The International Congress for Applied Mechanics:

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THE SIXTH INTERNATIONAL CONGRESS for Applied Mechanics, held at the Sorbonne, brought together for the first time since the war those scientists interested in theoretical and experimental work on the elastic and plastic properties of materials and structures, fluid mechanics, vibration, sound, friction and lubrication, thermodynamics, combustion, and heat transfer. At the last meeting, held in Cambridge, Massachusetts, in 1938, the American representatives on the international committee were J. S. Ames (since deceased), J. C. Hunsaker, Th. von Kármán, and S. Timoshenko. At the 1946 Congress, Hugh L. Dryden was elected to the international committee as the fourth U. S. representative; and H. U. Sverdrup and R. von Mises, who now reside in the United States, were elected individual members.

The present Congress was organized by a French organizing committee with H. Villat as president and M. Roy as general secretary. The attendance included about 100 Englishmen; 100 Frenchmen; 52 Americans; large delegations from Belgium, Holland, Italy, Switzerland, Roumania, and Czechoslovakia; many from Sweden, Turkey, and Poland; 3 from Russia; and 2 from China. Most of the leading workers in the field were present. It was decided that the next Congress would be held in 1950, but the place was not selected. During the Congress the international committee approved the formation of an International Union of Applied Mechanics, to be affiliated with the International Council of Scientific Unions. A provisional constitution was drawn up, and J. M. Burgers was named as secretary to take the first steps toward the organization of such a union.

The Congress was divided into four sections: I. Structures, Elasticity, Plasticity; II. Hydro- and Aerodynamics, Hydraulics; III. Dynamics of Solids, Vibrations and Sound, Friction and Lubrication; and IV. Thermodynamics, Heat Transfer, Combustion, Theoretical Questions Relating to Nuclear Energy. In addition to regular sessions of the four sections, symposia were arranged on turbulence, seaplanes, plasticity, jet propulsion and turbo-machines, hydraulics, friction and lubrication, supersonic flow, methods of calculation, impact, wing theory, instruments, and measurements. The present report covers chiefly the meetings of Section II.

The Congress was opened on Monday, September 22, at 9:30 A.M., following which Ives Rocard delivered a general lecture on methods of treating problems of nonlinear vibrations, with a great variety of illustrations of practical problems. Section II then convened, papers being presented by F. B. Farquharson, on the aerodynamic stability of suspension bridges; E. Crausse, on an example of resonance due to alternate vortices in an hydraulic installation; and M. Craya and P. Gariel, on the theoretical and experimental aspects of the flow in superposed layers of fluids of different densities.

At the first session of the turbulence symposium, held on Monday afternoon, H. L. Dryden presented a paper entitled "Some Recent Contributions to the Study of Transition and Turbulent Boundary Layers." The paper aroused much interest, since it contained the first public announcement of the work of Schubauer and Skramstad, both of the National Bureau of Standards, in verifying experimentally the Tollmien-Schlichting theory of boundary layer instability and the first complete measurements of the turbulent stress tensor in a separating turbulent boundary layer. G. K. Batchelor, of Cambridge, England, described measurements of certain new aspects of isotropic turbulence. His results appear to clarify the subject of the law of decay of isotropic turbulence. New experimental techniques were described. P. V. Chou presented a theory of turbulent flow along a semi-infinite plate. The other two papers at this session, by A. Fage and A. D. Young, were of a more practical nature, dealing with the effect of surface waviness and roughness on boundary layer transition and the drag of airplane wings.

The session of Section II on Tuesday morning dealt chiefly with the flow of liquids through porous and granular material and with the diffusion of small particles in a turbulent liquid. A general lecture by G. I. Taylor, entitled "Mechanical Tests at Large Velocities of Deformation," described a novel form of testing apparatus in which a lead bullet fired into an anvil extends a tensile specimen at a rate of strain up to 3,000 sec.$^{-1}$. In other experiments rates of strain up to 20,000 sec.$^{-1}$ were obtained by firing steel cylinders 3 inches in diameter with flat ends against armor plate. The ratio of the elastic limit in a dynamic test to that in a static test was found to be as large as 3.0 in mild steel of low yield point, but the ratio decreases to 1.0 when the steel is very hard. Similar results were obtained for duralumin.

The second session of the turbulence symposium was held on Tuesday afternoon. The first paper, by D. C. MacPhail, described hot-wire experiments on the turbulence between concentric cylinders at speeds up to far above the critical speed. The regular system of vortex rings which forms at the breakdown of laminar motion breaks up into fragments. Although the turbulence is actually three-dimensional, the scale of the turbulence is so much larger in the axial direction than in the radial or circumferential directions that the behavior as to dissipation is roughly two-dimensional. Even at speeds far above the critical, the turbulence spectrum contains a band of preferred frequencies.

The second paper, by P. Guienne, was entitled "Sur la Transition sur une Surface Courbe." The author gave a phenomenological theory of the detailed mechanism of transition on a sphere and of the effect of turbulence. In brief, he considered the case in which laminar separation occurs with a resulting free boundary layer which becomes turbulent and reattaches to the surface. The author uses the suggestion of Von Doenhoff and Abbott that transition occurs in a free boundary layer when the Reynolds number formed from the speed at the separation point and the distance along the free layer from the separation point attains a constant value. The constant value is, however, assumed by the author to depend on the turbulence of the general flow, decreasing as the turbulence increases.

P. Oguey then presented a paper entitled "La Dispersion des Jets d'Eau sous l'Influence de la Turbulence," offering a theory of the breaking up of a jet of water which appeared to ignore the effect of the surrounding air on the outer surface of the jet. The paper was severely criticized by the experimental hydraulic engineers. The word turbulence was used only in a general qualitative sense.

A paper by J. O. Hinze on the mechanism of disintegration of high-speed liquid jets presented the subject from the standpoint of the design of fuel injection systems, *i.e.* jets of small diameter in which surface tension phenomena cannot be neglected and with the usual instability considerations, tearing effect of relative motion of a jet with wavy surface and the air, etc.

H. Rouse described some experiments made in connection with a wartime project for clearing fog from airports, *i.e.* a study of the diffusion of heat from a line source in two-dimensional flow. The experiments dealt with the source located in a boundary wall and were in accord with a simplified theory.

J. Kampe de Feriet's paper, entitled "La Notion de Moyenne dans les Equations du Mouvement Turbulent d'un Fluide," was a discussion of the necessary and sufficient conditions imposed on the turbulent fluctuations to insure that the various mean values occurring in the Reynolds equations of turbulent motion should obey the rules of mathematical logic. Mathematically expressed, the spectra of the turbulent fluctuations must contain extended regions of zero intensity; physically expressed, there must be a definite range of space and time intervals such that the average values over these intervals are independent of the size of the interval. The paper aroused much discussion. It seems clear that there may be some turbulent motions for which Reynolds equations are not very useful, because the mean values are continuously changing functions of the interval over which the averages are taken, but there are many other cases where the assumptions are valid.

The final paper, by A. Favre, described apparatus for the measurement of time correlations in turbulent motion. The output of any convenient apparatus giving an electrical current proportional to the instantaneous value of the velocity is recorded on magnetic wire or tape. Two pickups can be spaced at any desired distance to reproduce the values of velocity at two times which differ by a constant amount corresponding to the distance between the pickups and the speed of the wire or tape. After amplifications (as modulations of a carrier-frequency later rectified) the outputs are applied to the vertical and horizontal plates of a cathode-ray tube. The correlation is determined from the pattern on the screen.

At the Wednesday morning session of Section II the following papers were presented: "Sur l'Impossibilité pour un Fluide Visqueux Homogene ou Heterogene d'un Mouvement à la Poinsot," by M. Berker; "Hydrodynamique Plane des Liquides Visqueux," by G. C. Moisil; and "Le Mouvement Rotationnel d'un Fluide," by I. Carstoin. H. A. Einstein gave a good general review and some speculations on the transport of sediment by streams of water. Two papers on the stability of laminar flow provoked much discussion. Th. von Kármán presented C. C. Lin's paper on the stability of two-dimensional parallel flow which has been available for some time in this country. D. Meksyn, who presented a paper on the stability of viscous motion between parallel planes, was sharply critical of the work of Tollmien and others. A full report of his work is to be published in the *Proceedings* of the London Mathematical Society. He seemed to have made some improvement in the accuracy of the mathematical computation of the stability limit but insisted that the other workers, including Lin, were wrong in spite of the good experimental confirmation of their work by the experiments of Schubauer and Skramstad at the National Bureau of Standards. The meeting of Section II was occupied largely with the work of S. Bergman, H. Poritsky, and H. Kraft on compressible flow problems. Their papers in this field are available in this country. R. Smelt presented a paper on the longitudinal stability and trim changes of an aircraft through the speed of sound, in which some of the earlier wartime work was described.

On Thursday morning the first session of the symposium on supersonic flow was held. W. F. Cope and G.

A. Hankins described in two papers some theoretical and experimental work on the Reynolds number effect on projectiles at supersonic speeds carried out at the National Physical Laboratory. W. D. Hayes presented his theoretical treatment of linearized conical supersonic flow. J. Ackeret described very briefly the work in progress at the Zürich Aerodynamic Institute on shock waves and the mechanism of compressibility drag. John Stack, of the National Advisory Committee for Aeronautics, presented a paper on the flow around a sharp leading edge of an airfoil at supersonic speeds. Pruden and Valensi showed a large number of pictures of shock-wave patterns in high-speed flow.

At the concluding session of this symposium, held in the afternoon, Ackeret showed motion pictures of the development and changing character of shock-wave patterns with increasing Mach number and increasing Reynolds number for laminar and turbulent boundary layers and of the unsteady motion when an airfoil lattice is driven above the blocking speed using the surface wave analogy of compressible flow. Papers which created much interest were those of Th. von Kármân on some investigations of transonic and supersonic flow and of J. W. Maccoll on the investigation of compressible flow at sonic speeds.

On Friday afternoon, at a third session of the turbulence symposium, there was some further discussion of Dryden's paper. Batchelor then presented a brief report on some recent theories regarding the correlation coefficient in isotropic turbulence at high Reynolds numbers. Three scientists, Kolmogoroff in the U. S. S. R., Onsager in the United States, and C. F. Weizsäcker in collaboration with W. Heisenberg in Germany, obtained the same result (that the correlation between parallel velocity fluctuations at two points distant r apart approaches the form $1 - Ar^{2/3}$ at high Reynolds number, provided r is small compared with the scale of the turbulence) by theories which have some elements in common but which vary in mathematical formulation. F. N. Frenkiel presented his measurements of correlation and other aspects of turbulent flow conducted under the guidance of Kampe de Feriet. H. L. Dryden presented a paper for H. Liepmann, of the California Institute of Technology, on measurements of turbulent shear flow.

The closing session of the symposium on supersonic flow was held on Saturday morning. A. C. Charters, Jr., described the spark photography range of Aberdeen Proving Ground. Riabouchinski reviewed his theoretical and experimental work on compressible flow. Teofilato discussed the well-known analogy between compressible flow of a gas and a current field in water. Bartels and Laporte discussed a linearized theory of the supersonic flow over conical bodies at an angle of yaw. Frank Malina discussed the problem of escape from the earth by means of a rocket, giving the usual one-stage and multistage simplified calculations and concluding that the technical accomplishment was nearly within sight.

The Congress closed with an official session at noon, at which representatives from several countries formally expressed appreciation for the work of the French organizing committee. The principal social events of the Congress were receptions by the organizing committee, by the city of Paris, and by the British ambassador, and a visit to the palace of Versailles with an informal dinner in the town.

There were, of course, many important papers presented at other sessions. In particular, Section II had sessions on hydraulics, hydrodynamics of ships, jet propulsion, theory of flow around wing sections, and general hydraulics which occurred concurrently with the sessions described.

It is difficult to pick out individual contributions as outstanding. The Congress included many papers describing war work, now released, which had been done in connection with aeronautics, ballistics, and structural design. There were also many contributions which represented work carried out in occupied countries in secrecy and under great difficulty. The contributions from America and Great Britain were of a high standard and represented a sharing of fundamental scientific knowledge with no threat to military security. The contributions from other nations were, on the average, perhaps not as far advanced, but there were important exceptions, such as the work of Ackeret and his colleagues on shock waves, of Crocco on supersonic diffusers, and of Koiter on buckling of plates.

Scanning Science—

The annual report of the Provost of the University of Pennsylvania, with the appended documents, makes a volume extending to 248 pages. It covers, however, a period of more than two years, from June 9, 1894, when Mr. Harrison assumed the duties of acting Provost, to September 1, 1896. This will probably always be regarded as one of the most important periods in the history of the University. . . . the chief gains [in the scientific departments] have been the appointments of Professor C. A. Doolittle, in astronomy; Professor E. G. Conklin, in comparative embryology, and Professor A. C. Abbott, in hygiene.

—February 5, 1897