CSIRO

Annual Report

1962-63

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

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Fifteenth Annual Report

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COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

AUSTRALIA

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CONTENTS

This report on the work of the Commonwealth Scientific and Industrial Research Organization for the year ending June 30, 1963, has been prepared for presentation to Parliament as required by Section 30 of the Science and Industry Act 1959.

Important administrative matters, a number of policy aspects of the Organization's work, and items of general interest are recorded in Chapter 1. Some of the significant research developments in the programs of a number of Divisions and Sections are given in Chapter 2. The remainder of the report lists scientific papers published by C.S.I.R.O. officers; committees; professional and senior administrative staff; and financial details.

Detailed information about the research program is contained in the annual reports issued individually by the Divisions and Sections of the Organization. A complete list of the Organization's laboratories and field stations together with their addresses is published separately each year under the title "C.S.I.R.O. Divisions and Sections".

General enquiries and requests for information on the Organization as a whole should be directed to the Secretary.

The Executive gratefully acknowledges the valuable assistance that C.S.I.R.O. has received from Commonwealth and State Government departments and instrumentalities, the Australian universities, members of the primary and secondary industries, and private individuals. Considerable help has also been received from many overseas institutions.

The Executive also wishes to thank those who have made their knowledge and experience freely available to the Organization by serving on C.S.I.R.O. committees or by personal advice.

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General Review

THE PRIMARY REASON for investment in scientific research by government and industry lies in its economic and social significance for national progress and development. This is particularly the case in Australia, where political, geographical, and economic needs all make essential the rapid development of our resources and our industries.

The task of C.S.I.R.O. is broadly to provide, through scientific research, knowledge which will remove limitations to industrial progress or present new opportunities for it. But this alone is not sufficient; if the community is to benefit it must itself respond to the challenge of opportunity which science presents. The new knowledge must penetrate deeply and widely throughout industry. The goal of full industrial development can be attained only if industrial leaders have the vision and ability to turn the knowledge which science provides into activities of economic consequence.

Until recently progress of this kind in Australia has been disappointing but there are today growing indications of change. The agricultural industries of the Commonwealth have advanced rapidly into active participation in research. They are ensuring the attention of science to their many problems by seeking collaboration with C.S.I.R.O., the Universities, and the State Departments of Agriculture. Leaders in these industries are well aware that the results of research must be known to, and used by, a very large number of producers throughout the country.

The increasing interest in research and its practical use by those industries concerned with the processing of minerals or of the products of the land is encouraging. There is, however, much room for improvement—the extent of this research is not great if assessed in terms of its potential value to overseas trade and to the economy in general.

The Australian manufacturing industries, which have expanded so remarkably under the stimulus of overseas and local investment and through the ready availability of overseas technology, face particular difficulties in using Australian discoveries as sources of new processes and products. There is a growing awareness that, if Australia is to compete in world markets in terms of price, novelty, and quality, research by industry itself with such objectives is essential.

If Australian science and Australian industry are to advance together in harmony both will require an adequate supply of trained men. The very welcome current development of the Australian universities and the growth of their research facilities and post-graduate schools are clear indications of the changing attitude of the community to the part which science and technology must play in Australia's future.

Executive

The Rt. Hon. the Lord Casey, P.C., C.H., D.S.O., M.C., M.A., was reappointed a part-time Member of the Executive for a period of 3 years.

Mr. E. P. S. Roberts was also reappointed a part-time Member of the Executive for a period of 3 years.

The Members of the Executive are listed on page 117.

Advisory Council

The following members retired from the Council:

Professor H. C. Forster, M.Agr.Sc., Ph.D.
C. M. Williams, O.B.E.

The following new members were appointed to the Council:

Professor Sir John Crawford, Kt., C.B.E., M.Ec.
C. R. Kelly, B.Agr.Sc.
C. G. McGrath
J. A. L. Matheson, M.B.E., M.Sc., Ph.D.
Professor V. M. Trikojus, D.Sc., D.Phil., F.A.A.
P. J. Young, B.Ag.Sc.

The Council met twice during the year—in November 1962 at Melbourne, and in May 1963 at Sydney.

State Committees

State Committees are appointed for a term of 3 years. The term of the existing State Committees will end on December 31, 1964.

The following new members were appointed during the year:

South Australia:	P. J. Young, B.Ag.Sc.
Victoria:	C. R. Kelly, B.Agr.Sc.
	C. G. McGrath
	J. A. L. Matheson, M.B.E., M.Sc., Ph.D.

The following former member was reappointed during the year:

Queensland:	W. Webster, H.D.A., B.V.Sc.

The following member resigned during the year:

Tasmania:	S. L. Kessell, M.B.E., M.Sc., Dip.For.

Organizational Changes

Division of Applied Mineralogy

The Cement and Refractories Section has been designated the Division of Applied Mineralogy and Mr. A. J. Gaskin, M.Sc., former Officer-in-Charge of the Cement and Refractories Section, has been designated Chief of the Division. Mr. Gaskin is also Officer-in-Charge of Mineragraphic Investigations.

Division of Chemical Engineering

The Chemical Engineering Section of the Chemical Research Laboratories has been designated a Division, and Dr. H. R. Pratt, D.Sc., Ph.D., former Officer-in-Charge of the Section, has been designated Chief of the Division.

Computing Research Section

A Computing Research Section has been established to operate the Organization's central computer, which will be built at Canberra, and the four subsidiary computers to be installed in Sydney, Melbourne, Adelaide, and Canberra. The Section will conduct research into computing techniques and assist other Government Departments. Dr. G. N. Lance, M.Sc., Ph.D., has been appointed Officer-in-Charge of the Section.

Division of Dairy Research

The Dairy Research Section has been designated a Division and Mr. G. Loftus Hills, B.Agr.Sc., former Officer-in-Charge of the Section, has been designated Chief of the Division.

Horticultural Research Section

The Commonwealth Research Station at Merbein, Victoria, has been renamed the Horticultural Research Section and Dr. J. V. Possingham, B.Agr.Sc.(Hons.), M.Sc., D.Phil., former Officer-in-Charge of the Station, has been designated Officer-in-Charge of the Section. The Section will continue the investigations carried out at the Station and will also undertake new horticultural research with particular reference to the vine. The Section will establish a laboratory in Adelaide where the physiology and biochemistry of horticultural plants and their fruits will be investigated.

Irrigation Research Laboratory

The name of the Irrigation Research Station at Griffith, N.S.W., has been changed to the Irrigation Research Laboratory.

Melbourne Regional Office

For many years the administrative staff at Head Office in Melbourne has, in addition to its responsibilities as a central secretariat, been responsible for the administrative work connected with C.S.I.R.O. Divisions and Sections in Victoria, South Australia, Western Australia, Northern Territory, and Tasmania. During the year under review this latter activity has been separated organizationally from the true Head Office activity as the Melbourne Regional Office along similar lines to the Regional Offices in Canberra and Sydney. Mr. A. P. Patterson, F.A.S.A., has been appointed Regional Administrative Officer.

Division of Wildlife Research

The Wildlife Survey Section has now been designated the Division of Wildlife Research and Mr. H. J. Frith, B.Sc.Agr., former Officer-in-Charge of the Section, has been designated Chief of the Division.

Obituary

Dr. Joseph Lade Pawsey, Ph.D., D.Sc., F.A.A., F.R.S., Assistant Chief of the Division of Radiophysics, died on November 30, 1962, after a prolonged illness.

After graduating from the University of Melbourne Dr. Pawsey proceeded to Cambridge where he carried out research on the ionosphere at the Cavendish Laboratory under Lord Rutherford. He returned to Australia in 1940 to work on the development of radar in the newly created C.S.I.R. Division of Radiophysics. Towards the end of the war he turned his attention to the study of the high intensity radio waves which radar observers had reported as apparently coming from the direction of the Sun, and became founder and leader of a group within the Division of Radiophysics which, under his guidance and inspiration, has been active over almost the whole field of radio astronomy.

Dr. Pawsey had been invited to accept the position of Director of the U.S. National Radio Astronomy Observatory at Greenbank, West Virginia, and had planned to take up this appointment towards the end of last year.

Retirements and Resignations

Mr. J. E. Cummins, M.Sc., retired from C.S.I.R.O. after 35 years' service with the Organization and its predecessor C.S.I.R. He held one of the original C.S.I.R. travelling studentships before becoming an officer of the Division of Forest Products. Subsequently he held a number of senior administrative appointments which he carried out with distinction. These included those of Officer-in-Charge of the C.S.I.R. Information Service and Chief Scientific Liaison Officer in London and in Washington. For a period he was seconded to the International Atomic Energy Agency in Vienna as Director of the Division of Scientific and Technical Information.

Mr. M. G. Grace, A.A.S.A., Secretary (Finance and Supplies), retired in December after 34 years with C.S.I.R. and C.S.I.R.O. He joined C.S.I.R. from the Defence Department in 1928, was appointed Assistant Secretary (Finance and Supplies) in 1945, after acting in that position for some years, and Secretary (Finance and Supplies) in 1952. In a rapidly growing organization Mr. Grace built up a financial structure which by the required standards of government accountancy was impeccable. But it was his particular virtue that he managed to do so without in any way sacrificing the flexibility essential in a research organization or the personal friendliness and trust of all the staff, whether scientific or clerical, who worked in it. It was in this sense that he made his greatest contribution to the spirit and to the proper development of C.S.I.R.O.

Dr. N. S. Noble, D.Sc.Agr., M.Sc., D.I.C., retired from C.S.I.R.O. after being Editor of the Organization's scientific journals and other scientific publications for some 16 years. Dr. Noble was appointed to the Organization in 1947 and had the unique experience of establishing a series of national scientific journals which C.S.I.R.O. publishes in collaboration with other scientific bodies. The present reputation of these journals is largely due to the high standards which he insisted on maintaining.

Dr. A. S. Fraser, M.Sc., Ph.D., of the Division of Animal Genetics, has been appointed Professor of Genetics at the University of California, Davis.

Dr. D. G. Lampard, M.Sc., Ph.D., of the Division of Applied Physics, has been appointed Professor of Electrical Engineering at Monash University.

Mr. N. F. Roberts, M.Sc., of the Division of Textile Physics, has been appointed Director of the recently formed Wool Research Organization of New Zealand.

Dr. J. F. Turner, M.Sc., Ph.D., of the Plant Physiology Unit of the Division of Food Preservation, has been appointed Professor of Agricultural Chemistry in the School of Agriculture at the University of Sydney.

New Chiefs and Officers-in-Charge

Dr. J. E. Falk, M.Sc., Ph.D., F.A.A., was appointed Chief of the Division of Plant Industry in succession to Dr. O. H. Frankel who was appointed to the Executive in February 1962. Dr. Falk joined C.S.I.R.O. in 1955 as leader of the Division's biochemistry group. He was elected to Fellowship of the Australian Academy of Science in 1961. He will be assisted by four Assistant Chiefs: Dr. J. B. Langridge, M.Sc., Ph.D.; Dr. R. M. Moore, D.Sc.Agr.; Dr. F. H. W. Morley, B.V.Sc., Ph.D., H.D.A.; Dr. J. R. Philip, B.C.E., D.Sc.

Dr. G. N. Lance, M.Sc., Ph.D., was appointed Officer-in-Charge of the newly formed Computing Research Section. Dr. Lance was previously Head of the Computer Branch of the Atomic Energy Establishment, Winfrith, U.K.

Mr. A. E. Scott, M.Sc., was appointed to the position of Editor-in-Chief, following the retirement of Dr. N. S. Noble. Mr. Scott joined the Editorial staff of C.S.I.R.O. in 1955 as Assistant Editor.

Mr. R. W. Viney, A.A.S.A., A.C.I.S., was appointed Finance Manager. This position was created following the retirement of the Secretary (Finance and Supplies), Mr. M. G. Grace. As Finance Manager, Mr. Viney is responsible for financial aspects of the Organization's policy, particularly in budgeting and the control of finances. He is also responsible for internal auditing and for the accounting practices and procedures used by the Organization. Mr. Viney joined C.S.I.R.O. in 1932 and was appointed Assistant Secretary (Finance and Supplies) in 1957.

Decorations

Dr. I. W. Wark, Member of the Executive, was appointed a Commander of the Most Excellent Order of the British Empire in the Queen's Birthday Honours.

Honours and Awards

Sir Frederick White, Chairman: President of A.N.Z.A.A.S.

Dr. J. R. Price, Chief, Division of Organic Chemistry: President of the Royal Australian Chemical Institute.

Dr. R. M. Moore, Assistant Chief, Division of Plant Industry: Doctor of Science in Agriculture, University of Sydney.

Dr. C. H. Gallagher, Division of Animal Health: Doctor of Veterinary Science, University of Sydney.

Dr. A. K. Head, Division of Tribophysics: Doctor of Science, University of Melbourne.

Dr. H. G. Higgins, Division of Forest Products: Doctor of Applied Science, University of Melbourne.

Mr. R. F. Isbell, Division of Soils: Edgeworth David Medal of the Royal Society of New South Wales.

Dr. K. E. Murray, Division of Food Preservation: Doctor of Science, University of Western Australia.

Dr. J. H. Piddington, Division of Radiophysics: Fellow of the Australian Academy of Science.

Dr. R. L. Reid, Division of Animal Physiology: Australian Medal of Agricultural Science, 1963.

Dr. R. G. Vines, Division of Physical Chemistry: Doctor of Science, University of Melbourne.

Conferences

An Australian Agricultural Extension Conference, convened by C.S.I.R.O. at the invitation of the Standing Committee on Agriculture, was held at Hawkesbury Agricultural College from August 13 to 17, 1962. This was the first national conference on agricultural extension to be attended by representatives of Federal and State Government Departments, C.S.I.R.O., the universities, and professional and commercial organizations. More than 150 delegates attended and some 167 papers were presented. Three extension specialists from overseas were invited to Australia to take part in the Conference, their attendance being financed by the Commonwealth Extension Grant, the Reserve Bank, and C.S.I.R.O. They were Mr. J. M. A. Penders, Director of Agricultural Advisory Services for the Ministry of Agriculture and Fisheries for the Netherlands; Mr. A. H. Maunder, Chief of the Foreign Education Branch, Division of Extension Research and Training, Federal Extension Service, United States Department of Agriculture; and Professor Hadley Read, Professor of Agricultural Extension and Extension Editor, University of Illinois.

The International Symposium on the Galaxy and the Magellanic Clouds, sponsored jointly by the International Astronomical Union and the Union Radio Scientifique Internationale, was held in Sydney and Canberra from March 18 to 28, 1963, under the auspices of the Australian Academy of Science. More than 30 prominent astronomers and radio astronomers from overseas attended the conference. Officers of the Division of Radiophysics presented a series of papers describing recent results, particularly those obtained during the first year of operation of the 210 ft radio telescope at Parkes. Delegates to the conference visited the radio telescope and also had an opportunity of inspecting from the air the site which has been selected for the Division's radio heliograph which is to be erected soon near Narrabri.

The Sixth Plenary Meeting of the World Power Conference was held in Melbourne from October 20 to 27, 1962. More than 1500 delegates attended from 46 countries.

C.S.I.R.O. officers took part in many of the sessions and presented a number of papers. An unofficial meeting dealing with recent trends in applied solar energy was held at the Engineering Section's laboratory at Highett in collaboration with the recently formed Australian and New Zealand Branch of the Association for Applied Solar Energy. More than 65 delegates and members attended.

The Third Specialist Conference on Fuel Research, convened by the British Commonwealth Committee on Fuel Research, met at Sydney from October 9 to 15, 1962. Mr. H. R. Brown, Chief of the Division of Coal Research, was Chairman of the Conference.

The Division of Coal Research held its Fifth Coke Symposium at Sydney on December 4 and 5, 1962. It was attended by 70 delegates from industry, the universities, the Joint Coal Board, the Australian Coal Association (Research) Ltd., and C.S.I.R.O.

The Second Australian Colloquium on Coal Science was held under the auspices of the Division of Coal Research at Sydney from May 14 to 16, 1963, and was attended by 60 research workers from the universities, industry, and C.S.I.R.O.

Several symposia, which were attended by a number of overseas scientists, were arranged in conjunction with the opening of the Controlled Environment Research Laboratory of the Division of Plant Industry in August 1962 (see page 18). These included a Symposium on the Environmental Control of Plant Growth which was held in Canberra by the Australian Academy of Science under the auspices of the International Union of Biological Sciences, a Symposium on Soil-Plant-Atmosphere Water Relationships organized by the Division of Land Research and Regional Survey in Canberra, a Conference on the Microclimate above and within Surface Vegetation organized by the Division of Meteorological Physics in Melbourne, and a Symposium on Engineering Aspects of Environmental Control for Plant Growth organized by the Engineering Section in Melbourne.

Liaison Activities

Agricultural Research Liaison Section

In addition to the preparation of liaison publications, the Agricultural Research Liaison Section has given an increasing amount of attention to other liaison activities. Studies have been undertaken with a view to determining how the flow of information between the extension officer and the research worker might be improved. The Section has also initiated, or been associated with, liaison efforts between different groups concerned with farm fences, plant introduction, foot rot, fleece measurement, weeds, and phosphate fertilizers.

Publications have been an important feature of the work of the Section since it was formed in 1951. Preparation of *Rural Research in C.S.I.R.O.* and other liaison publications has involved establishing and maintaining very close liaison between research workers and extension officers.

Increasing demands have been received for reprints of articles from *Rural Research in C.S.I.R.O.*, particularly those dealing with worm parasites, rabbits, skeleton weed,

and the adoption of new practices by farmers. An index of the first 40 issues of *Rural Research in C.S.I.R.O.* has been published.

Other major publications produced during the year include:

"Soil and Pasture Research in South-Western Australia"

Written primarily for extension workers, this 80-page book was prepared in collaboration with the Western Australian Department of Agriculture and the Institute of Agriculture at the University of Western Australia. It develops a regional, as distinct from a subject-matter, approach to agricultural research.

"Rabbit Control"

This leaflet was produced and distributed in collaboration with the several State rabbit control authorities. It stresses the importance of organization among neighbours for rabbit control, the need to define goals for rabbit control policies, and the need for the wider appointment of district rabbit control officers.

"Plant Industry"

The work of the Division of Plant Industry is described in this booklet which was specially prepared for visiting scientists.

"Dissolved Gypsum for Irrigated Soils"

This was written for farmers in the Riverina and explains how to build a simple machine for dissolving gypsum in irrigation water as an aid to pasture establishment on certain soils. It was prepared in collaboration with the New South Wales Department of Agriculture which has distributed copies to farmers.

An important role of the Section has been in convening, on behalf of C.S.I.R.O., technical conferences held under the aegis of the Australian Agricultural Council. A major conference held during 1962–63 was the Australian Agricultural Extension Conference at Hawkesbury (see page 6). A book of reviews, papers, and conference reports has been prepared for publication by the Section.

Professor Hadley Read, Professor of Agricultural Extension and Extension Editor at the University of Illinois, was invited to Australia for the Extension Conference. Following this, he spent three months working with the Section and examining the use of mass media in agricultural extension in Australia.

Industrial Research Liaison Section

The Section has continued to issue a bi-monthly publication, *C.S.I.R.O. Industrial Research News*, giving information about developments from C.S.I.R.O. research programs likely to be of interest to Australian manufacturers. The Section has also prepared other publications aimed at bringing aspects of C.S.I.R.O. research to the attention of industry and the general public.

An important part of the work of the Section relates to patents and patent licences. C.S.I.R.O. regards it as important that inventions arising from research in the laboratories should find the widest possible application in industry. Experience has indicated that in many cases industrial innovations based on these inventions are more readily taken up by industry when the inventions have been protected by patents.

Patenting of C.S.I.R.O. inventions serves several purposes. It protects the public interest by ensuring that they are not patented by others. It permits supervision to be exercised over industrial users to ensure that new products and processes do not

become discredited owing to the inventions being incompetently applied. It provides a means whereby a firm that is prepared to invest a substantial amount in developing an invention from laboratory operation to factory production may be given a measure of priority in its use, and thus permitted to recoup its development expenditure. In the case of inventions relating to wool textiles it provides a basis for technical promotion of new products and finishes, and permits these to be used overseas under the promotional control of the International Wool Secretariat and its affiliated bodies. Finally, and of relatively less importance, it permits C.S.I.R.O. inventions in some fields to be exploited for profit from royalties.

The Section has continued to provide assistance to the Divisions and Sections with patenting and licensing of inventions and with all aspects of the use of patents to promote the industrial application of C.S.I.R.O. research.

Thirty new patent licence agreements were entered into during the year. Four of these granted manufacturing licences on atomic absorption apparatus which originated in the Division of Chemical Physics; two of these licences were to British firms, one to the U.S.A., and the other was to an Australian firm which is the first Australian manufacturer to undertake construction of the complete atomic absorption apparatus.

The method of vacuum pressing of wool which was developed in the Division of Protein Chemistry is being further developed and brought to the stage of commercial application under a licence agreement with the Sunbeam Corporation Limited.

Patent applications have been made in Australia and overseas countries covering manufacture of butter powder developed in the Division of Dairy Research. An agreement has been entered into with the Australian Dairy Produce Board under which the Board will supervise commercial applications of this process.

At the conclusion of the period C.S.I.R.O. had current licensing agreements with 160 licensees. These agreements involved 61 Australian and 221 overseas patents covering 65 inventions.

Collaboration with Industry

It is the general policy of C.S.I.R.O. to work with an industry or public authority in seeking solutions to problems which are of concern to a number of companies or interests and from time to time it undertakes work for individual companies if other help is not available. During the year under review a number of new cooperative projects have been started including:

Investigation of sperm whale resources off the coast of Western Australia by the Division of Fisheries and Oceanography, with financial support from the Fisheries Development Trust Account; soil testing at the Moonie oil field by the Soil Mechanics Section for Bechtel Pacific Corporation Ltd.; a study of the problem of birds on air fields by the Division of Wildlife Research for the Department of Civil Aviation; research by the Division of Building Research to improve the durability of the colour and surface of concrete roofing tiles for Whitelaw Monier Pty. Ltd.; investigations by the Division of Food Preservation on the storage of peanut kernels in small packages for the Peanut Marketing Board; and studies by the Soil Mechanics Section

of the engineering properties of the earth to be used in the construction of a dam at Almurta, Victoria, for the Westernport Waterworks Trust.

The Organization has continued to be associated with the National Association of Testing Authorities and the Standards Association of Australia.

Collaboration with the Universities

Many C.S.I.R.O. Divisions and Sections continue to work in close collaboration with Australian universities on particular research programs. Officers of the Organization have continued to assist in university lecturing, demonstrating, and supervising in specialized fields.

In addition, grants have been made to support a number of university research programs of particular interest to C.S.I.R.O. These include grants for the following purposes:

University of Melbourne:
- Mathematical computing
- Pollen research

University of Queensland:
- Research Fellowship in Parasitology
- Research Fellowship in Veterinary Anatomy
- Development of solvent-in-pulp extraction process

University of Adelaide:
- Lectureship in Zoology

University of Western Australia:
- Research on marsupials

University of Sydney:
- Research on fruit fly
- Colloid science research
- Research on dairy and beef production
- Readership in Dairy Husbandry
- Research on heat and mass transference
- Research on plant viruses
- Research on mineral-deficient chloroplasts

University of Tasmania:
- Research on biophysics

University of New England:
- Research on cloud physics

Arrangements have been made for a small radio telescope of the Division of Radiophysics to be transferred to the R.A.A.F. Academy, University of Melbourne. The radio telescope will be erected at Point Cook for use by post-graduate students

from Melbourne, and to help develop an interest in radio astronomy amongst undergraduate students.

C.S.I.R.O. has continued its support to the Electrical Research Board, which made grants this year to the Universities of Sydney, Melbourne, Queensland, Western Australia, and New England, and which provided post-graduate scholarships in the Universities of Sydney and Adelaide.

The Radio Research Board, to which C.S.I.R.O. is a major contributor, has made grants for research in radio science at the Universities of Sydney, Melbourne, Queensland, Adelaide, Tasmania, and New England, and at Monash University.

Commonwealth Collaboration

Problems of scientific collaboration within the Commonwealth are discussed by the British Commonwealth Scientific Committee which meets every two years. The Committee comprises the heads of research organizations of Commonwealth countries. At the last meeting of the Committee in New Delhi in 1962, Australia was represented by the Chairman, Sir Frederick White, and the Secretary, Mr. G. B. Gresford.

The Commonwealth Agricultural Bureaux provide clearing houses for the interchange of information of value to research workers in agricultural science throughout the Commonwealth. The Bureaux consist of 3 Institutes and 10 Bureaux—each of which is concerned with a particular branch of agricultural science. They scan and index scientific journals in all languages, keep in touch with agricultural research in progress, and disseminate this information by the periodic issue of Abstract Journals. They also issue monographs on particular subjects within their respective fields and deal with inquiries received from research workers in all parts of the Commonwealth. The Institutes provide valuable taxonomic and identification services.

A special interim review conference of the Commonwealth Agricultural Bureaux was held in London in June 1963 to discuss the financial situation of the Bureaux following the withdrawal in recent years of a number of member countries. Australia played a leading role at this conference and was represented by Mr. W. Ives, the Australian C.A.B. Liaison Officer and an Associate Member of the C.S.I.R.O. Executive. Sir Arthur Coles, a Member of the Executive, also attended.

Aid to Developing Countries

The Executive has given increasing consideration to the part C.S.I.R.O. might play in Australian aid to underdeveloped countries and arrangements have been made to provide closer liaison with Commonwealth departments and instrumentalities concerned with the administration of foreign aid programs. As a result, the Organization has become more closely associated with a number of developmental projects in south-east Asia.

During the year under review the United Nations Conference on the Application of Science and Technology for the Benefit of Less Developed Areas (UNCSAT) was held at Geneva. This meeting had its origins in the motion introduced into the General Assembly of the United Nations in 1958 by Lord Casey, the Australian

Minister for External Affairs, that the United Nations should devote greater effort to the application of science and technology. Its purpose was to explore recent advances in science and technology which would benefit the less developed parts of the world and assess their potential impact on economic development as well as stimulating and promoting scientific and technological research for such areas. C.S.I.R.O. played a prominent role in the Australian preparations for the meeting and was responsible for the collection, editing, and preparation of the 96 Australian papers presented. The Australian delegation of 19, which was led by Lord Casey, included four C.S.I.R.O. officers.

The Organization has continued to make facilities available for the training of scientists from other countries who visit Australia under the auspicies of the Colombo Plan or various international agencies. In addition, a number of C.S.I.R.O. officers have been made available to carry out assignments overseas in connexion with Colombo Plan aid or developmental projects being undertaken by agencies of the United Nations.

Contacts with Overseas Science

Because of their geographical isolation it is particularly important that Australian scientists should keep in close touch with the trends of thought and the latest developments in their subject in the leading laboratories throughout the world. C.S.I.R.O. is active in encouraging and assisting scientists from overseas countries to visit Australia. These range from very senior scientists who come for short periods to discuss research problems, to give lectures and seminars, or to exchange views on research administration, to research workers who stay for longer periods and spend their time actively working at the bench or in the field. Such visits are not only of great benefit to the C.S.I.R.O. officers with whom the visitors work but also are a means of spreading information about the organization and its work when the visitors return to their homes.

The growing importance of Australia's standing in international science is demonstrated by the choice of Australia as the venue for a number of international scientific conferences during the past 12 months (see page 6). These have provided an opportunity for eminent overseas scientists to study Australian work in their own fields, and many of them took advantage of their presence in Australia to extend their stay to visit C.S.I.R.O. laboratories. In addition, a number of scientists attending the International Soil Science Congress in New Zealand in November 1962 accepted the invitation of C.S.I.R.O. to visit the Organization's soil research laboratories.

As well as encouraging visits to Australia by overseas scientists it is essential to ensure that Australian scientists have adequate opportunities to travel abroad to study new scientific developments, to obtain information on special research techniques, to undertake advanced studies at the invitation of overseas research organizations, and to attend international meetings. The Executive believes that such visits are of the utmost importance to C.S.I.R.O. and to ensure the vigorous development of Australian science; during the year under review the Executive has provided means for its officers to make such visits and it believes that the number of these must be maintained at a high level. As well as sending C.S.I.R.O. officers abroad for the

benefit of the Organization the Executive is gratified by the increasing number of invitations received by its officers to take part in international conferences.

Overseas Research Grants

For a number of years C.S.I.R.O. has received grants from overseas establishments for specific research projects of interest both to them and to Australia. The majority of these awards have come from agencies of the United Nations or the United States of America. Where necessary, special arrangements have been made to ensure that results of the work supported by the grant are not lost to Australia. Major grants received during the year include:

$29,300 from the U.S. Air Force for research on thermal expansion of solids at low temperatures, in the Division of Physics.

$16,600 from the U.S. Department of Health, Education, and Welfare, for research on heterosis and competition in *Arabidopsis thaliana*, in the Division of Plant Industry.

$4250 from the Sulphur Institute of Washington, U.S.A., for research on the use of sulphur–rock phosphate mixtures as slow-acting fertilizers, in the Division of Soils.

Overseas Liaison

One way in which C.S.I.R.O. maintains close contact with overseas scientific developments is through the Australian Scientific Liaison Office, London, and the Office of the Scientific Attaché to the Australian Embassy, Washington. These Offices also serve as centres for visitors, research students, and visiting scientists and for the recruitment of scientific staff. The Chief Scientific Liaison Officer in London and the Australian Scientific Attaché in Washington have represented Australia at scientific conferences in the United Kingdom, Europe, and North America.

The Washington office was formerly known as the Australian Scientific Liaison Office.

C.S.I.R.O. Post-Graduate Studentships

As part of its policy of encouraging post-graduate research training in Australia C.S.I.R.O. awards a number of post-graduate studentships each year. Because of the extremely high standard of the applications received in the year under review the Executive made available a greater number of senior studentships.

For the last four years the Science and Industry Endowment Fund has been used to supplement the 1851 scholarships awarded each year to Australian science graduates for post-graduate training in the United Kingdom. This support is now given from the C.S.I.R.O. Studentship Fund.

Junior Post-Graduate Studentships

These are awarded for one year only to persons holding a pass degree in Science, Agricultural Science, Veterinary Science, Engineering, or Arts with Mathematics as a main subject. There were 119 applications; 30 studentships were awarded (6 were

subsequently declined). The candidates who accepted them are listed below with their universities:

P. L. Adamson (Miss) (Sydney)
K. D. Barrow (Adelaide)
J. B. Bremner (W.A.)
J. H. A. Cane (Miss) (New England)
M. J. Clark (Miss) (Adelaide)
I. G. Darvey (N.S.W.)
P. G. Dodds (New England)
J. M. Gawthorne (W.A.)
N. F. Gersch (Miss) (Adelaide)
J. R. Harries (Adelaide)
J. G. Hewitt (W.A.)
R. J. Hill (Sydney)
N. V. Johnston (New England)
B. J. Kabriel (Sydney)
L. A. P. Kane-Maguire (Qld.)
N. A. P. Kane-Maguire (Qld.)
E. Lindgren (W.A.)
G. V. Meehan (W.A.)
D. R. Millard (Miss) (Adelaide)
A. C. Riddle (Sydney)
P. J. Symonds (Adelaide)
J. N. Ward (Sydney)
I. R. Wills (Melbourne)
R. T. Worley (S.A.)

Senior Post-Graduate Studentships

These are awarded for two years initially to persons holding at least an Honours degree in the fields listed. The period of the studentship may be extended for an additional year under special circumstances. During the year 166 applications were received; 52 awards were made (13 were subsequently declined). The candidates who accepted them are listed below:

E. E. Best (Sydney)
A. J. Blake (Adelaide)
S. D. Bradshaw (W.A.)
J. B. Byrne (Sydney)
I. C. Calder (Adelaide)
N. W. Cant (W.A.)
R. W. Cattrall (Adelaide)
B. S. Chandler (Adelaide)
W. H. Cherry (Melbourne)
P. J. Dallimore (W.A.)
I. G. Dance (Sydney)
J. A. Dash (Mrs.) (New England)
G. J. Day (Sydney)
G. K. Eagleson (Sydney)
J. A. Elix (Adelaide)
R. A. Fredlein (Qld.)
G. I. Gaudry (A.N.U.)
L. C. Gruen (Melbourne)
D. L. Haskard (Adelaide)
G. R. Hogg (Melbourne)
W. G. Hooper (Miss) (Sydney)
P. F. Johnson (Melbourne)
M. J. L. Kesteven (Sydney)
P. B. Kirkpatrick (Sydney)
M. McCamish (Qld.)
D. J. McCoy (Adelaide)
P. M. McCulloch (Tas.)
D. K. McIlroy (Qld.)
P. Mitchell (Adelaide)
L. R. Newsome (Qld.)
A. W. Nichol (N.S.W.)
R. G. Nicholls (Adelaide)
C. B. Osmond (Adelaide)
H. F. Paull (Miss) (Sydney)
R. J. Sleet (Sydney)
T. H. Spurling (W.A.)
A. D. Stokes (Sydney)
A. N. Vladcoff (Adelaide)
B. C. Young (N.S.W.)

Overseas Studentships

These are awarded to research workers in science and allied fields who have obtained, or who are about to obtain, the degree of Ph.D., to enable them to proceed

overseas, usually for one year, to work with leaders of research in their special field of interest. During the year 48 applications were received, and 19 candidates were selected, one of whom declined in favour of another award:

T. E. Bellas (W.A.)
J. F. Brotchie (Melbourne; California)
G. D. Clarke-Walker (W.A.)
P. J. Dart (Sydney)
D. J. Faulkner (Qld.)
R. L. N. Harris (Adelaide)
J. E. Lane (Qld.)
J. K. MacLeod (Qld.)
P. May (Swiss Fed. Inst. Technol.)
A. J. Morton (N.S.W.)
P. J. Nelson (Qld.)
R. N. Oram (Adelaide)
J. Passioura (Melbourne)
W. J. Peacock (Sydney)
R. J. Porra (Adelaide and A.N.U.)
H. C. Robinson (W.A.)
M. A. W. Thomas (Sydney)
J. R. E. Wells (Adelaide)

Awards by Outside Bodies

The Organization was again asked to select candidates for Australian Dairy Produce Board post-graduate studentships at the request of the Board. In addition, the Australian Cattle and Beef Research Committee also asked for assistance in the selection of suitable candidates for its post-graduate studentships. The Wool Research Committee also made available one Fellowship, and the Organization was asked to assist in selecting a candidate. Assistance was also provided to the Wheat Industries Research Council in the establishment of a number of post-graduate awards.

Science and Industry Endowment Fund

The Executive, as Trustees of the Science and Industry Endowment Fund, made grants to assist the following research workers: Mr. N. A. Wakefield to carry out a study on the fossil mammalian fauna of south-eastern Australia; Mr. B. R. Moore to enable him to undertake a geological survey of the Upper Yarra Dam district above Warburton, Victoria; Dr. N. V. Dobrotworsky to continue studies on the systematics and ecology of the Australian mosquitoes. Funds were provided for the purchase of a portable tape recorder for issue on loan to Mr. H. O. Webster for his field studies of the noisy scrub bird (*Atrichornis clamosus*).

Grants were made towards travelling expenses of the following research workers: Dr. I. R. Falconer to visit Central Australia with members of the Central Australian Research Committee on an expedition to the Great Victorian Desert, and Mr. J. C. Yaldwin to visit New Zealand to enable him to take part in an expedition to the Auckland Islands to investigate the fauna of littoral and shallow water areas.

The Trustees also made grants to the Science Teachers Association of New South Wales and the A.C.T. Science Teachers Association for annual school science awards; students of the Universities of Tasmania, Western Australia, Queensland, Adelaide, and the University College of Townsville to enable them to attend the annual School of Marine Biology held at the Division of Fisheries and Oceanography, Cronulla, N.S.W. They also continued financial supplementation of 1851 scholarships awarded to Australians.

Australian National Radio Astronomy Observatory

The 210 ft radio telescope at the Australian National Radio Astronomy Observatory, Parkes, N.S.W., has now completed its first full year of routine operation, and in all respects has exceeded the design expectations. The surface accuracy and precision with which the telescope can be pointed and moved permit effective operation down to a wavelength of at least 6 cm. The overall serviceability has been excellent, and apart from stoppages for routine maintenance, the instrument has been available and in active use for scientific observations every night and on most days.

Among the results obtained in the first year of operation are the first detailed observation of magnetic fields in regions of space well outside our own Galaxy; the discovery and identification of a number of interesting new radio sources, including the remnants of a supernova in the Large Magellanic Cloud; and evidence for the existence of intergalactic hydrogen. These initial discoveries are of such significance as to open new chapters in radio astronomy, and demonstrate convincingly the potentialities of this magnificent new instrument.

The Observatory is open to the public each Sunday afternoon, when demonstrations of the telescope are given. Some thousands of visitors have inspected the site during the past year.

Pastoral Research in Western Australia

During the year it was decided to sell part of the Division of Plant Industry's field station "Glen Lossie" at Kojonup in Western Australia and to purchase an area closer to Perth for the establishment of a new field station.

"Glen Lossie" was established in 1948, primarily to examine clover infertility in sheep which was then a major problem of the grazing industry in many parts of Australia. The site of "Glen Lossie" had been chosen because the country in the vicinity was typical of large areas where subterranean clover had become established.

"Glen Lossie" subsequently became a field station for other aspects of plant research work, and research on a wider range of agronomic problems became centred there. The results of this research, however, were not merely of importance to the Kojonup district but had applications to other areas of Australia.

Over the years a number of problems of pasture establishment were overcome and the emphasis of the work of the Division of Plant Industry in Western Australia shifted to investigations of the relationship between the pasture and the growing animal. For this work to be carried out successfully it was considered necessary for the research worker to have much closer contact between his experiments in the laboratory and the experimental animals in the field. Since the necessary laboratory facilities were already established in Perth and were shared by others whose work did not require field studies, it was considered essential for the Division of Plant Industry to find an area for a field station closer to the Perth laboratory.

An area of land was selected at Baker's Hill, some 45 miles from Perth. This area provides an environment within the general south-west pastoral zone which is particularly valuable from the research point of view. Rainfall isohyets converge

near this point so that areas of differing annual rainfall are located within a relatively small area. This will enable pasture species and nutritional responses to be evaluated over a wider range of environments than could be found at "Glen Lossie" and within a comparatively short distance of each other.

Gift by Mr. F. C. Pye

Mr. F. C. Pye, a prominent New South Wales grazier, has given his property "Geraldra" to C.S.I.R.O. "Geraldra", which is at Stockinbingal near Cootamundra, is one of the oldest properties in the district, with an area of some 8600 acres. It has been run in recent years as a mixed farming property, with about 2000 acres of wheat sown by share-farmers annually and, at the date of the gift, carried about 8000 sheep and over 100 cattle. The gift included all stock, plant, and equipment, in addition to the land and buildings.

The only condition attached by Mr. Pye to the gift was that either the property itself or the proceeds of its disposal should be used for the purposes of research related to the grazing or farming industry. The Executive decided that it would be inappropriate to develop all or part of "Geraldra" as a research or experiment station, and has therefore arranged for the sale of the property.

An F. C. Pye Research Trust Account has been established. The proceeds of disposal of "Geraldra" are being paid into this Fund and costs of interim management, pending sale of the land, and of the sales themselves are being met from it. To date, approximately 90% of the land has been sold and nearly all livestock, plant, and equipment. The estimated net realization, after allowing for running costs and costs of disposal, is approximately £240,000.

The Executive is actively considering the use to which the F. C. Pye Research Fund should be put, and expects to reach a decision shortly. It is intended that a substantial part of the Fund should be used to foster the development of a single aspect of the Organization's research related to the pastoral and farming industries. Its choice will be based on the selection of a field of work at the forefront of biological science, giving promise of significant contributions to the basic understanding of factors determining the level and efficiency of production from the land.

Computing Research Laboratory

In recent years C.S.I.R.O. has acquired complex scientific instruments such as the radio telescope and the phytotron, larger experiments have been conducted, and increasingly complex mathematical models have been investigated. As a result, vast amounts of data requiring technical analysis have accumulated and the need for computing facilities of a high order has been roughly doubling each year.

To provide for this need, the Commonwealth Government approved the establishment by C.S.I.R.O. of a basic network of computers for scientific research and technical computing and allocated £1,500,000 for this equipment. A Computing Research Section was established late in 1962 to operate the network of computers and to carry out basic research in the field of computing and automatic data processing.

Although much of the work load for the basic network of computers will arise from C.S.I.R.O.'s own research work, the computing facilities will be available to other research workers. The Computing Laboratory will be run on a service basis and it is expected that research workers from universities, the Atomic Energy Commission, the Bureau of Meteorology, the Aeronautical Research Laboratories, the Bureau of Mineral Resources, the National Mapping Section, and the Ionospheric Prediction Service will be among those using the facilities.

One of the most powerful of currently available computing systems, a CDC 3600, is to be installed at Canberra by Control Data Corporation of Minneapolis, U.S.A. Control Data Corporation will also install four smaller subsidiary computing systems—one in direct association with the larger system at Canberra and one each at Sydney, Melbourne, and Adelaide. The network is expected to be fully operational by October 1964.

The subsidiary computers will be compatible with the CDC 3600 computer. They will be capable of handling most types of computing arising from scientific research work in Adelaide, Melbourne, and Sydney areas and the compatibility will permit problems to be transferred from subsidiary computers to the central CDC 3600 if they become too big or if local subsidiary computers become temporarily over-loaded.

The national network has been designed so that universities and various Commonwealth Departments will be able to install and operate computers to suit their own requirements while still retaining compatibility with it.

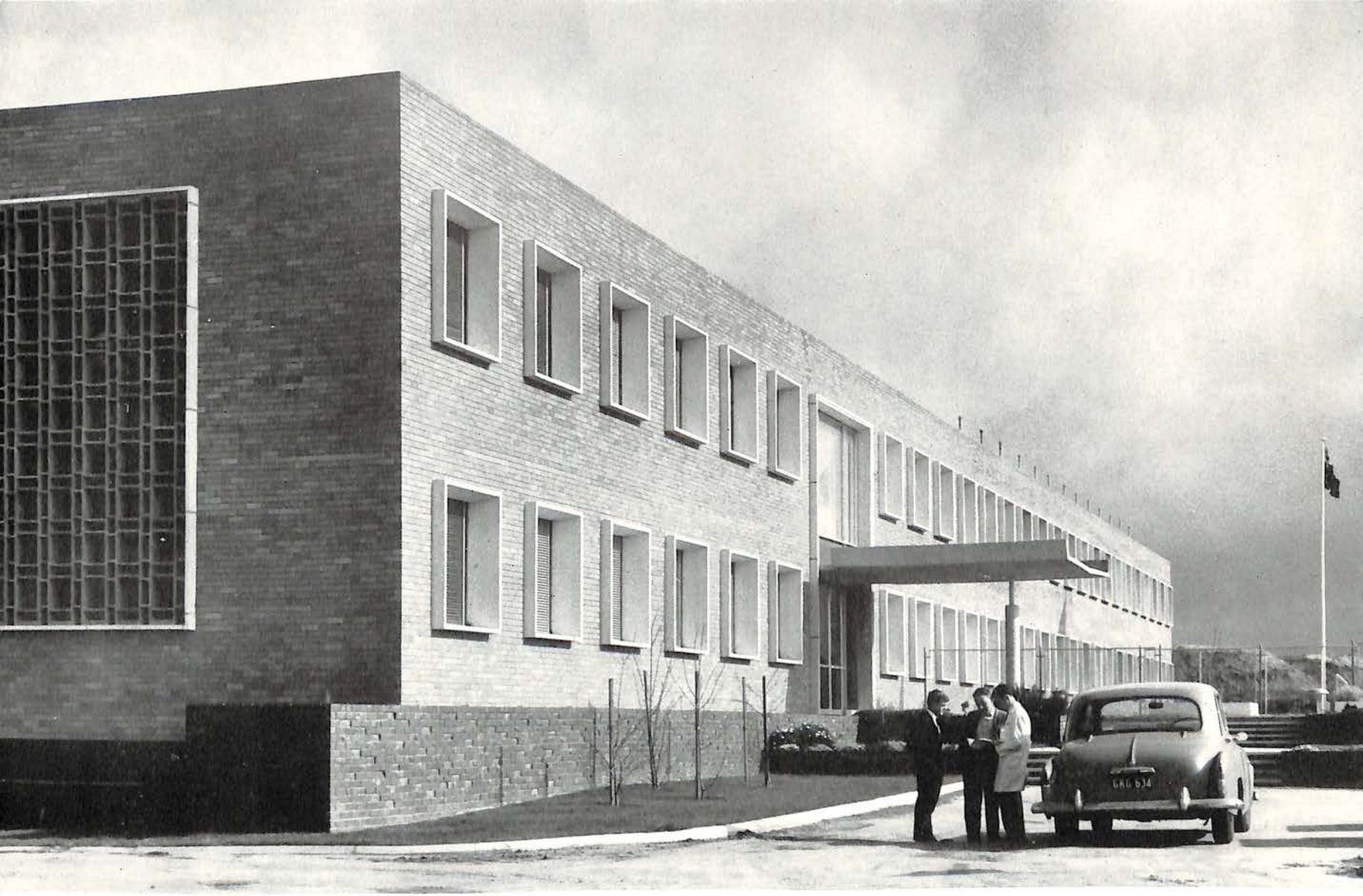
The scheme for a compatible network of scientific computers has attracted considerable interest overseas, and the specifications of the basic network have received favourable comment from a number of computer laboratories and manufacturers.

Controlled Environment Research Laboratory

The Division of Plant Industry's Controlled Environment Research Laboratory, CERES, was opened by the Prime Minister, Sir Robert Menzies, on August 29, 1962. One of the world's finest facilities for plant research, CERES is a laboratory in which plants can be grown under a wide range of precisely controlled climatic conditions. Laboratories of this sort, which are known as phytotrons, have been constructed in several other countries including the United States, Holland, France, and Russia. However, the Canberra phytotron, which was designed by the C.S.I.R.O. Engineering Section, has a number of unique features which have aroused considerable interest both in Australia and abroad, and several overseas research institutes plan installing similar controlled environment facilities on a smaller scale.

CERES is a two-storey building, 214 ft long and 78 ft wide. It contains naturally lit glass-houses each 150 sq ft in area. In each glass-house day and night temperature can be closely controlled. In addition there are 140 cabinets (to be increased eventually to 200) in which plants can be grown under even more closely controlled conditions. Some of these cabinets will be used inside the glass-houses. Some others, in which plants are grown under artificial light, are used elsewhere in the building. The building contains offices, preparation rooms, an engineering room, a workshop, dark rooms, and a "frost" room.

A view of the Controlled Environment Research Laboratory, or phytotron, of the Division of Plant Industry.



The new main block of the Division of Textile Industry, Geelong, Vic.

CERES will be used for experiments on the physiology, nutrition, pathology, breeding, and genetics of plants and for plant introduction studies. Near sterile conditions will be maintained in CERES and all equipment and plants brought into the building will be fumigated.

Although CERES is a laboratory of the Division of Plant Industry it is intended that its facilities will be widely used by plant research workers from other C.S.I.R.O. establishments and from universities, State Departments of Agriculture, and overseas institutes.

The phytotron project was initiated by Dr. O. H. Frankel, former Chief of the Division of Plant Industry, and by Dr. L. T. Evans who has been appointed Officer-in-Charge of the installation. The architects in charge of the project were Messrs. Grounds, Romberg, and Boyd, and W. E. Bassett and Associates were the consulting engineers. The phytotron was built at a cost of £600,000 with funds provided by the Commonwealth Government.

New Laboratory for Wool Research

A new main block at the C.S.I.R.O. Division of Textile Industry at Geelong, Victoria, was opened by the Prime Minister on May 3, 1963. Previously much of the Division was accommodated in temporary buildings. The new block includes physical and chemical laboratories, library, lecture room, and administrative offices. It was constructed at a cost of £295,000 with money provided from the Wool Research Trust Fund.

Consolidation of physical and chemical work in the new block has made possible a more efficient arrangement of processing equipment for conducting pilot and full-scale trials.

Secondary Industries Laboratory for Western Australia

Following discussions with the Western Australian Government and industry leaders, the C.S.I.R.O. Division of Applied Mineralogy, Melbourne, is establishing a branch laboratory in Perth to be known as the Secondary Industries Laboratory. The Officer-in-Charge of the Laboratory is Mr. W. E. Ewers, formerly Secretary of the Chemical Research Laboratories, Melbourne.

For the time being the Laboratory will be accommodated in the Chemistry and Zoology Departments of the University of Western Australia. Later a laboratory will be built at Floreat Park on a site made available to C.S.I.R.O. by the University by arrangement with the State Government.

Initially the Laboratory will be concerned with the development of products from minerals of local origin. It will also provide a link between the State's secondary industries and C.S.I.R.O. industrial research laboratories in other States.

Transfer of Applethorpe Field Station

During the year arrangements were made for the Division of Plant Industry's research station at Applethorpe, Queensland, to be transferred to the Queensland Department of Agriculture and Stock.

The station was established in 1933 to carry out apple rootstock trials and to test other orchard practices. These investigations have now been completed. However, it was felt that the facilities should continue to be used for the benefit of the industry and these have now been made available to the Department of Agriculture and Stock, for studying problems of special interest to fruit growers in the Stanthorpe district of Queensland.

Buildings and Accommodation

One of the major problems confronting the Executive is that of providing adequate laboratory accommodation for its various Divisions and Sections. The grave shortage which the Organization at present faces is due to a number of factors. For some years after the war, although the activities of C.S.I.R.O. were expanding, the position in the building industry made it impossible to build adequate laboratories. As a result a number of C.S.I.R.O. activities are today housed in temporary buildings and former army huts, which are quite unsuited for the nature of the work being undertaken in them. Many of them have reached a state of disrepair which it would be uneconomic to make good.

Another reason for the present difficulty arises from the fact that between 1927 and 1939 a number of laboratories were built within the grounds of universities. This was a definite policy and has been successful in producing scientific collaboration between the universities and C.S.I.R.O. However, the recent and continuing expansion of the Australian universities, combined with inadequate areas of land available to them, has resulted in pressure on C.S.I.R.O. to move from university grounds and find other accommodation.

Although in 1962–63 approximately £1,000,000 was made available from Treasury funds for capital works, only about half this sum could be used for the construction of major laboratories after the need for small buildings, minor works, furniture and fittings, etc., had been met. If the shortage of laboratory accommodation is to be overcome within a reasonable time, it will be necessary for the capital vote of C.S.I.R.O. to be considerably increased, and representations are being made to the Government for this purpose.

Among the major laboratory buildings needed are ones for the Division of Land Research and Regional Survey in Canberra, the Divisions of Animal Genetics, Coal Research, and Radiophysics at North Ryde, N.S.W., the Western Australian Regional Laboratory at Perth, the Division of Animal Health at Maribyrnong, Victoria, and at Indooroopilly, Queensland, the Division of Forest Products at Melbourne, and the Division of Plant Industry at Canberra.

In addition, there are two major projects for which finance is required. One is the rehousing of the Chemical Research Laboratories (at present situated at Fisherman's Bend, Victoria) at Clayton, Victoria, where a 35-acre site adjacent to Monash University has been obtained by C.S.I.R.O. The need to vacate Fisherman's Bend arises from the extreme inadequacy of many of the buildings and the pressure by the Aeronautical Research Laboratories of the Department of Supply, which share the same site. The second major project is the rehousing of the National Standards Laboratory at present in an inadequate building on the campus of the University

of Sydney and in nearby rented accommodation. It is planned to develop a new site for this Laboratory at Bradfield Park, N.S.W.

The carrying out of such a major building program involves a considerable amount of preliminary planning during the design and construction stages, and close collaboration with the Department of Works. This is the responsibility of the Buildings Branch which is now recruiting further staff to enable the forward planning to be done on major projects and the necessary assistance to be given to the Divisions and Sections.

The following buildings and works were completed during the year under review:

New South Wales	
North Ryde	First stage of new laboratory, Division of Animal Genetics
Tasmania	
Hobart	Laboratory for *Sirex* wasp investigations, Division of Entomology
Victoria	
Highett	Extensions to main workshop, Engineering Section
Parkville	Extensions to main laboratory, Division of Animal Health
South Melbourne	Log pond and experimental saw mill, Division of Forest Products
Syndal	New laboratory, Soil Mechanics Section

The following buildings and works were commenced during the same year:

Australian Capital Territory	
Canberra	Computer building, Computing Research Section
	First stage of new laboratory, Division of Land Research and Regional Survey
New South Wales	
Glebe	Extensions to McMaster Laboratory, Division of Animal Health
South Australia	
Glen Osmond	New laboratory, Horticultural Research Section
Tasmania	
Hobart	Garage and extensions to new laboratory, Division of Entomology
Victoria	
Clayton	New laboratory, Division of Chemical Physics
Highett	Extension to process building, Division of Dairy Research
Parkville	Covered yards and buildings for pleuropneumonia work, Division of Animal Health
South Melbourne	Timber laboratory, Division of Forest Products

Research Services

Films

Three of the Film Unit's films received awards in the 1963 annual competition of the Australian Film Institute. "The Rainmakers" received a special award for scientific photography in the documentary category; "Building on Research" was given an honourable mention in the public relations category; and "Fighting the Cattle Tick" a silver award in the teaching category for a lucid exposition of its subject.

Several recent films have been entered in various international film festivals. "Building on Research" was screened and awarded a "Diploma of Participation" at the International Festival of Scientific Films, arranged by the International Institute for Educational and Scientific Films, associated with the University of Rome.

During the year television stations made further use of excerpts from the Unit's film productions in both specialist and general release programs; the most notable being the inclusion of a natural history film in the Commonwealth Film Unit series "Australia Today". In addition, short television news films were distributed throughout Australia to cover the opening of two new laboratories—the Division of Plant Industry's Controlled Environment Research Laboratory in Canberra and the Division of Textile Industry's new laboratory at Geelong.

A black and white, silent print of the film "Sheepskins—An Aid to Nursing" was sent to United Press Movietonews in New York for incorporation in the U.S.I.A. Science Report, which is syndicated throughout the world.

The following films were produced during the year by the Film Unit:

"A Matter of Survival—Toxic Solvents"

16 *mm*, *Colour*, *Sound*, *Screening Time* 9½ *min*

This film is aimed at making laboratory workers aware of the safety precautions which should be observed in handling toxic solvents. It was produced in collaboration with the Safety Officer and the Chemical Research Laboratories.

"Sheepskins—An Aid to Nursing"

16 *mm*, *Colour*, *Sound*, *Screening Time* 10 *min*

Produced in collaboration with the Division of Protein Chemistry and the Department of Surgery of the Melbourne University, this film shows the advantages of using specially prepared sheepskins in hospitals for the comfort of bed-ridden and convalescent patients and to help prevent these patients from developing bed sores.

"Mechanization in Plant Breeding"

16 *mm*, *Colour*, *Sound*, *Screening Time* 17 *min*

New equipment and techniques developed by plant breeders at the Waite Agricultural Research Institute are shown. These simplify the sowing and harvesting of experimental plots and the analysis of the results. They also make it possible to handle a greatly increased program.

"Opening of the Controlled Environment Research Laboratory"

16 *mm*, *Colour*, *Sound*, *Screening Time* 29 *min*

On August 29, 1962, the Division of Plant Industry's new laboratory, designed for growing plants in a wide range of closely controlled climatic conditions, was opened by the Prime Minister, Sir Robert Menzies (see page 18). This film is a record of the opening, and includes portion of the addresses given by Sir Robert Menzies, Sir Frederick White, and Dr. O. H. Frankel. It also shows the construction of the laboratory and some of the work which will be carried out in it.

"The Direct Reading Regain Tester"

16 *mm, Black and White, Sound, Screening Time* 9 *min*

The Direct Reading Regain Tester, designed by the Division of Textile Physics, can be used on the mill floor to determine directly, without calculation, the moisture content of wool. It is quick, simple to use, and accurate. The main aim of the film is to promote the introduction of the equipment to textile mills in Australia and overseas.

"Disc Plough Investigations"

16 *mm, Colour, Silent, Screening Time* 7 *min*

The Agricultural Machinery Group of the Engineering Section has developed techniques for measuring the forces acting on plough discs and the forces generated by wheels. This film shows the techniques in use in the field.

"The Commercial Pea Sheller"

16 *mm, Colour, Sound, Screening Time* 3 *min*

The construction and performance of the prototype mechanical pea sheller, developed by the Division of Food Preservation, is shown.

"The Superb Lyrebird"

16 *mm, Colour, Synchronized Sound, Screening Time* 10 *min*

This synchronized picture-and-sound record of the territorial calls and display of the lyrebird was produced to help officers of the Division of Wildlife Research correlate the bird's throat and beak movements with the sounds produced.

"Insect Tissue Culture"

16 *mm, Colour, Sound, Screening Time* 16 *min*

The Division of Entomology has established successful techniques for the tissue culture of cells from insects. In this film the techniques used are shown, seven cinemicrographic sequences are presented, and various features of the growth of the cells before and after infection with a polyhedral virus disease are analysed.

Libraries

C.S.I.R.O. libraries, in common with other scientific libraries, continually face the problem of adequately housing the great quantities of information required by research workers. It is estimated that the volume of publication of scientific periodicals throughout the world is increasing at an exponential rate of 6% per annum. An even more urgent problem is to ensure that the material already acquired by libraries is readily available to the scientific worker. In a number of overseas countries this problem is at present being tackled by use of automated systems of documentation. There are at present between 50 and 60 different systems in use but sufficient experience with them has not yet been obtained to demonstrate conclusively their real effectiveness. Work on these systems has largely concentrated on storage and retrieval problems but research has already shown that, in addition, the mechanization of reading, of abstracting, and of coding may also be achieved. During the past five years the C.S.I.R.O. central library has maintained a close liaison with the Division of Mathematical Statistics in studying the potential of mathematical systems already in use, and their possible application in C.S.I.R.O. As a pilot experiment, a mechanized system covering the field of soil mechanics has been set up and has now reached a stage where it gives promise of useful results which may have considerable potential value in other fields.

During the year under review the library service to readers both in and outside C.S.I.R.O. has continued to grow. There has been an extension of existing exchange arrangements and many of the gaps in the Australian scientific and technical periodical holdings have been filled. As a direct result of this many enquiries for material which previously had to be referred overseas are now dealt with in Australia with a minimum of delay. The coverage of *Scientific Serials in Australian Libraries* has increased, both in relation to new periodical holdings and the number of libraries included.

Heavy demands continue to be made on the index to the work of the Organization's research staff. Although at present this is held in card form in Head Office library, it is planned to reproduce it in print in the near future so that the information which it contains will be more readily accessible to workers both in Australia and overseas.

Publications

C.S.I.R.O. publishes its research results in a series of scientific journals, in bulletins, in technical papers of the Divisions and Sections, and in special publications such as C.S.I.R.O. Wildlife Research, the "Land Research" series, and the "Soil Publication" series. Many research papers are also contributed by C.S.I.R.O. officers to other scientific journals both in Australia and overseas.

The Australian Academy of Science has continued to cooperate with C.S.I.R.O. in publishing and in maintaining a high standard in papers appearing in the scientific journals published by the Organization. These journals are: the *Australian Journal of Agricultural Research*, the *Australian Journal of Applied Science*, the *Australian Journal of Biological Sciences*, the *Australian Journal of Botany*, the *Australian Journal of Chemistry*, the *Australian Journal of Marine and Freshwater Research*, the *Australian Journal of Physics*, the *Australian Journal of Soil Research*, and the *Australian Journal of Zoology*.

Editorial policy is decided by a Board of Standards comprising: Professor W. P. Rogers (Chairman), Professor N. S. Bayliss, Professor Sir Macfarlane Burnet, Professor J. S. Turner, and Mr. A. E. Scott (Editor-in-Chief). Advisory committees are responsible for editorial matters affecting each individual journal, and members of the Board serve on appropriate journal committees.

The Royal Australian Chemical Institute, the Australian Institute of Physics, the Australian Veterinary Association, the Australian Institute of Agricultural Science, and the Australian Society of Soil Science are associated with the publication of the journals.

Contributions are published from research workers, irrespective of country or of the establishment to which they are attached. Many papers from workers in Australian universities and a limited number from overseas have been published.

Translation

Written and oral translations were produced by the Translation Section, which has officers in Melbourne and Sydney, and by translators attached to Divisions in Adelaide and Canberra. The languages translated include German, Dutch, Swedish, Norwegian, Danish, French, Italian, Spanish, Portuguese, and Russian.

The Translation Section has operated as Australian agent for the Index of Translations of the British Commonwealth Scientific Office, supplying copies of its own translations on request.

Finance

Details of the Organization's expenditure of £12,982,409 incurred during 1962–63 are set out in Chapter 5. Of this sum £12,184,972 was expended on investigations. The amount of £214,627 was made available to outside bodies such as the Commonwealth Agricultural Bureaux. Expenditure on capital works amounted to £797,437. Funds for this overall expenditure were derived from the Commonwealth Treasury, the Wool Research Trust Fund, and similar research funds. A number of direct contributions to the Organization were also received from industry. These are set out in detail in Chapter 5. The following table summarizes the sources of the Organization's funds and the activities on which they were expended.

SOURCE OF FUNDS	*Investigations* £	*Capital Works* £	*Total* £
Treasury Appropriation	9,494,069	349,628	9,843,697
C.S.I.R.O. Revenue	105,496		105,496
Total Treasury Funds	9,599,565*	349,628	9,949,193
Wool Research Trust Fund	1,885,026	417,495	2,302,521
Contributions (other than Wool)	700,381	30,314	730,695
	12,184,972	797,437	**12,982,409**

* See itemized list below.

In last year's Annual Report attention was drawn to broad general areas into which the C.S.I.R.O. research program was divided.

The following figures give an indication of how the Treasury funds available for investigations in 1962–63 were used. (These figures must be regarded as approximations only since the exact category in which some expenditure is placed has in some instances been arbitrary.)

	£
National Standards Laboratory (Statutory Obligations for Weights and Measures) and Meteorological Physics	1,011,400
The Science of Processing or Manufacturing Industries Based on Agricultural Products	971,400
The Science of Minerals and Coal	700,900
Science related to Engineering and Manufacturing Industries	317,000
Physical and Chemical Research related to a Wide Range of Secondary and Tertiary Industry	1,354,400
The Science of Animal Husbandry and Production	383,300
General Biological Research of Wide Agricultural Interest	1,090,900
The Science of Animal and Plant Diseases, Weeds, and Animal and Insect Pests	809,600
Regional Agricultural Research	1,216,100
Fisheries and Oceanography	240,100
Special Researches	295,700
Research Services	148,200
Promotion and Distribution of Research Results	383,200
Extra-mural Research and Studentships	152,600
Administration	524,765
	9,599,565

Organization

C.S.I.R.O. is organized in four major group laboratories and a number of Divisions and Sections. The four group laboratories are the Animal Research Laboratories grouping three Divisions, the Chemical Research Laboratories grouping six Divisions, the National Standards Laboratory grouping two Divisions, and the Wool Research Laboratories grouping three Divisions. There are also 17 independent Divisions in other research fields and an additional 14 independent Sections.

The Head Office is in Melbourne and associated with it are the central Library, Film Unit, and Translation Unit. Regional Administrative Offices are located at Melbourne, Sydney, and Canberra. The Organization also maintains the Australian Scientific Liaison Office in London and the Office of the Scientific Attaché in Washington.

Since the Organization's activities are Commonwealth-wide and often involve extensive field work, a number of branch laboratories and field stations have been established in various parts of Australia. The more important of these are included in the following lists.

LABORATORIES AND DIVISIONS

Animal Research Laboratories, consisting of the following three Divisions:

Animal Genetics, with headquarters in Sydney; laboratories in Sydney and Rockhampton, Qld.; and field stations at Badgery's Creek, N.S.W., at Rockhampton and Cunnamulla, Qld., and at Werribee, Vic.

Animal Health, with headquarters and laboratories in Melbourne; laboratories in Sydney and Brisbane; and field stations at Werribee, Vic., and at Amberley, Qld.

Animal Physiology, with headquarters and main laboratories at Prospect, N.S.W., and a laboratory with field station at Armidale, N.S.W.

Chemical Research Laboratories, Melbourne, consisting of the following six Divisions:

Applied Mineralogy, with a branch laboratory in Perth
Chemical Engineering
Chemical Physics
Mineral Chemistry
Organic Chemistry
Physical Chemistry

and

Microanalytical Laboratory
Sugar Research Laboratory

National Standards Laboratory, Sydney, consisting of the following two Divisions:

Applied Physics
Physics

Wool Research Laboratories, consisting of the following three Divisions:

Protein Chemistry, Melbourne

Textile Industry, Geelong, Vic.

Textile Physics, Ryde, N.S.W.

Other Divisions are:

Biochemistry and General Nutrition, with headquarters and laboratories in Adelaide and a field station at O'Halloran Hill, S. Aust.

Building Research, with headquarters in Melbourne and an office in Port Moresby, New Guinea

Coal Research, Sydney

Dairy Research, Melbourne

Entomology, with headquarters and main laboratories in Canberra, laboratories in Sydney and Brisbane, and field stations at Albury, Trangie, and Wilton, N.S.W., at Ingham, Qld., and at Cambridge, Tas.

Fisheries and Oceanography, with headquarters and main laboratories at Cronulla, N.S.W., and a laboratory in Melbourne

Food Preservation, with headquarters and laboratories in Sydney, and laboratories in Brisbane and Gosford, N.S.W.

Forest Products, Melbourne

Land Research and Regional Survey, with headquarters in Canberra, and field stations and laboratories at Alice Springs, Katherine, and Darwin, N.T., and Kununurra, W.A.

Mathematical Statistics, Adelaide, with officers stationed at a number of Divisions and Sections as well as at the University of Melbourne

Meteorological Physics, Melbourne

Plant Industry, with headquarters and main laboratories in Canberra, regional laboratories in Perth, Hobart, and Deniliquin, N.S.W., field stations and experimental farms at Canberra and at Kojonup and Baker's Hill, W.A., and a tobacco research institute at Mareeba, Qld.

Radiophysics, with headquarters and laboratories in Sydney, the Australian National Radio Astronomy Observatory at Parkes, N.S.W., and a solar radio astronomy observatory at Dapto, N.S.W.

Soils, with headquarters and laboratories in Adelaide, and a laboratory in Canberra

Tribophysics, Melbourne

Tropical Pastures, with headquarters in Brisbane, main laboratories in Brisbane and Townsville, a laboratory at Lawes, Qld., and field stations at Samford and Woodstock, Qld.

Wildlife Research, Canberra

INDEPENDENT SECTIONS

Agricultural Research Liaison, Melbourne
Computing Research, Canberra
Editorial and Publications, Melbourne
Engineering, Melbourne
Fodder Conservation, Melbourne
Horticultural Research, Merbein, Vic.
Industrial Research Liaison, Melbourne
Irrigation Research Laboratory, Griffith, N.S.W.
Mineragraphic Investigations, Melbourne
Ore Dressing Investigations, Melbourne, and Kalgoorlie, W.A.
Physical Metallurgy, Melbourne
Soil Mechanics, headquarters in Melbourne with a laboratory in Adelaide
Upper Atmosphere, Camden, N.S.W.
Wheat Research Unit, Sydney

REGIONAL CENTRES

Officers from a number of Divisions are located at:

Tasmanian Regional Laboratory, Hobart
Western Australian Regional Laboratory, Perth

2

Progress in Research

THIS CHAPTER consists of a brief survey of some of the more important and interesting developments in the research being carried out by C.S.I.R.O. Details of many of the individual projects may be found in the scientific papers and in the letters patent that are listed in Chapter 3.

Detailed information about the Organization's research program is available from annual reports issued by each Division and Section. These may be obtained from the Chief or Officer-in-Charge of the Division or Section concerned. The addresses of the headquarters of each establishment are given in Chapter 4.

Superphosphate for Pastures

Superphosphate is the most important fertilizer for crops and pastures in Australia and is a major factor in costs of agricultural products. A good deal of attention is therefore being given to more efficient use of phosphatic fertilizers. An important component in this respect is the residual value of the applied fertilizer, and this in turn requires a knowledge of the status of phosphorus in soils.

Organic Phosphorus in Soils

From one-third to two-thirds of the total phosphorus in soils occurs as organic phosphorus and is relatively unavailable to plants. The conversion of fertilizer phosphorus to the organic form in soils under pastures may reduce the residual value of past applications.

Little is known of the chemical nature of soil organic phosphorus or of its origins. Studies of organic phosphate preparations from soils showed that inositol phosphates ("phytate") are a major component. In addition to myo-inositol hexaphosphate, which is the normal isomer, soils also contain two other isomers that have not previously been found in nature. This suggests that this group of compounds is of soil rather than of plant origin.

Rate and Frequency of Applications to Pastures

Recent work on a number of different soil types of New South Wales and Victoria suggests that responses by old-established pastures to superphosphate are determined more by time since the last application than by the total amount already applied.

In many pastures, in spite of a history of application of superphosphate of more than 5 cwt per acre, large responses can still be obtained by further dressings of

superphosphate. Thus, with subterranean clover pastures it is important to determine the available phosphate status before deciding whether to add further superphosphate. Phosphorus determination after extraction of soil with ammonium fluoride in hydrochloric acid has been found to give a reliable index of the need for additional fertilizer.—*Division of Plant Industry.*

Nitrogen for Tropical Pastures

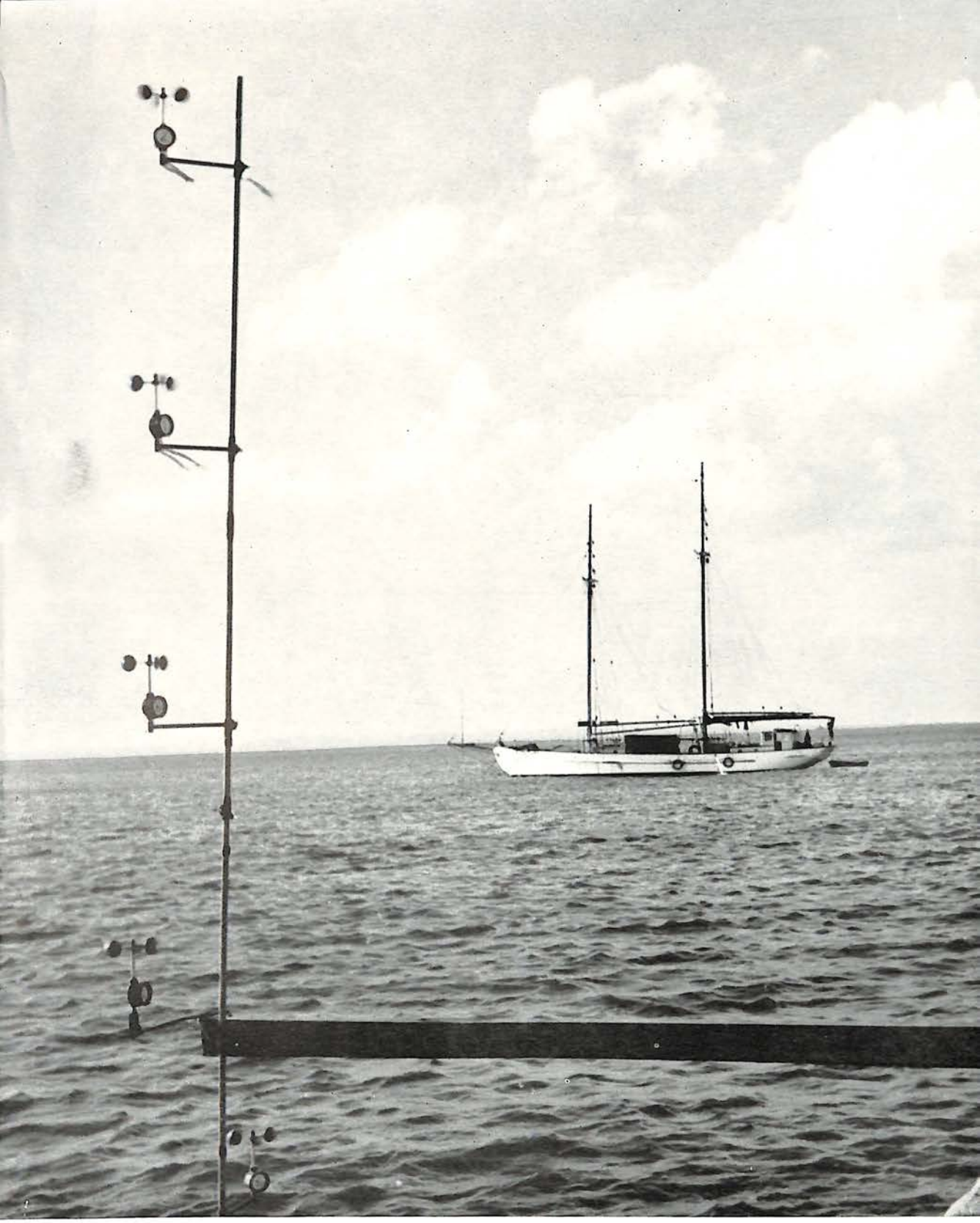
Many of the grazing lands of coastal areas in south Queensland which now produce poor yields of generally low quality pasture are less productive than when the land was first cleared. This deterioration has been ascribed to a progressive decline in general soil fertility, particularly in available nitrogen. This fact, combined with the general overriding importance of nitrogen for pasture production in Queensland, has led to the establishment of strong research teams, working on various aspects of nitrogen nutrition for tropical and subtropical pastures.

A major objective is the breeding and selection of legumes that will add large amounts of nitrogen to pastures. The use of nitrogen fertilizers on commercial cattle pastures is also being studied in a large grazing experiment in which the pastures receive adequate dressings of urea fertilizer.

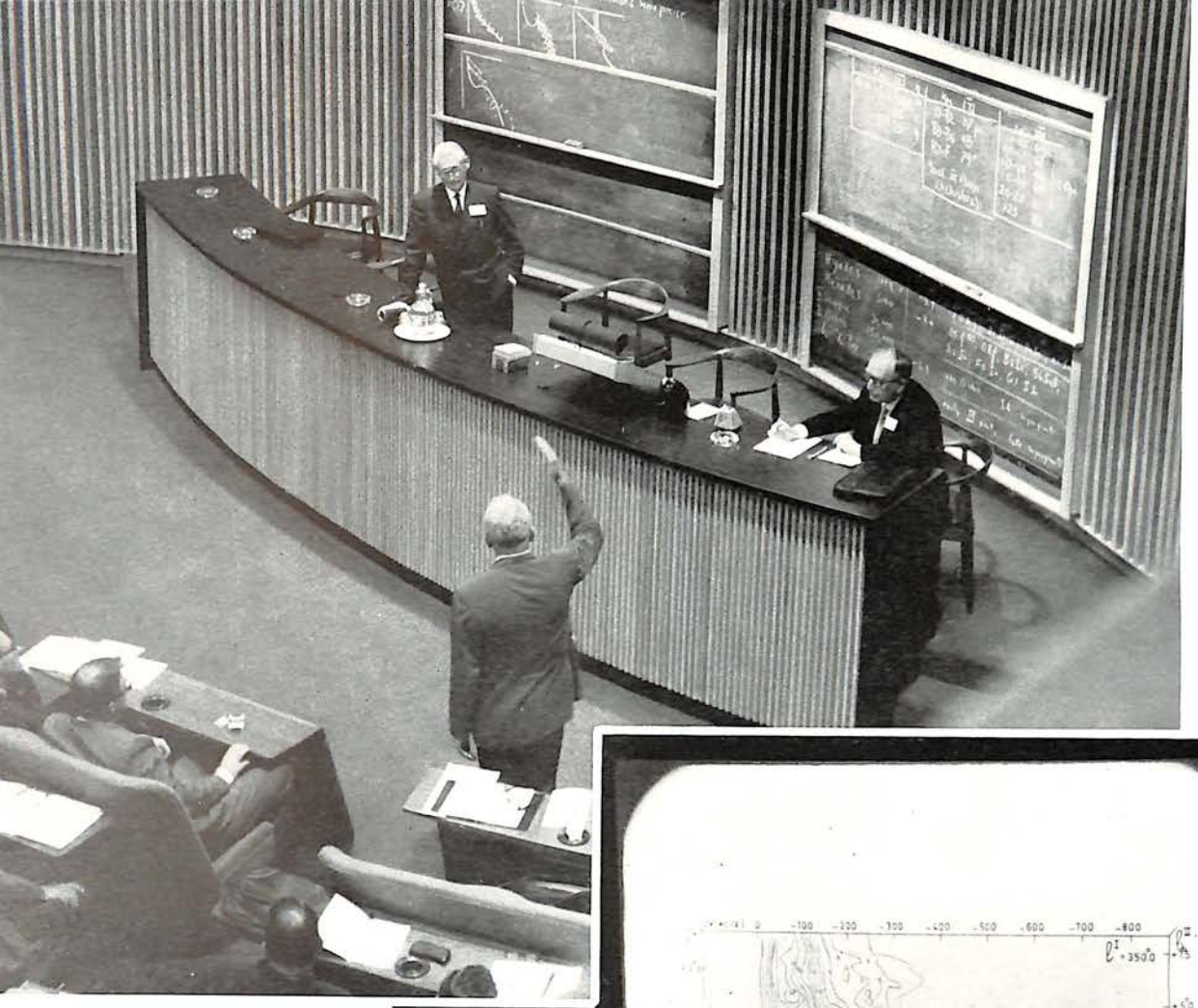
In conjunction with these projects, the nitrogen nutrition of pasture grasses is being studied with the aim of improving the efficiency with which nitrogen from the soil, legume, or fertilizer can be converted into animal feed. The following important results, relevant to large areas of well-watered country in southern Queensland, have been achieved with the nitrogen fertilizer aspects of this program at the Samford Pasture Research Station near Brisbane.

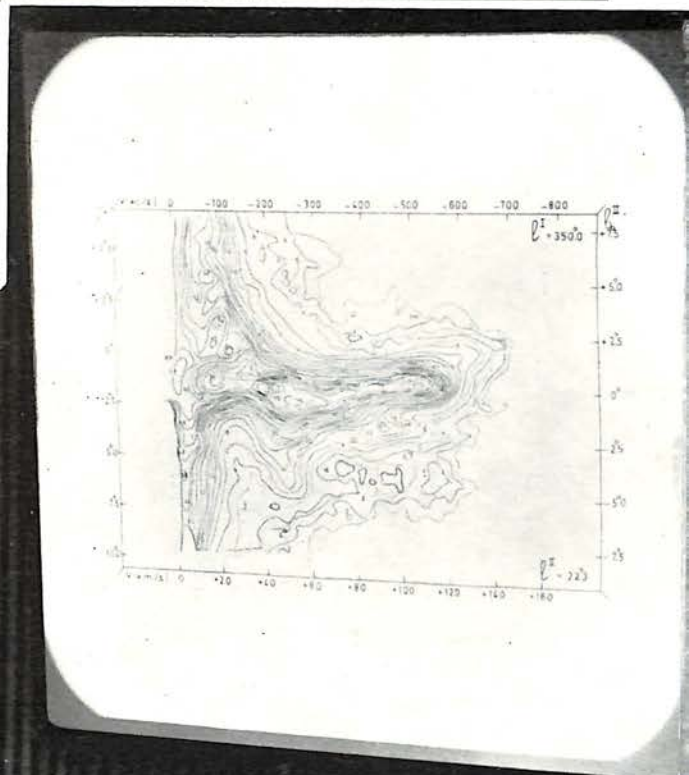
1. Introduced pasture grasses have given very high yields when soil fertility is raised to adequate levels. On land which generally supports blue couch pastures yielding about 1 ton dry matter per acre per annum, sown pasture experiments with Rhodes grass and other productive grasses have produced yields of up to 9 tons dry matter per acre when fertilized with sufficient nitrogen. These yields, which were obtained under a cutting system, required about 400 lb nitrogen per acre per annum; superphosphate and potassium fertilizer were also necessary. The rainfall at Samford, which averages 42 inches per annum, is adequate for these heavy grass yields in about 9 years out of 10. Without adequate nitrogen fertilization many productive sown grasses will not persist on these soils at their present level of fertility.

2. Other work at Samford has shown that the protein content of subtropical grasses, which is usually low when the plants are allowed to grow to maturity, can be maintained at much higher levels if the supply of nitrogen matches plant growth. By applying strategic fertilizer dressings during 1962 it was possible to maintain the protein content of Rhodes grass above 10% through the late summer and winter period from February to September. Protein content is a critical factor in animal nutrition, and this work has proved that the generally low protein level of subtropical grasses is due as much to nitrogen starvation as to the nature of the plants.—*Division of Tropical Pastures.*



A schooner engaged in meteorological work at sea.





Above

An international group of astronomers met in Canberra and Sydney from March 18 to 28, 1963. The occasion was the twentieth symposium of the International Astronomical Union, cosponsored by the International Union of Scientific Radio (URSI). These photographs were taken in the Australian Academy of Science Building in Canberra.

Right

Professor J. H. Oort, Director of Leiden Observatory, The Netherlands, illustrates the distribution of interstellar hydrogen atoms in the direction of the centre of the Milky Way galaxy.

Plant Nutrition and Tobacco Quality

The nutritional factors causing two types of low quality leaf in tobacco, trashy leaf and "flat" leaf, have been elucidated, and appropriate fertilizer treatments and culture practices have been devised which prevent these conditions.

Trashy leaf was originally thought to be associated with an excess of nitrogen in tobacco soils, but recent studies have shown it to be caused by potassium deficiency. High levels of nitrogen and excessive leaching both accentuate the potassium deficiency.

"Flat" leaf, which is associated with high chloride content of the leaf, has been shown to be caused by faulty nitrate nutrition. High chloride uptake occurs when the plant is supplied with nitrogen in the form of ammonia; much lower chloride levels occur when the nitrogen is supplied as nitrate. Chloride accumulation also occurs in leaves following the use of certain nematocides; these cause changes in the soil microflora which lead to an increase in ammonia nitrogen at the expense of nitrate nitrogen, and this in turn increases chloride uptake.—*Division of Plant Industry.*

High Quality Rice for the North

The growth of the infant rice industry in northern Australia has been hampered by the low quality of the grain that has been harvested. The varieties that have been grown in the north were imported from Africa and south-east Asia, but they suffered from low quality grain and weak straw which collapsed under the weight of grain when fertilizers were used to increase yields.

Plant selection work at the Kimberley Research Station and the Coastal Plains Research Station near Darwin has resulted in a new variety of rice known as Sircna which has been released for commercial production. Sircna is the first variety to be produced to meet the needs of the northern environment, although other selections are showing promise.

An independant quality test in the United Kingdom showed that Sircna was higher in quality than the world-renowned variety, Bluebonnet. Although its straw is a little longer than ideal for mechanized harvesting its strength is sufficient to withstand the wind and rain of northern wet seasons.—*Division of Land Research and Regional Survey.*

Lucerne for Cold Climates

Winter production by commercial lucerne on the tablelands of New South Wales is low. Cold-hardy strains of lucerne produce little forage in winter, whereas strains which grow better at low temperatures are damaged by frost. Crosses between these two strains combined winter growth and cold tolerance in second-generation plants. This indicates that, contrary to previous belief, growth at low temperatures and susceptibility to cold are controlled by separate genes. There are thus good prospects of breeding a strain which will grow in the winter and not be damaged by frost. A number of lines possessing these characteristics are being tested for commercial suitability.—*Division of Plant Industry.*

Structural Chloroplasts and Nutrient Deficiencies

In green plants chlorophyll, the key pigment of photosynthesis, is localized in subcellular particles called chloroplasts. By the use of phase contrast and fluorescence microscopy the internal structure of chloroplasts has been studied in great detail both in intact living leaf cells and in isolated chloroplasts extracted from green leaves.

Recent observations have revealed that chloroplasts are surrounded by an amorphous, mobile, peripheral layer resembling mitochondrial material. The behaviour of chloroplasts during swelling indicates that this layer is the only all-encompassing structure around the chloroplast. Once this layer has swollen and ruptured the remaining chloroplast structure behaves as if composed of many individual osmotic units. A model of chloroplast structure has been proposed which combines these observations with what is already known from electron micrograph studies.

A survey of the effects of nutrient deficiencies has shown that manganese deficiency causes profound changes in chloroplast structure. Whereas in normal chloroplasts the chlorophyll is concentrated in about 50 small grana, in chloroplasts of manganese-deficient leaves the chlorophyll is localized in 4 or 5 abnormally large grana and the size of the peripheral chloroplast layer is greatly increased.

These findings lead to a better understanding of the mechanisms of manganese deficiency and the role of manganese in plant growth.—*Division of Plant Industry.*

The Chlorophyll-Protein Complex

Chlorophyll and its precursor, protochlorophyll, exist in the plant as complexes with protein. Little is known about the structure of these complexes although they are of fundamental importance in photosynthesis.

The protochlorophyll-protein complex of dark-grown leaves has been isolated and purified and some of its properties determined. The protochlorophyll-containing molecules are visible in the electron microscope as spherical particles with a diameter of one-millionth of a centimetre. When the dark-grown leaves or the purified protein preparation are exposed to light, the protochlorophyll is converted to chlorophyll; kinetic and other techniques have been used to study the mechanism of this conversion.—*Division of Plant Industry.*

A New Tool for Transpiration Experiments

The wet-and-dry bulb hygrometer, which in its fully ventilated form is termed a psychrometer, is well known as a humidity measuring device that is simple in form and convenient to use but is subject to uncertainties in its performance unless used with proper understanding. An investigation of the physical principles which govern its behaviour has revealed that with proper design it can be employed in a variety of ways to give results of good accuracy and unusual reliability. Advantage has been taken of this in the design of instruments for many different purposes. Most recently

the method has been used to furnish a tool for transpiration measurements in connexion with research on cattle breeding and plant physiology. The device is a differential psychrometer which measures the difference in the water vapour contents of two otherwise similar streams of gas. In its application to studies on cattle, a measurement is made of the change that is produced in the moisture content of air by passing the air over portion of the hide of the beast, to determine its sweating, particularly under tropical conditions. In like manner, the instrument is being used extensively to record the transpiration of water by plants under various environmental conditions. —*Division of Physics.*

Bitter Pit in Apples and Calcium Sprays

The recognition of the importance of calcium and magnesium in the development of bitter pit in apples during storage leads to practical methods for controlling this disorder. Additional magnesium increases bitter pit whereas additional calcium decreases it. The additional calcium is applied as sprays while the fruit is developing.

A wide range of calcium compounds has now been tested on several apple varieties under various conditions, and at least 50% reduction of the disorder can be achieved. Fortunately, two of the cheapest materials, calcium chloride and calcium nitrate, have been shown to be the most effective; for red varieties calcium chloride is the more desirable and for green varieties the nitrate is more useful. Effective dosage rates and times of application have been established.—*Division of Plant Industry.*

Water-Repellent Sands

Interest in water-repellent sands has arisen following the large-scale development of pasture on sandy soils formerly carrying heath and low mallee scrub in some of the lower rainfall areas of southern Australia. Many such sands have developed a resistance to wetting especially marked in late autumn and early winter. Because of the shallow wetting, or wetting in irregular mosaic patterns, it has affected agricultural operations and pasture production. The cause of water repellence is the formation of organic films that are difficult to wet on the surfaces of the sand grains. In the laboratory these films can be removed by abrasion, or more completely by ignition, and the sands then are readily wetted by water.

In the field the typical affected condition shows the rain wetting the surface of the soil to a very shallow depth and then penetrating in narrow columns. The soil between the columns remains dry for long periods. In severe cases these dry areas are not wetted even at the end of the winter so that the water reserves in the soil at the beginning of the dry season are low. Plants that germinated where only the surface had been wetted by early winter rains may thus suffer from early drought because of the absence of moisture reserves in the lower horizons to carry them on until the next rain. Those seeds that were buried deeper in the sand may lie in a dry area for much of the winter before they germinate. Where rainfall is a limiting factor

to plant growth, any condition which lowers reserves of moisture and penetration of rain has great economic significance.

Infiltration techniques have been adapted in the field to follow seasonal changes in the rate of water entry into these sands and a laboratory method has been developed to assess the degree of repellence of sand samples. This provides a means of comparing the water relationship of the sands at different seasons, under different plant species and various farm management conditions.

It has been found that some pasture plant species with a coarse, woody root structure, such as phalaris, are more detrimental than others with a more fibrous root system, such as perennial veldt grass. There are wide seasonal variations in the intensity of water repellence. The sands become water repellent under conditions which favour the growth of certain microorganisms such as some Basidiomycetes, rhizosphere fungi, and associated suites of bacteria. Though rain penetration is improved by ploughing and the use of annual grain crops, water repellency develops again within a few years of sowing down to pasture.—*Division of Soils.*

Effect of Oestrogen at Mating Time on Fertility of Ewes

Permanent infertility in breeding ewes is known to be induced by oestrogenic substances occurring in pastures dominated by subterranean clover. There are now indications that much lower levels of oestrogen can induce temporary infertility.

Daily injections of 32 micrograms of stilboestrol at mating time almost completely prevent conception and partly inhibit oestrus. Levels of intake of oestrogen as high as this can occur on subterranean clover pastures, so that severe losses from temporary infertility may be widespread and just as important as the permanent effects from prolonged ingestion of oestrogenically active pasture. The experiments have shown that 8 micrograms daily may have some effect in depressing conception percentage and decreasing the proportion of multiple births.—*Division of Plant Industry.*

Tick-Fevers of Cattle in Northern Australia

In northern Australia losses associated with the cattle tick and the tick-fevers transmitted by it amount to millions of pounds annually. Although progress towards the control and eradication of the tick has been an outcome of research by the C.S.I.R.O. Division of Entomology, the extensive application of measures based thereon could be vitiated by severe losses from tick-fevers at stages when the tick population could intermittently increase during the process of eradication. In order to overcome this major difficulty, intensive research on the tick-borne parasites causing the fevers and on resistance to the disease is required. In the Division of Animal Health, recent research has revealed for the first time stages of multiplication of the parasite within the tick, and blood tests that have been devised are being used to make field assessments of the spread of infection in tick-infested cattle in selected environments. In their application, these advances should prove of importance not only to Australia but to many countries overseas.—*Division of Animal Health.*

Selection of Bulls for Progeny Testing

Improving dairy cattle by breeding is known to be a very slow process. This is partly because generation intervals are long, partly because there is little room for selecting between females, and partly because there is no way of selecting between males directly. Methods of progeny testing bulls have been devised in the last decade. But bulls to be tested must be picked at random. Recently, characters have been found which will improve on a random choice. The blood of mammals contains a protein which is known as β-globulin. The nature of this protein is under genetic control and the genes affecting β-globulin type in dairy cattle also affect milk yield and fertility. The inheritance of β-globulin type has been worked out and it should now be possible to choose for progeny testing only bulls with the most favoured blood type. A second character, depth of hair follicle, is found negatively correlated with milk yield in the cow. If this turns out to be a genetic correlation, this character can be used as well as β-globulin type for selecting bulls to be progeny tested. The correlation, so far known only in the cow, might be due to the size of hair follicle or the thickness of skin being affected by the drain of a heavy lactation, in which case it would not act as a guide to the potential of a bull.

Investigations are well under way to see if the correlation found between a cow's skin and her own milk production holds between a bull's skin and the milk production of his daughters.—*Division of Animal Genetics.*

Precautions in Drenching Sheep

Carbon tetrachloride has for long been recommended as an anthelmintic for sheep, particularly against liver fluke, although its use is known to cause occasional unpredictable and serious losses in some flocks. Many theories have been advanced regarding factors causing a seeming variation in susceptibility to the poisonous effects of this drug, but none had proved fruitful on investigation.

It has now been found that doses of carbon tetrachloride in liquid paraffin, in the quantity and proportion commonly formulated for use as drenches against fluke infection, may quickly kill sheep when purposely given into the larynx or onto the posterior ventral part of the pharynx so that the full dose cannot be swallowed immediately. Even administration into the mouth by discharge against the hard palate led to death after 14 hours.

Death following these methods of drenching with carbon tetrachloride in paraffin is considered to be due to inhalation of varying amounts of the drug. In practical terms, it means that, unless the drenching procedure is conducted with such care and precision that prompt swallowing of the mixture is ensured, there will always be a risk of death by inhalation of the drug. In a number of flocks under test, losses which had constantly followed drenching with carbon tetrachloride on previous occasions ceased when the correct drenching technique was adopted.

The results of these experiments have emphasized the critical importance of correct drenching procedure.—*Division of Animal Health.*

Lamb Losses

During the last 10 years, observations on lambing ewes have shown that a high proportion of deaths of new-born lambs in Australia cannot be attributed to any known disease, infectious or otherwise. On the contrary, there is ample evidence that many deaths are due to nutritional, physiological, and behavioural factors.

The ability of lambs to regulate their body temperature in cold, wet, and windy weather has recently received special attention. In comparison with other species, the new-born lamb is particularly well equipped to call on its body reserves to combat the effects of severe weather; for example, to maintain normal body temperature most lambs can increase their rate of heat production fivefold within minutes of birth. Small lambs are much less resistant to chilling than large lambs; the main reason for this is that the heat production is proportional to body weight while heat loss is proportional to surface area—the smaller the lamb, the greater is its surface area relative to its weight. It is now possible to predict, roughly, the environmental conditions under which lambs would begin to chill; a wet new-born lamb of say 5 lb would begin to chill in a wind of 10 m.p.h. at a temperature as high as 70°F, whereas a lamb of 10 lb would not chill under similar conditions until the air temperature fell below 40°F. Exposure to a wind of 10 m.p.h. is roughly equivalent in its effect on the lamb to reducing air temperature by 40 or 50°F.—*Division of Animal Physiology.*

Protection of Livestock Grazing *Heliotropium europaeum*

Over large areas in south-eastern Australia the poisonous plant *Heliotropium europaeum* grows so freely after summer rains that graziers often cannot find practical means of preventing livestock from having access to it. As losses may be great after two seasons' grazing, means of preventing the spread or growth of the plant are desirable but there seems to be little hope of finding a selective and economic method.

In these circumstances great importance attaches to a recent finding that, under experimental conditions at the laboratory, the rumen content of the sheep can act on one of the main poisons, the pyrrolizidine alkaloid heliotrine, in such a way as to render it harmless. Much research has been conducted on the relevant chemical changes with heliotrine and other alkaloids of this plant, and these have been found to proceed satisfactorily only if there is an adequate amount of vitamin B_{12} in the test-tube preparations.

On this evidence it seems very likely that all the alkaloidal poisons of this plant, being of a similar chemical pattern, may be destroyed in the rumen of the grazing sheep before they can be absorbed, provided that a constantly high level of ruminal vitamin B_{12} is ensured during the heliotrope season. A practical and economic means of maintaining such a level, that had already been devised by the C.S.I.R.O. Division of Biochemistry and General Nutrition in connexion with phalaris staggers in sheep, is the administration of cobalt "pellets". Field trials have now been set up on each side of the River Murray in Victoria and New South Wales to test under practical conditions of grazing whether protection from poisonous effects follows such admini-

stration. It will be at least two years before a definite assessment can be made but, in the meantime, the progress of experiments with penned sheep given cobalt pellets and receiving extracts of heliotrope in the food is encouraging.

An intensive study of the basic chemistry of pyrrolozidine alkaloids of heliotrope and other plants that cause liver damage is being continued and also biological studies on the means by which these poisons produce this damage.

Poisonous alkaloids of this group are found in other plants often eaten by livestock, and this is why poisonous weeds such as *Senecio jacobaea* (ragwort) and sometimes *Echium plantagineum* (Paterson's curse) may kill farm animals and why species of *Crotalaria* cause the death of horses in northern Australia (Kimberley disease) and in some overseas countries.

From general studies on these plant poisons it seems likely that if cobalt administration proves successful in preventing heliotrope poisoning it may similarly prevent poisoning of sheep and cattle by these other plants. In addition the possibility that the method may be effective in reducing or eliminating the inconstant but serious harmful effects of valuable pasture plants (for example, clovers with oestrogenic effects) is being investigated.—*Division of Animal Health and Division of Organic Chemistry.*

Facial Eczema of Sheep

The first appearance in Australia of the deadly hepatotoxic disease of sheep, "facial eczema", was a mild outbreak in 1956 in East Gippsland, which was followed in 1959 by a much more serious outbreak in the same region. The attacks have been regarded as sufficiently serious for the Department of Agriculture of Victoria to set up a Facial Eczema Field Station at Rosedale in Gippsland to carry out studies of the disease and investigate possible remedies. Previously, the disease has been known only in New Zealand, where considerable damage to sheep population has occurred over the last 60 years. There a very considerable effort has been made over the years to elucidate the origin of this disease and, in 1958, the New Zealand workers succeeded in showing that the cause of the disease was the fungus *Pithomyces chartarum* (previously named *Sporidesmium bakerii*) growing on rye grasses. The New Zealand workers (with R. L. M. Synge of the Rowett Research Institute) also succeeded in isolating in a purified form the compound which is regarded as the causative agent of the liver damage. This was named sporidesmin, $C_{18}H_{20}O_6N_3S_2Cl$.

Since it is of importance at this stage of the investigation to determine the structure of the causative agent, considerable efforts have been devoted to this problem. However, the solution proved rather difficult by classical chemical techniques and a parallel investigation was carried out by X-ray techniques. Through the generous cooperation of the members of the New Zealand Department of Agriculture at the Ruakura Animal Research Station, derivatives of sporidesmin considered suitable for X-ray studies were prepared. From one of these, the adduct involving methylene dibromide, the structure, including full details of the configuration at the five asymmetric centres, has been solved by a single-crystal X-ray study at $-150°C$. Sporidesmin has a rather complex ring system. It has certain structural similarities to another fungal

product, gliotoxin, and the structural relationship is such as to suggest that sporidesmin may be only one member of a whole family of compounds with similar properties.—*Division of Chemical Physics.*

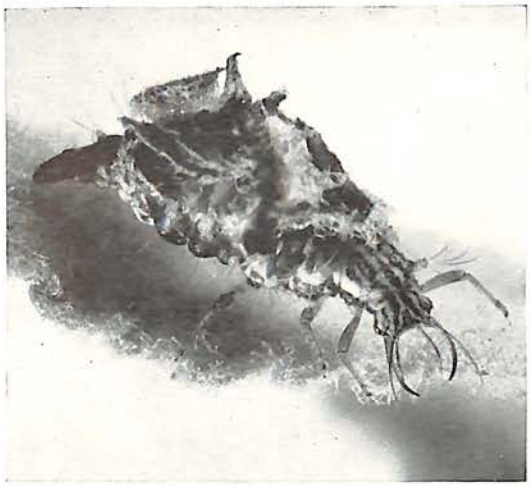
Posthitis in Wethers

This disease is troublesome and is responsible for serious economic losses. Previous research had indicated that it was not infectious and could be controlled by treating sheep with implantations of pellets containing testosterone. Recent research at Armidale has shown that the disease, in fact, is infectious and can be transmitted from wethers to rams, ewes, and even cattle. The causal organism is a bacterium which is usually quite harmless except to skin which has been wetted with urine; in consequence lesions are produced only on the prepuce or the vulva. The organism can easily be grown in culture and is quite susceptible to antiseptics. These findings open up new possibilities for the prevention and even eradication of posthitis from a flock.—*Division of Animal Physiology.*

Genetic Correlations

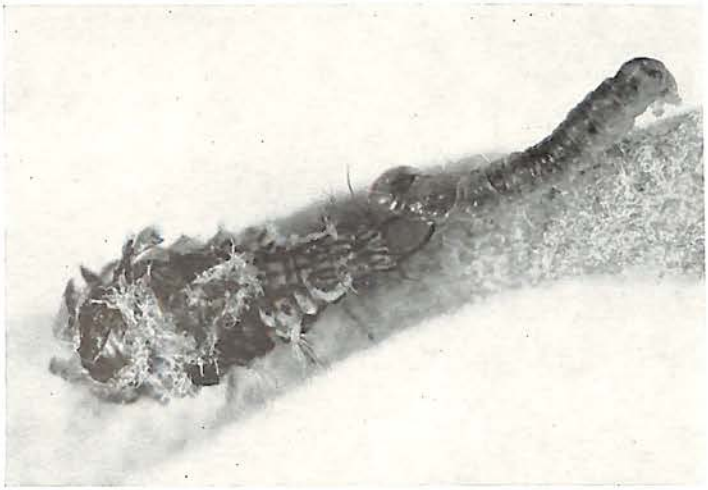
A genetic correlation is said to exist when genes controlling variation in one trait, say milk yield, also control variation in another, say length of sweat gland. A clearer insight into the nature and workings of genetic correlations has been achieved through experimental breeding of *Drosophila melanogaster*. It has been shown that there is a genetic correlation between two bristle types in *Drosophila* such that when one type of bristle increases in number the other in some circumstances also increases in number. However, in other circumstances when one type increases the other decreases. A negative or a positive genetic correlation may be found between these two characters. This has been shown to be due to the fact that the two characters are correlated because they share their genetic resources for development. When these are increased both characters receive an increased share; when reduced, a reduced share. But if the share is itself under genetic control, it is possible to increase the fraction of resources going to one character, in which case less goes to the other. Thus one source of influence generates a positive and one a negative genetic correlation. The net effect on correlations of selection on one character depends on the relative magnitude of changes brought about in total resources and the way they are shared up on the one hand, and the relative amount of change in total resource to amount of resource on the other. Thus, suppose total resource is originally 2 units apportioned 1 to 1 and resource is then increased by 2 and apportioning changed to $\frac{1}{3}$ to $\frac{2}{3}$. The first character moves from $\frac{1}{2}$ of $2 = 1$ to $\frac{1}{3}$ of $4 = 1\frac{1}{3}$, the second from 1 to $2\frac{2}{3}$. But if total resources are originally 20 instead of 2, the first character moves from $\frac{1}{2}$ of $20 = 10$ to $\frac{1}{3}$ of $22 = 7\frac{1}{3}$ and the second from 10 to $14\frac{2}{3}$. In one case both characters increase together with selection, in the other an identical change brought about by selection causes one character to increase and the other to decrease. This principle could have wide application in interpreting selective breeding.—*Division of Animal Genetics.*

Predator

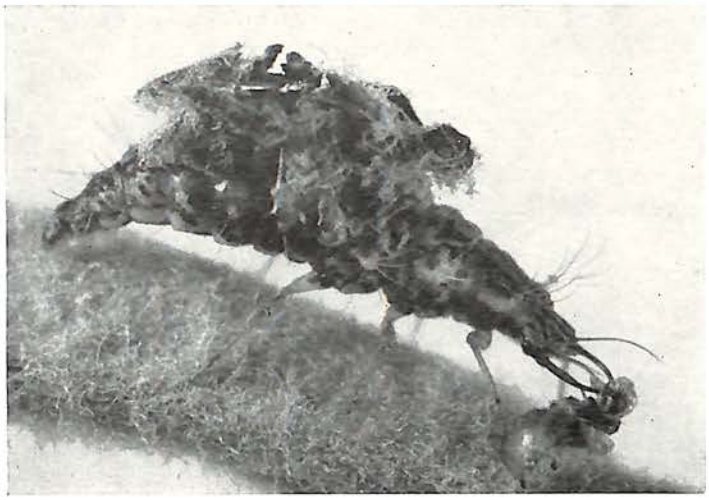


The light-brown apple moth, *Epiphyas postvittana*, a native leaf roller, has become a major pest of apples and pears in eastern Australia. Its abundance can be limited by natural enemies, of which predators form an important component. One group of common predators of the light-brown apple moth is formed by chrysopid larvae which usually camouflage themselves with the remains of their prey or with bits of debris gathered from the host plants. The figures show:

◀ (1) a *Chrysopa* sp. larva, camouflaged with apple bud scales, seeking prey on the edge of an apple leaf;



◀ (2) the capture of a light-brown apple moth larva; and



◀ (3) the remains of the light-brown apple moth larva when fully consumed.

The piercing and sucking mouth parts of chrysopid larvae are particularly well adapted for preying upon soft-bodied insects.

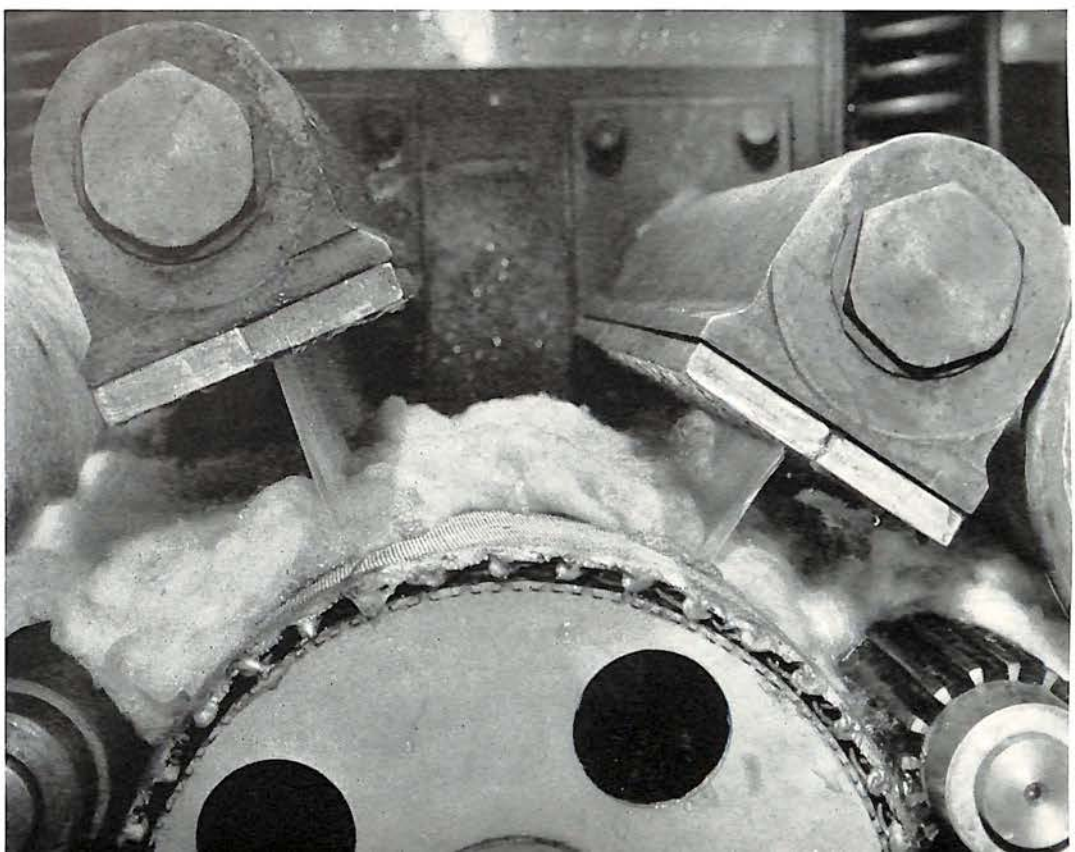
Division of Entomology

Left

In oceanography and in the study of fisheries the principal aim of research is to relate the plant and animal populations to their environment, the sea. This involves the study of the ocean basins, the movements and chemical and physical properties of the waters in them, and the animal and plant life in these waters. Specially built or fitted ships are used for this work; they are equipped with a large number of instruments for collecting and analysing samples of seawater, as well as with many different kinds of nets, dredges, grabs, and trawls for sampling animals, plants, and ocean sediment. The Hayward Standard Bucket or "orange-peel grab" is an efficient instrument for collecting sediment or fauna from the ocean floor. The photograph shows a 2-cu ft sampler being lowered from H.M.A.S. *Gascoyne*, which has surveyed the sediment and the animals at the bottom of the continental shelf from Brisbane to Fremantle.

Below

A unit of the C.S.I.R.O. Geelong jet scour. Wool is seen passing under a pair of transverse jets. These may deliver either organic solvent or aqueous detergent. The wool is supported by a drum perforated to prevent flooding, and thus disturbance, of the staples.



Rapid Testing of Cattle for Pleuropneumonia

One of the major aims of research on contagious bovine pleuropneumonia has been the finding of practical and accurate methods of making a "crush side" diagnosis under the difficult conditions that prevail on large pastoral holdings in the north. The C.S.I.R.O. complement fixation test, devised by Campbell and Turner and now accepted as a world standard, is suited to the laboratory but not to rough field conditions. A special modification of this test has been evolved by Huddart in Kenya and after intensive study in the laboratories of the Division of Animal Health a field trial has been conducted under Australian conditions.

In order to have a reasonable chance of encountering infected animals the field trial was carried out at Wyndham in the north of Western Australia. With the ready cooperation of the manager of the local meatworks, nearly 2000 incoming animals were tested over a few days. The results of the rapid blood tests were checked for accuracy by close examination of the lungs after slaughter; the Director of the Animal Industry Branch, Northern Territory Administration, was responsible for this latter aspect of the work and for the taking of material from lesions for later examination at Alice Springs.

This first trial of the Huddart field test gave such encouraging results that it may now be used more extensively in the north. Although not strictly a "crush side" test, 500 head of cattle could be bled and tested in one day in the field while being held with temporary identification marks until late that afternoon. The test is expected to be of value to the present organized effort by the Commonwealth and States to control this disease in northern Australia and ultimately eradicate it.—*Division of Animal Health.*

Synchronization of Oestrus in Ewes

Synchronization of oestrus in groups of ewes is of value for experimental purposes and for breeding by artificial insemination. Synchronization is usually achieved by injections of progesterone every second day for 12–14 days. Recent work has shown that a commercially available progesterone derivative is also effective when administered to ewes by mouth, but the dose level needed is high (60 mg/day compared with 5–10 mg/day for injected progesterone).

The fertility following artificial insemination at the synchronized oestrus is variable and sometimes quite low. Investigation of this problem by variation of dose, interval between doses, and time of day when doses are given, has indicated that there may be a dosage schedule that will allow good fertility, but a difficulty is that this optimal schedule varies with the season and possibly with the breed of ewe. The low fertility is usually the result of the eggs not being fertilized, and this, in turn, results from the absence of sperm in the fallopian tubes at the appropriate time. Evidently sperm transport or sperm survival in the female genital tract is reduced by the progesterone treatment.

Synchronization of oestrus in cattle, particularly in beef cattle, is likely to be of more practical significance, but preliminary studies with beef heifers indicate that the same problems have to be overcome.—*Division of Animal Physiology.*

Abnormal Crimp in Wool

There are several varieties of abnormally crimped wool in the Australian wool clip, and those with severe crimp deterioration are usually classified by the wool trade as "rough fleece". The proportion of rough fleece in the national clip has increased in recent years to $\frac{3}{4}\%$ of the total wool clip, while the proportion of the choicest styles of wool has decreased. This in itself is reason for concern, since rough fleece sells for considerably less than better styles. The rough fleece consists principally of "doggy" wool ($\frac{1}{2}\%$) and "steely" wool ($\frac{1}{4}\%$). All wool-growing areas produce some rough fleece, the proportion tending to increase with rainfall.

A survey of dogginess in Merino, Corriedale, and Polwarth flocks in Queensland, New South Wales, Victoria, Tasmania, and South Australia has revealed no flock free of abnormal crimping. Also, the proportion of wool with severe crimp deterioration is but a fraction of the total showing some degree of crimp abnormality. In one flock the incidence of abnormally crimped fleeces was influenced by the time of mating.

In individual fleeces the onset of crimp deterioration follows a rather consistent pattern which is remarkably similar to the regional pattern of the amount of wax produced by the skin.

An association between the proportion of follicles with grossly enlarged outer root-sheaths and the severity of crimp deterioration has been confirmed. An attempt to produce this follicle abnormality experimentally showed that sheep skin can be adversely affected by various substances applied to it. Well-crimped and poorly crimped fibres from within a single staple of wool differ considerably in properties related to both fibre growth and fibre substance. Current research on abnormal wool is providing information on a possible mechanism of crimp formation.—*Division of Animal Physiology.*

Sulphur Content of Wool

One of the characteristics of wool is its high content of sulphur, which is present chiefly as the amino acid cystine. Wool consists of a mixture of proteins, some having high and some a low content of sulphur. It has long been known that the sulphur content of wool varies considerably, but there has been very little information on the causes of these variations. During experiments at Prospect on the role of nutrition in wool growth, it has been observed that rations which led to an increased rate of wool growth also led to an increase in the sulphur content of the wool. Conversely, the sulphur content fell as wool growth fell in response to lowered levels of nutrition. When sheep were kept on a constant diet, the sulphur content of the wool showed very little variation. The most striking changes in sulphur content have been produced by infusing small amounts of the sulphur-containing amino acids (cystine or methionine) into the abomasum of sheep. These amino acids produced rapid and substantial increases in wool growth and up to 30% increase in sulphur concentration. Some of these wool samples have been analysed by the Division of Protein Chemistry, and it

has been shown that the increased sulphur content is due to an increase in the proportion of high-sulphur proteins in wool.

It has thus become clear that the sulphur concentration in wool can be varied at will by dietary procedures, and this has provided a most valuable tool for the study, at the Wool Research Laboratories, of the structure and textile properties of wool fibre.—*Division of Animal Physiology.*

Damage by Crows

Damage by the Australian raven or "crow" to lambs at or near the time of birth is being assessed in conjunction with Professor D. McFarlane of Sydney University. Evidence to date suggests that crows can be blamed for less than 5% of these neo-natal mortalities, a figure many farmers will be reluctant to accept, since nearly every dead lamb has been mutilated by crows when found. However, expert post-mortem examination shows that the vast majority of these lambs were already dead when attacked by crows whilst many of the others would have died shortly from other causes (disease, malnutrition, etc.) if the crow had not hastened the process.

Analyses of food samples from crow stomachs suggest an extremely wide diet in the species. The diet consists mainly of insects and seed. The flocks appear to change their food source to another locally available rather than travel widely in search of the same diet. Birds gleaning fallen grain from a crop paddock will shift to pasture and feed on grasshoppers rather than search for another stubble.—*Division of Wildlife Research.*

Losses of Sheep after Shearing

It has been recognized for some time that a major part of sheep losses off-shears is due to exposure to cold. Although a good deal is known about the thermal insulation (that is, the protective value against cold) by woollen clothing for man, hardly any work has been done on the fleece as clothing for the sheep. In recent research, the insulation of the wool remaining on the sheep after shearing has been found to be quite considerable and, except for the most exposed parts of the sheep, resistant to wind. It is likely that if more wool were left than is customary, the losses off-shears might be greatly reduced.

At first sight, this seems a very simple solution of the problem of losses off-shears. But unfortunately, shearing heads are designed for close shearing, not for leaving a specific amount of wool on the sheep. The closer the shearing, the more efficiently the head works. Attempts in New Zealand to modify the head to leave more wool on the sheep have been only partly successful, and these modified heads are particularly difficult to use with Merino sheep. This is a case where the physiology of protection from cold is only part of the pastoral research problem and it seems that a new type of shearing head would need to be designed to solve it. This may involve new work on the mechanics of shearing.—*Division of Animal Physiology.*

Feedback Mechanisms in Rabbit Populations

The role of behavioural and physiological feedback mechanisms in population regulation is a central theme in mammal population research. Do mammal populations possess intrinsic mechanisms which react to density changes in such a way as to control numbers at levels which prevent catastrophic mortalities and the threat of extinction?

Before malfunction of the pituitary-adrenal system can be indicted as a direct cause of physiological disturbances in dense populations it is necessary to know how these organs change throughout the year in both sexes and in all age groups.

In natural rabbit populations the adrenals of adult animals show marked changes throughout the year. At the beginning of the breeding season adrenal size increases, the zona fasciculata broadens by hyperplasia along its inner margin, and the zona reticulata becomes very narrow. The increase in size is greater in males, which are more involved in aggressive behaviour and territorial defence. When breeding ceases the inner fasciculate zone breaks down and becomes reticulate. These broad trends are accompanied by various other histological events which appear to be in no way related to density but to seasonal changes in function.

Changes in pituitary size accompany these changes in the adrenals. The female pituitary increases in weight much more markedly than the male pituitary during the breeding season.

This work when fully analysed will form a firm foundation for critical experimentation on this important subject.—*Division of Wildlife Research.*

Age Determination and Growth Rate of Kangaroos

As part of the ecological studies at present in progress it is necessary to be able to estimate the age of wild red and great grey kangaroos and to determine the extent of their breeding seasons. Dental criteria appear to be the only practical indicators of age of adult kangaroos so the teeth of a series of captive animals of both species are being examined periodically. Kangaroo teeth are peculiar in that the molars continue to erupt until the age of about 8 years, the teeth are progressively shed from the front, and the whole tooth row moves forward in the jawline throughout life. It has been tentatively concluded that the forward movement of the teeth relative to a process on the side of the skull is a more precise indicator of age than the shedding pattern, at least after the last molar is fully erupted. So far criteria for aging animals up to about 9 years have been established but it is known that kangaroos of both species may live to about 20 years of age in captivity.

Since both species carry their young in the pouch for at least 7 months it is possible to estimate the breeding time of each individual by knowing the age of the pouch young and the gestation period. Growth rates of young of which the age is known precisely are being determined by taking several body measurements and weights at various intervals. It has been shown that the grey kangaroo young grow at a much slower rate than those of the red kangaroo although the adults are roughly the same size.—*Division of Wildlife Research.*

Saving Churning Losses: the Role of Copper

When cream is churned the fat globules are concentrated by foam formation in a manner rather analogous to the concentration of minerals by flotation. The smaller lipid particles in the cream tend to escape in the churning process. The total value of the butterfat so lost in Australian butter factories would amount to £1,500,000 annually. Reduction in these losses thus offers a field of research with great economic potential.

In a long-term approach to this problem, the interrelation of churning acidity (the pH of the cream is adjusted during processing), losses of butterfat in the buttermilk, keeping quality of the butter, and the extent of trace copper contamination have been studied for several years. Some very important facts have recently emerged. Losses of fat in churning increase with the pH (over the normal range of 6·5 to 8·0) but keeping quality of the butter is at the same time significantly improved. To ensure the keeping quality demanded of our butter on both export and local markets the industry has widely adopted a pH of about 7·5 as its average value, paying the price of the additional fat losses. Results obtained in recent extensive storage experiments show that the use of high pH is essential to good keeping quality only if the copper content of the butter is above about 7 parts per hundred million. With low copper content a pH of about 6·7 can quite safely be used and the losses of fat are greatly reduced.

Copper in butter is derived in part from copper natural to milk (2 to 4 parts per hundred million) and in part from exposed copper and copper-containing alloys in milk and cream handling equipment on both farm and factory. The copper content of Australian butter is above that of other major butter-producing countries. It is now apparent that the elimination of copper contamination will open the door to savings in fat losses in churning which could well return an additional £200,000 to the industry. A campaign to bring these facts forcefully before the industry is now under way.—*Division of Dairy Research.*

Reducing Losses in Casein Manufacture

Casein, used in Australia mainly as an adhesive in the manufacture of plywood, is exported to the U.S.A. and Japan for use in the coating or "sizing" of high quality papers. Production has grown rapidly over recent years and export alone this year will be valued at £2,200,000. In the precipitation of the casein from skim milk by addition of hydrochloric acid the very fine nature of the dispersion makes it difficult to avoid losses, and in the usual manufacturing process about 8–10% of the casein goes out with the whey or wash-water.

A method of precipitation which greatly reduces these losses, and at the same time ensures more uniform quality, has been developed. Acid and skim milk are mixed very rapidly in a special device so that chemical equilibrium is established with all the casein particles before precipitation occurs. With the prompt cooperation of dairy engineering firms the device has been made available on a commercial scale for the dairy industry and is already installed in many casein factories. The value of the casein to be saved by full application of this method in the Australian casein industry is £150,000 per annum.—*Division of Dairy Research.*

Recombining Dairy Products in Asia

The Australian Dairy Produce Board has recently undertaken, in conjunction with Malayan financial interests, the setting up in Asia of plants to recombine from Australian butter-oil and skim-milk powder such dairy products as sweetened condensed milk, evaporated milk, ice-cream, and pasteurized and sterilized milks. Following the discovery by health authorites in the Philippines of the adverse effects on health of the "filled" evaporated milk being manufactured there from coconut-oil and maize-oil, the filled-milk factories are to be changed over to the production of the entirely dairy-based product. The first of the Australian recombining plants will thus be in Manila. The second will be in Thailand, and the third probably in Burma.

The possibilities of recombining dairy products have for many years been a subject of special interest to the Division of Dairy Research, and a number of its projects have been related to the problems involved. The specialized knowledge so obtained has proved of considerable value in the initial design of the recombining plants to be installed in Asia. With commercial production about to be undertaken, research in this field, supported financially by the Dairy Industry Research Fund, is being intensified.

An experimental recombining plant is being set up on a pilot-plant scale. Besides providing necessary information on the precise technical requirements in the materials supplied from Australia as ingredients for the various recombined products, the investigations are yielding information on the processes to be used and providing opportunity for the training of those responsible for the technical control of the Asian plants. The Division, by continuing to provide a backing of appropriate and specialized research activity, intends to match the new enterprise of the Dairy Produce Board that is designed to extend the market for Australian dairy products in Asia.—*Division of Dairy Research.*

Export of Cheese-making Machinery

One of the major current changes taking place in the food-manufacturing industry is the conversion of cheese-making from a traditional and largely manual art to a fully mechanized and, ultimately, an automated process. The change will result in a saving of labour, in far more hygienic operation, and in more effective control of the variables affecting the quality of the product.

In the field of Cheddar cheese manufacture (which accounts for over 90% of Australian production) the Division of Dairy Research initiated work more than ten years ago. This early start, together with considerable concentration of the resources of the Division into this project, have resulted in the production in Australia of cheese-making machinery which has attracted the interest of all major cheese-producing countries.

The automatic curd milling, salting, and hooping unit, which covers one of the most labour-demanding parts of the manufacturing process and is in use in many Australian factories, is now being exported. Two machines have already been sent to the United Kingdom and two to the United States and reports from these countries suggest that more units will soon be going overseas.—*Division of Dairy Research.*

Salmon

The Australian salmon industry is one of the largest beach and estuary fisheries in Australia. Yet evidence exists which suggests that the inshore schools on which the fishery concentrates might be only a proportion of the total population. If this were true the salmon catch probably could be increased by fishing at sea, but if it were untrue then probably the industry already exploits this stock to the full and perhaps control measures should be applied. Obviously, an estimate of total population size is needed as soon as possible. There are various ways of making such an estimate; one consists of first estimating the number of females (from a knowledge of total eggs spawned and the average number of eggs produced by each female) and then using the sex ratio to estimate the total population. However, for this method one must be able to identify the salmon eggs and larvae; a task often complicated by the small degree of distinction that exists between the eggs and larvae of different species. A critical problem then has been to obtain a description of the eggs and larvae of the salmon so that they could be identified in plankton catches and counted. A major step forward in this work has recently been made in this Division. Using milt from an identified male it has been possible to fertilize eggs obtained from a ripe female, and then to watch and record the developmental stages of the embryo within the egg, and subsequently the developmental stages of the larva up to 120 hours of age. Further work will now be started, by experimenting in aquaria, and by obtaining an overlapping series of larvae from the sea.—*Division of Fisheries and Oceanography.*

Bluefin Tuna

Six bluefin tuna grounds are exploited in Australian and New Zealand waters; two by Australian fishermen and four by Japanese. A knowledge of the relations between stocks in these six grounds is of importance to development of fishing operations on these grounds.

In 1962 juvenile stocks of bluefin tuna were found in the Albany area and, on subsequent analysis of length frequency distributions, three distinct groups were detected. A total of nine groups has now been detected; three in each of the waters of New South Wales, South Australia, and Western Australia. However, tagging operations have shown that these groups are not distinct. One group is common to the three State grounds, one group is common to New South Wales/South Australian waters, and another group is common to South Australian/Western Australian waters. There remain two other groups for which no connexions have yet been found.—*Division of Fisheries and Oceanography.*

Phosphorylation of Alcohols

Phosphate esters—organic derivatives of phosphoric acid—are of paramount importance in the functioning of living cells. The so-called "biological phosphates" play a key role in enzymic reactions of all kinds, and a very great amount of biochemical research is concerned with how these compounds perform their unique function in the chemistry of life. Such research often requires initial preparation of the

biological phosphate in the laboratory. For example, laboratory synthesis makes possible the introduction of radioactive atoms into the phosphate, and this radioactive labelling then allows the molecule to be traced in a biological reaction. The preparation of organic phosphates has thus become a very active area of research. Arising from a study of phosphonic acids in a program of organometallic research, a new method for preparing organic phosphates has been discovered. The reaction is easy to carry out; it has high specificity and gives high yields of pure products. By its use, certain phosphates have been prepared for which a synthesis was not formerly known.—*Division of Organic Chemistry.*

FM Communication with an Optical Carrier Wave

The principles of a frequency-modulated system using a light wave as carrier have been demonstrated over a link of about 1 mile. With a 2 watt white-light source, useful voice communication can be established. Links of 30 miles should be readily obtainable.

The system involves a tiny Fabry-Perot interferometer, whose plates are separated by barium titanate transducers. The application of an audio-frequency voltage to the latter changes the interferometer plate separation, in synchronism, and modulates the frequencies of the spectral maxima transmitted. An identical interferometer is used in the receiver, in front of a photomultiplier tube, the interferometer being servo-controlled to follow the spacing changes of that in the transmitter. The electrical voltages necessary to achieve this can be applied to an acoustic speaker system.

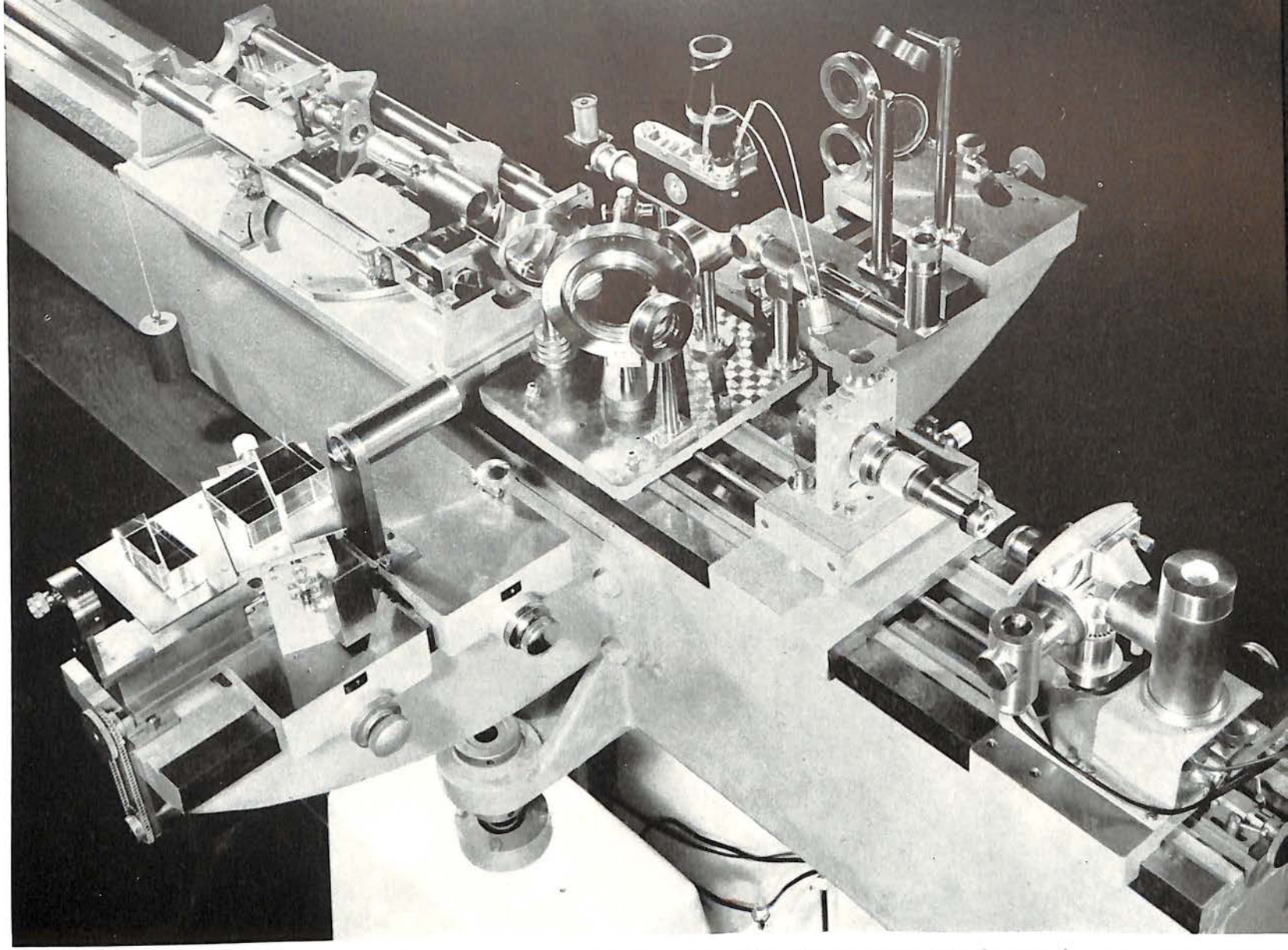
In practice, the interferometers are used in conjunction with telescopes to increase the efficiency of the system.

FM systems turn out to be much less affected by atmospheric scintillation than are AM systems. Advantages of optical communication are freedom from interference from or with radio-frequency channels, and high directivity. However, it is comparatively noisy and so is unlikely to be useful for high-fidelity transmission.—*Division of Physics.*

Thermal Expansion at Low Temperatures

The physics of the solid state at very low temperatures has developed very rapidly in recent years and has important practical applications. A considerable amount of interesting information has now been gathered about the thermal expansion and contraction of various solids at very low temperatures from the use of new and very sensitive techniques developed for determining length changes. These techniques, which involve comparing small electrical capacitances, allow movements smaller than one-thousand-millionth of an inch to be detected.

The expansion of many cubic metals down to a few degrees above absolute zero has been found to be much as was expected from simple theory and from measurements at more normal temperatures, but, within a few degrees of absolute zero, the contribution from the conduction electrons, which was hitherto undetected, has been observed to become significant. In the alkali halide family sodium and potassium



An interferometer for measuring aberrations in microscopes and small camera lenses. This equipment was used also for research on interferometer design.

Above

Calibration of a standard lamp on the 5-metre photometric bench. The light from the lamp is measured by means of a special photocell.

Below

During the past year spectroradiometric equipment was obtained by the Engineering Section to study the thermal radiation characteristics of engineering materials. This information is essential to the research programs on solar energy utilization and radiative heat transfer. The equipment permits the detailed study of the wavelength range from 0·25 microns in the ultraviolet to 25 microns in the far infrared region. The photograph shows a heated cavity reflectometer, infrared spectrometer, integrating sphere, and associated controlling and recording equipment. Reflection and transmission of heat and light for either smooth or rough materials as a function of incidence angle can be precisely measured.

salts show interesting differences, which can be related to their elastic properties and to the sizes of the atoms. Glasses show rather large negative expansion coefficients, that is, they contract markedly on being warmed up from the lowest temperatures, as also do the metals invar and chromium. Those materials that have diamond-like structures, such as silicon and germanium, are puzzling in that they first expand on warming, then contract, and later expand again. Metals of non-cubic structure, including zinc, cadmium, magnesium, and bismuth, are now being examined. Generally, these metals show very different behaviours in different directions in the crystal.—*Division of Physics.*

Identification of a Radio Source

One of radio astronomy's most exciting vistas is that of being able to penetrate beyond the furthermost optical horizons, and so provide glimpses of the Universe at an earlier stage of its development than is currently available by optical methods. The extent to which it can succeed in doing this, however, is dependent upon the identification of a sample of the nearer radio sources with objects which can be studied optically. For such identifications, the positions of radio sources must be known with high precision, and the most accurate method available for this at the present time—observation of the precise times at which a source is obscured and uncovered by the Moon—was exploited during the year with particularly interesting results using the 210 ft radio telescope of the Australian National Radio Astronomy Observatory at Parkes. This technique can be used only with a large and fully steerable instrument.

A radio source in the constellation Virgo, catalogued as 3C273, has been recognized for some years past but its position was not known accurately enough for identification with an optical object to be attempted. Data obtained with the 210 ft radio telescope at several occultations during the past year, however, have indicated that this source is a doublet and have provided the position of each component with a precision higher than has been available before for any radio source. With this precise positional information optical astronomers of the Mt. Wilson–Palomar Observatories have identified the source as a thirteenth magnitude star-like object, an unusual feature being an associated faint wisp or jet of nebulosity whose tip coincides with one of the components of the doublet. The apparent luminosity of the object, combined with the fact that it shows a red shift of about one-sixth of the velocity of light, and the associated jet, present puzzling features which have not yet been resolved.

The identification of radio source 3C273, however, provides another instance of how radio astronomy tends to direct attention to parts of the Universe where unusual and challenging events are taking place.—*Division of Radiophysics.*

Magnetic Fields in Remote Galaxies

One of the most important achievements of the 210 ft radio telescope of the A.N.R.A.O. at Parkes in the first year of its operation—and one that marks the opening of a new chapter in radio astronomy—has been the observation of magnetic fields in regions of space well outside the Milky Way system. It is the first time that detailed observations of this kind have been possible.

The presence of magnetic fields within our own Galaxy was first invoked to account for the acceleration of cosmic rays and the polarization of starlight, and there is now adequate experimental evidence for the existence of such fields, although there are uncertainties as to their strength and distribution. It is likewise difficult to account for the spiral structures of external galaxies without an assumption of a magnetic field, and the only workable hypothesis so far proposed for the generation of the powerful radio waves that are observed from distant galaxies is that they originate from electrons moving with speeds approaching that of light in a magnetic field.

A distinguishing characteristic of radiation originating in a magnetic field is its polarization, and from the outset the 210 ft radio telescope was provided with a rotating feed holder so that it would be suitable for polarization measurements. Almost immediately success was scored when the northern component of the central double source of Centaurus A (one of the nearer of the external galaxies, some 13 million light years away) was found to exhibit considerable polarization, while some of the outer regions of this extended object showed polarization as high as 40%. Measurements of the polarization at different wavelengths show that this is a function of wavelength and hence provide means for determining the direction of the original magnetic field and information about the field existing in the intervening space. Linear polarization has also been found in 20 of 50 other radio galaxies that have been investigated.

These observations are still in a preliminary stage but are significant in that they have confirmed the synchrotron mechanism of the radio emission of radio waves from these sources; demonstrated that magnetic fields exist over enormous distances in these objects and provide means for determining their structure; and made available an additional tool for studying the magnetic field within our own Galaxy.—*Division of Radiophysics.*

Shapes of Atoms in Molecules

Exploitation of the extensive diffraction data available in X-ray studies of crystal and molecular structure is dependent on the adequacy of theoretical atomic scattering factors. In earlier studies, a better approximation to the spherically averaged scattering factor was computed from refined poly-detor approximations to atomic structures that permitted a better accommodation of electron correlation effects. Further development has necessitated study of aspherical scattering factors to take account of the intrinsic asymmetry of the electron charge distribution, of which there are two components—a centric and an acentric (or antisymmetric). Calculations have been made for N, O, F, P, S, and Cl in sp^2 and sp^3 hybrid valence state approximations.

With the extension of the study to aspects of intrinsic asymmetry, there have arisen various questions regarding the significance of the results for detailed structure refinement procedures. The calculations have revealed the potential existence of hitherto unknown sources of error of such magnitude that previous claims of high accuracy must be accepted with considerable reservation. The reasons why most X-ray electron distribution studies have failed to yield the type of information consis-

tent with current theories of chemical bonding may be clarified, and it is apparent that extensive modification of present-day Fourier and least-squares refinement procedures will be required. The value of the X-ray method as a powerful means of studying the spatial distribution of electron density about atom centres in molecules should be considerably enhanced by the modified procedures.

Examination of a model system involving a nitrogen atom in the sp^3 hybrid state indicates that the use of spherically averaged curves can introduce spurious atomic shifts of about 0·02Å and considerable apparent thermal anisotropy, and these erroneous parameter adjustments have seeming high reliability as assessed by customary criteria of accuracy.—*Division of Chemical Physics.*

Structure and Properties of Liquids

The detailed arrangement of molecules in a liquid and the way in which the forces between the molecules determine this arrangement have hithterto defied a satisfactory theoretical description. Understanding of this question would be of great importance in many branches of physics and chemistry. Recent work has made considerable progress in this driection. A description of the structure of a liquid or highly compressed gas in terms of a disordered "tunnel" structure has been developed; on this picture most of the disorder in the structure of a liquid arises from the fact that whole lines of molecules can move randomly along tunnels of which the walls are formed by neighbouring lines of molecules. This picture is in quantitative agreement with experimental structural data from X-ray and neutron diffraction, and is sufficiently simple to permit detailed calculations of the way in which macroscopic properties are determined by the forces between the molecules. Thus experimental data on gases can be used to determine intermolcular forces and this information can in turn be used to predict the properties of liquids. The results of these calculations are in encouraging agreement with experiment for simple liquids. Important applications to the properties of liquids at high pressures, solutions, liquid surfaces, and multilayer adsorption are being studied.—*Division of Physical Chemistry.*

A New Reaction Technique

Recent work on the chemical properties of atoms has led to the development of a technique which has provided both new methods for studying reaction mechanisms and new processes for making conventional materials, and has also led to the fabrication of completely new compounds. In each case the technique makes use of the atomic species of conventional reagents.

Atoms of such gaseous reagents as chlorine, nitrogen, hydrogen, and oxygen may conveniently be produced by streaming the gases at fairly low pressures through a high frequency field. Such a field is present in the tuned inductance of a radio-frequency amplifier or oscillator, or in the waveguide system attached to a microwave generator. Various types of apparatus capable of operating in the region 1–50 megacycles per second (Mc/s) or at 2450 Mc/s have been set up.

Among several new discoveries it has been found that zirconium and hafnium oxides, which are white and are electrical insulators, may be reduced, in the atomic

hydrogen from the 2450 Mc/s generator, to form golden materials of high electrical conductivity. The properties and structures of these hitherto unknown materials are proving of great interest.

Mechanisms involved in the gasification of carbon (burning with oxygen, formation of methane with hydrogen, and the water-gas reaction) have been studied using atomic oxygen, atomic hydrogen, and hydroxyl radicals produced from water vapour. Considerable light was thrown on the processes involved, in particular on the role of the somewhat hypothetical "active sites" supposed to exist on carbon surfaces. Publication of these findings has resulted in the commencement of similar investigations in the laboratories of Pennsylvania State and Yale Universities in the United States of America.

Details of the new technique have also been made available to workers in several of Australia's industrial research laboratories, and one company has set up a section to investigate the properties of some of the new compounds which can thus be prepared.—*Division of Mineral Chemistry.*

A New Technique for Studying Crystallization Processes

The phenomenon of crystallo-luminescence, that is, the emission of light during crystallization, has been known for a long time, but neither its origin nor its significance has been understood. Recent work has shown that crystallo-luminescence requires the presence of certain heavy-metal impurities which, by acting as crystal phosphor impurities, convert into light some of the energy which is released as the crystal lattice grows. A study of the shapes and time distribution of the light pulses emitted in the early stages of crystallization provides a new and powerful tool for solving the fundamental questions: what is the nature of a crystallization nucleus, and how do nuclei initiate crystal growth and influence the later stages of growth? These questions are of vital importance in chemical, metallurgical, and semiconductor fields of research and in the production of pure or mixed crystals having special qualities. There are tremendous potentialities for changing and improving the bulk properties of materials by eliminating the many imperfections that exist in crystals formed by conventional methods.—*Division of Physical Chemistry.*

An Unusual Natural Protein

All Divisions of C.S.I.R.O. are confronted at various times with unusual or even exotic problems put to them by members of the general public. Sometimes these problems can be solved quickly and with little effort, and the scientific results often prove to be of unusual or unexpected interest.

The natives in the Rabaul area of New Guinea believe that pythons follow a ghost at night and that in order to light the way the snake carries a pearl in its mouth. This pearl it spits out and then picks up again, whereby the pearl becomes luminous. A sample of such a "pearl belong snake" was received from Mr. F. E. Towner of the Police Station, Rabaul. It was a hard, round, glassy object, about $\frac{1}{4}$ in. in diameter,

and chemical tests showed it to be protein, presumably keratin, the type of protein that comprises horn, hair, finger-nail, and similar material. An amino acid analysis by the Division of Protein Chemistry revealed that the "pearl belong snake" has a very high content of methionine, a quite unusual feature for any protein. Since many Divisions of C.S.I.R.O. are interested in proteins, from the biosynthesis of these substances in plants and animals to, say, the shrinkproofing of a woollen blanket, efforts are being made to discover the biological origin of this most unusual member of the protein family.—*Division of Organic Chemistry.*

Conformation of Soluble Proteins Extracted from Wool

All proteins in solution rotate the plane of polarized light because they contain numerous asymmetric carbon atoms. In addition, the optical rotation is influenced by the manner in which the polypeptide chains are folded, and the well-established fact that the optical rotation of protein solutions becomes more negative when the protein is denatured is evidence of this. In many proteins the polypeptide chains are partly in the form of a helix with some 3·7 amino acid residues per turn—the α-helix—and this is the structure most likely to contribute to the optical rotation of the native protein.

Moffitt, Yang, Doty, and others have shown that the conformation of proteins can best be investigated by measuring the relationship between wavelength and optical rotation. If it is assumed that the protein exists either as a random coil or as a right-handed α-helix, comparison of the optical rotatory dispersion measurements with those obtained from synthetic polypeptides, known to exist entirely as the helix, gives an estimate of the helical content of the protein.

The soluble extracts from wool keratin may be fractionated into two main classes of proteins, one with a much higher sulphur content and the other with a much lower sulphur content than the wool from which they are derived. Optical rotatory dispersion measurements on the former group showed that they exist in solution in the random-coil conformation. Even in a solvent such as 2-chloroethanol, which favours the helix conformation much more than water, only about 10% of the protein is in the helical conformation. The reluctance of this group of high-sulphur proteins to take on appreciable helical conformation supports the idea that they originate in the amorphous matrix of the fibre. Inability to form a helix is also expected in view of their high content of residues such as proline which inhibit helix development.

The low-sulphur group of proteins on the other hand give values corresponding to about 50% helical content. This is an extraordinarily high helical content for a protein whose disulphide cross-links have been severed. In 2-chloroethanol the helical content is increased to about 60% and it is possible that this represents an upper limit for the helical content of the organized microfibrillar protein. The conformation in aqueous solution appears to be thermodynamically preferred, for, although on converting the protein to the random-coil form by means of denaturing agents such as heat or urea the optical rotation is reversed, the original value is restored when the denaturing agent is removed.—*Division of Protein Chemistry.*

N-Acetyl Groups in Wool Proteins

Two classes of proteins can be extracted from wool, the first with a higher sulphur content and the second with a lower sulphur content than the original wool. The "high-sulphur proteins" have molecular weights in the range 10,000 to 27,000 and the "low-sulphur proteins", which are currently believed to constitute the major structural crystalline region of the wool fibre, have molecular weights around 60,000.

If, like other large proteins, the wool proteins consist of non-cyclic polypeptide chains it should be possible to identify the amino acids at the "amino end" and at the "carboxyl end" of the chains. With a single molecular species only one end group would be identified for each end of the chain. End group determinations on wool and on the soluble proteins from wool have revealed a variety of *N*-terminal and *C*-terminal amino-acid residues. The extracted proteins showed the same distribution of end groups as did whole wool. These are individually present only in very small amounts and no one end group in itself is present in sufficient concentration to be an end group of a homogeneous molecule. Strong evidence has now been obtained that at least some of the amino end groups of wool and of the high-sulphur and low-sulphur proteins of wool are masked by acetyl groups. In this respect they resemble ovalbumin, cytochrome c, tobacco mosaic virus protein, and other proteins. On the other hand, one wool protein classed with the high-sulphur group has been shown to have arginine as an *N*-terminal amino acid.

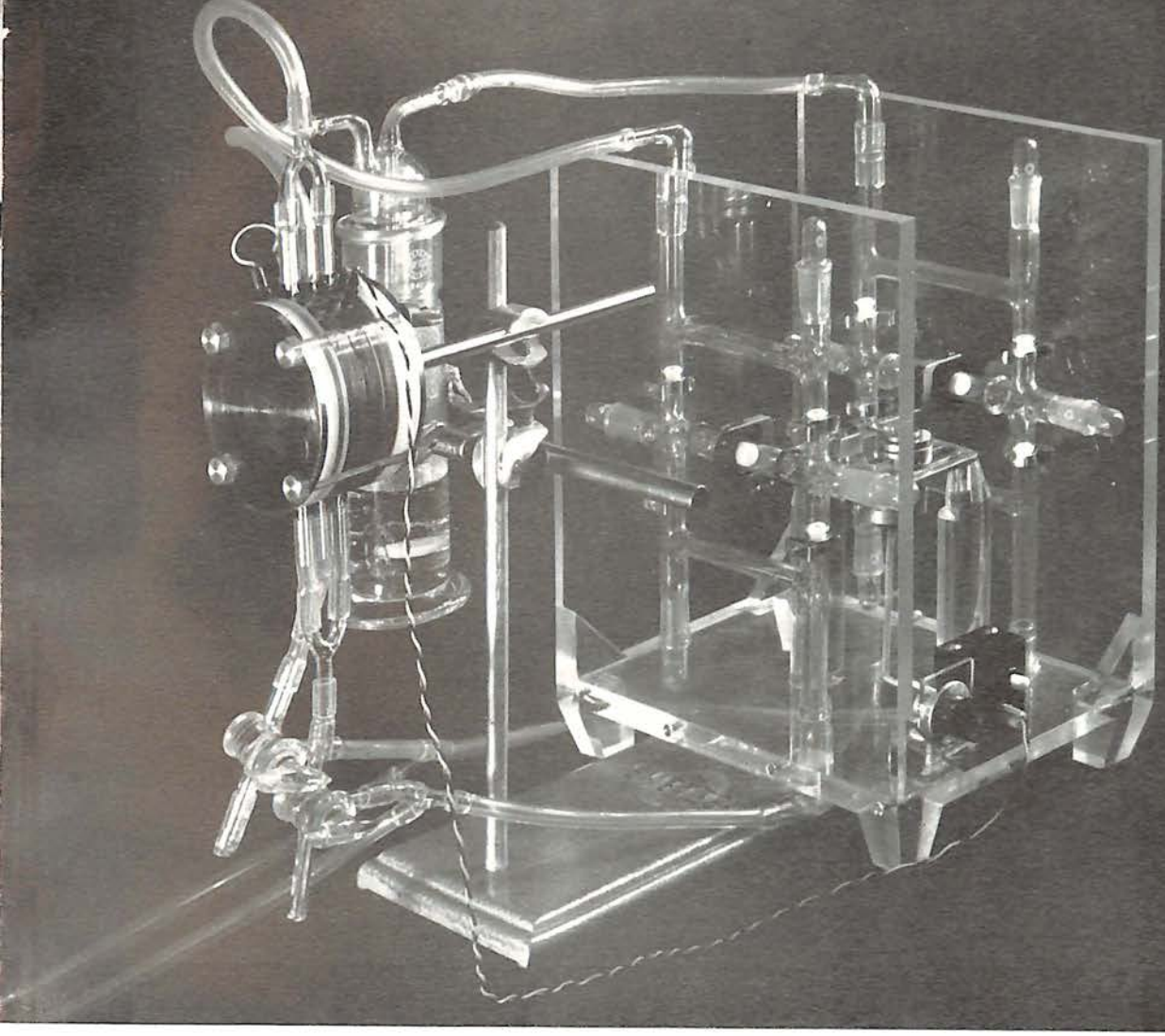
These results suggest that traces of amino-acid end groups which are present in the soluble proteins of wool are either formed by random rupture of the main polypeptide chain or constitute the ends of short peptides adsorbed on the protein molecules.—*Division of Protein Chemistry.*

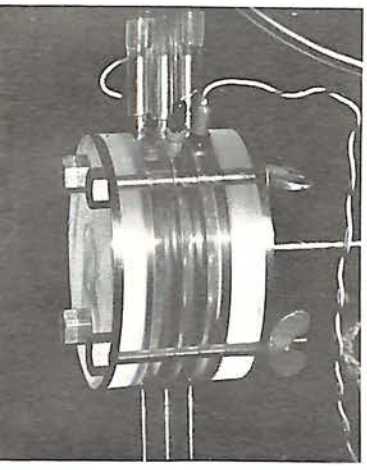
Catalyst for Fuel Cells

The name "fuel cell" was first used in 1890 to describe an electrolytic cell which could generate electrical power directly from low-cost fuels such as coal; by this means it was hoped to double the efficiency of power generation. The idea has never proved to be commercially feasible, but in the last five years cells utilizing relatively expensive fuels, such as hydrogen, have been developed overseas for use as power plants in manned space vehicles.

The hydrogen fuel cell can operate at normal temperatures and certain types employ an organic ion exchange resin membrane as a solid electrolyte. In such cells a very active catalyst is needed and the most successful has been platinum, which, of course, adds considerably to the total cost of the cell. Good contact between the catalyst and the ion exchange membrane is essential for efficient operation, and during the course of a study of fuel cell reactions a novel process has been developed by which the catalyst is deposited directly on to the membrane surface by chemical reduction.

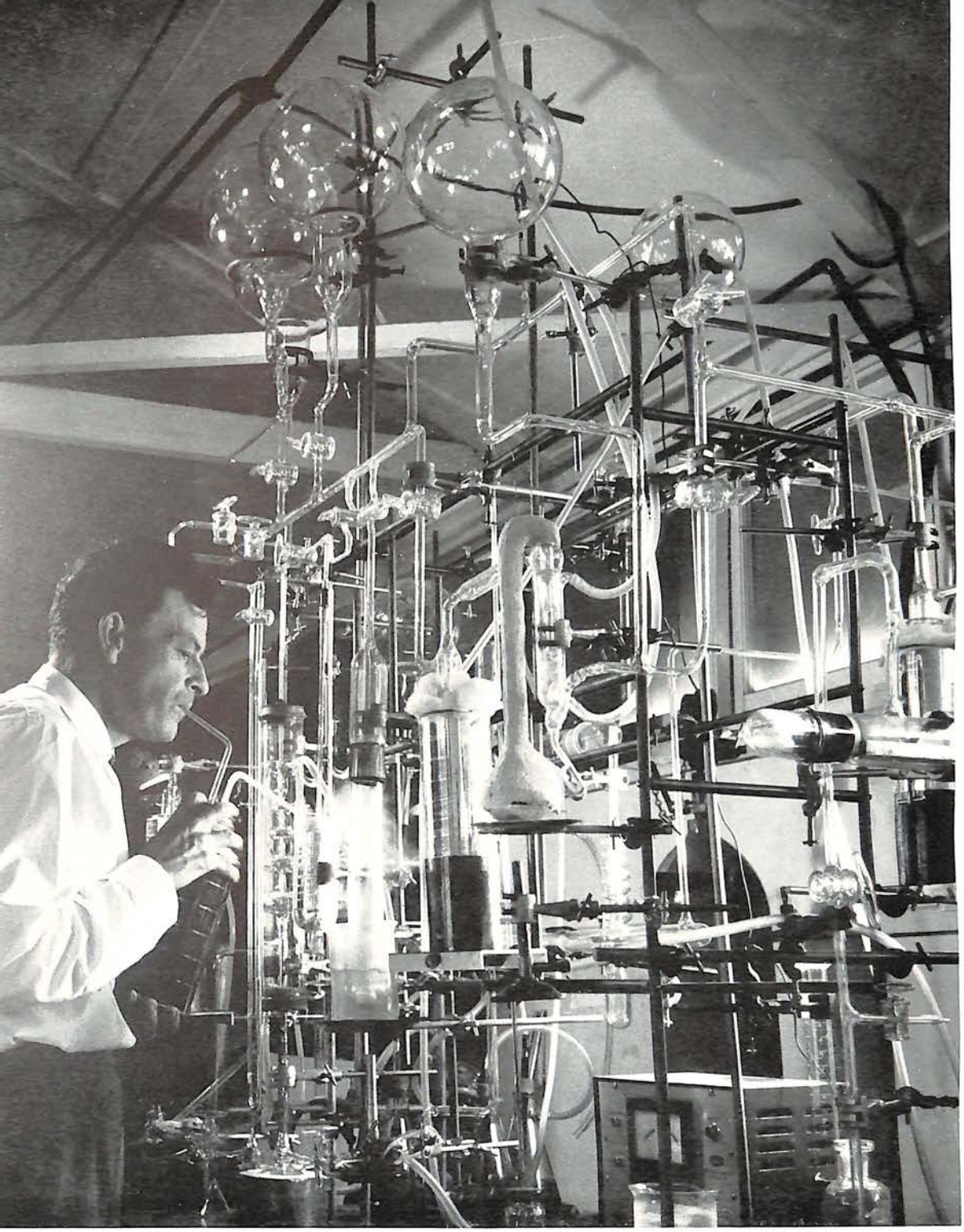
The surface of the membrane is covered with negatively charged sites and it is possible to adsorb on to these sites a positively charged compound which is capable of reducing platinum in solution. When the membrane with the adsorbed species is immersed in a platinum solution, reduction to the metal occurs adjacent to the sites



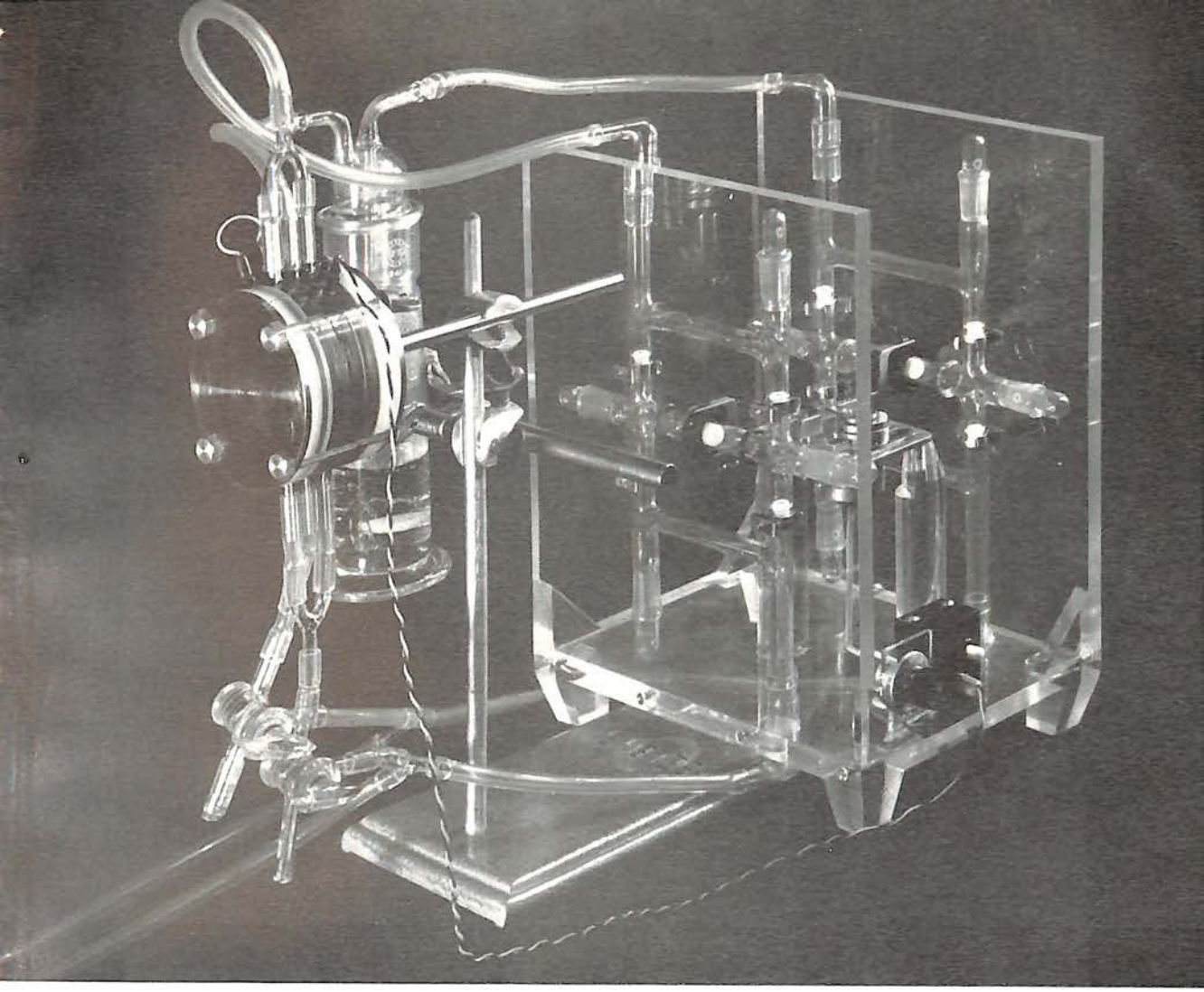


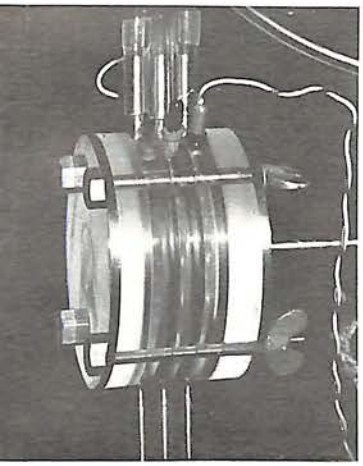
The experimental fuel cell battery illustrated at the left consists of two cells, each with two gas compartments, one containing hydrogen and the other oxygen, separated by a cation exchange membrane which acts as an electrolyte for the transfer of hydrogen ions. Deposits of finely divided platinum, on both faces of the membrane, catalyse the two electrochemical reactions: (i) oxidation of fuel (hydrogen) and (ii) reduction of oxidant (oxygen or air), the final product being water. Electrons released at the fuel catalyst electrode are collected, and in passage to the oxidant electrode through an external circuit constitute a low-voltage electric current. The cell developed at the Division of Mineral Chemistry has been designed to permit easy interchange of membranes and catalyst electrodes, and for the study of both liquid and gaseous fuels.

In the experimental assembly illustrated above, hydrogen and oxygen are recirculated through the fuel cells to study the membrane–water equilibrium and removal of product water. Power generation is demonstrated by operating the pump motor directly from the fuel cell battery.



Apparatus for studying the surface area of calcium sulphate hemihydrate by gas adsorption. An investigation of the physical changes that occur in hemihydrate during the calcination of gypsum throws light on variations in the setting time of plaster of paris.





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which will carry the current through the membrane. Consequently, for a membrane with a discrete number of current-carrying sites less platinum is required than is currently used in the mechanical methods for catalyst impregnation of membranes that are employed overseas.

A fuel cell employing a catalyst deposited by this new technique of chemical reduction was recently demonstrated at the First Australian Conference on Electrochemistry. It was successfully operated by members of the public over a period of seven days.

The resultant saving in platinum by the method described here is an incidental feature of the current research program, which is also revealing how the activity of the catalyst may be increased. The main object of the project is the application of this new knowledge to the catalysis of cheap organic fuels.—*Division of Mineral Chemistry.*

Organic Cloud-Seeding Agents

At present, rain-making efforts are based exclusively on the use of silver iodide as a cloud-seeding agent. However, this material has many disadvantages, and considerable effort has been expended during the past 10 years in searching for a more suitable substitute that would combine the necessary requirements of cheapness, non-toxicity, low solubility, and resistance to decomposition by light. To this end, a comprehensive survey of organic compounds has been undertaken, the results of which are most encouraging. It has been found that a number of steroids and fluorene derivatives possess ice-nucleating properties comparable with those of silver iodide and, in particular, that the nitrogen-containing compound α-phenazine surpasses silver iodide in this respect. It appears that its activity arises from the very close similarity between its crystal structure and that of ice. There is a strong possibility that α-phenazine could supersede silver iodide as a cloud-seeding agent, and field tests await only the assurance that the compound is completely non-toxic.—*Division of Physical Chemistry.*

Atmospheric Radiation

The ultimate source of energy for all atmospheric motion is radiation received from the Sun. The various processes which this energy undergoes, until it is finally re-radiated to space in quantity equal to its initial amount, are the basic causes of all dynamical effects in the atmosphere, and hence of weather and climate. A knowledge of the geographical distribution of radiation at both ends of the atmospheric heat engine is thus essential to meteorological studies.

A simple radiometer, suitable for measuring both net radiation and its components, has been developed and is now manufactured commercially. This is finding wide use in Australia and overseas, not only in meteorological work but also in studies of water conservation, agricultural research, solar heating, etc. The sensitivity is such that two instruments can be used to measure the divergence of long-wave radiation flux during clear nights. One significant finding is that such divergence provides an important key to the understanding of fog formation.

An even simpler version of this instrument is now under development, which, carried at high levels in the atmosphere, will measure the long-wave radiation loss to space, i.e. the heat loss at the condenser of the atmospheric heat engine. It would thus supplement with important detail the broad-scale pattern of atmospheric heat loss now becoming available from the "Tiros" satellites.

In many contexts it becomes necessary to supplement the network of measurements by estimates of radiation components based on more generally familiar variables. A formula for the long-wave radiation received at the surface from the atmosphere has been derived in terms of the single variable, screen temperature: this provides, over a comprehensive range of world-wide conditions, more satisfactory agreement with measured values than previously widely-used formulae involving both temperature and humidity.—*Division of Meteorological Physics.*

Heat Budget and Evaporation of the Indian Ocean

Throughout 1963 and 1964 ships of many nations are taking part in the International Indian Ocean Expedition to study the oceanography, biology, and meteorology of an area hitherto comparatively neglected but one of increasing significance as a food source for India and south-east Asia.

Through its heat and vapour transfer to the air, deriving from the radiation at the surface, the Indian Ocean is a major source of atmospheric energy and one of particular relevance to the monsoons of India and northern Australia. A radiation program is being carried out on cruises of H.M.A.S. *Diamantina* and *Gascoyne*. With recording of the net income of radiant energy is combined automatic photography of the cloudiness of the sky at frequent intervals. This is providing basic data which, married with the wealth of cloud distribution data currently being secured by "Tiros" satellites, should lead to reliable estimates of radiation income over the whole Indian Ocean.

Accurate measurements of sea surface and air temperatures, wind, etc. are made for the evaporation study. The turbulence of the wind over the sea needs to be measured also, but hitherto ship motion has made this very difficult. However, an apparatus on a new principle is being developed to yield the desired information from measurements of the wind fluctuations of such high frequency that the slow rolling motions of the ship can easily be eliminated.—*Division of Meteorological Physics.*

The Moon and the Weather

The age-old belief that the Moon has an effect on the weather has long been a subject of controversy but it has now received scientific support as a result of recent work by the Division of Radiophysics. A remarkable relation between precipitation and phase of the Moon has been demonstrated, extreme precipitation tending to occur near the first and third quarters of the lunar month (particularly 3–5 days after both new and full Moon) while the second and fourth quarters are correspondingly deficient in heavy rainfall.

This was the first in a series of discoveries during the past year which, although too recent to have yet been fully evaluated, promise to have important repercussions in the field of atmospheric physics. The association between precipitation and freezing nuclei—known to exist from previous work—suggested that the freezing nucleus count might also vary during the lunar cycle; and this indeed is convincingly demonstrated in the various series of measurements which the Division has carried out in recent years. Next, examination of radar observations of meteors for both the northern and southern hemispheres showed that the hourly meteor rate also varies in a similar manner, i.e. with maxima near first and third quarters.

These results are consistent with the meteor dust hypothesis (in which heavy precipitation follows some 30 days after the entry into the Earth's outer atmosphere of dust of meteoritic origin), the significant new factor just revealed being interception, and thus modulation, by the Moon of meteoritic material which would otherwise have entered the Earth's atmosphere.

Confirmation of this role of the Moon in intercepting particles which would otherwise have reached the Earth has also emerged from a study of the incidence of magnetic storms. These storms, which are well known to be due to the arrival of streams of high-speed particles from the Sun, show a remarkable tendency to avoid the period around new Moon (when the Moon is directly between the Sun and the Earth); they occur most frequently in the first and third quarters of the lunar month. In both cases, however, the magnitude of the effects produced by the Moon make it necessary to invoke a process additional to that of simple physical interception: the indications are that electrostatic charges are involved.—*Division of Radiophysics.*

Strength of Paper

Considerable controversy has taken place in recent years over the nature of the forces holding cellulose fibres together in a sheet of paper. It is now generally accepted that hydrogen bonds develop within and between fibres as the paper is dried, but arguments have continued on the way in which these bonds contribute to the strength of the sheet. One view is that interfibre bonding depends on the plasticity, or conformability, of the wet fibres, which allows them to be pressed into intimate contact. Against this, the opinion has been maintained that external fibrillation, i.e. the presence of minute fibrillae on the fibre surface, is essential for adequate interfibre hydrogen bonding to develop, and that the plasticity of the fibre interior is of secondary importance.

This question has been resolved by means of an experiment in which conformability could be varied while external fibrillation was unaltered, and vice versa. Essentially this consisted of comparing the properties of *Eucalyptus* pulps which had been subjected to the following treatments: (*a*) never dried, i.e. kept in the wet state until the final process of papermaking; (*b*) air dried as pulp in the presence of starch, which was subsequently removed by an enzyme; and (*c*) air dried as pulp. The state of external fibrillation was similar in (*a*) and (*b*), but different in (*c*); this was confirmed by examination of the fibre surfaces by means of the electron microscope. The conformability in (*b*) and (*c*) was similar but was different in (*a*); this could also be confirmed independently. Examination of the strength of paper made from these

pulps showed that lateral conformability of the wet cellulose fibre was in fact the dominant supermolecular factor in interfibre bonding and its associated strength properties, but that external fibrillation may contribute to tearing strength, which is not primarily dependent on bonding. An appreciation of these conclusions is fundamental to the efficient processing of wood pulps for papermaking.—*Division of Forest Products.*

Concrete Reinforcement

Steel reinforcing rods embedded in concrete play a vital part in sustaining tensile loads that cannot be borne by the concrete alone. Efficient transfer of internal stresses from the concrete to the reinforcement can only be achieved when relative movement between the rods and the surrounding medium is prevented. As concrete sets and hardens around the usual types of smooth-surfaced rods a certain amount of bond is developed, but insufficient to ensure that the rods will not slip under heavy loading conditions and allow cracks to develop as tensile forces affect the concrete. Normal practice relies largely on end anchorages to provide positive locking of the rods into concrete structures, the bond developed between the rods and the surrounding concrete being relegated to a very minor place in design considerations.

Using common steel rods, it has been found possible to ensure that greatly enhanced positive mechanical bond is developed by coating the steel with a film of epoxy resin, a synthetic adhesive of great strength and stability, then applying a layer of sand to the resin and curing the combination to obtain a rough-surfaced rod which can be embedded in concrete without end anchorage. Mild steel rods so treated cannot be pulled out of concrete, when embedded more than a few inches, before the steel itself fails in tension. Excellent bond characteristics can also be obtained with resin-treated high-tensile steel wire or bars which yield at high stresses.

Beams fabricated with the coated reinforcement have been made and tested to destruction during the course of collaborative work with industry and also with the University of Melbourne. The beams supported much greater flexural stresses than usual and did not develop serious failure cracks on the underside until extreme loading forces were applied in bend tests.

Publication of details of the technique has brought a variety of enquiries from both local and overseas sources. These include consideration of the use of coated reinforcement in road and rail structures in Australia and Britain, applications to structural components in Japan, and in rock-bolting techniques at the Snowy Mountains scheme.

A useful feature of the method is the anti-corrosion effect provided by the epoxy resin film. The action of salt water or warm moist atmospheres in marine environments can be a serious factor in the breakdown of reinforced concrete as the rods are corroded away and replaced with swollen masses of decomposition products. Typical situations in which the resin-coating technique is being considered largely for its protective value include housing structures in warm moist localities such as Nauru, piling in salty ground-water areas, and harbour works in Australian ports.—*Division of Applied Mineralogy.*

Design of Large-Scale Fluidized Bed Units

Processes which involve the intimate contacting of solid particles with gases are of great importance in chemical engineering operations. However, the technological problems involved are more difficult than those encountered in processing liquids and gases, although much headway has been made in the past two decades in the development of fluidization as a technique for processing solids. Thus, fluidization, which involves the passage of a gas stream through a bed of particulate solids so that it "boils" in a similar manner to a liquid, is being employed on an ever-increasing scale in a wide variety of industries, e.g. minerals processing, oil refining, plastics, and steel production. However, although the literature on the subject is extensive, it contains little positive information on the design of full-scale units.

To overcome this deficiency an experimental program is being conducted with fluidized beds of large cross-sectional area. Data are being obtained on the effect of such variables as bed material, bed depth, bed area, tuyere spacing, and tuyere geometry on the limits of stable operation of single- and multi-stage fluidized beds.

Work so far completed has established the relationship between the proportion of the tuyeres in an assembly that are operating at any given time and the total gas flow, on models up to 64 sq ft in cross-sectional area, with tuyere spacings ranging from 6 in. to 16 in. and with bed depths ranging from 1 ft 6 in. to 8 ft 0 in. Bed materials used have ranged from zircon to silica sand, with incipient fluidizing velocities of 0·1 to 0·36 ft/sec.

The effect on tuyere design and spacing on the bubble pattern in the bed is also being studied over the same range of variables, using motion-picture analysis techniques. This work is yielding promising results on the general problem of fluidization stability in large models.—*Division of Chemical Engineering.*

Scale Control in Sea-Water Evaporators

The economic production of fresh water from saline waters, particularly sea-water, is becoming increasingly important. Desalination by evaporation suffers from limitations caused by the formation of scale deposits on heated surfaces, and these reduce the rate of transfer of heat to the evaporating sea-water, so that costs are considerably increased.

"Spray" or "fog" evaporation, which involves the passage of a fine mist of water droplets suspended in steam moving at high velocity through a steam-jacketed tube, is being used to study methods of preventing the formation of such scale deposits on the inside wall of the heated tube. These experiments are being conducted with sea-water that is obtained from a carefully selected local source, shown to possess the same composition as "standard" sea-water, without detectable dilution or contamination.

It has been found that the addition of very small amounts of low-molecular-weight polymers such as polyacrylic acid to the sea-water prevents the formation of scale, and that the tube surface remains remarkably clean for long operation periods. There

is strong evidence that the polyacrylic acid forms a brittle protective film which alternately strips off and reforms on the metal surface, thus preventing scale deposition.

This regenerating film technique with polyacrylic acid and other polymers may find practical application for the evaporation of sea-water and other scaling solutions.—*Division of Chemical Engineering.*

Methane Production by Carbon-Hydrogen Reaction

Methane is an important constituent of town gas, and much work is in progress at the present time on its synthesis by direct reaction of carbonaceous materials, e.g. coal, with hydrogen-containing gases at high temperature and pressure.

The detailed chemical processes involved in the formation of methane by reaction of hydrogen with various carbons have been determined from small-scale laboratory experiments. From a knowledge of these processes it has proved possible to calculate the rate of methane formation from carbon as a function of the hydrogen and methane partial pressures and of the temperature. Using this information, a mathematical model has been set up of an actual full-scale reactor for the production of methane. Calculation by digital computer has shown that it is possible to predict how a reactor will behave under actual operating conditions. Furthermore, a technique has been devised for determining the optimum operating conditions necessary for the production of the maximum possible amount of methane.—*Division of Chemical Engineering.*

Measurement of Optical Transfer Functions

To obtain a more reliable assessment of an optical instrument than is given by looking at the image, some measure of image quality is needed. A measure often used is the resolving power, or the finest detail that is just visible in the image. But resolving power does not give a full measure of the image and it can even be misleading: some instruments with high resolving power give poor images of the coarser detail. A measure is required that shows how well all sizes of detail are reproduced in the image.

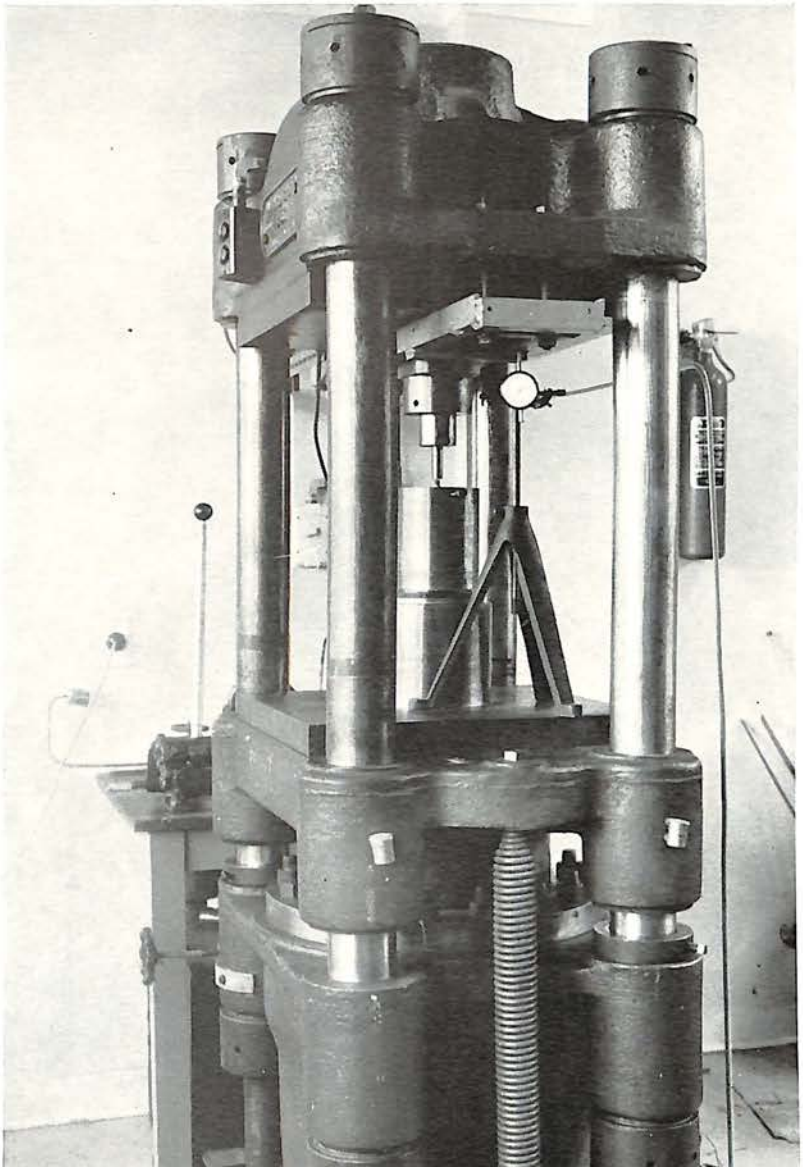
The optical transfer function is such a measure. It applies to objects that have a sine-wave variation of light intensity and gives the contrast reduction of these in the image for different spacings or spatial frequencies of the sine waves; it is sometimes called the frequency response curve of the optical system. Although sine-wave objects are not typical, in principle any object can be synthesized with them, and so the transfer function has general application.

The theory of transfer functions has been studied over some years past, and equipment for measuring them has now been made and tested. This equipment can measure the transfer function of small lenses such as microscope objectives; as sine-wave objects, it uses the interference fringes formed by a special adjustable interferometer. The adjustment is motor-driven, giving a scan of spatial frequency, and the contrast of the image is continuously recorded. Although such measurements are too complex for the routine testing of lenses, they are most valuable when very high quality optical systems are required or when a new lens design is being evaluated.—*Division of Physics.*

High Pressure Research

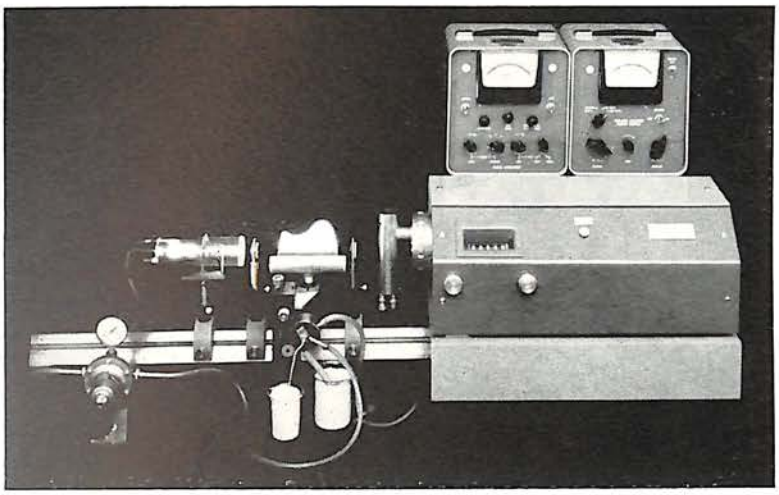
Right

The head-on collision in air of two explosive shock waves. The shocks were photographed, in daylight, with an exposure time of 1/5,000,000 second. Intense shock waves of this kind are being used to investigate the behaviour of matter at extremely high dynamic pressures and high temperatures.

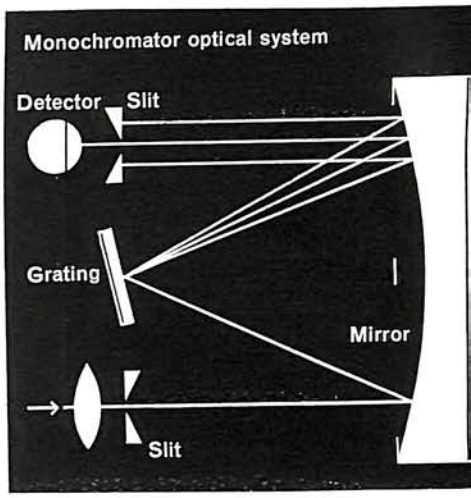


Left

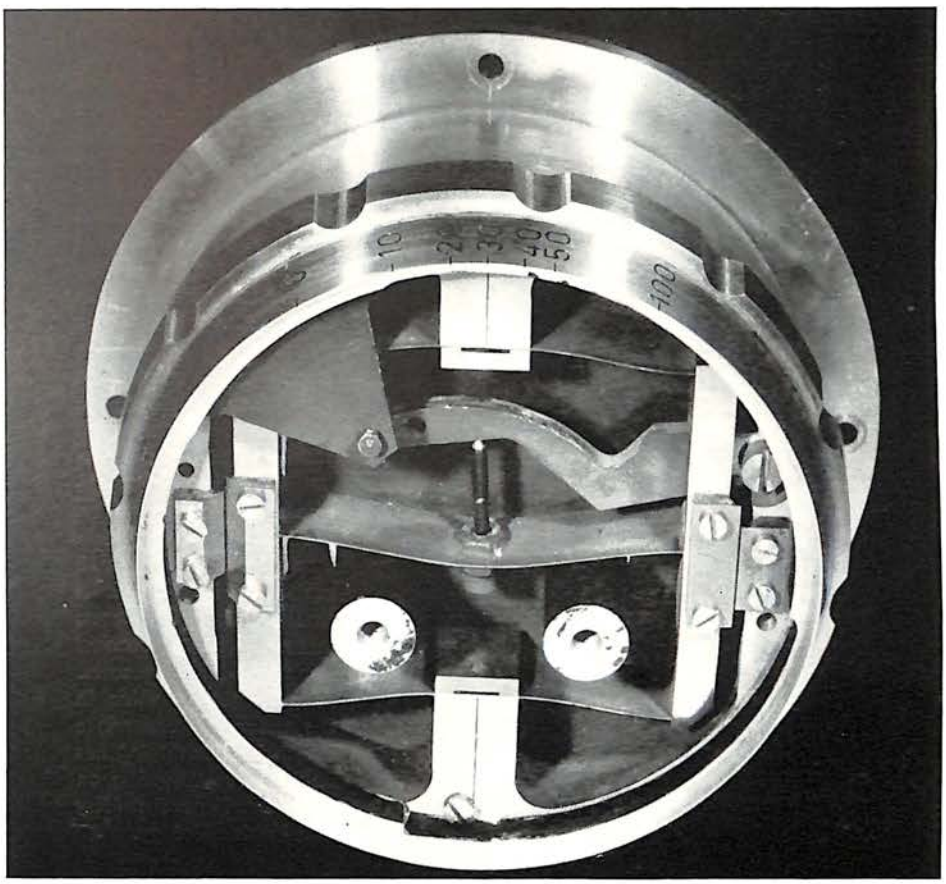
Apparatus for research into the physical and chemical properties of substances at high hydrostatic pressures. A 200-ton hydraulic press provides a supporting pressure of 25,000 atmospheres around a thick-walled steel cylinder, enabling it to withstand an internal pressure of 50,000 atmospheres. The internal pressure is generated by a tungsten carbide piston driven into the cylinder by a subsidiary 30-ton ram, shown mounted on the bottom platen of the press. The apparatus has yielded significant information about the influence of pressure on the rates and equilibria of chemical reactions. In particular it has shown that weak electrolytes, including water, become strong at high pressures. Apart from its value in the theory of electrolyte solutions, this finding has an important bearing on aspects of geochemistry and marine biology.



Australian-made monochromator for analysis by atomic absorption.



Path of light.



Twin-slit mechanism of monochromator for local production.

Monochromator for Manufacture in Australia

With the widespread acceptance, both in Australia and overseas, of the atomic absorption method of chemical analysis developed in the Division of Chemical Physics, there has been a steadily increasing demand on Australian manufacturers for the supply of necessary equipment, such as special light sources and their power supplies, burners, optical rails, saddles and condenser lenses, signal amplifiers, power supplies for the detector, and so on. One major item which up till now has had to be supplied from overseas is the monochromator, whose function is to isolate light of a suitable wavelength from all the light emitted by the lamp.

However, now that diffraction gratings equal in quality to the world's best are being produced on the machine developed in the Division of Chemical Physics (see Annual Report 1960–61, p. 52) it has been possible to design a monochromator suitable for production in Australia. A laboratory prototype has already been built and tested with excellent results. A manufacturing prototype is now under development and it is expected that commercial production of this instrument in Australia will commence about the middle of 1963.

Though its design was stimulated by the success of the atomic absorption method, the monochromator is suited to a wide variety of uses, as in spectrophotometry, spectropolarimetry, and the control of evaporated thin films.—*Division of Chemical Physics.*

Adjustable Slit for Spectroscopy

Adjustable slits whose jaws can be set accurately to any gap width from about one millimeter to as little as a few microns are important parts of spectroscopic instruments. A new design of slit mechanism based on the use of spring flexures has greatly simplified and reduced the cost of construction whilst leading to a slit of improved performance. A very important advantage of this design is its particular suitability for the construction of double slits that can be operated simultaneously by the one mechanism. It is expected that this slit will be used in an Australian-produced monochromator.—*Division of Chemical Physics.*

Improved Interferometer

The units of length are now defined internationally in terms of wavelengths of light and for the realization of such units use is made in most countries of an optical instrument known as the Fabry-Perot interferometer. In its usual form it consists of two optically flat, highly reflecting, non-absorbing surfaces which are parallel to one another. Hitherto, an important limitation in the use of such devices has been in the control of the parallelism of the optical surfaces. This difficulty has been overcome in a novel way: the departures from parallelism are revealed interferometrically, sensed photoelectrically, and corrected by the application of the appropriate voltages to piezo-electric transducers used as mounts for the plates. Even without taking

precautions to isolate the interferometer from the vibrations usually present in a building, this method is so effective that the errors due to lack of parallelism are less than those due to the residual non-flatness of the surfaces (less than 5×10^{-6} mm), irrespective of the separation of the surfaces. This development has widened the possible uses of the Fabry-Perot interferometer. It is expected that automatically controlled interferometers will be used for very high precision length measurement, for the automatic maintenance of precise lengths, for spectral filters to be used in astronomical research, for the evaluation of isotopic abundances, and possibly for the control of optical masers. The device should be capable of being used by semi-skilled personnel. Patent coverage of the invention has been sought in Australia, U.S.A., and the U.K., and it is expected that instruments incorporating the invention will be manufactured under licence in Australia for export overseas.—*Division of Physics.*

Light Sources for Raman Spectroscopy

Raman spectroscopy provides a powerful technique for studying molecular structure and for chemical analysis. One of the main limitations of this method has been due to the fact that commercially available equipment is applicable only to solutions that are essentially colourless.

A new type of Raman light source has been developed which permits Raman spectra of coloured solutions to be obtained. The new lamps and associated electrical supplies are now being manufactured commercially in Melbourne by Ransley Glass Instruments and Techtron Ltd. The apparatus is simple and inexpensive, and is the only commercially available equipment of its type in the world.—*Division of Chemical Physics.*

Deformation of Timber under Load

It has long been known that when wood in service is subjected to a prolonged load, e.g. in bridge structures, house roofs, etc., it undergoes progressive deformation with time. Recent work has shown that a considerable part of this deformation is associated with fluctuations in moisture content, since, in wood held at strictly constant moisture content, deformations are considerably reduced. The possibility thus exists that, in the design of structures where the size of members is chosen primarily to eliminate unsightly deformations of this type rather than to provide a minimum mechanical strength, the reduction or inhibition of moisture content changes in the wood could achieve greater economy of use.

Basic studies of the mechanism by which moisture content changes produce these deformations are being made and experiment has already indicated that there is a very close correspondence between the rate and extent of deformation and the rate and extent of moisture content change. These studies have also shown that changes in the moisture content are able to modify considerably the pattern of internal stresses commonly present in wood. Apart from the scientific importance of these new observations, this work has already enabled treatments to be applied to plywood

panels to reduce some types of distortion that may arise during manufacture. A clearer understanding of the relief of stresses during wood seasoning and the consequent further reduction in the degrade of timber during seasoning is also likely to follow.—*Division of Forest Products.*

Wood Extractives

In order to meet the increasing world-wide demand for paper and pulp products, it will be necessary in the immediate future to use tree species that have not been used previously. Amongst these will be a great number of hardwoods that contain extractives in greater quantity than, and of a different nature to, those in the coniferous species now mainly used for pulp. These extractives can deleteriously affect the production of pulp and paper. Some of the problems encountered in the use of eucalypts have been traced to ellagitannins and an ellagic acid-inorganic ion complex. This knowledge will do much to alleviate some of the problems arising during the pulping of these species.

The factors responsible for the formation of extractives in the tree have been examined. It has now been established that extractives are formed *in situ* from stored or translocated carbohydrate and the amount formed is dependent on the amount of carbohydrate remaining after other growth processes are completed and, furthermore, the amount appears to be more dependent on environmental conditions than on genetical factors.—*Division of Forest Products.*

Cooperative Research on Timbers of the Pacific

Continuing grants from the Governments of New Guinea and Fiji have enabled appreciable progress to be made in studies of the anatomy and properties of timbers growing in the Pacific Islands. These timbers are becoming of increasing importance on the Australian market, and the work is aimed at providing data that will be of value both to Australian consumers and to the forestry administrations concerned. It is progressively resulting in the assessment of the most suitable uses for various timbers and in the rational grouping of timbers with similar properties.

The anatomical features of some 170 species of New Guinea timbers have been studied, leading to the preparation of identification keys. In addition, investigation on some 70 species has covered physical and mechanical properties; natural resistance to stain, decay, and borer attack; treatability with preservatives; and suitability for manufacture of pulp and paper.

Some 30 potentially commercial Fijian species have been investigated similarly, but with particular regard to sawing and machining characteristics and seasoning. In addition, some half-dozen selected species have been studied for peeling and gluing. Sections for microscopic examination from over 150 miscellaneous species of the area have been prepared for use by the Forestry Department.—*Division of Forest Products.*

Pole Drying

The supply, fitting, and maintenance of wooden poles for power transmission and communication purposes in a modern community is an important and costly undertaking. A considerable and increasing part of the cost is due to drying charges, and these, in turn, are being further enlarged by material losses due to drying degrade. A contributory factor is the slowness of present drying methods. There is need to improve the pole supply position by a wider use of free-splitting native species.

Several research investigations have, therefore, been set up with the objective of (i) reducing drying degrade in free-splitting species, and (ii) accelerating the drying rate of slow-drying timbers; for the latter the aim is a reduction in drying time from 6 months to less than 48 hours. Scout studies have shown that this is possible by a change in drying practice from air seasoning to a suitable adaption of vapour drying, steam-and-vacuum drying, superheated steam drying, or boiling under vacuum in a suitable oil.

Other measures under investigation include the chemical treatment of pole surfaces to reduce barrel checking, end-sealing and restraining irons to control end splitting, incising and barrel slotting to relieve drying stresses, and transpiration drying as a possible means of reducing growth-stress damage.—*Division of Forest Products.*

Road Tars

Cheap methods of road construction are vital to the development of Australia, particularly in the outback. The recent trend in roadmaking has been to use bitumen as the binder, despite its considerably higher price compared with coal-tar products. Bitumen has a lower temperature coefficient of viscosity, which makes the road surfaces resistant to breakdown. High temperature susceptibility has the opposite effect, the surfaces being too brittle in winter and too soft in summer.

It has proved possible to make road-tars with flow properties as good as those of bitumen by adding 10% of coal to the tar before distillation, provided that water is present at the beginning of the distillation. Coals of widely differing properties produce this effect. The use of these findings in road construction would not only lower the cost, but would also provide a valuable outlet for coal tar, at present burned as a low-value product. Industrial firms are at present making practical trials using these tars on actual road surfacing.—*Division of Coal Research.*

Volatile Sulphur Compounds in Canned Mutton

Many protein foods evolve small quantities of hydrogen sulphide when heated, and undoubtedly this contributes something towards the characteristic flavour of each food. An excessive concentration of hydrogen sulphide will, however, render most food flavours unacceptable. In the case of canned meat products any volatile sulphur compounds set free on heat sterilization of the can will also cause staining within the can, due to interaction between the sulphur compounds and the metal container.

Research workers have found that there is in mutton a connexion between the nutritional condition of the animal immediately before slaughter and the amount of volatile sulphur products evolved from the meat on subsequent heating. The pH during heating being one of the major factors determining the amount of hydrogen sulphide released from proteins, it was logical to compare the pH of meat from animals in good condition with that from emaciated sheep. It was established that the pH of meat from the latter was abnormally high and was strongly correlated with the higher evolution of sulphur volatiles on heating. Strangely, a similar relationship was not found with beef, where poor nutritive condition of the cattle at slaughter appeared to have little relevance to hydrogen sulphide liberated subsequently.

The source of the hydrogen sulphide is undoubtedly sulphur-containing amino acids such as cystine and cysteine, known to be present in most proteins. These amino acids are also known to undergo reactions at higher alkalinity, which result in the release of free sulphides, and it is probable that similar processes are involved here. The investigations have shown that problems of sulphur staining in canned mutton can readily be avoided by simply ensuring that the pH during processing does not exceed about 6·3. This may be achieved by the addition of lactic acid or by admixture with normal meat.

The findings should facilitate the utilization of some types of mutton which are frequently available in substantial quantities as a by-product of the Australian wool industry.—*Division of Food Preservation.*

New Equipment for Canned Food Sterilization

The successful sterilization of canned foods by heating requires a minimum of heat treatment at the centre of the can, and conventional methods of can sterilization in retorts suffer from the disadvantage that transfer of heat to the centre of the can may be very slow, even with fairly liquid products. The result may well be that the outer layers in the can are over-cooked before the inner portions have had sufficient heat processing. Since bacteriological safety cannot be sacrificed, there is always a risk of inducing undesirable changes in colour, texture, flavour, and nutritive value through over-cooking.

Heating and cooling of cans containing any appreciable amount of free liquid can, however, be greatly accelerated by controlled agitation or rotation of the cans during processing. Application of this principle to the processing of acid foods, such as fruits and fruit juices, which can be sterilized in steam at atmospheric pressure, is now commercially practicable in continuous equipment designed by C.S.I.R.O. research workers and installed in the Canning Section of the Division of Food Preservation. Rapid cooling after sterilization, by spinning the cans under cold-water sprays, is also provided for in the new equipment. Rates of rotation of the cans and rates of travel through the spin cooker can be varied to obtain optimum processing conditions for a given product.

The new continuous spin cooker-cooler is capable of processing orange juice, for instance, at the rate of 24 1-lb cans per minute, and can easily be scaled up for larger-scale commercial production. It is particularly suitable for such heat-sensitive

liquid products as citrus and passion-fruit juices, and tropical fruit purees, and is also excellent for freestone peaches and apricots, which easily become over-soft on cooking. A notable achievement is the successful spin cooking of glass-packed foods, which pass through the treatments of rapid heating and cooling without breakage.

Spin cooking offers no especial advantage with solid packs. Also, low-acid canned foods, such as meat, vegetable, and milk products, require sterilizing at higher temperatures than can be obtained by steam at atmospheric pressure. Extension of spin cooking to the latter poses, therefore, a number of special engineering problems which are now being studied. Should suitable equipment for spin cooking under pressure be developed, it is likely that the range of foods which can be satisfactorily canned will be extended considerably.—*Division of Food Preservation.*

New Information about Eggs

The coagulation of egg white by heat is a phenomenon familiar to everyone, and is due to heat denaturation of egg proteins. The principal protein in egg white is ovalbumin, which can easily be prepared in a pure crystalline state by standard techniques. The purified material is known to have three components which differ somewhat in their electrophoretic behaviour but these differences can be accounted for in terms of the proportion of combined phosphoric acid groups, and ovalbumin has therefore long been regarded as a homogeneous protein.

A study of the denaturation of egg albumin under acid conditions has recently been made and this work indicated that ovalbumin is not as homogeneous as was previously supposed, there being present a small proportion of a component which is much more resistant to heat denaturation than the whole albumin. This substance has been given the name "S-ovalbumin" and is indistinguishable from whole ovalbumin except for its greater heat stability—a fact which was utilized in developing a simple and rapid method of isolation. Further investigation showed that S-ovalbumin occurred in variable amounts in different preparations of ovalbumin, and this variability was ultimately traced to variations within the eggs themselves. It was then found that normal ovalbumin converts slowly to the more stable form, even within the egg, the rate of conversion being greater at higher pH and at higher temperatures. Since shell eggs normally lose carbon dioxide when stored and this leads to an increase of pH within the shell, the variable S-ovalbumin content of eggs with different storage histories and of different age is thus explained. It has indeed been found that, if loss of carbon dioxide, and consequent rise in pH within the egg, is restrained by oiling the eggs before storage, there is correspondingly less conversion of normal ovalbumin to S-ovalbumin.

Since deterioration of shell eggs was also inhibited by oiling, it is logical to enquire whether changes in egg quality, as judged, for instance, by loss of stiffness of the thicker portion of egg white, is related to the S-ovalbumin content of the egg white. Of particular significance in this regard may be the observation that, unlike ovalbumin, S-ovalbumin has the property of inhibiting the gelling of preparations of

ovomucin under certain laboratory conditions. The protein ovomucin is thought by some to be responsible for the gel-like structure of thick egg white, and if the firmness of this part of the egg is adversely affected by S-ovalbumin the fact may be of great importance. Further research is therefore currently being undertaken in order to establish whether interaction between S-ovalbumin and ovomucin has a bearing on the mechanism of breakdown of thick white on storage.—*Division of Food Preservation.*

Detergent Jet Scouring of Wool

The jet principle as applied in solvent degreasing has been extended to detergent scouring of wool. A pilot plant has been constructed and is now being used continuously to ascertain the economics of the process when operated over a period. The plant in its present form consists of four stages of jetting. The wool is conveyed by means of rotating porous drums and, after jetting, the liquor is expressed through normal types of squeeze rollers. The jetting action is shown in the photograph. Another advantage of this type of process is that the size of the plant is much smaller than a conventional scouring machine and in final form would probably occupy only one-quarter of the space of the latter.—*Division of Textile Industry.*

New Techniques for Permanent Setting of Wool

A dry setting technique for permanent pleating and creasing has been developed. By this method, the mill can apply the setting reagent to the cloth during finishing and the tailor will simply be required to press without the addition of any solution; this has not hitherto been possible without wetting the cloth. The new technique has no effect on desirable properties of wool such as handle. This method would be more acceptable than other methods to many sections of the clothing trade that have been reluctant to apply previously developed techniques for permanent pleating which rely on spraying of the garments with setting solution or with water prior to pressing them. Other extensions of the method are in the embossing of felts and the development of surface lustre effects in knitwear.—*Division of Textile Industry.*

Aid for Shearing

The application of the grease repellent polytetrafluoroethylene (P.T.F.E.) to the undersurface of the shearing comb inhibits the accumulation of wool grease.

The thick layer of grease which normally accumulates on the shearing comb slows down the movement of the hand-piece through the fleece and causes the shearer to tilt the comb towards the skin surface. This increases both the number of skin cuts and the number of skin pieces appearing in the fleece. These are a serious form of contamination especially in lambswool, since they are not easily removed in processing. Tilting the comb also appears to increase the number of second cuts during shearing, which similarly depreciate the value of the fleece, since the short lengths of fibre so produced pass into the noil or fall out of the wool and are lost during processing. By the prevention of accumulation of grease much of this loss can be avoided.

Officers of the Division of Protein Chemistry are collaborating with shearing experts of the Australian Wool Bureau in extensive trials to test the P.T.F.E.-treated combs under shearing shed conditions. Preliminary enquiries indicate that the cost of the treatment may limit its use initially. However, in view of the promising results obtained the investigations will be extended.—*Division of Protein Chemistry.*

Direct Reading Regain Tester

The Direct Reading Regain Tester is now being manufactured by the National Instrument Company, Essendon, Victoria, under licence from C.S.I.R.O. Deliveries of the first production batch are complete and are performing well in local mills. Further production for local and overseas sales are under way.

The tester was developed to provide a quick way of determining the amount of moisture in wool without calculations. It consists of a high-powered hot air dryer, a can which holds the wool tightly so that the air must pass through it, and a novel type of balance which reads directly the percentage change after the water is dried out of the sample. The tester accepts a sample of wool 200–500 grams in weight, dries it in less than 6 minutes, and indicates regain reliably to $\pm \frac{1}{2}\%$.—*Division of Textile Physics.*

Felt Moulding

The Division of Protein Chemistry has been collaborating with Mr. R. G. Tugen in the development of a process invented by him for felting and forming wool into finished patterned articles in one operation. The process involves the controlled movement of wool fibres during felting from the thinner regions of a mould cavity to the thicker regions, causing a pattern to be moulded rather than pressed into the felt. In the laboratory experimental equipment, a variety of patterns has been formed in flat felt, and simple seamless articles such as berets, mittens, and bags have been manufactured.

Felt moulding appears to offer considerable potential for wool, since the manufacturing processes are simple and cheap and it exploits the unique felting property of this premier animal fibre. It may be necessary to seek collaboration with an overseas firm to evaluate the commercial potential of the process. The International Wool Secretariat is interested and is assisting C.S.I.R.O. to make suitable arrangements to develop the process.—*Division of Protein Chemistry.*

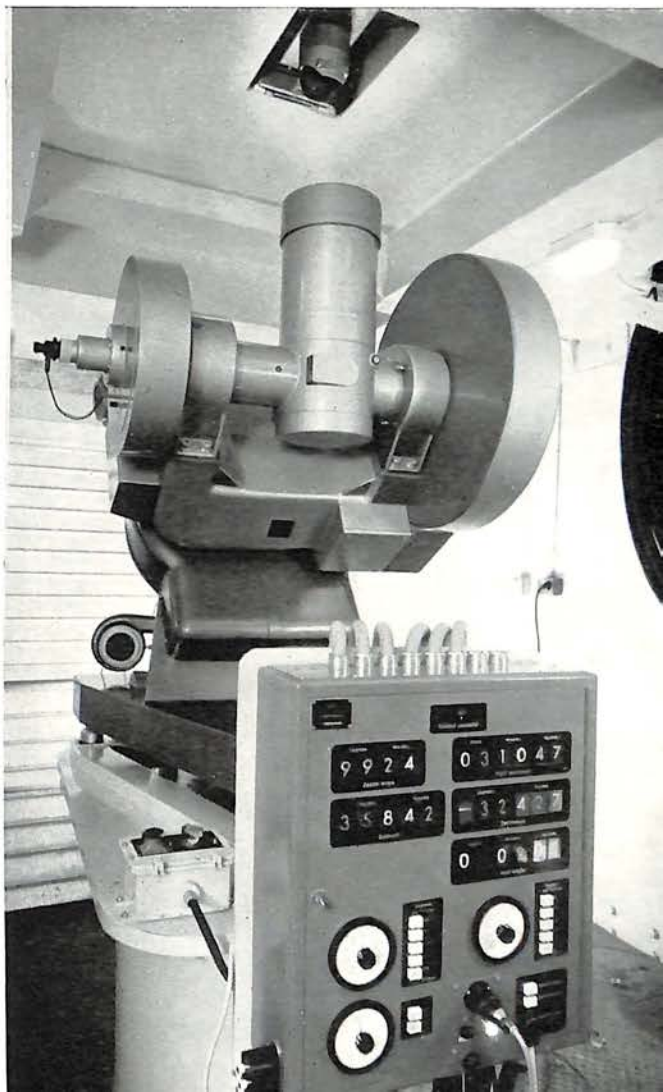
Characteristics of Ipswich Coals

Almost half of the coal produced in Queensland comes from the Ipswich Coalfield, located about 20 miles from Brisbane. Output is expected to increase considerably in the coming decade, with the construction of a 360-MW power station at Swanbank near Ipswich.

The characteristics of all seams worked in this coalfield have been examined in considerable detail and their industrial potential, particularly for metallurgical coke making, investigated as part of the Organization's comprehensive and systematic assessment of the coal resources of Australia. Although only a small proportion of

Above

The huge radio telescope of the Division of Radiophysics at Parkes, N.S.W., is completely controlled and operated from a control desk located at the top floor of the observatory tower.



Right

The drive and control system of the radio telescope at Parkes.

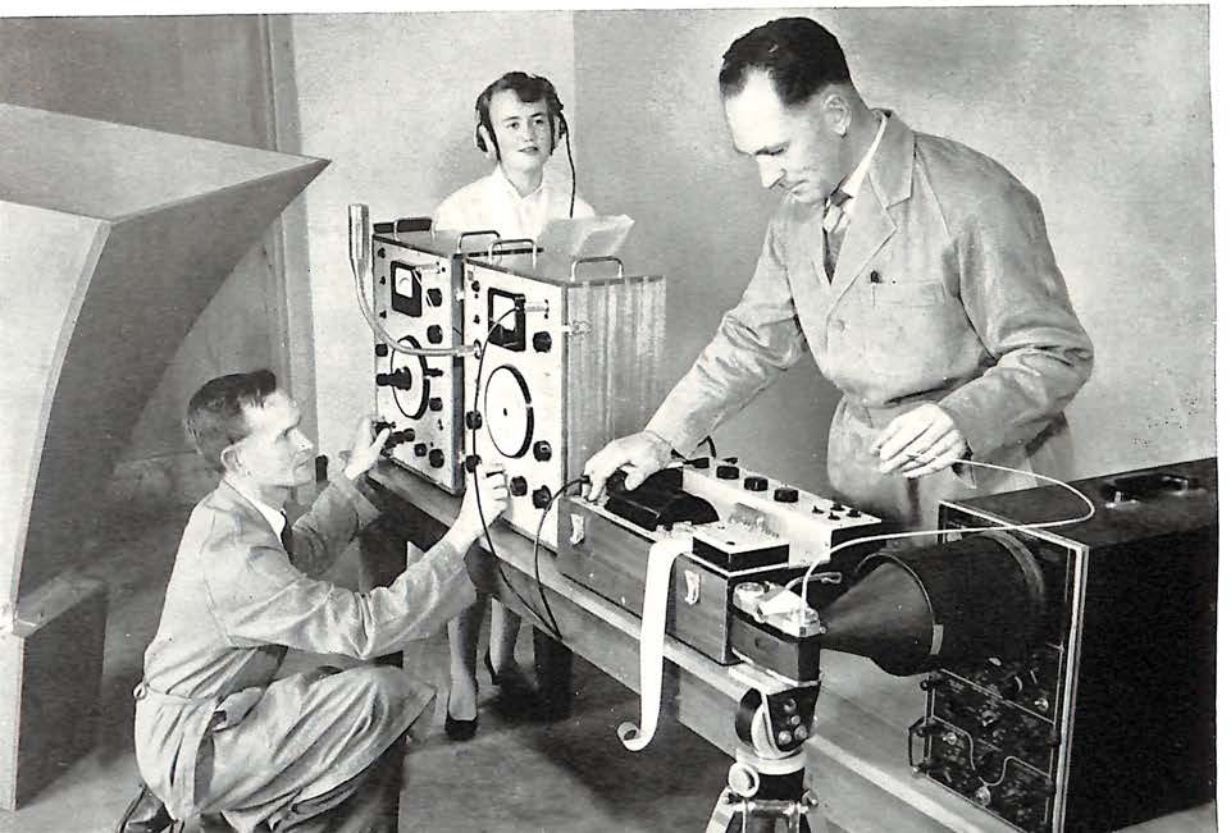
A miniature precision-built equatorial unit (which is effectively a small telescope) is located at the intersection of the altitude-azimuth axes of the radio telescope. This unit may be pointed and made to move wherever required, and the radio telescope is made to follow it exactly by means of an ingenious master-slave system. In the hub of the radio telescope is an error detector which operates by means of a beam of light; this senses whenever the radio telescope is not aligned with the master unit and generates signals which operate the altitude and azimuth motors to bring the radio telescope into alignment.

Left

Model of a group of acoustic chambers to be erected at the Division of Building Research. A reverberation chamber (*right*) is a large bare room in which the effect of an acoustic absorbent can be measured. The transmission chambers (*left*) are two bare rooms which can be separated by a wall whose transmission characteristics are to be measured. The anechoic chamber or "dead" room (*centre*) will be lined with absorbent materials to remove all sound reflection.

Below

The most informative measurement in room acoustics is the reverberation time, that is, the time taken for the sound to become inaudible after a loud noise has been suddenly stopped. Equipment used for measuring reverberation times includes a wave form generator and loudspeaker, a microphone and selective amplifier, together with a cathode ray oscillograph and high speed level recorder for measuring the rate of sound decay.



the output is at present used for the manufacture of metallurgical coke, the results of blending tests showed that Ipswich coals could be utilized more widely for this purpose.

All the coals were high in mineral matter, but the trace-element contents and compositions of the ashes from the coals were in no way unusual. Much of the mineral matter could not be removed by washing. None of the coals tested would be particularly suitable for burning on travelling-grate stokers, owing to their troublesome clinkering properties, and they would probably be difficult to burn satisfactorily in slag-tap or cyclone furnaces. They should, however, give satisfactory results in dry-bottom, pulverized-fuel furnaces.—*Division of Coal Research.*

Machinability of Steels

The machining of metals plays an important role in the economy of the Australian manufacturing industry, since efficient use of materials, machines, and cutting tools has a direct bearing on production costs. Research in machining in the laboratory has been aimed at investigating the mechanism of cutting, and simple and rapid techniques for measuring machinability have been developed. These have been applied to obtain a better understanding of the causes of variability in machinability of certain Australian steels. In particular, some study has been given to the effect of the chemical composition and microstructure on the machinability of hot-rolled C.S. 1114 steel. For instance, nitrogen additions were found not to have any marked influence for the better and the element having the biggest single effect upon machinability was carbon. Uniformity in the microstructure was desirable for reduction in variability and necessitated close control at the ingot stage.

These results have been used by the Australian steel industry not only to obtain better uniformity in the machinability of existing free machining steels but also to develop new and improved grades and to establish routine procedures for the control in the steel works of machinability characteristics.—*Division of Applied Physics.*

Selective Absorbers of Solar Energy

The useful heat output of a solar absorber is the difference between the heat absorbed and heat lost to its surroundings. A major loss is the radiation emitted from the surface of the absorber plate. If this can be decreased while the solar absorption remains high, the performance can be considerably improved. The best types of selective surfaces are produced by thin highly absorbing films deposited on a polished metal base. Over the solar spectrum, the properties of the film control the absorption; in the long wave region the emittance is essentially that of the base metal.

Surfaces with high solar absorption and low emission at low temperatures have been produced by the controlled oxidation of polished copper. Solar water heaters treated in this way show about 10% improvement in performance.

Experimental solar air heaters also using this principle have shown high thermal efficiency when operating at temperatures of 100°F above ambient.—*Engineering Section.*

3

Published Papers

THE FOLLOWING PAPERS were published during the year ending December 31, 1962. Letters Patent granted to C.S.I.R.O. during this period are also included.

In previous reports the list was compiled for a year ending June 30 but often it was not possible to cite a full reference to papers published outside Australia or even to be sure that they had been published during that period. The present arrangement avoids this difficulty.

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DIVISION OF ANIMAL GENETICS

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DIVISION OF ANIMAL HEALTH

See Animal Research Laboratories

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See Animal Research Laboratories

ANIMAL RESEARCH LABORATORIES

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4

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DIVISION OF PHYSICAL CHEMISTRY

See Chemical Research Laboratories

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Headquarters: Stowell Avenue, Hobart

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Experimental Officer—J. K. Raison, B.Sc.(Hons.) (*on leave*)
Experimental Officer—C. W. Wrigley, M.Sc.

DIVISION OF WILDLIFE RESEARCH

Headquarters: Barton Highway, Canberra

Administration

Chief—H. J. Frith, B.Sc.Agr.
Divisional Administrative Officer—P. E. R. Magi, B.A.
Scientific Librarian—Mrs. E. M. Wylie, B.Sc.

Marsupial Biology

Principal Research Officer—G. B. Sharman, D.Sc.
Senior Research Officer—J. H. Calaby, Dip.App. Chem.
Research Officer—S. Barker, B.Sc.(Hons.), Ph.D.
Research Officer—W. E. Poole, B.Sc.(Hons.)
Experimental Officer—P. T. Bailey, Dip.Agric. Ent., B.Sc.
Experimental Officer—R. F. C. Smith, B.Sc.

Rabbit Biology

Principal Research Officer—K. Myers, B.Sc. (Hons.)
Senior Research Officer—R. Mykytowycz, D.V.M.
Research Officer—J. D. Dunsmore, B.V.Sc.
Research Officer—R. L. Hughes, B.Sc.(Hons.)
Experimental Officer—A. P. Andrews, B.Sc.
Experimental Officer—Miss E. M. Kingsmill, B.Sc.(Hons.)
Experimental Officer—B. S. Parker, B.Sc.

Rabbit Control

Senior Research Officer—B. V. Fennessy, B.Agr. Sc.

Field Ecology

Principal Research Officer—D. L. Serventy, B.Sc. (Hons.), Ph.D. (*at Perth*)
Senior Research Officer—M. G. Ridpath, B.Sc. (Hons.) (*at Hobart*)
Research Officer—I. C. R. Rowley, B.Agr.Sc.
Experimental Officer—L. W. Braithwaite, B.Sc.
Experimental Officer—S. J. J. F. Davies, B.A. (Hons.) (*on overseas studentship*)
Experimental Officer—F. N. Robinson, B.A.

Bird Population Studies

Senior Principal Research Officer—R. Carrick, B.Sc.(Hons.), Ph.D. (*overseas*)
Experimental Officer—Miss S. E. Ingham, B.A. (Hons.)

Animal Physiology

Principal Research Officer—M. E. Griffiths, D.Sc.

WOOL RESEARCH LABORATORIES

Wool Textile Research Committee

F. G. Lennox, D.Sc. (*Chairman*)
V. D. Burgmann, B.Sc., B.E.
M. Lipson, B.Sc., Ph.D.
C. Garrow, B.Com., D.P.A. (*Secretary*)

DIVISION OF PROTEIN CHEMISTRY

Headquarters: 343 *Royal Parade, Parkville, Vic.*

Chief—F. G. Lennox, D.Sc.
Laboratory Secretary—C. Garrow, B.Com., D.P.A.
Librarian—Miss M. M. Clippingdale, B.A.
Senior Principal Research Officer—W. G. Crewther, M.Sc.
Senior Principal Research Officer—R. D. B. Fraser, Ph.D., D.Sc.
Senior Principal Research Officer—H. Lindley, B.A., Ph.D.
Principal Research Officer—J. M. Gillespie, M.Sc.
Principal Research Officer—M. A. Jermyn, M.Sc., Ph.D.
Principal Research Officer—S. J. Leach, B.Sc. Tech., Ph.D.
Principal Research Officer—I. J. O'Donnell, M.Sc.
Principal Research Officer—T. A. Pressley, B.Sc., Ph.D.
Principal Research Officer—W. E. Savige, Ph.D., M.Sc.
Principal Research Officer—E. O. P. Thompson, M.Sc., Dip.Ed., Ph.D.
Principal Research Officer—E. F. Woods, M.Sc., A.R.M.T.C.
Senior Research Officer—B. S. Harrap, Ph.D., M.Sc.
Senior Research Officer—A. S. Inglis, M.Sc.
Senior Research Officer—J. A. Maclaren, Ph.D., M.Sc.
Senior Research Officer—T. P. MacRae, M.Sc.
Senior Research Officer—P. H. Springell, M.A., Ph.D.
Senior Research Officer—F. H. C. Stewart, B.Sc., Ph.D. (Belfast and Cantab.)
Senior Research Officer—J. F. K. Wilshire, B.Sc., Ph.D.
Research Officer—R. A. De Deurwaerder, Ph.D.
Research Officer—A. Miller, Ph.D.
Research Officer—B. Milligan, Ph.D. (Adel. and Cantab.), B.Sc.
Research Officer—B. G. Newsom, B.Sc., Ph.D.
Research Officer—G. W. Stevenson, B.A., M.Sc., Ph.D.
Research Officer—B. J. Sweetman, M.Sc., Ph.D.
Research Officer—J. R. Yates, Ph.D., M.A.
Experimental Officer—A. K. Allen, B.Sc.
Experimental Officer—P. J. Beck, A.R.M.I.T.
Experimental Officer—J. B. Caldwell, B.Sc.
Experimental Officer—L. M. Dowling, B.Sc.
Experimental Officer—Miss J. E. Eager, B.Sc.
Experimental Officer—B. K. Filshie, B.Sc.
Experimental Officer—G. F. Flanagan, F.R.M.T.C.
Experimental Officer—Mrs. J. L. Hill, M.Sc.
Experimental Officer—P. Jakobsen, B.Sc.Agr., A.R.M.I.T.
Experimental Officer—I. H. Leaver, B.Sc.
Experimental Officer—A. B. McQuade, B.Sc.
Experimental Officer—D. E. Rivett, A.B.T.C.
Experimental Officer—R. J. Rowlands, B.Sc.
Experimental Officer—C. M. Roxburgh, Ph.D., B.Sc.
Experimental Officer—I. W. Stapleton, Dip. Chem., B.Sc.
Experimental Officer—D. J. Tucker, A.G.Inst. Tech.
Experimental Officer—K. I. Wood, A.R.M.T.C.
Scientific Services Officer—J. P. E. Human, Ph.D., M.Sc.

DIVISION OF TEXTILE INDUSTRY

Headquarters: Princes Highway, Belmont, Geelong, Vic.

Chief—M. Lipson, B.Sc., Ph.D.
Administrative Officer—J. H. G. Watson, A.A.S.A.
Librarian—L. A. MacGowan
Senior Principal Research Officer—G. W. Walls, B.Sc.
Principal Research Officer—A. J. Farnworth, M.B.E., M.Sc., Ph.D., A.G.Inst.Tech. (*seconded to Australian Wool Board*)
Principal Research Officer—D. S. Taylor, B.A., B.Sc., Ph.D.
Principal Research Officer—G. F. Wood, B.Sc., Ph.D.

Senior Research Officer—C. A. Anderson, B.Sc., Ph.D.
Senior Research Officer—R. E. Belin, M.Sc.
Senior Research Officer—J. Delmenico, B.Sc., Ph.D.
Senior Research Officer—J. R. McPhee, B.Sc., D.Phil.
Senior Research Officer—W. V. Morgan, B.Sc.
Senior Research Officer—V. A. Williams, B.Sc., Ph.D.
Senior Research Liaison Officer—J. M. Preston, D.Sc.
Research Officer—D. E. Henshaw, B.Sc.
Research Officer—R. Pearcy, M.Sc.
Engineer—B. B. Beard, A.G.Inst.Tech.
Experimental Officer—I. B. Angliss, A.G.Inst. Tech.
Experimental Officer—K. D. Broadfoot, B.E., F.S.A.S.M.
Experimental Officer—B. C. Ellis, A.M.C.T.
Experimental Officer—H. D. Feldtman, A.G.Inst. Tech.
Experimental Officer—G. N. Freeland, A.G.Inst. Tech.
Experimental Officer—R. G. Ganly, A.G.Inst. Tech.
Experimental Officer—R. J. Hine, A.G.Inst.Tech.
Experimental Officer—H. J. Katz, B.Sc., Ph.D.
Experimental Officer—B. O. Lavery, Nat.Cert. in Mech.Eng.
Experimental Officer—A. R. W. Lee, B.Sc., Dip. Ed.
Experimental Officer—J. D. Leeder, A.G.Inst. Tech.
Experimental Officer—B. G. Parnell, G.I.Mech.E.
Experimental Officer—D. C. Shaw, B.Sc. (*overseas*)
Experimental Officer—J. L. Woo, M.Sc.
Scientific Services Officer—G. C. West, A.G.Inst. Tech.

DIVISION OF TEXTILE PHYSICS

Headquarters: 338 *Blaxland Road, Ryde, N.S.W.*

Chief—V. D. Burgmann, B.Sc., B.E.
Divisional Administration Officer—J. I. Platt, B.Sc.(Econ.)
Librarian—Miss H. G. Barr, B.A.
Senior Principal Research Officer—J. G. Downes, B.Sc.
Senior Principal Research Officer—M. Feughelman, B.Sc., A.S.T.C.
Senior Research Officer—K. Baird, M.Sc., Ph.D.
Senior Research Officer—E. G. Bendit, B.Sc. (Eng.), M.Sc.
Senior Research Officer—H. G. David, B.Sc.
Senior Research Officer—A. R. Haly, M.Sc.
Senior Research Officer—H. W. Holdaway, B.Sc., B.E.
Senior Research Officer (Fellow)—P. Mason, M.Sc., Ph.D.
Senior Research Officer—P. Nordon, B.Sc., A.S.T.C.
Senior Research Officer—I. C. Watt, M.Sc., Ph.D.
Research Officer—M. W. Andrews, B.Sc., Ph.D.
Research Officer—E. F. Denby, B.Sc., Ph.D., D.I.C.
Research Officer—J. F. P. James, M.Sc.
Research Officer—D. T. Liddy, B.Sc.
Research Officer—B. H. Mackay, B.Sc., A.S.T.C.
Research Officer—B. J. Rigby, M.Sc., A.S.T.C.
Research Officer—I. M. Stuart, M.Sc.
Engineer—H. W. Lunney, B.Sc., B.E.
Experimental Officer—J. E. Algie, B.E., A.S.T.C., M.Sc.
Experimental Officer—N. W. Bainbridge, B.Sc.
Experimental Officer—P. G. Burton, B.Sc. (*overseas*)
Experimental Officer—R. L. D'Arcy, B.Sc., A.S.T.C.
Experimental Officer—Miss J. C. Griffith, M.Sc., A.S.T.C.
Experimental Officer—Miss P. Hetherington, B.Sc. (*overseas*)
Experimental Officer—G. B. McMahon, B.Sc.
Experimental Officer—T. W. Mitchell, A.S.T.C.
Experimental Officer—R. E. O'Donnell, B.E.
Experimental Officer—R. M. Rabbidge, A.S.T.C.
Experimental Officer—A. McD. Richardson, B.E.
Experimental Officer—L. J. Smith, A.S.T.C.
Experimental Officer—A. E. Stearn, B.Sc.
Experimental Officer—G. L. Stott, A.S.T.C.

UNATTACHED OFFICERS

Senior Principal Research Officer—G. H. Munro, D.Sc. (*seconded to Electrical Engineering Department, University of Sydney*)
Principal Research Officer—J. C. M. Fornachon, B.Agr.Sc., M.Sc. (*seconded to Australian Wine Research Institute*)
Experimental Officer—A. C. Blaskett, B.Sc. (*on leave*)
Experimental Officer—K. E. Dixon, M.Sc. (*on leave*)
Experimental Officer—L. Heisler, B.Sc. (*seconded to Electrical Engineering Department, University of Sydney*)
Experimental Officer—P. R. Strutt, B.Sc. (*on leave*)
Experimental Officer—J. A. Thompson, B.Sc. (*on leave*)
Experimental Officer—T. E. Treffry, B.Ag.Sc. (*on leave*)
Scientific Services Officer—D. V. Walters, M.Agr. Sc. (*seconded to N.S.W. Department of Agriculture, Sydney*)

5

Finance

A summary of the Organization's receipts and expenditure from July 1, 1962 to June 30, 1963 has been given on page 25. Details are given below:

Expenditure

	£	£	£
Salaries and Contingencies*			**450,420**
Investigations			
Animal Research Laboratories		1,331,867	
LESS contributions from—			
Cattle and Beef Research Trust Account	27,681		
Wool Research Trust Fund	633,759		
Rural Credits Development Fund	953		
Dairy Produce Research Trust Account	7,676		
General Donations	167		
Ian McMaster Bequest	2,870		
Alexander Fraser Memorial Fund	131		
U.S. National Institutes of Health	229		
Burdekin Bequest (Drought feeding)	513		
The Population Council Inc.	1,302		
Merck, Sharp & Dohme (Aust.) Pty. Ltd.	2,002		
Special Revenue Funds—"Belmont" Field Station	9,214	686,497	645,370
Plant Research			
Plant Industry		1,244,587	
LESS contributions from—			
Tobacco Industry Trust Account	77,179		
Wheat Research Trust Account	11,668		
J. O. Holston Legacy	300		
Brown Rot Trust Fund	1,366		
Colonial Sugar Refining Co.	495		
Dairy Produce Research Trust Account	6,012		
Department of Primary Industry	33		
International Atomic Energy Agency	1,631		
Wool Research Trust Fund	258,374		
Cattle and Beef Research Trust Account	282		
Coresta	438		
Sulphur Institute of America	1,250		
River Murray Commission	1,500		
Fisons Pest Control and J. R. Geigy	13,728		
Australian Pastoral Research Trust	2,758	377,014	867,573

* The main items of expenditure under this heading are salaries of the administrative staff at Head Office; salaries and expenses of officers at the Liaison Offices in London and Washington; staff and upkeep of State Committees; travelling expenses of Head Office staff; and general office expenditure.

	£	£	£
Tropical Pastures		219,547	
LESS contributions from—			
Cattle and Beef Research Trust Account ..	28,302		
Dairy Produce Research Trust Account ..	2,425		
Imperial Chemical Industries A.N.Z. Ltd. ..	2,151		
General Donations	23		
Special Revenue Fund—Samford Farm ..	1,204	34,105	185,442
Suspense (Overseas transactions)			3,885
			1,056,900
Entomology		508,070	
LESS contributions from—			
Department of Health	18,155		
Wheat Research Trust Account	1,425		
U.S. National Institutes of Health	3,313		
Cattle and Beef Research Trust Account ..	5,049		
Wool Research Trust Fund	14,931		
Dairy Produce Research Trust Account ..	3,432		
World Health Organization	3,309		
River Murray Commission and Snowy Mountains Hydro-Electric Authority	2,372		
Special Revenue Fund—Ingham	304	52,290	455,780
Soils and Irrigation—			
Soils		384,911	
LESS contributions from—			
Wool Research Trust Fund	3,945		
Australian Mineral Industries Research Association	27		
Australian Fertilizers Ltd. and Sulphide Corporation Pty. Ltd.	1,105		
S. Aust. Woods and Forests Department, W.A. Forests Department, and Australian Paper Manufacturers Ltd.	6,267		
W.A. State Forests Department	200		
Wheat Research Trust Account	9,817		
Dairy Produce Research Trust Account ..	1,487		
Australian Petroleum Exploration Association Ltd.	112		
Bureau of Mineral Resources	39		
Commonwealth Fertilisers & Chemicals Ltd., Australian Fertilizers Ltd., Cuming Smith and Mt. Lyell Farmers Fertilisers Ltd.	2,132		
Wollogorang Pastoral Co. Pty. Ltd.	1,000	26,131	358,780
Plant Nematology			4,657

	£	£	£
Soil Mechanics		112,588	
LESS contributions from—			
Department of the Army	2,668		
Launceston City Council	1 Cr.		
Broken Hill Pty. Ltd.	2,571		
S. Aust. Housing Trust	2,839		
Lime Manufacturers' Association of Australia ..	1,582		
Country Roads Board, Victoria	3,325		
Bechtel Pacific Corp. Ltd.	317		
Tasmanian Department of Health	233		
Westernport Waterworks Trust	98		
U.K. Colonial Office	604	14,236	98,352
Commonwealth Research Station, Merbein ..		109,812	
LESS contributions from—			
Dried Fruits Control Board	1,257		
Packing Companies and Co-operative Dried Fruit Sales Pty. Ltd.	363		
Special Revenue Fund—Coomealla	372	1,992	107,820
Irrigation Research Station, Griffith		133,684	
LESS contributions from—			
N.S.W. Water Conservation and Irrigation Commission	10,065		
Special Revenue Fund—Griffith Research Station ..	7,764	17,829	115,855
Suspense (Overseas transactions)			2,902
			688,366
Food Preservation		420,003	
LESS contributions from—			
N.S.W. Department of Agriculture	2,146		
Metropolitan Meat Industry Board	498		
Queensland Meat Industry Board and Australian Meat Board	1,807		
Australian Egg Board	543		
Department of Primary Industry	4,044		
Various Contributors	6,943		
Australian Egg Board and National Cottonseed Growers	682		
Australian Dried Fruits Association	194		
Broken Hill Pty. Ltd.	5,406		
Australian Apple and Pear Board	418		
Peanut Marketing Board	451		
Australian Apple and Pear Board, Australian Apple and Pear Shippers' Association, Fibre Board Development Council	807	23,940	396,064

	£	£	£
Forest Products		451,044	
LESS contributions from—			
Australian Paper Manufacturers Ltd. Associated Pulp and Paper Mills Ltd. Australian Newsprint Mills Pty. Ltd. New Zealand Forest Products Ltd. ..	5,786		
Department of Territories	3,082		
General Donations	945		
Australian Plywood Board	12,640		
Department of Forestry, Fiji	3,317	25,770	425,274
Mining and Metallurgy		64,124	
LESS contributions from—			
Australasian Institute of Mining and Metallurgy ..	963		
General Donations	766	1,729	62,395
Radio Research—			
Upper Atmosphere Section		42,607	
Radio Research Board Activities	41,204		
LESS contributions from—			
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission	20,874	20,330	62,937
Research Services		527,655	
LESS contributions from—			
Wool Research Trust Fund	21,192		
Wheat Research Trust Account	12,704	33,896	493,759
Chemical Research Laboratories		1,038,559	
LESS contributions from—			
Cement and Concrete Association of Australia ..	9,157		
General Donations	129		
State Electricity Commission of Victoria, Gas and Fuel Corporation of Victoria, and Australian Paper Manufacturers Ltd.	158		
Smith, Kline, and French Laboratories (U.S.A.) ..	10,782		
Mary Kathleen Uranium Ltd.	1,000		
Reserve Bank of Australia	3,377		
The Population Council Inc.	965		
W.A. Chamber of Mines	630		
Consolidated Zinc Pty. Ltd.	10		
Hardman Chemicals Pty. Ltd.	47 Cr.		
Wool Research Trust Fund	26,510		
Union Carbide Aust. Ltd.	9,538		
Colonial Sugar Refining Co. Ltd.	1,922	64,131	974,428

	£	£	£
Fisheries and Oceanography		281,761	
LESS contributions from—			
Department of the Navy	4,419		
Department of Primary Industry	2,665		
South Pacific Commission	557		
Electricity Commission of N.S.W.	425	8,066	273,695
Mathematical Statistics		114,967	114,967
National Standards Laboratory		878,253	
LESS contributions from—			
U.S. National Aeronautics and Space Administration	3,648		
U.S. Air Force	4,241	7,889	870,364
Tribophysics		130,714	
LESS contributions from—			
Union Carbide Aust. Ltd.		2,827	127,887
Building Research		232,165	
LESS contributions from—			
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries Ltd., and Colonial Sugar Refining Co. Ltd.	4,419		
General Donations	138		
Housing Commission of Victoria, State Electricity Commission of Victoria, Victorian Railways Department	1,289		
Cement and Concrete Association of Australia ..	836		
Whitelaw Monier Pty. Ltd.	405		
Jayworth Besser Ltd.	1,336	8,423	223,742
Biochemistry and General Nutrition		180,103	
LESS contribution from—			
Wool Research Trust Fund		70,564	109,539
Fodder Conservation		42,767	
LESS contribution from—			
Dairy Produce Research Trust Fund		2,778	39,989
Radiophysics		553,937	
LESS contributions from—			
U.S. National Aeronautics and Space Administration		23,485	530,452
Metallurgical Research			18,919
Computing Laboratory			20,201
Meteorological Physics		137,611	
LESS contribution from—			
Tobacco Research Trust Account		638	136,973

	£	£	£
Dairy Research		143,667	
LESS contribution from—			
Dairy Produce Research Trust Account		42,674	100,993
Wool Research		823,669	
LESS contributions from—			
Blanket Freight Equalization Fund	1,072		
Wool Research Trust Fund	802,015		
Wool Buying and Selling Account	5,605		
Worsted Processing Research–Various Donations	633	809,325	14,344
Fuel Research		341,277	
LESS contributions from—			
Electricity Trust of South Australia	11,047		
Department of External Affairs	937		
State Electricity Commission of Victoria	12,998		
General Donations	2,446	27,428	313,849
Wildlife Research		210,501	
LESS contributions from—			
Wool Research Trust Fund	53,408		
Altona Survey Group	9	53,417	157,084
Land Research and Regional Survey		406,482	
LESS contributions from—			
Department of National Development	2,641		
Cattle and Beef Research Trust Account	6,203		
Department of Territories	105,540	114,384	292,098
Pastoral Research Laboratory, Townsville			49,487
Miscellaneous—			
Patent Fees		4,839	
Extra-mural Investigations		37,669	
Furlough and Compensation		39,372	
Unattached Officers		4,024	
Wheat Research		23,825	
Grants to Scientific Workers		1,260	
Geological Microbiology		6,549	
Various		22,540	
		140,078	
LESS contributions from—			
Science and Industry Endowment Fund	1,260		
Wheat Research Trust Account	21,516		
Mining Research Association	4,499		
Wm. McIlrath Fund	3,590	30,865	109,213
TOTAL INVESTIGATIONS			**8,765,069**

	£	£	£
Other Services			
Research Associations—Grants			
Bread Research Institute	15,400		
Wine Research Institute	5,000		
Tobacco Research Trust	10,500		
Coal Association (Research) Ltd.	20,000	50,900	
Overseas Research Studentships	120,760		
LESS contributions from—			
Wool Research Trust Fund	330		
Science and Industry Endowment Fund ..	1,881	118,549	
Other Grants—			
Commonwealth Agricultural Bureaux	82,276		
Standards Association of Australia	96,500		
National Association of Testing Authorities ..	22,043		
Australian and New Zealand Association for the Advancement of Science	1,000		
National Institute of Oceanography	3,134		
Minor International Associations	9,674	214,627	
TOTAL OTHER SERVICES			**384,076**
TOTAL SALARIES AND CONTINGENCIES, INVESTIGATIONS, AND OTHER SERVICES			**9,599,565**
LESS receipts from sales of equipment, publications, etc., and revenue earned by Divisions and Sections, details of which are shown on page 160 ..			105,496
			9,494,069

Contributions

This Section shows receipts and disbursements during the year 1962–63 of the funds provided by contributors and recorded in a special account entitled "Specific Research Trust Fund". It includes transactions financed from wool funds, details of which appear on pages 158–60. Of the total expenditure of £3,033,216 recorded in this Fund, £2,585,407 refers to normal research activities and £447,809 to capital works. The following table summarizes the sources of these funds and the activities on which they are expended.

SOURCE OF FUNDS	ACTIVITY		TOTAL
	Investigations	*Capital Works*	
	£	£	£
Wool Research Trust Fund	1,885,026	417,495	2,302,521
Contributions (in addition to Wool)	700,381	30,314	730,695
	2,585,407	447,809	3,033,216

The details are as follows:

	Receipts 1962–63 & *Balances brought forward* 1961–62	*Expenditure* 1962–63
	£	£
Wool Research Trust Fund (*details are shown on pages* 158–60)	2,324,237	2,302,521
General Donations—*Myxomatosis Investigations* ..	1,082	167
Dairy Produce Research Trust Account—*Infertility in Dairy Cattle*	4,022	4,022
Alexander Fraser Memorial Fund—*Fluke Investigations* ..	33	131*
Dairy Produce Research Trust Account—*Virus Diseases of Dairy Cattle*	3,014	1,655
Estate of the late Captain Ian McMaster—*Scholarship* ..	3,020	2,370
Estate of the late Captain Ian McMaster—*Visit to Australia of Dr. Pierce*	500	500
Dairy Produce Research Trust Account—*Endoparasites of Dairy Cattle*	2,000	1,999
Burdekin Bequest—*Drought Feeding Investigations* ..	4,288	513
Cattle and Beef Research Trust Account—*Genetic Studies* ..	9,500	9,141
Rural Credits Development Fund—*Visit of Dr. G. Lampkin* ..	1,000	953
Merck, Sharp & Dohme (Aust.) Pty. Ltd.—*Anthelmintics Research*	6,093	2,002
Cattle and Beef Research Trust Account—*Virological Diseases of Cattle*	7,247	5,094
Special Revenue Fund—"*Belmont*" *Field Station, Rockhampton, Qld.*	23,171	9,214
U.S. National Institutes of Health—*Visit of Dr. Adler* ..	216	216
Cattle and Beef Research Trust Account—*Nutritional Studies*	10,028	13,447*
Beef Cattle Nutrition Account (Animal Physiology) ..	89	NIL
U.S. National Institutes of Health—*Visit of Dr. Druger* ..	38	13
General Donations (Animal Health)	3	NIL
Roche Products Pty. Ltd.—*Overseas Visit of Dr. M. C. Franklin*	500	NIL
The Population Council Inc.—*Studies on Induced Infertility* ..	2,988	2,267
Trust Fund Brown Rot Investigations—*Brown Rot Survey* ..	1,375	1,366
River Murray Commission—*Alpine Ecology*	1,500	1,500
North Queensland Tobacco Growers' Co-op. Association Ltd.—*Investigations in Burdekin Valley*	739	NIL
Western Australian Golf Association—*Research on Grasses* ..	50	NIL
Australian Tobacco Research Trust—*Tobacco Investigations*	81,004	77,818
International Atomic Energy Agency—*Movement of Strontium 90*	153	366*
International Atomic Energy Agency—*Measurement of Mutation Rates in Plants*	1,321	1,265
Coresta—*Contribution to Overseas Visit of A. V. Hill* ..	438	438
Acquisition and Development of Baker's Hill Field Station ..	6,113	18,208*
Sulphur Institute of America—*Plant Nutrient Element Deficiencies*	3,546	1,250
Australian Pastoral Research Trust—*Pasture Utilization Development*	3,250	2,758
Dairy Produce Research Trust Account—*Nutrition of Dairy Pastures in Western Australia*	6,621	6,014
Fisons Pest Control and J. R. Geigy—*Chemical and Plant Antifungal Investigations*	35,381	13,727
U.S. National Institutes of Health—*Genetic Studies* ..	3,687	NIL

* Expenditure on this work in excess of receipts will be recovered in 1963–64.

	Receipts 1962–63 & *Balances brought forward* 1961–62 £	*Expenditure* 1962–63 £
Estate of J. O. Holston—*Alpine Ecology*	650	300
Colonial Sugar Refining Co.—*Genetics Research* ..	500	495
Special Revenue Fund—*Grazing Trials, Samford Farm* ..	1,923	1,204
Department of Primary Industry—*Ecology of Skeleton Weed*	2,000	33
Various Contributors—*Soybean Harvester*	321	23
Cattle and Beef Research Trust Account—*Pasture Plant Collecting and Testing*	1,250	282
Imperial Chemical Industries of Australia and New Zealand Ltd.—*Nitrogen Grazing Experiments*	2,151	2,151
Dairy Produce Research Trust Account—*Pastures of Coastal Plains, Southern Queensland*	2,689	2,425
Cattle and Beef Research Trust Account—*Pasture Development and Plant Nutrition Investigations*	24,918	28,302*
Special Revenue Fund—*Cattle Tick Investigations, Ingham* ..	106	304*
Cattle and Beef Research Trust Account—*Acaracide Problems*	3,448	3,859*
General Donations (Entomology)	1,055	NIL
Cattle and Beef Research Trust Account—*Tick Survival* ..	2,639	1,189
U.S. National Institutes of Health—*Multiplication of Insect Polyhedron Virus*	3,803	3,313
Dairy Produce Research Trust Account—*Black Beetle Investigations*	3,857	3,432
Snowy Mountains Hydro-Electric Authority and River Murray Commission—*Phasmatid Investigations*	2,796	2,372
World Health Organization—*Insecticide Resistance in Cattle Tick*	2,679	2,638
World Health Organization—*Insecticide Resistance in House Flies*	1,450	225
Department of Health—*Sirex Wasp Investigations* ..	37,250	25,653
World Health Organization—*Overseas Visit of R. W. Kerr* ..	446	446
Various Contributors—*British Conference*	10	NIL
Australian Petroleum Exploration Association Ltd.—*Microbiological Testing for Petroleum Deposits*	102	112*
S. Aust. Woods and Forests Department, Australian Paper Manufacturers, W.A. Department of Forests—*Problems of Growth*, Pinus radiata	9,070	6,267
Australian Minerals Industries Research Association—*Purchase of X-ray Spectrograph*	681	27
Australian Fertilizers Ltd. and Sulphide Corporation Ltd.—*Phosphate Requirements of Soils*	1,200	1,105
Commonwealth Fertilisers and Chemicals Ltd., Cuming Smith and Mt. Lyell Farmers Fertilizers Ltd., and Australian Fertilizers Ltd.—*Bacterial Fertilizers*	5,534	2,132
Dairy Produce Research Trust Account—*Moisture Balance of Soils on Lower Murray Swamps*	1,490	1,487
W.A. State Forests Department—*Atomic Absorption Equipment*	200	200
Tasmanian Department of Health—*Foundation Investigations in Tasmania*	1,336	233
Launceston City Council—*Landslip Investigations* ..	1 Dr.	1 Cr.
Broken Hill Pty. Ltd.—*Jaspalite Beneficiation Project* ..	4,631	2,571

* Expenditure on this work in excess of receipts will be recovered in 1963–64.

	Receipts 1962–63 & *Balances brought forward* 1961–62 £	*Expenditure* 1962–63 £
S. Aust. Housing Trust—*Research in Soil Mechanics and Land Use in Urban Areas*	4,627	2,839
Lime Manufacturers Association of Australia—*Lime Stabilization of Soil*	158	1,582*
Wollogorang Pastoral Co.—*Automatic Analyser*	1,000	1,000
Country Roads Board, Vic.—*Lower Yarra Crossing*	3,325	3,325
Department of the Army—*Soil Stabilization Project*	9,668	2,668
Bechtel Pacific Corporation Ltd.—*Foundation Investigations at Moonie Oil Field*	317	317
Westernport Waterworks Trust—*Almurta Reservoir Investigations*	375	98
Bureau of Mineral Resources—*Microbiological Prospecting for Oil*	1,545	39
U.K. Colonial Office—*Visit of D. M. Lang*	603	604*
Packing Companies and Cooperative Dried Fruits Sales Ltd.—*Dried Vine Fruit Investigations*	3,174	363
N.S.W. Water Conservation and Irrigation Commission (Griffith Research Laboratory)	10,642	10,065
Dried Fruits Control Board—*Dried Fruits Investigations*	3,688	1,257
Nyah-Woorinen Dried Fruits Inquiry Committee—*Dried Fruits Investigations*	93	NIL
Special Revenue Fund—*Coomealla*	1,316	372
Special Revenue Fund—*Research Laboratory, Griffith*	10,281	7,764
Metropolitan Meat Industry Board of New South Wales—*Meat Investigations*	571	498
Queensland Meat Industry Board and Australian Meat Board—*Meat Investigations*	1,513	1,807*
Department of Primary Industry—*Fruit Fly Investigations*	453	453
Australian Apple and Pear Board, Australian Apple and Pear Shippers' Association, Fibreboard Development Council—*Contribution to Overseas Visit of E. G. Hall*	808	808
Australian Apple and Pear Board—*Apple and Pear Investigations*	1,498	418
Australian Dried Fruits Association and Australian Dried Tree Fruits Committee—*Dried Tree Fruits*	279	194
Various Contributors (Food Preservation)	14,636	6,944
Australian Banana Growers Council—*Banana Research*	4,060	NIL
Broken Hill Pty. Ltd.—*Research on Tinplate Containers*	10,788	5,406
Australian Egg Board—*Egg Investigations*	1,553	543
Peanut Marketing Board—*Storage of Peanut Kernels*	550	451
Department of Primary Industry—*Spray Residue Investigations*	222	161
National Cottonseed Products Association of U.S.A. and Australian Egg Board—*Contribution to Overseas Visit of F. S. Shenstone*	682	682
N.S.W. Department of Agriculture—*Fruit Storage Investigations*	2,255	2,146
Department of Primary Industry—*Fruit Fly Commodity; Treatment of Citrus Fruits and Pears*	4,719	3,429
Paper Companies and New Zealand Forest Products—*Paper Pulp Investigations*	8,927	5,786

* Expenditure on this work in excess of receipts will be recovered in 1963–64.

	Receipts 1962–63 & *Balances brought forward* 1961–62 £	*Expenditure* 1962–63 £
General Donations (Forest Products)	5,242	945
Department of Territories—*Development of Pulp and Paper Industry in New Guinea*	4,204	3,082
Australian Plywood Board—*Veneer, Gluing, and Plywood Research*	16,712	12,640
Government of Fiji—*Timber Research in Fiji*	4,618	3,317
Australasian Institute of Mining and Metallurgy (Mineragraphic Investigations)	5,494	963
General Donations (Ore Dressing)	1,634	766
State Electricity Commission of Victoria—*Geological Consultations*	1,870	NIL
Miscellaneous Contributors (Mineragraphic Investigations)	237	NIL
Postmaster-General's Department, Australian Broadcasting Control Board, and Overseas Telecommunications Commission—*Radio Research Board Activities*	21,437	20,874
General Donations (Engineering Section)	200	NIL
Consolidated Zinc Pty. Ltd.—*Thorium Project*	10	10
Hardman Chemicals Pty. Ltd.—*Chlorination of Tin Project*	540	47 Cr.
Miscellaneous Contributors (Chemical Research Laboratories)	9,275	128
State Electricity Commission and Gas & Fuel Corporation—*Clinkering of Brown Coal Ash*	919	158
Western Australian Chamber of Mines (Inc.)—*Cyanidation of Gold*	5,795	630
Union Carbide (Aust.) Ltd.—*Semi-polymers*	12,393	9,538
Cement and Concrete Association of Australia—*Cement Investigations*	13,006	9.157
Reserve Bank of Australia—*Fuel Cell Project*	13,120	3,377
Colonial Sugar Refining Co. Ltd.—*Sugar Research*	2,274	1,922
Mary Kathleen Uranium Ltd.—*Water Evaporation Control*	NIL	1,000*
Smith, Kline, and French Laboratories, U.S.A.—*Phytological Survey and Drug Plant Collection*	10,947	10,782
Fisheries Development Trust Account—*Sperm Whale Investigations*	3,000	2,665
South Pacific Commission—*Survey of Pearlshell Beds of Manihiki*	557	557
Department of Chief Secretary and Social Services, N.S.W.—*Oyster Investigations*	124	NIL
Department of the Navy—*Marine Fouling Investigations*	5,800	4,419
Department of Primary Industry and External Affairs—*Overseas Visit of G. L. Kesteven*	1,171	NIL
Electricity Commission of N.S.W.—*Fly Ash Program*	798	425
U.S. Air Force—*Thermal Expansion of Solids at Low Temperatures*	4,231	4,242*
U.S. National Aeronautics and Space Administration—*Cinematograph Study of Solar Magnetic Fields*	NIL	3,648*
Machinability Donations Account (Applied Physics)	114	NIL
General Donations (Applied Physics)	1,370	NIL
General Donations (Tribophysics)	115	NIL
Union Carbide (Aust.) Ltd.—*Catalytic Oxidation of Olefins*	8,806	2,828

* Expenditure on this work in excess of receipts will be recovered in 1963–64.

	Receipts 1962–63 & *Balances brought forward* 1961–62 £	*Expenditure* 1962–63 £
Associated Fibrous Plaster Manufacturers of Australia, Australian Plaster Industries, and Colonial Sugar Refining Co. Ltd.—*Fibrous Plaster Research*	4,768	4,419
General Donations (Building Research)	7,566	138
Cement and Concrete Association of Australia—*Concrete Research*	1,905	836
Whitelaw Monier Pty. Ltd.—*Research into Cement Tiles* ..	2,000	405
Jayworth Besser Ltd.—*Efflorescence on Concrete Blocks* ..	1,404	1,336
Housing Commission of Victoria, Victorian Railways Department, and State Electricity Commission of Victoria—*Mould Infestation in Dwellings*	1,328	1,289
Dairy Produce Research Trust Account—*Silage Studies* ..	2,838	2,778
Department of Civil Aviation—*Radio Navigational Aids* ..	7,352	NIL
General Donations (Radiophysics)	25	NIL
Ford Foundation—*Construction of RadioHeliograph* ..	43,139	4,599
U.S. National Aeronautics and Space Administration—*Radio Astronomy*	74,036	23,485
Various Contributors—*Rain and Cloud Physics Research* ..	8,000	NIL
Dairy Produce Research Trust Account (Dairy Research) ..	62,468	42,674
Residual Funds of Australian Leather Research Association—*Leather Research*	1,195	NIL
Wool Buying and Selling Account	11,310	5,605
General Donations (Protein Chemistry)	141	NIL
Donations for Worsted Processing Research	2,003	632
General Donations (Textile Industry)	279	NIL
Associated Woollen and Worsted Textile Manufacturers of Australia—*Blanket Freight Equalization Fund* ..	2,021	1,072
General Donations (Textile Physics)	2	NIL
General Donations (Coal Research)	7,774	2,446
Department of External Affairs—*Survey of Coal from North Borneo*	1,854	937
Colonial Sugar Refining Co. Ltd.—*Purchase of Special Equipment* (Coal Research)	54	NIL
Electricity Trust of S. Aust.—*Investigations into Boiler Gas Path Problems*	15,000	11,047
State Electricity Commission—*Brown Coal Investigations* ..	16,899	12,998
Petfoods Ltd.—*Food for Budgerigars*	79	NIL
N.S.W. Public Trustee—*Purchase of Metal Bird Bands* ..	200	NIL
Altona Survey Group—*Banding Stormy Petrels*	9	9
W.A. Department of Agriculture—*Cattle and Beef Research Project, Kimberley*	1,600	1,468
Department of National Development—*Kimberley Research Station*	3,092	2,641
Cattle and Beef Research Trust Account—*Investigations in Northern Territory High Rainfall Areas*	5,719	4,735
Department of Territories—*Resources Survey in Papua and New Guinea*	56,371	55,157
Australian Meat Board—*Pasture Development in Central Australia*	5	NIL
Northern Territory Administration—*Rice Research* ..	54,087	50,384

	Receipts 1962–63 & *Balances brought forward* 1961–62 £	*Expenditure* 1962–63 £
William McIlrath Fund—*Grant to University of Sydney* ..	3,590	3,590
Sundry Contributors (Commonwealth Scientific and Industrial Research Organization)	183	NIL
Science and Industry Endowment Fund	3,168	3,141
Wheat Research Trust Account	61,327	57,128
Radio Astronomy Trust	9	9
Australian Minerals Industry Research Association—*Geological Microbiology*	5,225	4,499
David Rivett Memorial Fund	12,126	NIL
	3,410,816	**3,033,216**

Wool Research Trust Fund

Details of transactions during 1962–63 are as follows:

	£	£	£
RECEIPTS			
Balance brought forward from 1961–62		50,236	
Received from Department of Primary Industry during 1962–63		2,274,000	**2,324,236**
EXPENDITURE 1962–63			
Investigations			
Biological Research—			
Animal Research Laboratories—			
Division of Animal Physiology, Ian Clunies Ross Animal Research Laboratory ..	309,520		
Regional Laboratory and "Chiswick" Field Station, Armidale, N.S.W.	116,147	425,667	
Division of Animal Health, McMaster Laboratory	54,198		
Animal Health Laboratory	15,828	70,026	
Division of Animal Genetics Sheep Breeding, Cunnamulla, Qld.	46,239		
Animal Genetics Investigations, Sydney ..	62,089		
Sheep Breeding, McMaster Laboratory, McMaster Field Station, Armidale, Canberra, and Deniliquin, N.S.W.	29,290	137,618	
Suspense (Overseas transactions)		448	633,759

	£	£	£
Plant Industry—			
Headquarters, Canberra	118,637		
Regional Pastoral Laboratory, Falkiner Memorial Field Station, Deniliquin, N.S.W.	56,311		
Field Investigations, Armidale, N.S.W. ..	12,517		
Western Australian Investigations	70,909	258,374	258,374
Entomology—			
Field Investigations, Armidale, N.S.W. ..		14,930	14,930
Soils—			
Cobalt Work in Tasmania		3,944	3,944
Research Services—			
Agricultural Research Liaison Section		20,392	
Wool Publications		800	21,192
Biochemistry and General Nutrition—			
Nutrition Laboratory, Adelaide		42,699	
Field Studies at Glenthorne, S. Aust.		27,865	70,564
Wildlife Research—			
Wildlife Investigations		53,408	53,408
			1,056,171
Wool Research—			
Wool Research Laboratories—			
Protein Chemistry, Melbourne	269,938		
Textile Physics, Sydney	222,081		
Textile Industry, Geelong, Vic.	307,866		
Suspense (Overseas transactions)	2,131	802,016	
Chemical Research Laboratories—			
Chemical Physics	6,678		
Physical Chemistry	6,240		
Organic Chemistry	12,886		
Suspense (Overseas transactions)	705	26,509	
Overseas Studentships		330	828,855
TOTAL INVESTIGATIONS			**1,885,026**

	£	£	£
Capital Works			
C.S.I.R.O. EXPENDITURE			
Biological Research—			
Animal Research Laboratories—			
Laboratory Equipment	24,179		
Plant Industry—			
Laboratory Equipment	9,914	34,093	
Wool Research—			
Wool Research Laboratories—			
Laboratory Equipment and Textile Machinery ..		61,770	
		95,863	
EXPENDITURE ON C.S.I.R.O. BUILDINGS BY DEPARTMENT OF WORKS			
Biological Research	88,118		
Wool Research	36,094	124,212	
EXPENDITURE ON BUILDINGS BY C.S.I.R.O.			
Wool Research		197,420	
TOTAL CAPITAL WORKS			**417,495**
TOTAL EXPENDITURE			**2,302,521**
BALANCE CARRIED FORWARD TO 1963–64			**21,715**
			2,324,236

During the year £67,583 was received from sales of sheep, wool, and other produce from C.S.I.R.O. Field Stations and Laboratories financed from wool funds. This amount was paid to the Department of Primary Industry for credit to the Wool Research Trust Fund.

Miscellaneous Receipts

During 1962–63 miscellaneous receipts amounted to £105,496. Details of the receipts are as follows:

	£	£
Sale of Publications	8,452	
Sale of Equipment Purchased in Former Years, and Other Receipts	25,342	
Sale of Produce by Field Stations and Laboratories ..	34,495	
Royalties from Patents	5,927	
Testing Fees	20,450	
Sale of Animals	6,539	
Miscellaneous	4,291	**105,496**

The receipts from the sale of produce represent revenue earned by Divisions and Sections apart from the Special Revenue included under Contributions.

The amount of £105,496 was credited to the Treasury appropriation and consequently reduced the requirements from the Treasury by that amount (*see* Expenditure).

Works Projects (Under Control of C.S.I.R.O.)

Treasury expenditure on works projects financed from funds made available directly to C.S.I.R.O. is as follows:

	£	£	£
Animal Health			
Parkville Laboratory	174	174	
Plant Industry			
Canberra Laboratories	42,174		
Development of Phytotron	71,597	113,771	
Tropical Pastures			
Rodds Bay	476		
Townsville Field Station	20,975		
Maryborough	310		
Howard	180		
Cooper Laboratory	1,489		
Cunningham Laboratory	2,753		
Beerwah	2,165		
Samford Farm	3,199		
Nunbank	254	31,801	
Administrative Office, Canberra	4,830	4,830	
Horticultural Research Station, Merbein ..	1,213	1,213	
Irrigation Research Laboratory, Griffith ..	1,291	1,291	
Soil Mechanics			
Syndal Laboratory	2,341	2,341	
Food Preservation			
North Ryde Laboratory	4,720		
Cannon Hill Laboratory	447		
Gosford Laboratory	6,408	11,575	
Ore Dressing	1,162	1,162	
Buildings Branch	300	300	
Chemical Research Laboratories			
Site at Monash University	21,744	21,744	

	£	£	£
Fisheries and Oceanography			
Cronulla Laboratory	4,150	4,150	
Mathematical Statistics	27,779	27,779	
Radiophysics			
Giant Radio Telescope	65,660	65,660	
Meteorological Physics			
Lysimeter Project, Aspendale	4,044	4,044	
Dairy Research	600	600	
Wool Research Laboratories	40,000	40,000	
Fuel Research			
Coal Research Laboratory	3,194	3,194	
Wildlife Research	13,999	13,999	
TOTAL TREASURY EXPENDITURE			**349,628**