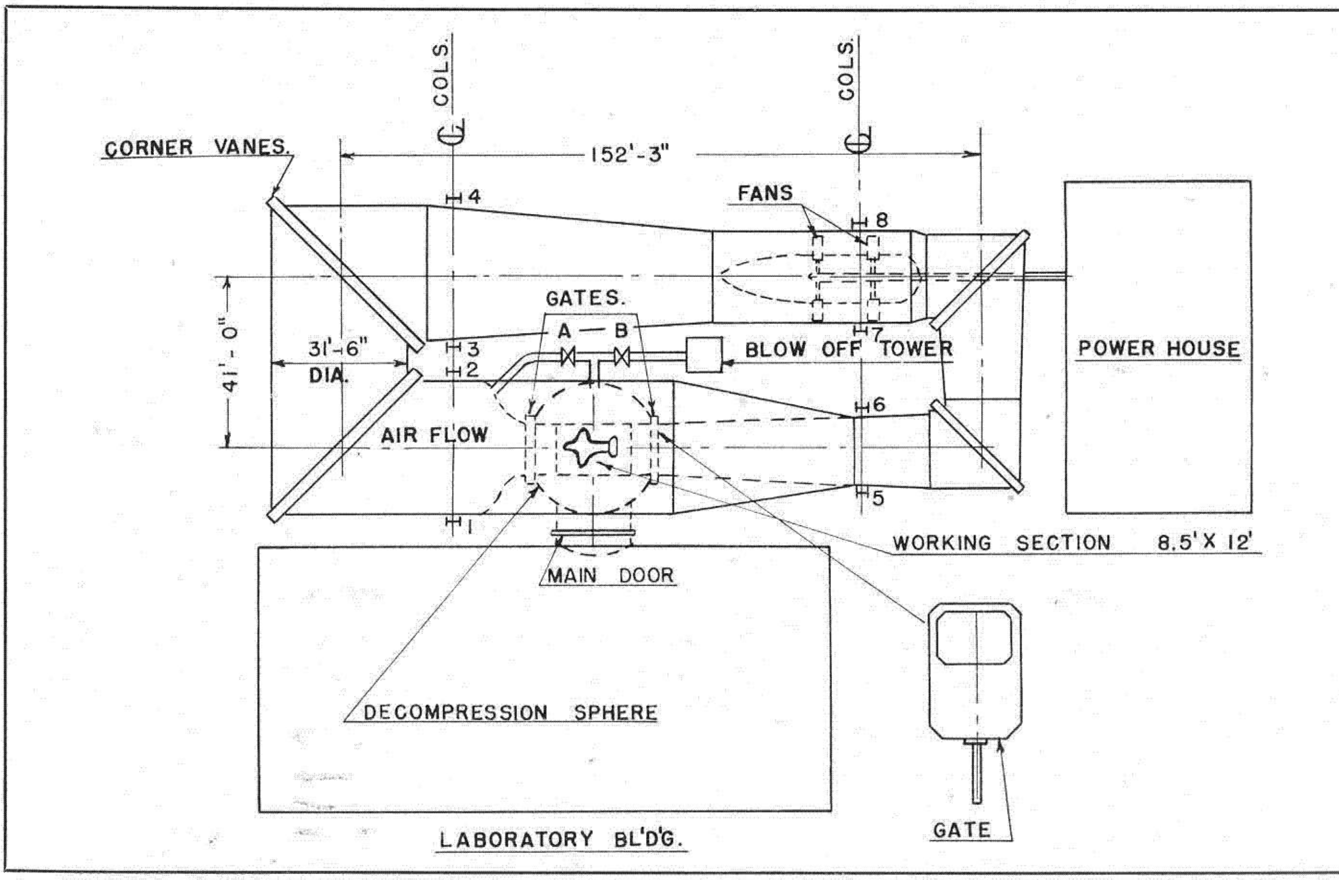

FIG. 3. Diagrammatic plan view of tunnel, showing supporting columns.

FIG. 4. Side view of tunnel during construction.

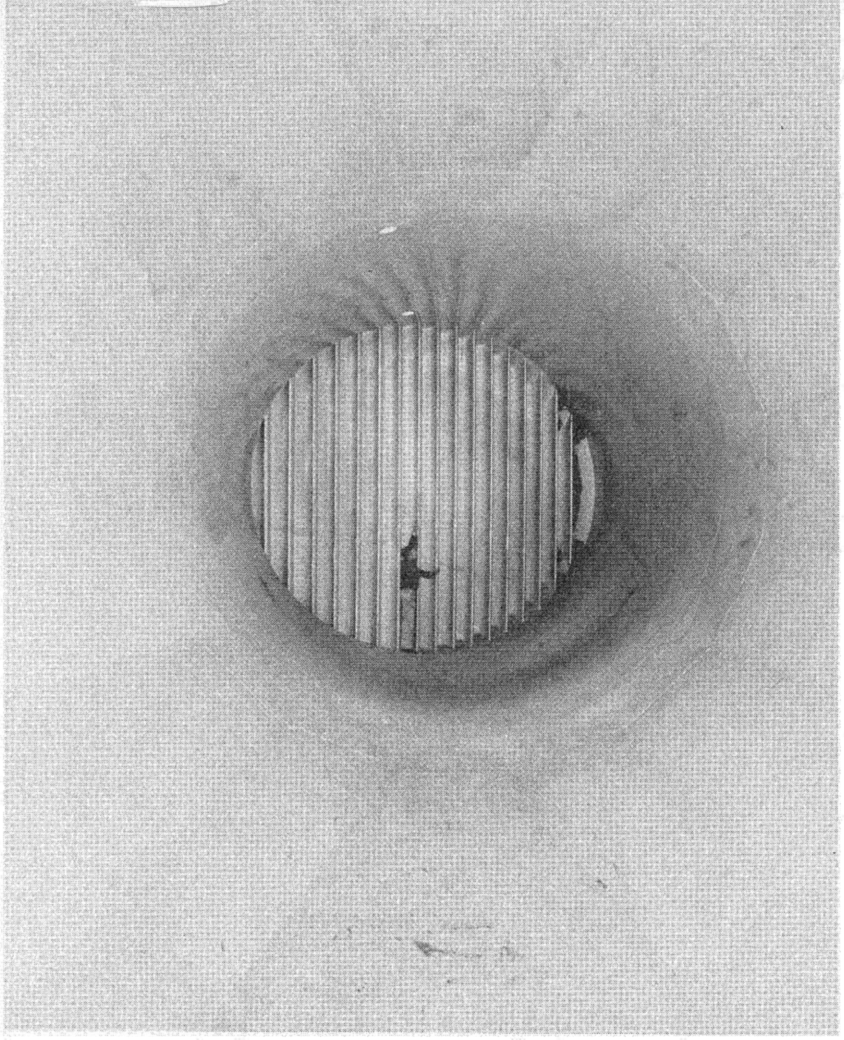

FIG. 6. Turning vanes downstream from working section.

(FIG. 5. Cover illustration, shows adjustable turning vanes at one corner of tunnel.)

left center of *Fig. 1.* This chamber, which may be entirely closed off from the rest of the tunnel in less than a minute, is essentially an air lock, 31½ feet in diameter, and contains a throat or Venturi which is 12 feet wide and eight and one-half feet high. Dynamometers are provided for use in conjunction with power models. The dynamometer room is shown adjacent to the control room in the lower left portion of *Fig. 1.*

The fan system, shown in the right center portion of *Fig. 1,* is connected through the 30-foot steel shaft to two-power units with a total capacity of 12,000 *hp.* These units consist of a 2,000 *hp* direct current motor, supplied by a motor-generator set, and a 10,000 *hp* alternating current induction motor.

Several separate types of mountings are provided for the models, depending upon the type of models tested and the nature of the test to be performed. Test mounts are installed on small flat cars, which operate on steel floor rails that may be pushed directly from the model room into the decompression sphere.

A unique feature of the tunnel operation is an ingenious system of translating the test data to the final results by means of equipment supplied by International Business Machines Corporation. The data are recorded automatically on printed working sheets and on punched cards. The final result is obtained through additional I. B. M. machine operations. Provision is made for the control of temperature and humidity of the air within the tunnel. Some of the interesting features of the wind tunnel are discussed in some detail in the following sections.

PURPOSE AND REQUIREMENTS

THE general purpose of all wind tunnel tests is to obtain data from which the airplane designer can develop the design of a new airplane. Because of the extreme complexity of modern high performance airplanes, a great many varieties of data are required before it is possible to lay out a balanced design. In most instances it is impossible or at least very uneconomical to obtain accurate design information from airplanes in flight, thus making it highly desirable to be able to obtain data by other methods than flight testing. For this reason wind tunnels have been developed.

Many types of wind tunnels have been built, but all have the purpose of creating a uniform stream of air which passes through a test chamber in which a scale model of an airplane is mounted. The model is mounted on struts or wires fastened to a system of balances which enable the tunnel operator to measure the forces and moments acting on the model.

The forces and moments which act on the airplane, and on the model in the wind tunnel, depend on its attitude with respect to the direction of the air stream. That is, they depend on its angle of attack and angle of yaw. The variation of the forces and moments with these angles is important to the airplane designer. For this reason it is necessary that the model-supporting mechanism which is attached to the balances be capable of varying the angles of attack and yaw of the model in the wind tunnel. In fact a typical run of a wind tunnel test consists of varying either the angle of attack or the angle of yaw, while holding the other angle at a fixed value, and recording the magnitudes of the forces and moments at each of a number of positions of the model.

Certain types of investigations which may be carried out in a wind tunnel are of more theoretical interest than of immediate applicability in the design of aircraft, and really belong to the field of fluid mechanics. Apart from investigations of this sort, wind tunnel tests fall generally into one of two classifications. Tests may be conducted for the purpose of obtaining basic aerodynamic data

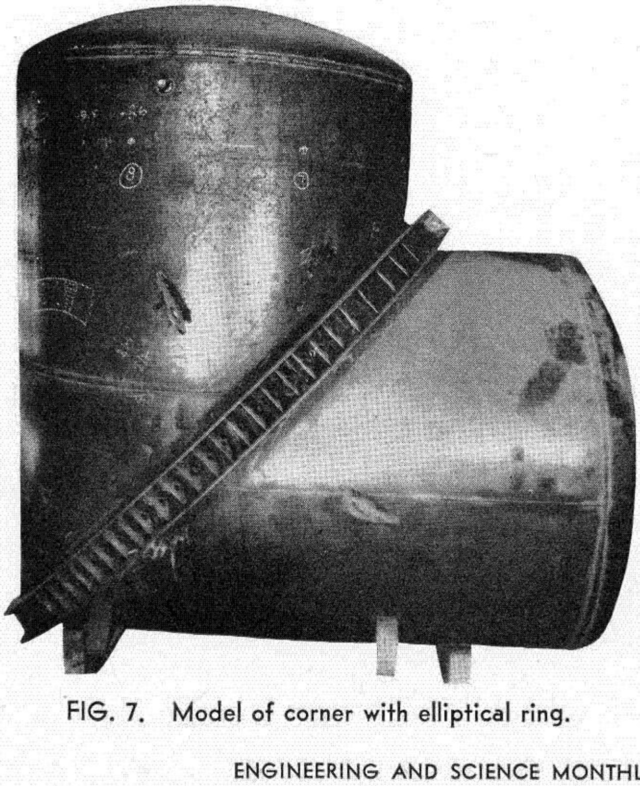

FIG. 7. Model of corner with elliptical ring.