maps showing the distribution of economic species and other subjects.

The Conseil Scientifique pour l'Afrique au Sud du Sahara, and in particular Prof. Lebrun, are to be congratulated on organizing such a useful meeting, and it is to be hoped that means will be found to implement many of its recommendations.

R. W. J. Keay

NINTH INTERNATIONAL CONGRESS OF APPLIED MECHANICS

THE ninth International Congress of Applied Mechanics was held at the Université Libre of Brussels during September 5–13. More than seven hundred members attended the Congress, and no less than five hundred communications were presented. The Congress was administered by the International Committee for Congresses of Mechanics, which is one of the organizations adhering to the International Union of Theoretical and Applied Mechanics. The president was Prof. F. van den Dungen and the secretary-general M. Jean Vandenkerckhove. A feature of the organization was the special provision which was made for young scientists, who were able to obtain cheap accommodation and meals in the Cité Universitaire, while a grant of 2,000 dollars was also available to help with their expenses of travelling to Brussels.

The main interest of the Congress naturally centred around the one-hour addresses. Mr. K. S. Davidson, of the Stevens Institute of Technology, Hoboken, N.J., gave a lecture on "Ships", in which hydrodynamics, boundary-layer theory and practical yachtsmanship were pleasantly combined. Much of the substance of this lecture is available in the Sir Geoffrey Taylor Memorial Volume entitled "Surveys in Mechanics" (Cambridge University Press, 1956).

Prof. R. Hill, of the University of Nottingham, gave a lecture on "New Horizons in the Mechanics of Solids". In this lecture he set up a theoretical framework sufficiently general to include problems of visco-elastic solids, including the theory of creep and work hardening.

Prof. P. Germain, of the University of Lille, lectured on "Some Recent Advances in Theoretical High Speed Aerodynamics". This was a general survey of problems of linearized supersonic theory treated by the method of the Laplace transform. Some extensions to second-order effects were also included in the lecture, which was remarkable for the speed with which it covered almost all recent developments in this subject.

Prof. H. Mettler, of the Technische Hochschule, Karlsruhe, spoke on "Forced Non-linear Vibrations of Elastic Bodies".

But perhaps the address which was most appreciated was that by Sir Geoffrey Taylor, which bore the title of "Steady Flow of Fluid entering a Region through Porous Boundaries", and which in fact dealt with the hydrodynamics of paper-making, and of painting with rollers and ordinary artists' brushes. In this extremely interesting address, Sir Geoffrey gave an account of the recent work which he has carried out to investigate the flow of the paper pulp over the rollers in paper-making machines. His investigations of roller painting and of brush painting consisted not only of simple theories embodying the main physical factors, but also of experiments which satisfactorily bore out the predictions of the theory and which were remarkable for the economy of material with which they were executed.

Apart from these general addresses, the work of the Congress was divided into two sections, the first dealing with fluid mechanics and containing some 258 papers, and the second with the mechanics of solids, containing 243 papers. In view of this great mass of material, it was necessary to limit the time available for the presentation of most papers to 15 minutes, although a certain number were given 30 minutes. The papers were grouped in such a way that only two papers were ever being read at the same time, namely, a 30-minute paper in Section I and a 15-minute paper in Section II, or vice versa.

The section on fluid mechanics included papers on aerodynamics in subsonic, transonic, supersonic and hypersonic conditions, on atmospheric pollution, boundary-layer theory, hydrodynamics of water-entry problems and surface waves, lubrication, cavitation, and seepage problems in the Nile valley. A particularly interesting demonstration was given by Prof. M. Reiner, of the Israel Institute of Technology, of his centripetal pump. This machine consists of two parallel plates ground accurately flat, of which one forms the stator and the other the rotor. A pressure hole is located at the centre of the stator and the rotor is rotated at a few thousand revolutions per minute. Initially, the pressure at the centre of the stator is reduced; but as the distance between the plates is progressively reduced to a few thousandths of an inch, a pressure of several feet of water is built up.

The section on the mechanics of solids included some papers on classical problems of vibrations, on the elastic theory of plates and shells, on buckling and post-buckling problems, and on a yielding subsoil; but the emphasis seemed to be on plasticity, limit analysis, creep and visco-elasticity.

Mention must also be made of the social activities and of the financial support which the Congress received from Belgian banks and industries. Members of the Congress enjoyed the traditional Belgian hospitality at two receptions and a banquet. A reception was given at the University by the President, Vice-President and Rector of the Free University of Brussels and a reception at the Town Hall by M. L. Cooremans, mayor of Brussels. The banquet was held at the Hotel Metropole.

It is planned to hold the next International Congress of Applied Mechanics in 1960 in Italy.

THE NUCLEI OF ATMOSPHERIC CONDENSATION

ATMOSPHERIC aerosols cover a wide range of particle-size from about 10^{-7} cm. for the small ions to more than 10μ radius for the largest salt and dust particles, and a range of concentrations from less than 100/cm.^{3} over the oceans and in the upper air to, perhaps, 10^6/cm.^{3} in the polluted air of large cities. Being the products of natural and man-made combustion, of dust and spray raised from the Earth's surface, of chemical reactions taking place in the

atmosphere, and perhaps even of matter entering the atmosphere from outer space, the particles will vary greatly in chemical composition and, because of coagulation, will often be of mixed constitution. The abundance, size, physical properties and nature of these particles are matters of particular interest to those working in the fields of cloud physics, atmospheric electricity, atmospheric pollution and atmospheric chemistry.

Since the pioneer work of Aitken seventy-five years ago, a great deal of effort has been devoted to measurement of the concentration, size, mobility and electric charge of the smaller particles with radius between 10^{-7} and 2×10^{-5} cm. But in recent years more attention has been given to the particles larger than $0{\cdot}1\mu$ in diameter—the so-called 'large' and 'giant' nuclei—since it is these which are mainly responsible for the formation of cloud droplets. The selective sampling of these larger particles has necessitated the development of new techniques for collection and measurement; but at these sizes it now becomes possible to use electron microscopy, electron diffraction and microchemical methods for identification.

These trends were reflected in the proceedings of the Second International Symposium on Condensation Nuclei, held in Basle and Locarno during October 1–4 and attended by scientists from ten countries.

After the delegates had been welcomed by Prof. F. Verzár on behalf of the organizing committee, the conference opened with a review by Dr. B. J. Mason (Imperial College, London) in which he summarized and assessed the present state of knowledge concerning the abundance, size distribution, physical properties, nature and origin of condensation nuclei, particularly of those which are likely to be involved in cloud formation.

An interesting paper by A. C. Chamberlain, W. J. Megaw and R. D. Wiffen (Harwell) described the consequences of the attachment of radioactive particles (particularly the decay products of radon and thoron) to condensation nuclei, the use of radioactive markers to study the behaviour of condensation nuclei, and the production of condensation nuclei by ionizing radiations. The diffusion constant of radium A and thorium B ions was found to be $0{\cdot}054$ cm.^{2}/sec. when uncombined, and of order 10^{-5} cm.^{2}/sec. when attached to condensation nuclei, this difference having an important effect on the site of deposition in the human respiratory system of inhaled radioactive matter. Unattached radioactive particles are largely deposited in the nose, trachea and bronchi, but the attached particles penetrate to the alveoli. The new radioactive method of determining the diffusion constant of nuclei gave results which differ from those obtained by the normal methods by a factor of about two—a discrepancy which has still to be resolved.

Reviewing the methods of measuring the concentration of Aitken nuclei, Prof. L. W. Pollak (Dublin) stressed the limitations of the Aitken pocket counter and of the Schulz counter and described the development, calibration and accuracy of the Nolan–Pollak photoelectric counter, which has proved a much more satisfactory instrument. There followed papers by various members of the Dublin school describing a nucleus counter with stereophotographic recording of the deposited droplets, the formation and decay of the fog in the photoelectric counter, and the results of some experiments carried out with Verzár's automatic photoelectric counter.

There were two other papers of particular interest from the instrumental point of view. Prof. A. Goetz (Pasadena) described an ingenious device for the separation and size classification of airborne particles greater than $0{\cdot}2\mu$ diameter. The particle-laden air is introduced into the space between a helical screw and an outer cylinder rotated at high speed. The particles are deposited on the surface of the helix under a centrifugal acceleration, the linear displacement being proportional to the ratio particle diameter/mass. Under these conditions, the particles move only slowly relative to the air and so are not subjected to large shearing forces.

Dr. J. Podzimek (Prague) described some preliminary experiments on the formation and growth of clouds produced in Findeisen's large expansion chamber (capacity 2 m.^{3}) and, in particular, the effects of varying the initial temperature, expansion ratio and rate of expansion (that is, the rate of cooling of the air).

The role of condensation nuclei in atmospheric electricity, and in particular the effect of their concentration, charge and mobility on the conductivity of the air, was the subject of papers by H. Israël (Aachen), J. A. Chalmers (Durham) and Herpertz, Israël and Verzár.

Dr. C. Junge (Air Force Research Center, Cambridge, Mass.) described the results which have emerged from the chemical analysis of samples of rain-water collected once a month at some sixty stations spaced across the whole of the United States. Maps showing the geographical distribution of chlorides are very similar from month to month, with high concentrations near the coast, but dropping to a fairly constant value inland. This, together with the fact that the total number of giant salt particles occurring in unit vertical column of the atmosphere is much the same over both land and sea, suggests that the air undergoes strong vertical mixing when it passes over the continent, and also that the giant salt particles are not effectively removed from the atmosphere by rain. Junge estimates the mean half-life of the giant salt particles to be three to four days in the eastern part of the United States, where the average rainfall is 0·1 in./day, and six to seven days in the western part of the continent, where the average daily rainfall is only 0·05 in. The half-life of the smaller natural aerosols, measured by radioactive techniques, was estimated to be about twelve days. This all suggests that natural aerosols may be transported for great distances over the Earth before falling out or being washed out by precipitation.

During the second part of the conference, held in Locarno, Prof. Giuseppina Aliverti (Naples) reviewed recent researches on the condensation and ice-forming nuclei which are of particular interest in cloud physics.

Dr. B. J. Mason (London) reopened the old controversy as to whether salt particles produced by sea spray are the main source of condensation nuclei involved in cloud formation. His experiments show that air bubbles of diameter between $\frac{1}{2}$ mm. and 2 mm., bursting in sea water, each produce about three hundred nuclei which, under the electron microscope, are mainly between $0{\cdot}1\mu$ and $0{\cdot}5\mu$ in diameter, the smallest containing only 10^{-15} gm. of sodium chloride. These results, together with measurements of the size distribution of salt nuclei collected over the oceans in areas of spray formation, indicate that the total concentrations of salt nuclei over the oceans in winds of up to 15 m./sec. probably do not

exceed 100/cm.^{3}. The corresponding rate of production of salt nuclei at the sea surface is estimated to be 1,000/cm.^{2} sec. It was therefore inferred that sea-spray contributes perhaps only one-fifth of the nuclei involved in cloud formation, the majority being the products of combustion.

A paper by K. Isono (Tokyo) described how the residues of cloud droplets collected on the summit of a mountain 150 km. from the sea have been examined under the electron microscope and their nature determined by electron diffraction. Most of the nuclei are less than 1μ in diameter; about 30 per cent consisted of sodium chloride, 20 per cent of unidentified soluble particles, and 50 per cent of insoluble particles—probably combustion products.

H. Dessens (France) has established that giant hygroscopic nuclei ($r > 10\mu$) exist in concentrations of at least 100/m.^{3} in the equatorial forests of the Belgian Congo, while nuclei of radius less than 0·4μ are present in much higher concentrations. No sodium chloride crystals have been identified among the giant particles, the most important source probably being the savannah fires. M. Dessens also described some very interesting experiments in which he has been able to produce quite large cumulus clouds in an otherwise clear sky by the burning of vegetation.

Other aspects of the subject were represented by contributions from H. W. Georgii (Frankfurt) on the measurement of the turbulent diffusion of aerosols near the ground, and by F. Volz (Mainz) on the production of dusts and their spatial distribution in the atmosphere.

Although a good deal of the material presented was not entirely new, the conference produced much vigorous and good-humoured discussion and some clarification and agreement as to what are the important problems. These include the collection and identification of the large and giant nuclei over both land and sea at different levels in the atmosphere, and investigation of the processes by which they are produced and transported.

The organizing committee is to be congratulated on the excellence of the arrangements in ideal surroundings. The proceedings of the conference will be published in a special issue of *Geofisica Pura e Applicata*. It is expected that the next symposium will be held in Britain in 1958. B. J. Mason

WORLD TELECOMMUNICATION

The major part of the inaugural address as president of the Institution of Electrical Engineers, delivered by Sir Gordon Radley, director general of the Post Office, on October 4, was devoted to a consideration of world telecommunication, a subject particularly topical in view of the recent opening to traffic of the first trans-Atlantic telephone cable. The practical realization of inter-continental multi-channel telephone communication by submarine cable is, in Sir Gordon's view, revolutionary in its possibilities, because the traffic capacities of such cables are likely to exceed the existing demand for telegraph and telephone facilities on their routes. It is important to appreciate that it is the advent of the submerged repeater or amplifier which has rendered long-distance submarine telephony practicable. The attenuation of the Newfoundland–Scotland section of the trans-Atlantic telephone cable at 164 kc./s. is approximately 1·6 db. per nautical mile, and an input power at the enormous level of 100 MW. would not be detectable by the most sensitive galvanometer at a distance greater than 150 miles. In the cable, repeaters are inserted every 38 miles, and the gain of each of these is 65 db., representing a power amplification greater than 10^6. On this basis multi-channel telephony is practicable on the longest submarine circuits.

The trans-Atlantic cable circuit utilizes, for the longest ocean link, separate cables for the two directions of transmission. The 'one-way' repeaters in these cables are accommodated in flexible housings only a little larger in diameter than the cable itself. These repeaters can be passed over the laying gear of the cable ship, and laying can be carried on continuously as with a conventional cable. The alternative arrangement of two-way transmission on a single cable requires a considerably greater space in the repeater housing to accommodate the additional filters and more complex circuits. The rigid housings for these repeaters require special handling in laying and considerably complicate that operation. The devising of means whereby the laying of such rigid repeaters could be carried out as part of a continuous cable-laying operation is, in fact, an immediate task of great importance.

Sir Gordon devoted considerable attention to the relative costs of single- and double-cable schemes, illustrating the matter by curves showing the estimated capital cost and annual cost per telephone circuit for cables 2,000 miles long, plotted to a base of total band-width transmitted in each direction. The cost per circuit is shown to decrease rapidly as the band-width or total capacity of the system is increased. It is thus economically advantageous to include in one cable, or pair of cables, all required facilities, telegraphy, telephony and—ultimately—television.

In regard to the economics of telephone-cable schemes on the main cable routes of the world, there appears to be a marked distinction between the North Atlantic route and all others. Sir Gordon remarked that the impetus to the growth of traffic between Western Europe and North America given by the 1956 telephone cable might well produce an early demand for a second cable of the greatest capacity technically possible. Eighty circuits in a single-cable system or two hundred in a twin-cable system was an objective only just beyond the limits at present imposed by repeater spacing and cable diameter, and either system, if reasonably loaded with traffic at the present call-rates, would be profitable.

On other world routes the economic prospects are less promising. Circuits to Australia and New Zealand, 12,000 miles long, might have a volume of traffic between 5 per cent and 10 per cent of the traffic with North America. It is clear that, for so great a distance with a small group of circuits, cable could not be competitive on cost with radio. On the other hand, experience of the propagation of high-frequency waves has shown that satisfactory radio communication cannot be maintained continuously over such difficult routes as the North Atlantic, or to the Antipodes.

It thus appears that the challenge to the communication engineer is that of providing submarine cable facilities on the main trunk routes of the world on a similar scale to that which has become established practice on land. This challenge is of very direct concern to British manufacturers, for Britain has a unique tradition of submarine cable manufacture