Expenditure during the year totalled £5,449,643 compared with £4,861,873 in 1953–54. Of this, £554,858 was spent on plant problems, £533,061 on animal health and production problems, £439,850 on industrial chemistry, £429,661 on the National Standards Laboratory, £275,441 on radiophysics, £266,812 on wool textile research, £240,654 on forest products problems, £179,423 on food preservation and transport problems, £168,400 on entomological studies, £147,183 on fisheries investigations, £57,587 on mathematical statistics, £119,068 on building research, £116,626 on fuel research, £105,692 on land research and regional survey, £102,108 on biochemical and general nutrition studies, £161,433 on soil problems, as well as £91,891 on soils and problems of irrigation settlements, and £83,117 on wildlife survey. £71,591 was allocated to tribophysics, £53,671 to meteorological physics, £42,615 to dairy research, £33,237 to plant fibre research and £27,834 to genetics.

As in the immediately preceding annual reports, the material is arranged according to subject, rather than according to the Divisions or Sections concerned. Besides a full list of staff and personnel of the Council and Committees, there is an index of papers published during the year, arranged according to sections. The Division of Soils is the central body engaged in soil research in Australia and, besides systematic mapping of Australian soils in broad categories, more detailed classification and mapping of soils in specific areas, applied research into soil fertility and on soil mechanics, undertakes fundamental research on the pedology, chemistry, physics, mineralogy and microbiology of Australian soils. Considerable advances have been made in the study of the mineralogy of both clay and the coarser fractions as a guide to soil classification, the genesis of soil profiles, and as a useful attack on the geochemistry of the soil which may enter into fertility problems. Besides the X-ray studies, emphasis is being placed on the petrographic study of the non-clay fraction, and a new section dealing with clay mineralogy has been set up. The approach to microbiological studies has been broadened with the commencement of work on humus and on the nature and activity of organisms in the rhizophere immediately adjacent to the roots.

As part of a long-term programme of investigations of basic importance to plant introduction work in Australia, studies were begun at Canberra on problems of drought resistance and seasonal dormancy in introduced plants. In connexion with biophysical work at the University of Tasmania, a recording growth meter has been constructed which detects growth of a rapidly elongating root in a few seconds. Studies during the past year have greatly clarified the understanding of cobalt deficiency of grazing sheep and clarified especially the occasional rapid precipitation of the deficiency syndrome in flocks depastured on incipiently cobalt-deficient terrain. Marked progress was also made in the study of BHC and DDT dipping fluids for control of cattle tick.

The Division of Tribophysics has shown that at least three mechanisms may operate in the liberation of stored energy in the heating of a deformed metal, and the manner in which the energy associated with these three processes varies with the deformation has been studied for nickel, arsenical copper and pure copper. Analytical and kinetic investigations with selected hydrocarbons show that gaseous oxidation at high temperatures occurs in two successive stages, the first controlled by the accumulation of active intermediates in the gas phase, and by processes at the walls of the reaction vessel, whereas in the second stage, gas phase reactions predominate. In the Division of Physics, a new method for controlling humidity, using a small ionic crystal as detecting element, has been devised, which has given promising results in the automatic measurement of dew-point temperature, in the accurate regulation of humidity in air-conditioned rooms, and as a self-balancing instrument with sensitivity equivalent to 0·01 deg. C. in dew-point, and response time of only 0·3 sec. The energies of alpha particles from certain natural radioactive substances and the gyromagnetic ratio of the proton have been redetermined, and work continued on the relation between the chemical and physical structure of pure compounds and their dielectric properties. Investigation of a proposed method for navigating long-range aircraft by distance measurement was concluded, but is not being carried further on account of the complexity of the instrumentation and the limit of 1,400 miles on the separation of the stations. Laboratory and road trials established the reliability of two radio-Doppler devices for remote measurement of the speed of road vehicles. Basic studies are being made of the physics of the atmosphere, with the object of attaining a more fundamental understanding of the weather and the processes which control it, and the Division of Radiophysics made several important studies relating to the Sun and galaxy. A detailed study of the southern part of the galaxy is in progress, which, when combined with the results from similar studies in the northern hemisphere, should afford a three-dimensional map of the spiral structure of the galaxy. A special interferometer, 1 km. wide, for use on solar disturbances is being constructed, while search has been made for evidence of radio emission from the planet Jupiter. Theoretical work centred on the origin and transmission of electromagnetic waves in an ionized gas.

CHEMICAL ENGINEERING IN THE UNITED STATES

THE Department of Scientific and Industrial Research, Overseas Technical Report No. 2 (pp. vi+24. H.M. Stationery Office. 2*s*.), on "Chemical Engineering in the U.S.A.", is one of a series of surveys on technological subjects which is being made under the ægis of the scientific attaché to the British Embassy in Washington. The present report was prepared by Dr. P. H. Calderbank, a member of the staff of the Chemical Research Laboratory, and is based on visits to educational and industrial establishments, and on meetings with representatives of those concerned with the selection, training and employment of chemical engineers in the United States. The report deals with the development of chemical engineering, the progress of which in the United States has been spectacular, the present position in chemical engineering education, and some recent trends in chemical engineering practice.

The older engineering professions have been concerned with the application of certain scientific principles to the building of structures and machines. The creation of the chemical industry required the introduction of a new range of principles, among

which the rate-process figured prominently; and from this development chemical engineering emerged. It led to a quickened interest in equilibrium conditions and in thermodynamics generally; and in the mechanisms of turbulent transfer and the processes occurring at phase boundaries.

Chemical process development in Germany occurs through co-operation between the industrial chemist and the mechanical engineer with process training (the 'process engineer'). In the United States the co-operation is between mechanical engineers and chemists who have had process training ('chemical engineers'). This difference, the report remarks, "seems to be due to the historical reasons which determined whether chemists or mechanical engineers took the initiative in embracing the principles of the physically controlled rate-process. However, the chemists' established familiarity with the chemical rate-process and the fact that the latter is frequently modified by physically controlled transfer phenomena seem to suggest that the American development was the more logical and satisfactory".

Of particular interest is the American approach to chemical engineering training. Under the 'practice school' made famous by the Massachusetts Institute of Technology, groups of students work in an industrial plant with their instructor on problems of interest to their host company. Many industrial firms are willing to take part in this scheme, which is generally considered to offer valuable training and a useful introduction to industrial life. The 'plant design' class, which is usual in Britain, has also been widely adopted in the United States. Students are required to co-operate with each other and with their supervisor in designing full-scale chemical plant. This emphasizes the element of co-ordination between various fields of study and introduces the importance of economic factors. There is also the 'co-operative scheme', similar to the British 'sandwich course', in which students divide their time between the university and industrial undertakings to which they are apprenticed.

The original division of the subject into 'unit operations' is coming to be regarded as arbitrary. It is increasingly appreciated that much of chemical engineering involves the wider application of comparatively few basic principles, which afford a greater economy and elegance of treatment than the former avenue to the subject through unit operations. The 'problem method' of instruction lays stress on the solution of large numbers of set problems: an approach enabling the student to meet a variety of different processes, not in compartments as unit operations, but as exemplars of the basic techniques. A recent development is thus an increasing emphasis on teaching simply the fundamental principles of engineering science. These courses contain no technology, but concentrate entirely on basic physics, chemistry and mathematics. Graduates are expected to fit equally well into any of the established branches of engineering. Specialization is relegated to a later stage: the student acquires his specialist training either by postgraduate research and advanced study or by practical experience as an apprentice in industry itself.

The report explicitly avoids any comparison between British and American chemical engineering practice. But some of the unique features of the American organization, both of the profession and the training required for it, invite close and profitable attention.

AUTOMATIC COMPUTERS IN CLERICAL WORK

THE first report of the inter-departmental study group representing the National Physical Laboratory, the Treasury and the Ministry of Pensions and National Insurance which is working at the National Physical Laboratory on methods of doing clerical work with fully automatic computers has now been published*. It deals with wage accounting and gives detailed information applicable to all forms of payroll work. The report covers the subject broadly, while taking the specific case of weekly wage accounting at the Central Office of the Ministry of Pensions and National Insurance at Newcastle as an example for more detailed study, and is written for a wide range of readers, from the expert in business who knows little about computers to the expert in computers who knows little about business.

The contents consist of fourteen sections and five appendixes. After an introductory section, the essential features of a fully automatic computer are outlined and some details are given of the particular serial computer DEUCE (Digital Electronic Universal Computing Engine), which is used as an example in the report. The main store in DEUCE is a magnetic drum of capacity 250,000 bits, and data and instructions are fed into the store on punched cards. Section 3 describes the task of the pay branch at Newcastle in respect of weekly wages and the methods used, together with an estimate of the cost, and Sections 4–7 a hypothetical computer system, based on the use of DEUCE, with the addition of auxiliary equipment consisting of magnetic tape-operated printing equipment, which is proposed to replace the present methods. The auxiliary equipment is not yet available, but it is considered that it could be developed within the next two years. The scheme considered employs a high-speed computer to calculate each worker's overtime and find out how much income tax he should pay and then deduct it and his National Insurance contributions from his gross wages. Many organizations arrange for voluntary contributions for sports clubs and the like. Not only will the computer deal with this, but it also remembers to give a warning a fortnight before a man's pay increment is due.

Section 8 gives an estimate of the annual cost of such a computer system and shows that it can be economic. Calculations for a staff of 3,400 paid weekly with overtime but not piecework can be done by the machine in an hour, but forty-three man-hours of labour are required to feed and extract the information. It would require a total staff of eleven, most of them on a part-time basis, against twenty-two full-time staff used at present, though, of course, as in other forms of automation, the staff retained would have to be fairly highly skilled. Further details of the type of auxiliary equipment required are given in Section 9 and various possible alternatives of design of the computer system in Section 10. Topics discussed in the remaining sections include the application of computers to other payroll work than that of the Central Office; reliability, faults and fault indication; and data sorting. The appendixes include notes on the binary scale and binary coded notation.

* National Physical Laboratory. Wage Accounting by Electronic Computer—Report No. 1 of the Inter-Departmental Study Group on the Application of Computer Technique to Clerical Work. Pp. ii+57. (London: H.M. Stationery Office, 1956.) 2s. 6d. net.