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Commonwealth Scientific and Industrial Research Organization

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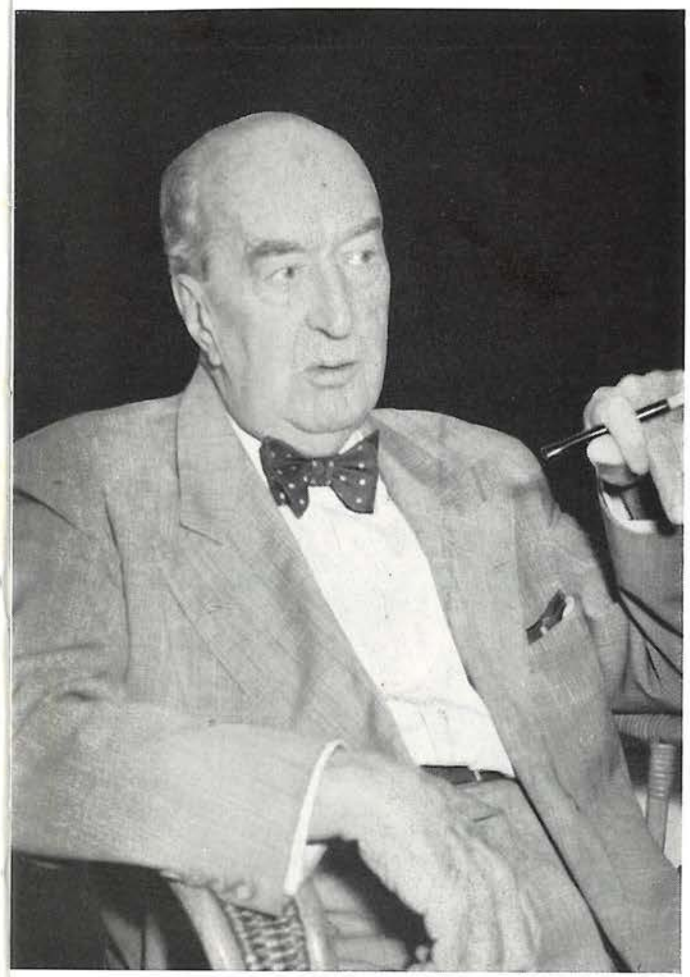
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

contents

The C.S.I.R. Executive Committee of 1926. From left, Sir George Julius, Sir David Rivett, F.R.S. and Professor A. E. V. Richardson.



Lord Bruce

introduction

C.S.I.R.O., the Commonwealth Scientific and Industrial Research Organization, is Australia's premier national research body. Its achievements during its short but colourful history are a source of pride to the Australian people. Farmers, graziers, orchardists, timber millers, mining companies, manufacturers and public authorities have reaped inestimable benefits from the results of its research. C.S.I.R.O. scientists have contributed over 10,000 papers to the world's scientific literature and have played a major part in winning for Australia a fine international reputation for first rate basic research.

The story of C.S.I.R.O. really began in 1925, when the Prime Minister of Australia, Mr. S. M. Bruce (now Viscount Bruce, F.R.S.) invited an eminent British science administrator, Sir Frank Heath, to advise the Government on the re-organization of national scientific research in Australia. In 1926 the Federal Parliament passed the Science and Industry Research Act, which created C.S.I.R., the Council for Scientific and Industrial Research. The Act conferred on the Council a flexibility and a freedom to conduct its own affairs seldom enjoyed by Government or semi-Government bodies.

In 1926, the Council commenced its work. The first annual report presented to the Prime Minister in June, 1927, listed 41 scientific officers. The Council had only one laboratory of its own; a small chemical laboratory housed in rooms rented from the Technical School at Brunswick, Victoria.

The Council in its early years was guided by an executive committee of three far-sighted men—Mr. G. A. (later Sir George) Julius, an eminent consulting engineer, Professor A. C .D. (later Sir David) Rivett, F.R.S., and Professor A. E. V. Richardson.

Sir David Rivett, the Chief Executive Officer, was the only full-time member of the committee. Sir David's vision and leadership were responsible, perhaps to a greater extent than any other individual's, for the basic pattern of C.S.I.R. and its successor, C.S.I.R.O.

Problems galore faced the new organization. The cattle industry was ravaged by pleuropneumonia and the sheep industry by "black disease", pulpy kidney and liver fluke. Fence posts rotted and rabbits multiplied. Huge tracts of well-watered land mysteriously failed to support pasture growth. Insect pests ruined crops of grain, fruit and vegetables. Manufacturing was at a low level, and the average Australian citizen wore a shirt made in Manchester, shoes from Northampton, and drove a motor-car made in Birmingham or Detroit.

During the pre-war years 1926-1939, all the emphasis was on problems of primary production—diseases of animals and plants, insect pests, food preservation, irrigation problems and forest products. Only a few of the Council's officers were engaged in such non-agricultural pursuits as radio research and mineragraphy. In 1936, the Government decided to extend the activities of C.S.I.R. to embrace the problems of Australia's secondary industries. This proved to be a fortunate decision, for the National Standards Laboratory, the Aeronautics Laboratory and the Division of Industrial Chemistry created in the years 1937–1940 were to play an important part in the rapid war-time development of Australian industry.

Sir Ian Clunies-Ross

After the war Members of Parliament began to advocate changes in the constitution of C.S.I.R., arguing that scientific freedom and national security were not always compatible, and in 1949 the Council was reconstituted by Act of Parliament as C.S.I.R.O. The new Organization relinquished all secret or "classified" work, and its Division of Aeronautics became a part of the Department of Supply. Sir David Rivett, who had succeeded Sir George Julius as Chairman on the latter's death in 1946, retired, but the principles he had laboured so hard to establish were largely carried on in the new Organization.

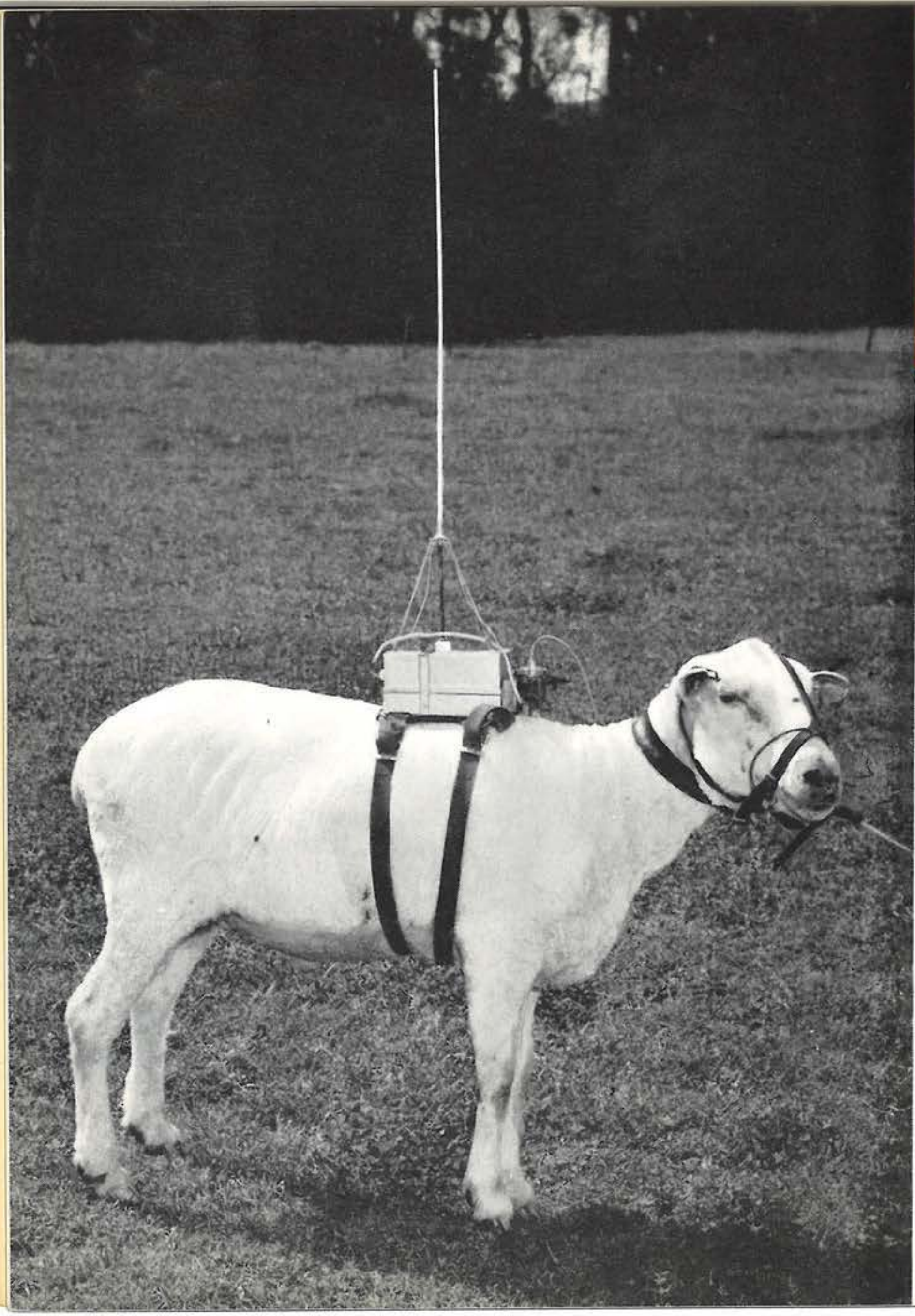
The first Chairman of C.S.I.R.O. was Dr. (later Sir Ian) Clunies-Ross. Under Sir Ian's inspiring leadership the Organization continued to grow and to expand into new fields. One of the most notable ventures was the establishment of Wool Research Laboratories to study wool as a textile fibre. When Sir Ian died in 1959 he was succeeded by the present Chairman, Dr. F. W. G. White.

C.S.I.R.O. has come a long way since work began in rented rooms in 1926. Thirty-five years later the Organization consisted of forty-five research establishments, thirty of which are rated as major Divisions. C.S.I.R.O. scientists are at work in every capital city in Australia, in ships at sea, in aeroplanes, in remote field stations in the Northern Territory, in New Guinea and in Antarctica. The annual investment in C.S.I.R.O. research has increased from a few thousands to over ten million pounds each year. The scientific staff has grown from 41 in 1927 to nearly 1,500, and the total staff to over 4,500.

Some of the achievements of the Organization are set out in the following pages. The list is not comprehensive—indeed, some of the smaller sections carrying out research into such topics as fodder conservation, wheat quality, the upper atmosphere, and physical metallurgy, are not mentioned at all.

The field covered is a wide one, growing ever wider. Much has been accomplished and much more remains to be accomplished. C.S.I.R.O. believes, as do most Australians, that the money spent on maintaining it has been an outstanding national investment.

Dr. F. W. G. White



animals

THREE years after the foundation of C.S.I.R. in 1926 a prominent New South Wales grazier, Mr. F. D. (later Sir Frederick) McMaster, gave the Council £20,000 for the establishment of an animal health laboratory. The Division of Animal Health came into being in January, 1930, with Dr. J. A. Gilruth, formerly Professor of Veterinary Science at Melbourne University, as the first Chief. It consisted of a team of scientists working at the McMaster Animal Health Laboratory, which was built in the grounds of Sydney University, a second group at a field station near Townsville, loaned by the Queensland Department of Agriculture and Stock, and in Melbourne a number of previously unattached veterinary scientists who were located in university laboratories.

In 1935 Dr. Gilruth retired, and was succeeded as Chief by another distinguished veterinary pathologist and bacteriologist, Dr. L. B. Bull. Shortly afterwards the Division obtained a lease of land and buildings in the grounds of the Melbourne University Veterinary Research Institute at Parkville, Victoria. The Parkville laboratory was used initially for the study of contagious diseases of farm animals. At the McMaster Laboratory a programme of research into the parasites of sheep was developed under the leadership of Dr. I. Clunies-Ross, later to become Sir Ian Clunies-Ross, the first Chairman of C.S.I.R.O. Work at the Townsville station ceased in 1936, but the Division

Research on the grazing habits of sheep. A transistorized radio attached to the sheep's back transmits information about the animal's chewing habits to the laboratory.

acquired new facilities including the McMaster Field Station at Badgery's Creek, New South Wales (1936), the 'Gilruth Plains' Field Station at Cunnamulla, Queensland (1937), and a new laboratory for the study of infectious diseases and chemical pathology on the Parkville site (1938).

After the war, the Division increased in size, and more laboratories and field stations were acquired. A regional laboratory was established at Armidale, New South Wales, in 1946; a cattle parasitology laboratory at Yeerongpilly, a Brisbane suburb, in 1947; a poultry breeding research centre at Werribee, Victoria, in 1948; a cattle breeding station near Rockhampton, Queensland, in 1953; and a sheep biology laboratory at Prospect, New South Wales, in 1953.

In 1959, the animal research laboratories were divided into three separate divisions, named the Division of Animal Health, the Division of Animal Genetics, and the Division of Animal Physiology.

In the Division of Animal Health the study of bacterial diseases at the Parkville laboratory has followed an established pattern—study of the diseased animal, isolation and identification of the responsible micro-organism, preparation of a vaccine. Pleuro-pneumonia of cattle was one of the first diseases to be tackled, and the laboratories have for many years supplied vaccine for use in the endemic areas in Australia and overseas. Some 1,300,000 doses are now prepared each year. Another disease successfully tackled was black disease of sheep, which was estimated to cost the industry £4,000,000 a year in pre-war days. Enterotoxaemia of sheep, or "pulpy kidney", was the next to be studied. The vaccines for black disease and pulpy kidney are now manufactured by the Commonwealth Serum Laboratories, and their use is standard throughout large pastoral areas of Australia. Bovine mastitis was studied intensively, and control methods based on milking shed hygiene were worked out. A successful line of work developed at Parkville has been chemical pathology, particularly of the liver, due to alkaloids and the excessive uptake of the mineral elements, copper and molybdenum. This has led to means for the prevention of toxaemic jaundice and the notorious Kimberley horse disease.

Recently a virology unit has been established with the idea of anticipating future trouble from virus-borne diseases.

At the McMaster Laboratory, and at Armidale, the parasites of sheep have been studied in the laboratory and within the environment of the pasture. Research has been concentrated on both internal parasites (particularly stomach worms) and external parasites such as the blowfly, the tick, the louse, and the itch mite. At Yeerongpilly, the internal parasites of cattle, and "tick fever" in cattle infested with ticks, have been the principal topics of research.

The animal geneticists have their headquarters in Sydney and have taken over the sheep breeding station 'Gilruth Plains', the cattle breeding station near Rockhampton, the Badgery's Creek property and the Poultry Research Centre at Werribee. The Division is mainly concerned with two problems of the utmost importance to the future development of our animal industries. Firstly, they aim to develop more efficient methods of selection for economic characters including improved wool production. Secondly, they are studying characters of importance in the adaptation of cattle to the hot climates of northern Australia. Their aim is not to produce a new breed, but rather to identify the genetic characters which should be singled out for future study, and which should form a basis for selection for use by the beef industry. As a means of speeding up genetic studies, the poultry breeding research was undertaken after the war, and a number of ways of improving poultry breeding have come out of the main stream of fundamental work.

A horse afflicted with Kimberley horse disease caused by eating a poisonous plant.

The headquarters of the Division of Animal Physiology are at the Ian Clunies Ross Laboratory at Prospect, on the outskirts of Sydney. The programme of research is chiefly concerned with the physiology of merino sheep. The physiologists are trying to find out how breeding, feeding and management can best be manipulated to bring out those fleece qualities most sought after by the wool textile industry. They must carefully study the normal sheep to find out what biological factors influence the length, diameter, crimp, and soundness of the wool fibres. The reproduction rate of sheep, and the survival of lambs, are also important studies since selection for good characters can be intensified when the number of new lambs raised each year is high.

Research has also been aimed at finding out the answer to the question, "What makes one sheep produce more wool than another?" Some valuable information has already come out of this work. The part played by hormones in controlling wool growth has been closely studied, as has the effect of good and poor nutrition.

The other major topics of research at Prospect concern the influence of climate on sheep and wool production, and the efficiency of wool production—how much wool a sheep can produce from a certain amount of pasture.

During recent years the animal industries have levied themselves to provide funds for further research into their respective problems. New projects are being added to an ever-growing programme of research.

A group of Zebu cattle bred at "Belmont" near Rockhampton.

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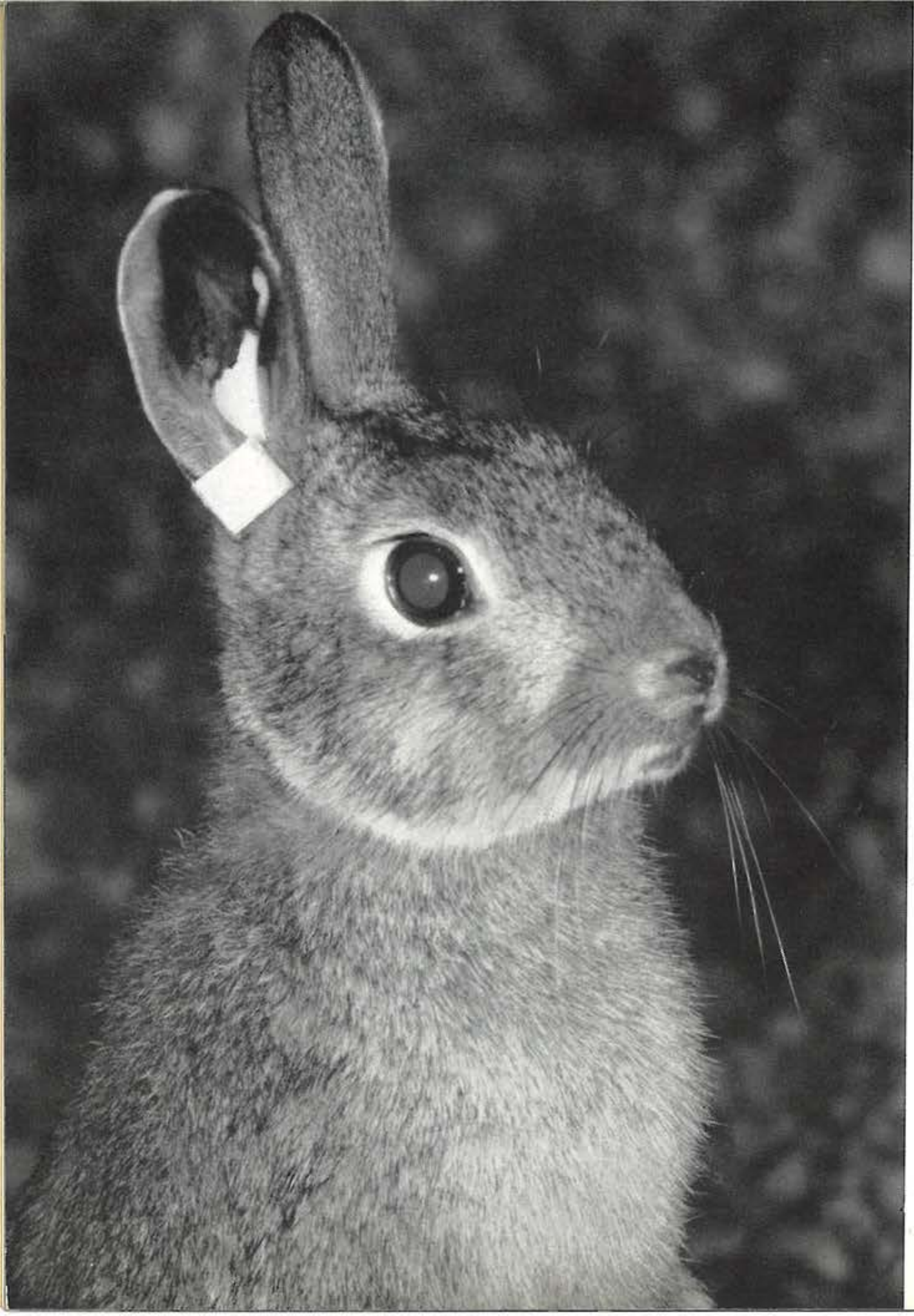


wildlife

TWO events stimulated the establishment of a C.S.I.R.O. Wildlife Survey Section in 1949. The first was a recommendation from the Australian and New Zealand Association for the Advancement of Science that a research group should be set up to study the Australian native fauna, which was of world-wide interest and needed a conservation policy based on sound ecological knowledge.

The second stimulus was the post-war rabbit situation, which by 1949 had become exceptionally serious in every State, leading to widespread and repeated demands that it should be tackled scientifically on a national basis.

During the first few years the Officer-in-Charge, Mr. F. N. Ratcliffe, and his staff devoted their attention almost exclusively to rabbit control. Their experiments with myxomatosis, an infectious and generally fatal disease of rabbits, were not encouraging until in 1951 a release of myxoma virus was made in what proved to be ideal conditions for the spread of an epidemic.

With the co-operation of virologists from the Australian National University, and State vermin control authorities, the Section studied the effects of the disease in the field for several years. It was soon realized that although the rabbit population was quickly reduced to a tenth of its former size the rabbit would, given time and opportunity, develop resistance to myxomatosis. So in 1957 the Section began to study rabbit vulnerability from other points of view. The study of rabbit poisoning, begun in 1949, was revived, and a study of the social behaviour of rabbits was undertaken in enclosures at Canberra and Albury, N.S.W.

Since 1953 the Section's work has broadened to include creatures other than the rabbit. The animals and birds studied include the kangaroo, dingo, fox, mutton bird, magpie, quokka, emu, ibis, waterfowl of various kinds, and Antarctic fauna.

Some studies, such as that of the present Officer-in-Charge, Mr. H. J. Frith, on the Mallee fowl are of dual purpose—they combine results of great fundamental scientific interest with valuable pointers to methods of conservation. The scientific interest in the case of the Mallee hen was centred around the complex methods by which the bird maintains the temperature of her nesting mound at a temperature of 92° Fahrenheit.

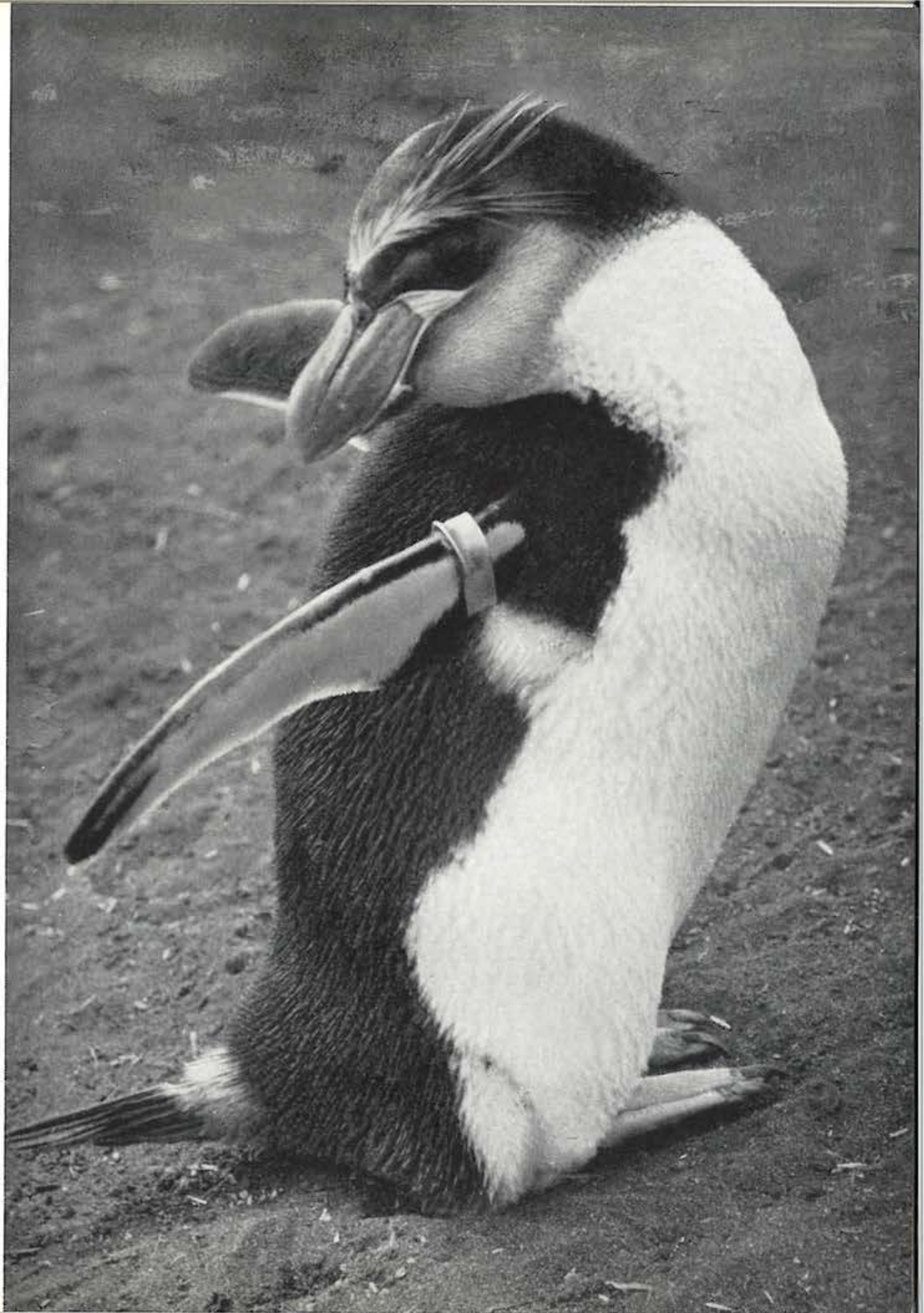
The mutton bird, on which is based a small but locally important industry, was scientifically interesting because of its unusual migratory pattern, clearly delineated by the use of bird banding.

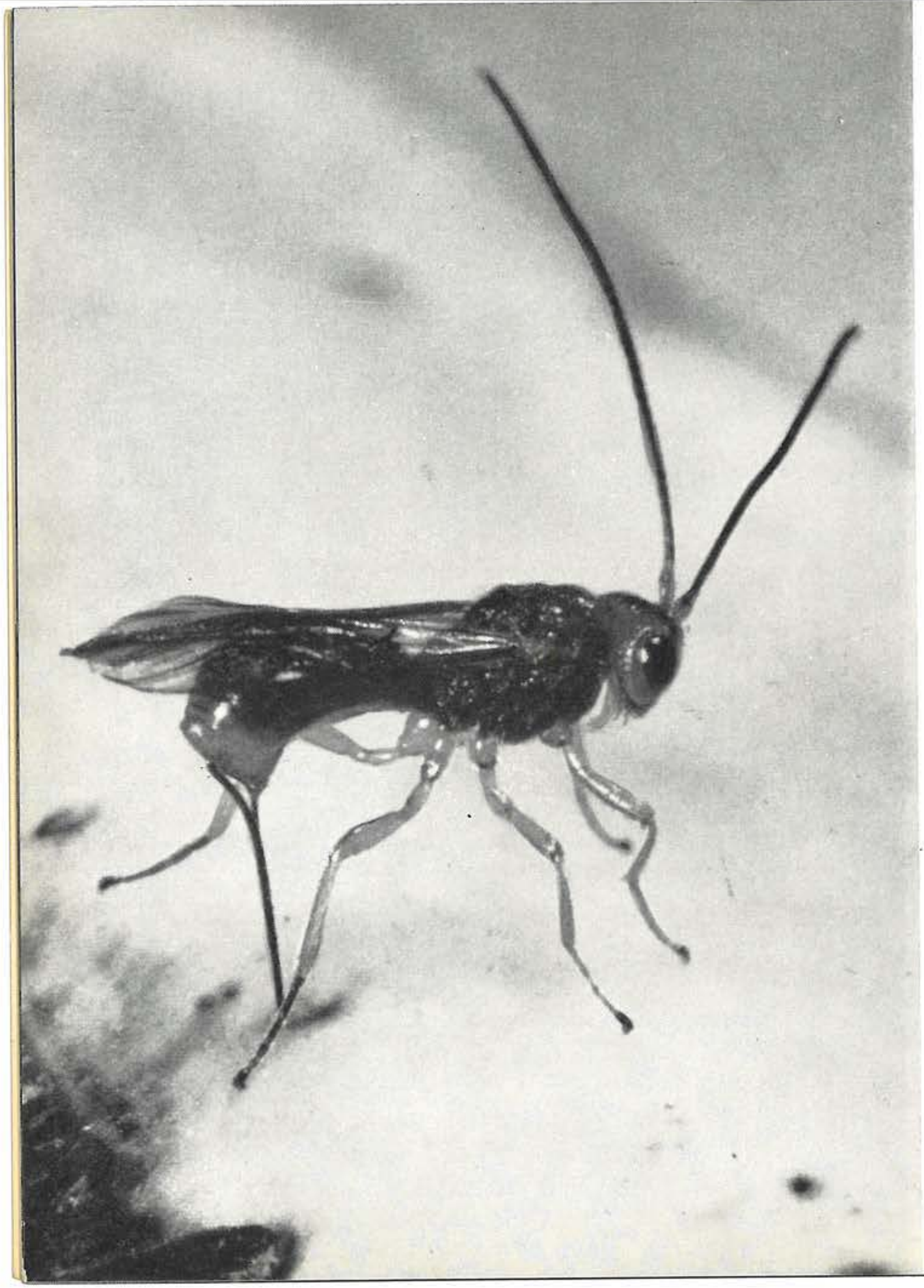
The Antarctic studies, centred on the royal penguin and the elephant seal, have been carried out with the co-operation of the Australian National Antarctic Research Expeditions. The natural history of both creatures has proved of great scientific interest.

Since 1953, the Section has organized the Australian Bird Banding Scheme. Some hundred amateur and professional ornithologists have taken part, and the recovery of some 25,000 banded birds of many species has helped to build up an intimate knowledge of their movements.

FAR LEFT—*The behaviour of individual rabbits has been followed throughout the day and night. Recognition is facilitated by marking the fur with dyes and by ear tags made of phosphorescent tape which are clearly visible in the beams of spotlights.*

RIGHT—*The Royal Penguin is found only on Macquarie Island where it breeds in countless thousands. This handsome fellow, with his golden crest, red bill and pink feet, seems puzzled by his flipper-band—a special design for penguins whose legs are too short to carry leg-bands.*





entomology

◀ *Opius oophilus, a parasite of the Queensland fruit fly. The insect has thrust its ovipositor through the skin of a banana and is laying its egg inside the egg of the fruit fly. There it remains dormant until the fruit fly has developed to the pupal stage. Then the parasite's egg starts to grow, and the developing larva lives on and consumes its host.*

The C.S.I.R.O. laboratory buildings at Black Mountain, Canberra, in which the headquarters of the Division of Entomology are located.

C.S.I.R.O. inherited an interest in entomological research from its early predecessor, the Institute of Science and Industry. The Division of Economic Entomology was set up in Canberra under Dr. R. J. Tillyard, F.R.S., soon after the Council was established.

Early work in the Division was concerned largely with the sheep blowfly and with biological control of plant and insect pests by the importation of beneficial insects. Both projects are still continuing. A great deal has been learned about the sheep blowfly. Efficient control is now possible by a simple surgical technique involving the removal of the loose skin from around the sheep's crutch (the Mules operation) and by fleece sprays which can give good protection for several months.

The pest-status of a number of insects has been reduced substantially as a result of biological control. These insects include the greenhouse white fly, the woolly aphid, mealy bugs, the green vegetable bug, and various scale insects. An intensive effort to control the Queensland fruit fly by biological control methods is now in progress.

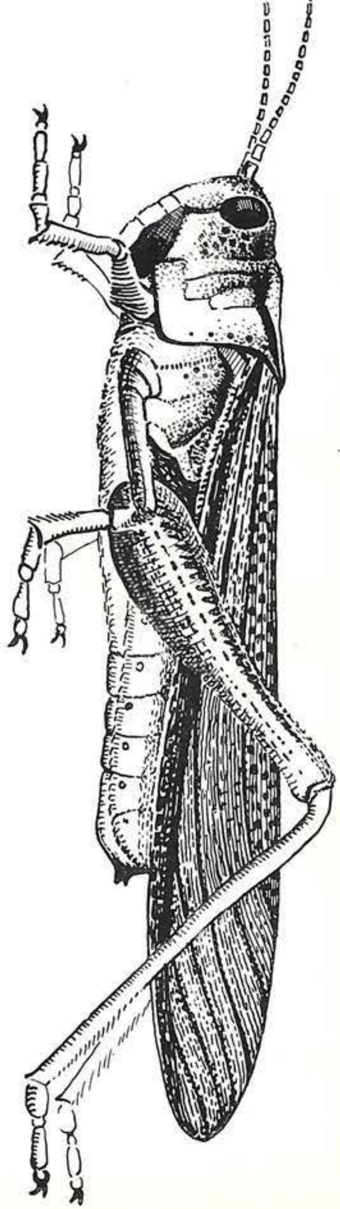
In 1934 Dr. A. J. Nicholson became Chief of the Division, an office he held until 1960 when Dr. D. F. Waterhouse succeeded him. Under Dr. Nicholson the Division of Entomology broadened its field to include ecological studies and insect physiology and biochemistry.

One of the main aims of the ecological work of the Division has been to find more satisfactory means of insect control than by the use of large quantities of non-specific insecticides. Ways have been sought to control insect populations by making changes in their environment, for example, by varying agricultural practices. One instance of this new approach to insect pest control has been the discovery that multiplication of the cattle tick can be prevented by spelling (vacating) infested pastures for certain periods of the year. Recent ecological work using "natural control" methods promises greater control of orchard pests, grasshoppers and forest insects.

Research in insect physiology, biochemistry and taxonomy has been of a basic nature. Many important results have been obtained and a good deal has been learned, for example, of how clothes moths and carpet beetles digest wool; of the characteristics of insect cuticle, which is the point of entry for many insecticides; and of some of the peculiarities of insect muscle. The taxonomy of insects must be known in order to differentiate between pest and beneficial species.

Many insects have become resistant to new insecticides and work is in progress to determine how they acquire this resistance. In addition, many aphids and leafhoppers carry virus diseases of plants and these are being studied.

As a result of the Division's work many insect pests, including termites, the Argentine ant and weevils in stored grain, can now be controlled. The savings to Australian primary industry amount to millions of pounds each year. There is scope for even greater savings in the future.



fisheries

THE Commonwealth started investigating fisheries in 1909, but abandoned the research programme in 1914 when the research ship was lost with all hands. Proposals to resume the work were made in 1933, and in 1935 the Government asked C.S.I.R. to enter the fisheries field. Specifically, the Council was asked to explore fishing grounds with a research vessel, carry out experiments on the canning, curing and preserving of fish, and to engage in marine biological work on the life history and distribution of economically important species.

In 1937 the first Officer-in-Charge, Dr. Harold Thompson, arrived in Australia from Newfoundland, where he had been Director of a fisheries research station. Dr. Thompson decided to establish headquarters on the site of an existing hatchery at Cronulla, near Sydney. The fisheries research vessel "Warreen" was commissioned and the exploration of fishing grounds began. One group in the Division, using the "Warreen", concentrated on open sea fisheries, while a second group began a study of the coastal and estuarine waters which are, in Australia, the main fishing grounds.

The open sea programme was short-lived, as the "Warreen" was taken off the job in the early days of the war. There was a consequent concentration on coastal fish, and valuable studies were made of the mullet and of clupeoids (e.g. the pilchard).

After the war the Division expanded its interests in several directions. The Western Australian crayfish, an important export commodity, was studied. At Thursday Island, off Cape York, facilities were set up for the study of pearl shell and pearl culture. In Tasmania, an officer undertook a study of the fresh water fish in the island's lakes and rivers.

A number of small research vessels became available and work on the open sea fisheries was resumed. The scope of the Division's research widened to include some oceanographical topics, and when Dr. G. F. Humphrey succeeded Dr. Thompson in 1956 the Division was renamed "Fisheries and Oceanography".

Examining collecting plates for young pearl oysters at Thursday Island.

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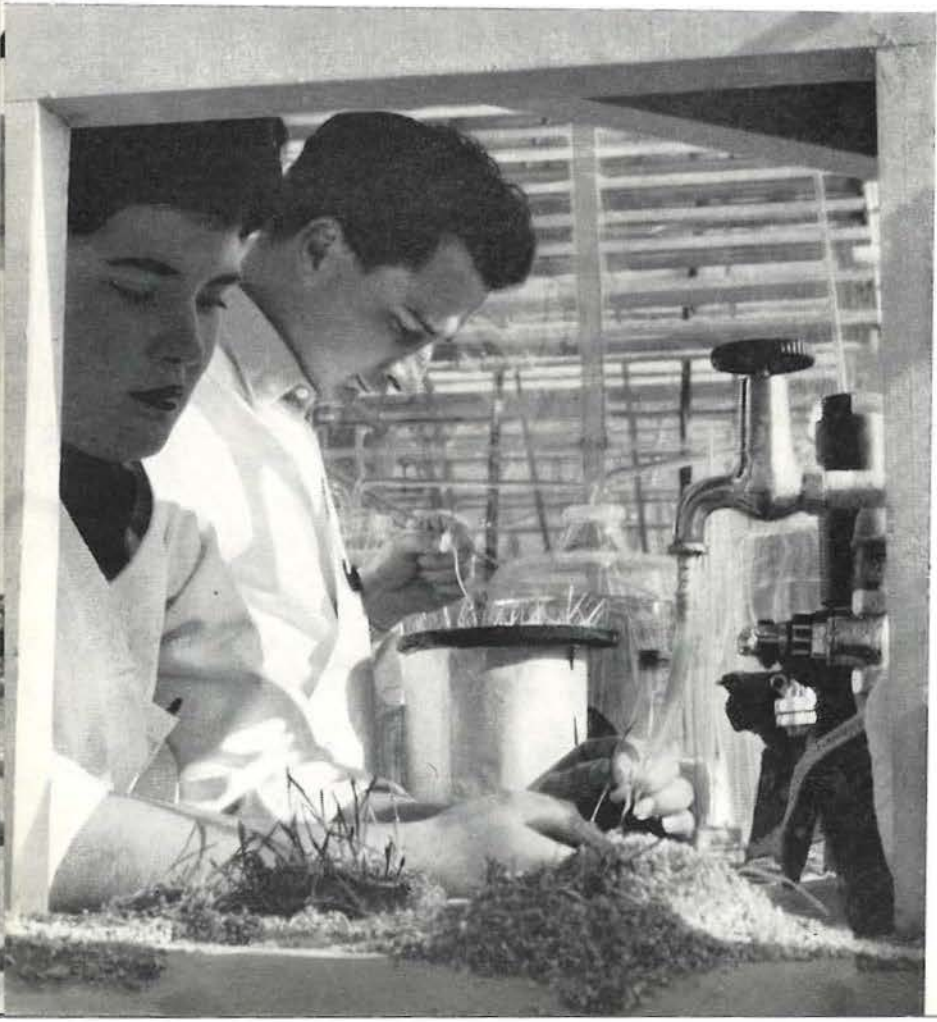
Oceanographical research received a tremendous fillip in 1959 when the Royal Australian Navy decided to allow two of its frigates to participate in oceanographical research. These two ships, H.M.A.S. "Diamentina" and H.M.A.S. "Gascoyne", have been fitted with laboratories, and their cruises of 40,000 miles per annum are planned with the object of gaining new scientific information in the fields of fisheries, navigation and meteorology.

The results of fisheries and oceanographical research are generally unspectacular, but the gradual accumulation of knowledge of the habits and movements of whales, open sea fish, coastal fish, fresh water fish, shell fish and crustaceans has provided a basis for planning the rational utilization of living aquatic resources. Similarly, studies of the temperature, the salinity, the currents and the plankton population of the oceans are building up a clearer picture of the seas from which the fish are harvested.

The "Derwent Hunter", one of the fisheries research vessels of the Division of Fisheries and Oceanography.

plants

Washing clover plants in the Plant Nutrition Laboratory before placing them in liquid media for nutrition experiments.



THE Division of Plant Industry is both the oldest and the largest of C.S.I.R.O. Divisions. In the early days it was called the Division of Economic Botany, and consisted of a number of research workers scattered around Australia, housed in the laboratories of various universities and Departments of Agriculture. The Chief was Dr. B. T. Dickson, who came out to Australia from Canada, where he had been Professor of Plant Pathology at McGill University. After Dr. Dickson retired in 1950, Dr. O. H. Frankel F.R.S., came from New Zealand's Wheat Research Institute to take the Chief's position.

In 1930 new laboratories were built in Canberra for the Divisions of Plant Industry and Entomology. Since that time the buildings have been extended, glasshouses have been built, and a major new research facility for growing plants in a range of controlled conditions, sometimes called a "phytotron", has been constructed. The Division of Plant Industry's work encompasses genetics and plant breeding, plant introduction, microbiology, general chemistry, plant nutrition, plant biochemistry and biophysics, ecology, agricultural physics and agronomy. Pastures and special crops are studied at field stations and laboratories in Western Australia, Tasmania, New South Wales and Queensland. Canberra, with over a hundred plant scientists, has become one of the largest plant research centres in the world. Much of the Division's work is designed to serve the needs of the sheep industry, which is contributing substantially to the cost of the research programme through the Wool Research Trust Fund.

Plant introduction is one of the oldest established fields of research. The work is of national significance, since it provides a service for the whole of Australia, including other Divisions of C.S.I.R.O. and all the State Departments of Agriculture. Over the years some 25,000 species of pasture, forage and crop plants have been collected from

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different parts of the world and brought back to Australia. Some recent introductions including buffel grass, sorghum almum and new strains of phalaris, clover and cocksfoot have proved to be of outstanding value. It is expected that the phytotron, which will contain 140 controlled-climate glass cabinets, will be of great assistance in making rapid assessments of introduced species.

Plant breeding studies in the Division were established more recently, but already some promising results have been achieved. A new strain of lucerne looks like being a better all-round producer of fodder than the established commercial variety. New strains of subterranean clover have been bred for better disease resistance and higher winter production. A recent innovation has been the establishment of a radiation mutation unit. Irradiation of plant material can cause useful changes in plant characters, and early experiments have resulted in mutants of tobacco plants which resist blue mould, and tomato plants which resist nematode attack.

The Division's microbiologists are interested in rhizobia, the root nodule organisms which "fix" nitrogen for use by plants. They are concerned in the mechanism of nitrogen fixation in nodules, and the effect of the environment on the process. Fungi and viruses are studied, since they are responsible for plant disease. The growth of the fungus in the plant, and its transmission from one plant to another are important research topics. It is important, too, to know how virus infections are established.

The chemical work of the Division is concerned with soil fertility and the availability of nutrient elements to plants. Not only is it necessary to study the chemical nature of nutrients as they exist in the soil; the chemical factors governing their uptake by plants should also be understood. The chemical work is, of course, closely associated with the work of the plant nutrition group. For instance, both are concerned with fertilizers. Whereas the chemists are concerned with the influence of fertilizers on the chemical properties of the soil, the plant nutritionists are concerned with the effect of fertilizers on plant growth. A special field of nutrition work is concerned with the role of minerals, and important discoveries have been made concerning the part played by molybdenum in plant nutrition, and the effect that silicon compounds in plants have on the animal which eats those plants.

The biochemistry group has a team working on tetrapyrrole compounds, which include chlorophyll, the green colouring matter in plants. The function of these compounds and the roles they play in the metabolism of plants are being investigated. Other biochemically interesting compounds being studied include a substance extracted from apple fruitlets which influences cell division, and an anti-fungal substance which has been extracted from peas and which has been called "pisatin".

The ecologists are studying the behaviour of many different plants in relation to their environment. Work in the Australian alps, for example, has shown how plant growth can have important effects on water run-off and erosion. Ecologists are working in the rain forests of North Queensland and the arid zones of the interior. Knowledge of weed ecology is a necessary pre-requisite to weed control. But most important of all is pasture ecology—the study of the plant in relation to such environmental factors as temperature and grazing intensity. The study of the soil-water-plant-animal complex is being extensively pursued in several field stations, including those at Cunnamulla (Queensland), Armidale and Deniliquin (N.S.W.), Canberra and Kojonup (Western Australia).

Research into various special crops and special problems is carried on at Canberra and at distant field stations. At Mareeba, North Queensland, for example, there is a vigorous programme of tobacco

research, embracing plant breeding and plant nutrition. At Applethorpe, Queensland, experiments on apple tree root stocks are carried out, and at Hobart plant physiologists are studying the development of apple fruits, and the behaviour of apples in cold storage. At Deniliquin special problems of irrigation are under investigation, and a successful method of dosing water with gypsum has been devised to help the water to penetrate heavy clay soils.

The Division has grown steadily over the years as more and more crucial problems in Australian agriculture have come to light. Two other Divisions, Land Research and Regional Survey (see "Underdeveloped Regions" and "Tropical Pastures"), began as groups within the Division of Plant Industry. The work of the Division has been brought to bear on almost every part of Australia's expanding primary industry.

Interior of one of the glasshouses at the Division of Plant Industry, in Canberra.

This four-leaved mutant of subterranean clover was induced by treatment of the seed with X-rays.

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An apparatus at Merbein used to simulate problems pertaining to flow of fluids through porous media (water through soils). Such problems include drainage of irrigated soils, seepage through channels and ground-water movement generally.

C.S.I.R.O. has two irrigation research stations, one at Merbein (Victoria) in the Murray Irrigation area, and the other at Griffith (N.S.W.) in the Murrumbidgee Irrigation area. Both were established before C.S.I.R. came into being.

The establishment of the Merbein station in 1919 was a result of the initiative of local viticulturists who raised funds for its support, impelled by drainage problems and the ravages of fungal diseases such as black spot. The station became associated with the Bureau of Science and Industry, and became a part of C.S.I.R. when the Council was formed.

In the early days work was concentrated on a study of the growth phases of vines, their irrigation, nutrition and protection from disease, and on combating waterlogging and the build up of excessive salinity in irrigation soils. In more recent times the station's investigations have broadened to cover the entire process of sultana production, from vine propagation to the finished, packaged product. Although the needs of the dried fruit industry have been kept in the foregound, other irrigation crops including citrus and stone fruits, vegetables, lucerne, tannin and drug plants, tobacco and cotton have been studied.

Over the years much has been achieved. A means of forecasting probable sultana yields ten months in advance has resulted from microscopic studies of vine buds. Study of the irrigation soils has produced a better understanding of drainage

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requirements. Research has led to more effective vine pruning techniques and improved methods of drying the crop. Plant breeders have produced new varieties of disease resistant tomatoes, well adapted to irrigation conditions. The effects of the eelworm, an important plant parasite in irrigation areas, have been minimized.

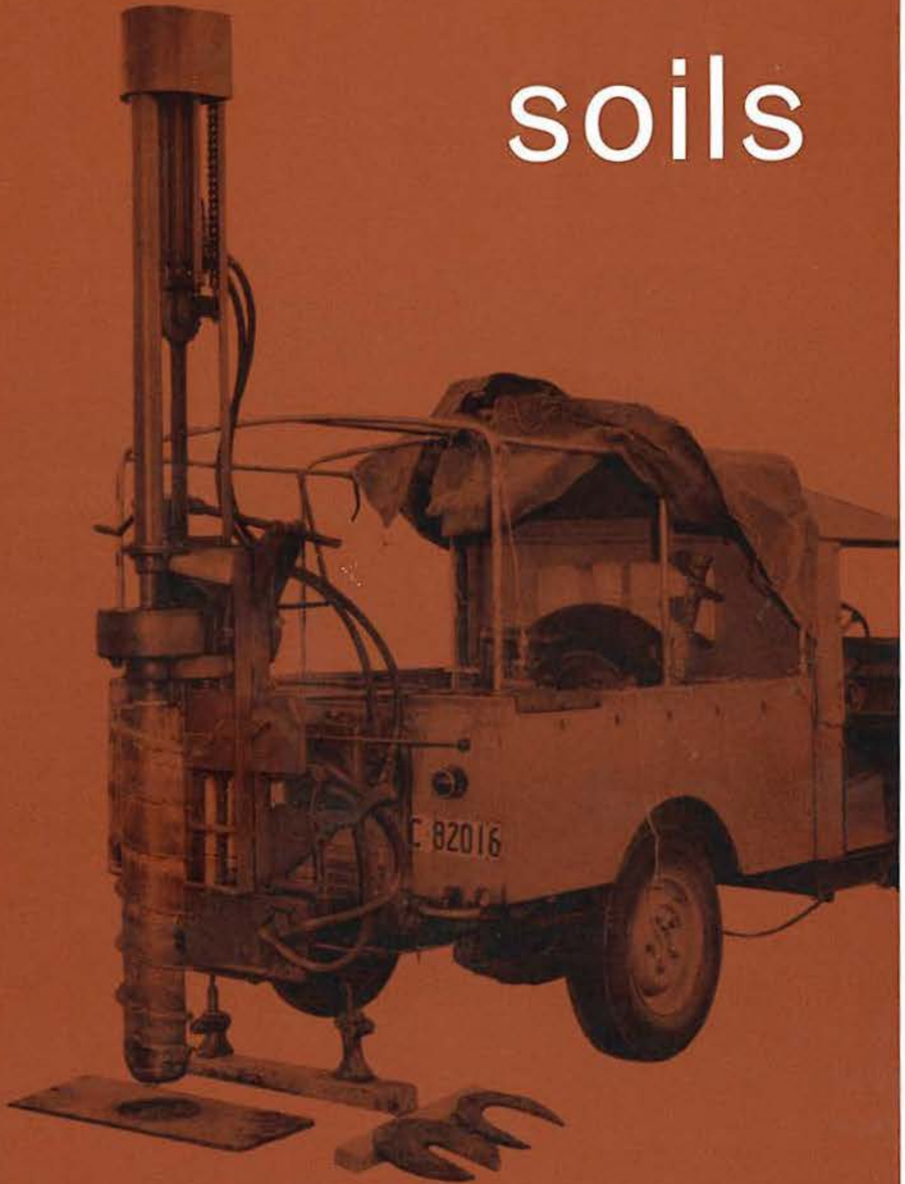
Established in 1924, originally for citrus research, the Griffith Station has always received strong support, including an annual contribution of funds, from the New South Wales Water Conservation and Irrigation Commission.

The major project at Griffith during the first years was a study of the nutrition of oranges, leading to the finding that zinc deficiency was induced by phosphate applications to the soil. A later experiment showed that poor fruit quality was due to an incorrect nitrogen-phosphorus ratio in the soil. This led to altered fertilizing practices, with a consequent increase in quality. Other citrus investigations included work on frost prevention by forced air circulation and scientific assessments of the winter requirements of citrus trees for irrigation water.

In more recent years the station has opened up several important subjects. There has been, for example, a fundamental study of the usage of irrigation water to find out just what irrigation practices will give the best results on different slopes and with different soil types. Under irrigation conditions plants can be exposed to extremes of water tension, and the station has been investigating the effects on plants of too much and too little water. Rice, cotton, vegetables and various fruit crops have been included in the station's research programme, which also embraces studies on salinity and underground water, and the use of sunshine by plants.

At Griffith, plant physiologists measure the stem length of Sunflower plants used in determining the growth effects of applied hormones.

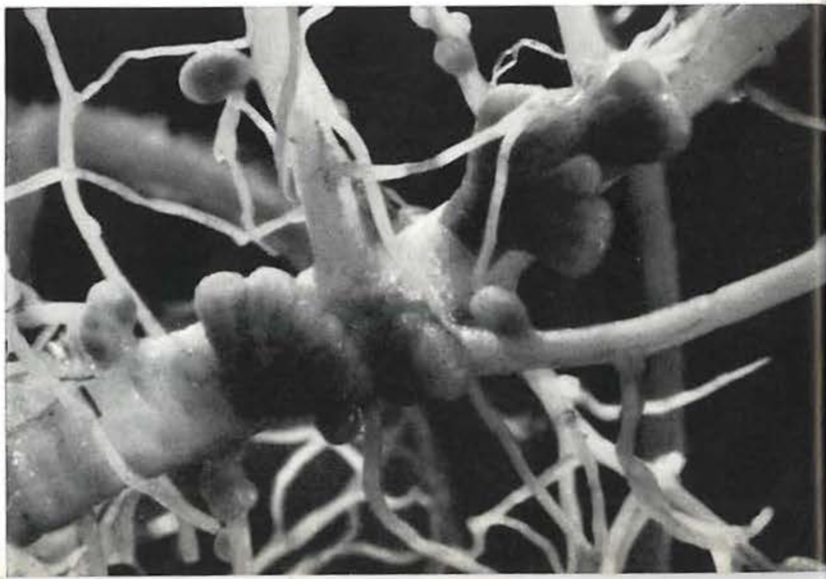
soils



SOON after C.S.I.R. was established, a small group of soil scientists was appointed to work in Adelaide at the Waite Institute on problems of irrigation soils. In 1929 the group was constituted as the nucleus of a new C.S.I.R. Division of Soils, Professor J. A. Prescott, F.R.S. (who later became Director of the Waite Institute), acted as Chief of the Division in a part-time capacity until 1947, when he was succeeded as Chief by Mr. J. K. Taylor, who had been with the Division since its inception. The present headquarters laboratory

A power-driven motor-mounted device, which withdraws an undisturbed core of soil from depths of 30 feet or more, is greatly aiding the immense task of mapping Australian soils.

Soil microbiologists are studying rhizobia, the bacteria which live in nodules on the roots of leguminous plants.



is in the grounds of the Waite Institute. There are four regional laboratories in Brisbane, Canberra, Hobart and Perth, and several sub-regional centres.

For the first ten years of its existence the Division was very largely preoccupied with irrigation soils. During the second decade there was a pronounced diversification of research interests, as the scope of the work was gradually enlarged to include a wide range of arable soils extending through every State in Australia. During this period more scientific disciplines were brought to bear on soil problems, and by 1948 four internal sections had become recognized, specializing in Soil Classification and Mapping, Soil Chemistry, Soil Physics, and Soil Microbiology. More recently two other sections have emerged. The first of these is concerned with the rapidly advancing subject of Clay Mineralogy, and the second with Micropedology, the microscopic study of the soil "fabric" and structure and the development of the natural soil profile.

Soil mapping in Australia has been extended steadily in two senses since Professor Prescott produced the first soil map of Australia in 1931. Firstly, a much greater area of Australia has been subjected to study. By 1961 some 30,000 square miles had been surveyed in moderate detail, and a further 800,000 square miles in reconnaissance, the latter largely by soil surveyors of the Division temporarily attached to the survey teams of the Division of Land Research and Regional Survey (see "Under-developed Regions"). At the same time the accuracy and detail of the maps have been improved. Dr. Stephen's Manual of Australian Soils, produced in the 'fifties, defined 45 soil groups as compared with 18 groups used in 1931, and an Atlas of Australian Soils is being produced in 10 sheets, the first of which appeared in 1960, designed to show yet more detail.

As Australian soils are almost universally short of phosphorus much of the Division's chemical work has been concerned with this element, and, in particular, with the immediate and residual availability of phosphate fertilizers. There has been an extensive investigation of the trace element status of Australian soils by chemical and spectrographic methods, including surveys of distribution and occurrence of such essential plant nutrients as manganese, copper, zinc, boron, cobalt and molybdenum. Studies of soil nitrogen and potassium are being made, together with the estimation of fertility status of soil groups.

The soil microbiology group has concentrated largely on the important rhizobia organisms which "fix" nitrogen and make it available to plants. This, in turn, has inspired a chemical study of the exudates from the roots of leguminous and other plants, since these exudates evidently influence the bacteria in the soil region near the roots. The same lines of work have been carried into the relationship and function of mycorrhizal fungi associated with roots of many trees.

Soil-water relationships in one form or another dominate the the attention of the Division's physicists, who have made valuable contributions to our knowledge of moisture movement in soil. The swelling and shrinking of soils under the influence of water has been a major field of study since it can have important practical effects on the stability of building foundations and the water holding capacity of dams. The structure, strength and tillage characteristics of arable soils have been examined.

The mineralogy group has made detailed investigations of the nature and properties of soil clays as affecting the chemistry and physics of the soils.

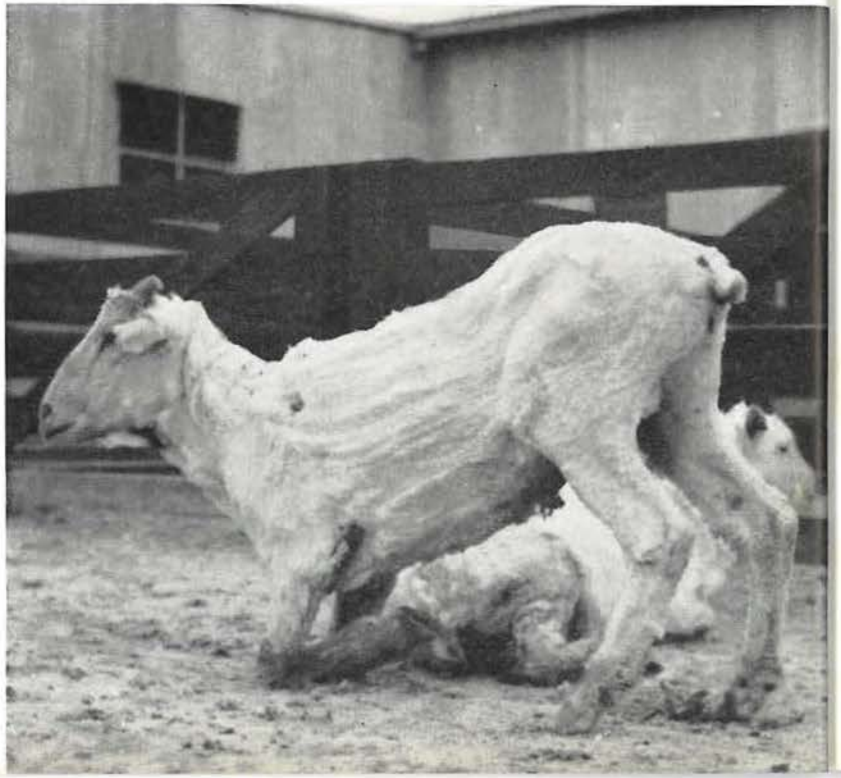
Engineering problems of the soil are studied by a Soil Mechanics Section which was formerly a unit of the Division of Soils. This group became an independent section in 1958, with laboratories in Melbourne. It is concerned with basic physical characteristics of soils, soil stabilization, and soils as foundations.

nutrition

Useless heath country—the former "Ninety-mile Desert" of over five million acres near the Victoria-South Australia border—which defied development until its trace element deficiencies were revealed about 1945.

Part of the same country known as the Coonalpyn Downs, three years after treatment with superphosphate, copper, and zinc and sowing to subterranean clover and Phalaris tuberosa. It now carries more than two sheep per acre.

Typical case of staggers precipitated by shearing. Cobalt will prevent, but not cure, phalaris staggers.



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revent,

A Division of Animal Nutrition was formed in Adelaide in 1927, the first Chief being Professor T. Brailsford Robertson, incumbent of the Chair of Biochemistry and General Physiology in Adelaide. Two years later the Chief died, and Sir Charles Martin, F.R.S., who had just retired from the Directorship of the Lister Institute in London, came to Australia to lead the Division for three years. In 1932 Sir Charles returned to London, and the Division was then merged with the Division of Animal Health (see "Animals"). Twelve years later it was again accorded the status of an independent Division, and the present Chief, Dr. H. R. Marston, F.R.S., assumed control. The Division's laboratory is situated in the grounds of the University of Adelaide, and its 600 acre field station is at Glenthorne, a few miles from the city.

Although the Division's interests extend throughout the fields of nutritional biochemistry and nutritional physiology, the greater part of its efforts has been concentrated upon research associated with sheep nutrition and wool production.

From its earliest days the Division has devoted its attention to the role of heavy metals, particularly copper and cobalt, in animal nutrition. In 1935 Dr. Marston and his co-workers showed that minute amounts of cobalt maintained sheep in vigorous health while grazing pastures on which previously the animals would have died. Investigation of "coast disease", a wasting disease of sheep prevalent in South Australia, showed that the disease was caused by a dual deficiency of copper and cobalt.

It was later found that a disease called "phalaris staggers", caused by a toxic principle in the valuable pasture species *Phalaris tuberosa*, could be prevented by giving animals a protective dose of cobalt.

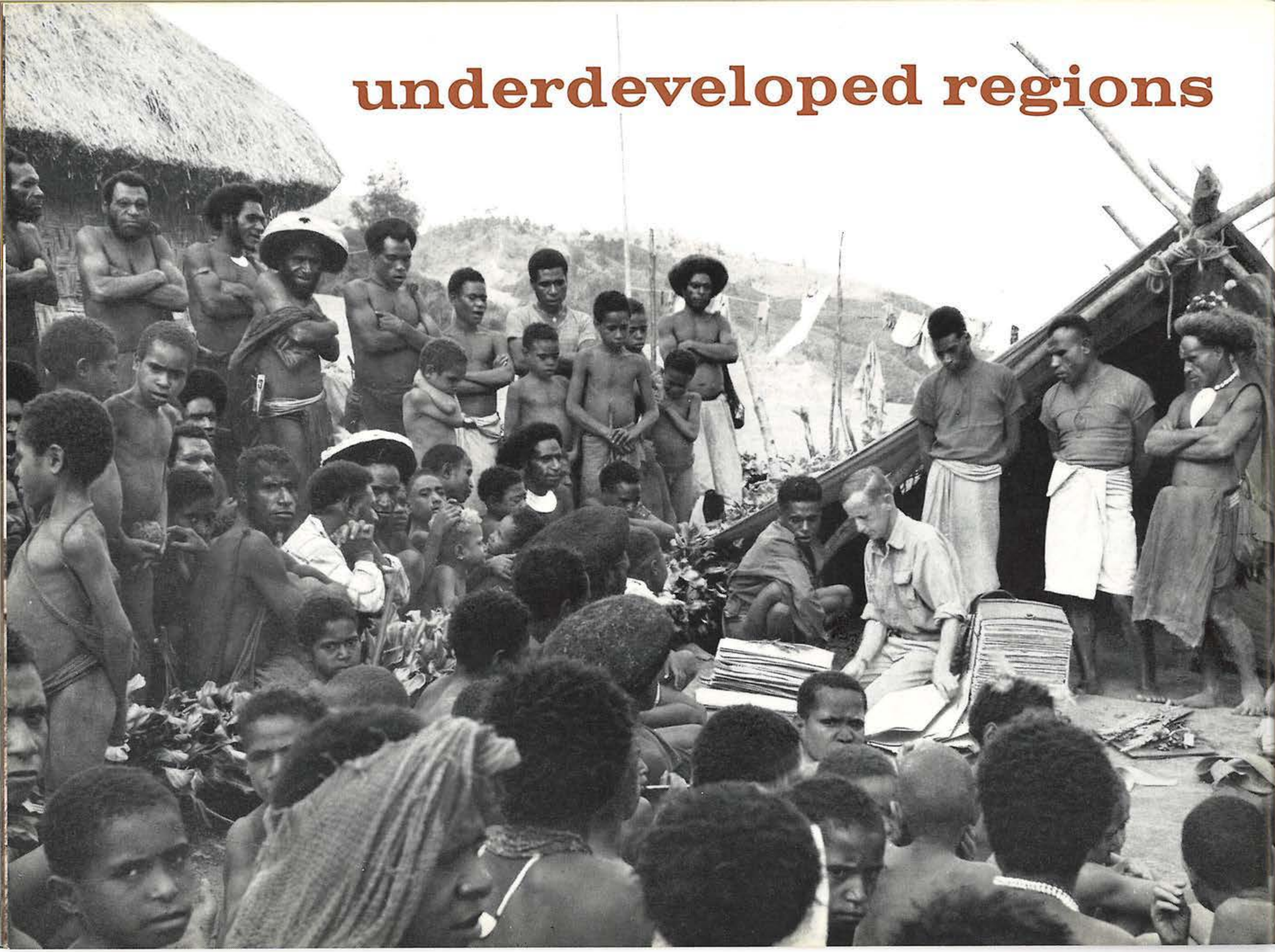
A discovery of great practical importance was made in 1957 when it was shown that a protective dose of a trace element such as cobalt could be incorporated in a heavy pellet which could be administered to a ruminant and retained in the animal's fore-stomach. Now millions of sheep and cattle carry in their paunches "cobalt bullets" to protect them from the consequences of cobalt deficiency.

Research into the role of trace elements in plant nutrition has also yielded valuable results. It has been found that the addition of small quantities of trace elements such as copper and zinc will transform very poor country into high yielding grazing land. By the application of this knowledge large tracts of country, previously regarded as desert, are now being profitably farmed.

While the Division's trace element work has been spectacularly successful, many other research projects have added to our basic knowledge of animal nutrition.

There has been a long-term study of the ruminant as a converter of feed into wool and, more recently, meat. Many aspects of the sheep's metabolism have been investigated, including its requirements for fluorine, and its tolerance of salt. A new line of work presently being developed is centred on factors which control appetite, knowledge of which is basic to our understanding of the processes underlying growth and development.

underdeveloped regions



C.S.I.R.O.'s interest in the underdeveloped regions of northern Australia began in 1945, when the Government of Western Australia asked for Commonwealth assistance with an appreciation of the Ord River region in the far north of the State. Mr. C. S. Christian, an officer of the Division of Plant Industry, was asked to join the reconnaissance team.

Events moved swiftly in 1946. Following the reconnaissance of the previous year the Kimberley Research Station was set up in the Ord Region by the Western Australian Department of Agriculture and C.S.I.R.O. The Station was to investigate the possibilities for an irrigated agriculture which would justify investment in a water conservation and irrigation project.

The North Australian Development Committee, representing the Federal Government and the Queensland and Western Australian Governments, asked C.S.I.R.O. to undertake a series of regional surveys to assess the agricultural and pastoral possibilities of the under-developed north. A survey of the Katherine-Darwin region of the Northern Territory was undertaken and a second research station, for the study of dry land agriculture, was established at Katherine. During the next five years further surveys were made of the Ord-Victoria region, the Townsville-Bowen region of Queensland, and the Barkly Tableland.

During these years Mr. Christian and his group in Plant Industry developed unique methods of land survey, which have proved invaluable for rapidly taking stock of land resources. The surveys began with the aerial photography of a whole region. From the photographs it was possible to recognize recurring patterns which represented different types of land. Areas of land corresponding to the various patterns were then explored and studied in the field by scientific teams which included specialists in such fields as soil science, geomorphology, plant taxonomy, ecology and climatology. The survey area was then classified into a number of "land systems", sometimes as many as 80 in a region.

It was, of course, necessary to "borrow" specialists in the non-plant sciences from other Divisions, so in 1951 the group was established as an independent unit called the Land Research and Regional Survey Section. The Section was elevated to Divisional status in 1956.

In 1953, the work was extended from mainland Australia to include New Guinea, the land resources of which were unknown. Six large tracts of New Guinea land have since been surveyed. Some first-class agricultural land has been found, and the survey results have been of great value to the Administration in planning the country's development.

On the mainland further surveys have been carried out in the Kimberleys and the Gulf Country. Arid zones near Alice Springs and in the Wiluna-Meekatharra region of Western Australia have been surveyed. A new departure has been the survey of a region which has already been developed, the Hunter Valley in New South Wales. A third research station, for the study of rice-growing, has been set up on the coastal plains near Darwin.

As a result of the Division's work there is now a sound basis for agriculture in some major areas of northern Australia where a stable, permanent agriculture has never before existed. At Katherine good potential for mixed farming has been demonstrated, with fodder crops and pastures. In the Kimberleys sugar, rice, safflowers, cotton, linseed and soybeans have grown well under irrigation.

The next stage of development in the Kimberleys, following this research, is a pilot scheme to test the economic soundness of large scale irrigation development. In 1960 the Commonwealth Government agreed on a multi-million pound project for damming the Ord. The first stage of the scheme will allow 10,000 to 20,000 acres of agricultural land to be farmed. Mr. Christian has estimated that if large scale projects like this confirm that major development is economically sound, crop production in the north could contribute £50,000,000 per annum to the national income.

◀ *A C.S.I.R.O. scientist pressing plant specimens while New Guinea natives show a keen interest and co-operate by giving the native names.*

radiophysics

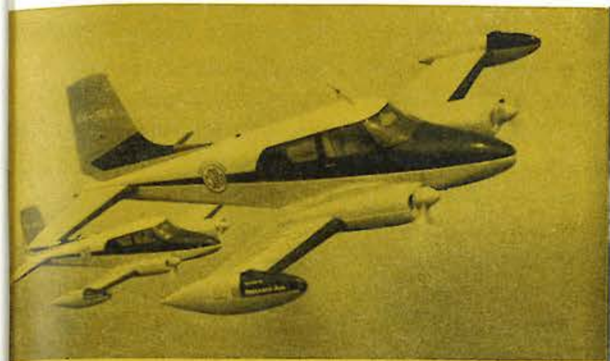
In the late nineteen-thirties, when the threat of war in Europe loomed large, scientists in Great Britain were intensifying research into radar. On 24th February, 1939, the British Government secretly requested the Australian Government to send a scientist to England, in order that Australia might be brought up to date on the progress in radar research. Dr. D. F. Martyn, F.R.S. (now Officer-in-Charge of the Upper Atmosphere Section), went to London, and returned later in 1939 to set up a sub-centre for radar research in Australia.

With the outbreak of war, plans proceeded quickly. A new wing to house the radar team (styled, for the sake of anonymity, the Division of Radiophysics) was added to the National Standards Laboratory, then under construction, and work began in 1940. A year later Dr. Martyn became leader of an army operations research group, and was succeeded as Chief by Dr. F. W. G. White, the present Chairman of C.S.I.R.O., who had been loaned to Australia from Canterbury University College in New Zealand. When Dr. White joined the Executive in 1945 he was succeeded by Mr. J. N. Briton, an experienced engineer who had been seconded to C.S.I.R.O. from the radio industry. The wartime work of the Division was of great value to the Australian and American armed forces in the Pacific. The Laboratory developed coast defence radar equipment and fire control devices for anti-aircraft guns, but the most important achievement was, probably, the development of light, compact, transportable radar equipment which could be moved by air. Units of this kind gave sterling service in the island campaigns of the Pacific theatre.

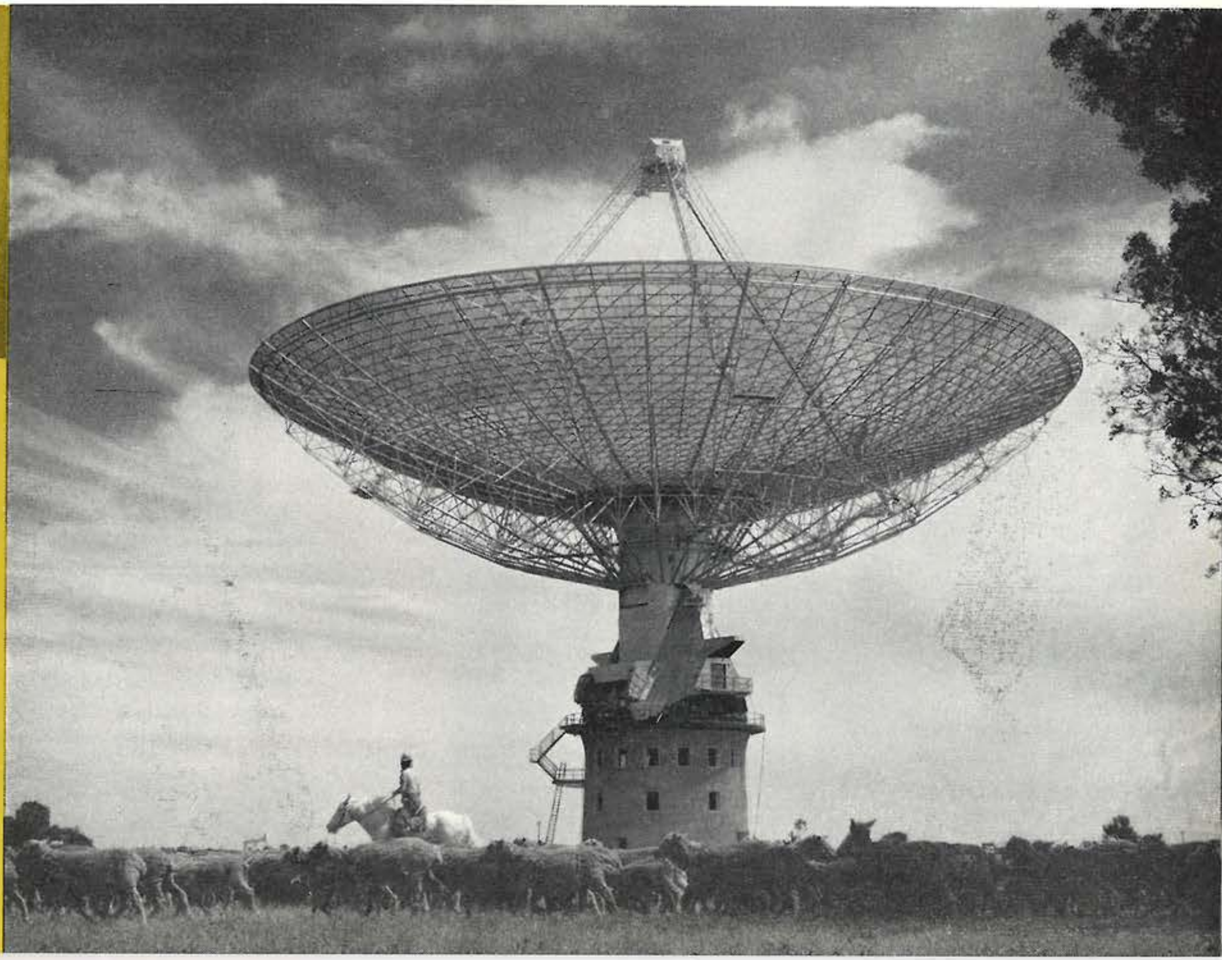
Shortly after the end of the war, Dr. E. G. Bowen, who had been a member of the original team under Sir Robert Watson-Watt responsible for the development of radar in Great Britain, became Chief of the Division and, with Dr. J. L. Pawsey; F.R.S., as Assistant Chief, laid the foundation of the Laboratory's peacetime programme. An obvious application of the new techniques mastered in wartime was the use of radar as an aid to aircraft navigation, and the Division produced a device for aircraft known as "distance measuring equipment" or "D.M.E", which allows a pilot to read his distance in miles from a reference beacon on the ground. There are now about 180 ground beacons installed along the air routes, and Australian domestic airlines have used D.M.E. ever since.

In 1946 confirmation that "blips" on a radar screen could be induced by activity on the sun led the Division to plunge into the infant science of radio astronomy, the study of extra-terrestrial sources of radio noise. Since then, the Division has become one of the leading centres of radio astronomy in the world. It was responsible for the first identification of a "radio star", or source of radio noise, with a visible object (the Crab nebula, which, according to Chinese astronomers, exploded in 1054 A.D.). A number of novel and ingenious devices for observing "radio stars" have been invented, one of which has been used for detecting the high-intensity short-period radio emissions of the Sun. In 1961, thanks to the generosity of two American foundations and the Australian Government, C.S.I.R.O. was able to build the world's most powerful steerable radio telescope at Parkes, N.S.W.

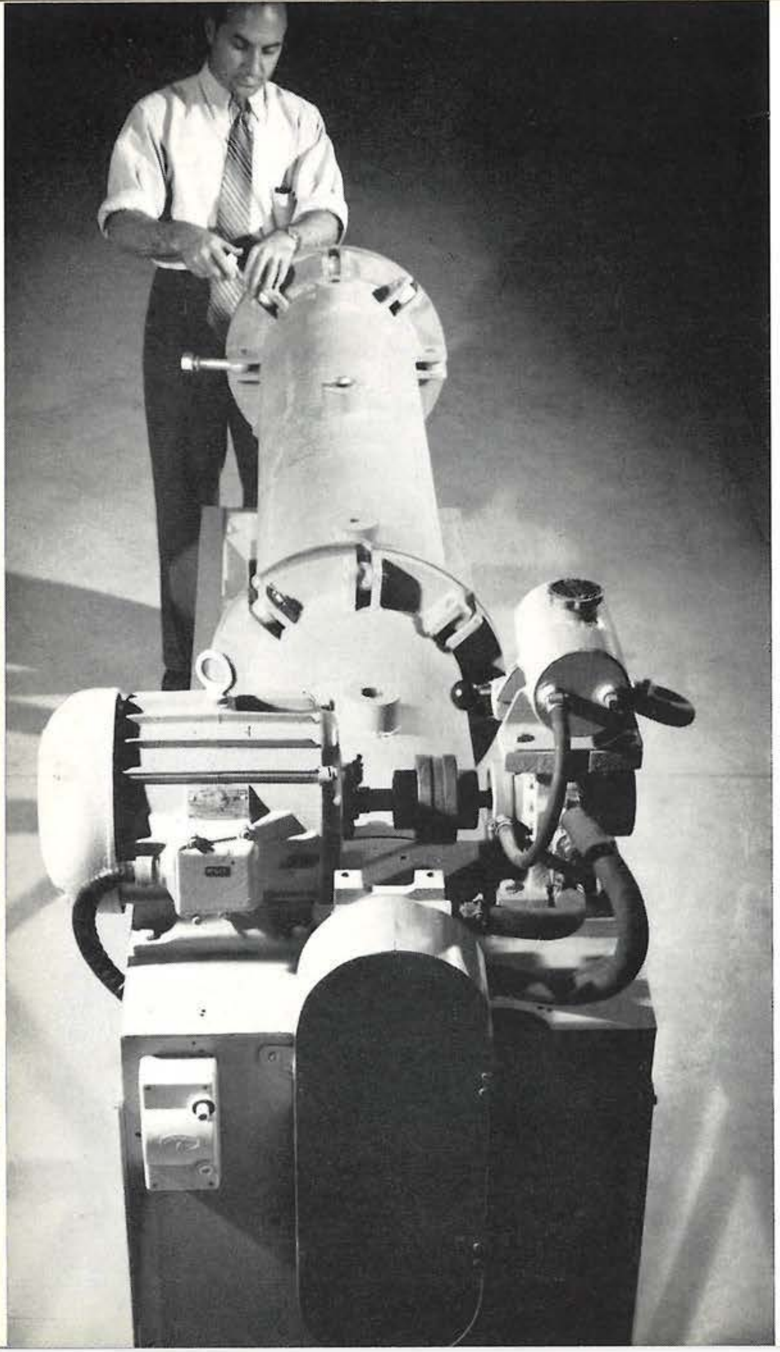
A second major aspect of the Division's research programme also had its beginning in 1946, following the demonstration by American scientists Langmuir and Schaefer that snowfall could be induced artificially by cloud seeding. The Division's staff knew that radar could be used for measuring the size of water droplets in clouds. As Australia is chronically short of water it was decided to undertake a thorough study of the physical processes in the atmosphere which are responsible for the formation of cloud and rain and of the feasibility of "rainmaking". The decision proved a fortunate one and the Division has been responsible for major advances in this field. The first artificially induced rain ever to hit the ground fell in New South Wales after a cloud seeding experiment early in 1947. Within a few years, hundreds of single clouds had been successfully seeded, and by 1961 a series of experiments had been initiated to find out whether rainfall in areas on the western slopes of the main dividing range could be increased significantly. These experiments have not yet been concluded but the results obtained so far indicate that worth while increases in rainfall are possible in those areas in which cloud and topographical features are favourable.



C.S.I.R.O.'s two Cessna 310B aircraft for rainmaking investigations, circling over Sydney Harbour on their arrival from U.S.A.



The 210 ft. radio telescope at Parkes, N.S.W. was recently commissioned. The structure is as high as an 18 storey building.



food

DURING the early years of C.S.I.R. there were a few scientists engaged in research on the ripening of bananas and on freezing of meat and fish. A survey of food preservation and transport, with special regard to refrigeration, was made in 1931-32, and it became clear that much more work was needed in order to reduce waste and improve quality. In 1932 a Food Preservation Section was established and Dr. J. R. Vickery, an Australian who had been engaged on a survey of the New Zealand meat industry, became its leader. Dr. Vickery has been Chief of the Division since the group acquired Divisional status in 1941.

The first headquarters of the Division were established at the abattoir at Cannon Hill, a suburb of Brisbane. The group at headquarters concentrated on the problems involved in the export of chilled beef, and a second group in Melbourne undertook a study of the influence of storage conditions on fruit quality.

In 1938, when the Division's headquarters were transferred to the abattoir at Homebush, near Sydney, work was extended into other fields, including fish preservation and bacteriological studies of the spoilage of eggs.

When war broke out in 1939 it was necessary to gear the resources of the Division to the needs of the armed forces. There was a great upsurge in requirements for canned, frozen, and dehydrated fruits and vegetables and much developmental research in pre-processing treatments and processing practices was called for. The Division became a source of information for the many new food processing factories which were established.

Since the war a wide range of basic and applied research has developed. The Division's chemists, for example, have made funda-

Experimental pressure spin cooker in the canning laboratory of the Division of Food Preservation. Cans are rotated mechanically during processing under steam pressures up to 15 lbs./square inch.

mental contributions to our knowledge of the waxy coatings of fruits, the physical chemistry of proteins, the chemistry of the destruction of vitamin C, and "non-enzymic browning" which is responsible for spoilage in a variety of foods.

The physicists have studied the transfer of heat and moisture through foodstuffs and given us a new theoretical understanding of the canning process. Work on the transport of highly perishable foods has influenced the design and performance of refrigerated and ventilated railway vehicles.

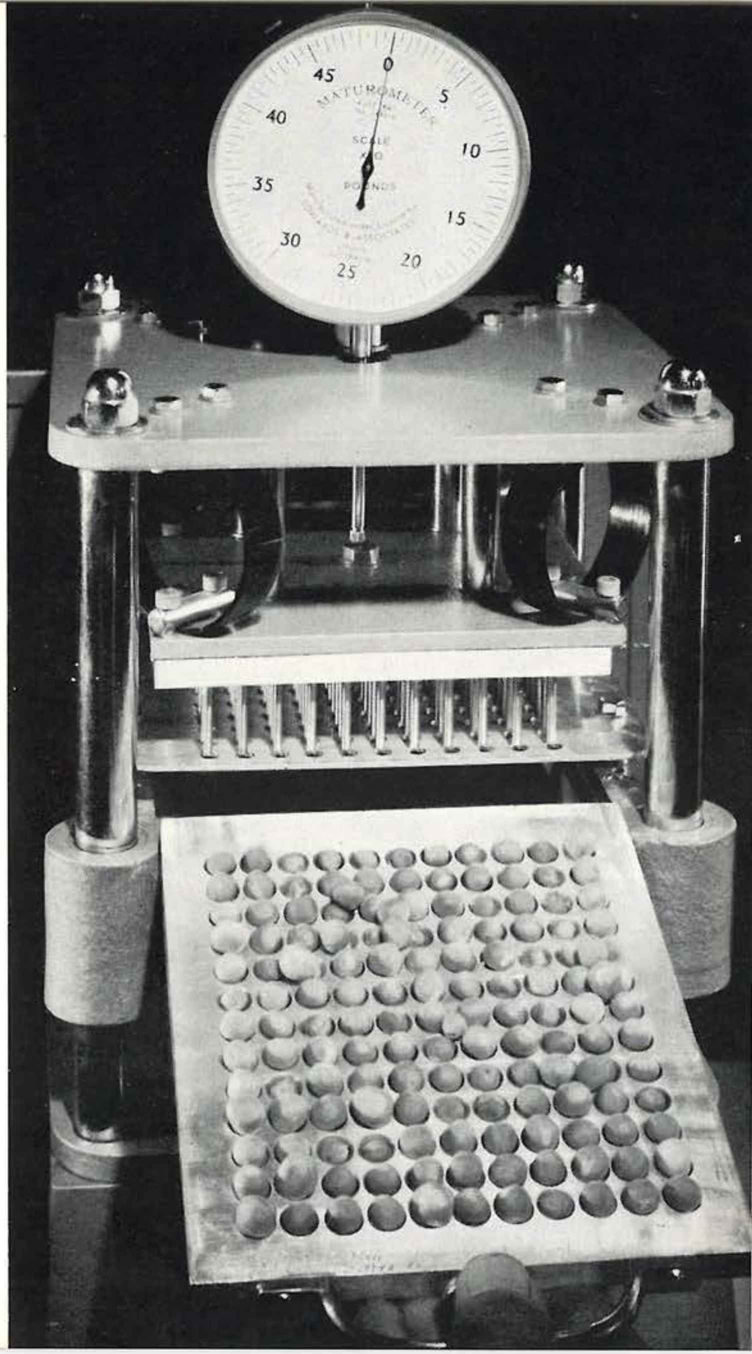
Basic work in the microbiological section has been concerned with the water requirements of micro-organisms, and the resistance of food spoilage bacteria to heat, cold, and high-salt concentration.

The plant physiology group has advanced our knowledge of the physiology of salt uptake of plant cells, and the growth, development, ripening and ageing of fruits.

In the applied field, solutions have been found to many of the problems encountered in the preservation of meat, fish, eggs, fresh and frozen fruits and vegetables, canned foods and dehydrated foods. Acceptable conditions for freezing, storing and canning Australian species of fish have been worked out. The Division has devised ways of predicting the optimum maturity of vegetables, such as peas and sweet corn, for canning. Treatments have been found to combat mould growth on citrus and grapes, bitterness in orange juice, and superficial scald in apples. Variety trials are conducted to show which varieties of fruit and vegetables are best suited for processing.

In 1961, after nearly thirty years tenancy of abattoir accommodation, the Division moved into fine new buildings at the Sydney suburb of North Ryde.

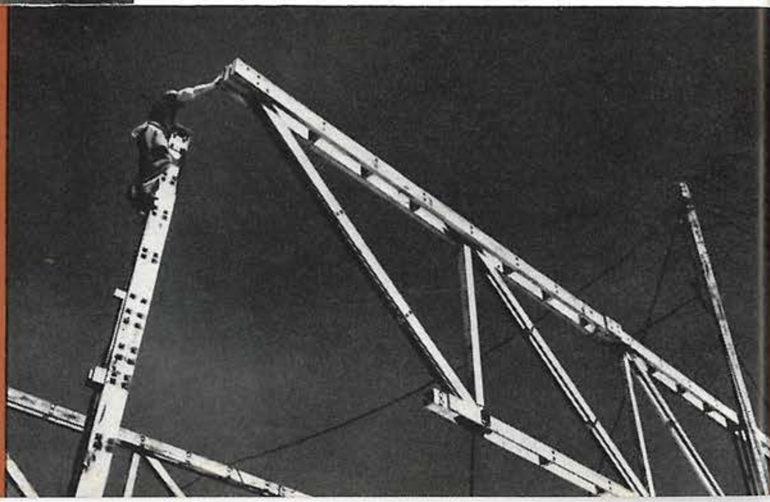
This device, developed in the Division of Food Preservation, enables the maturity of peas to be measured.



forest products

The strength of sample telegraph poles is measured in a giant testing machine.

A major part of the work of the timber mechanics section consists of the determination of the strength properties of various species of timber and their application to the design of structures. A roof truss, designed from data obtained in the Division, is shown being erected on a site near Melbourne.



THE Division of Forest Products was founded in 1928, under the leadership of the late Mr. Isaac Boas. At that time, Australia was paying enormous sums for imported timber, while the potential value of her own native timbers remained unrecognized.

The Division's research was directed from the beginning toward more effective use of timber resources, by reducing waste in forest, mill and factory; by reducing losses from decay and insect attack; and by improving for timber and pulp the quality of wood in the growing forest by the study of wood properties associated with tree breeding and silvicultural treatment.

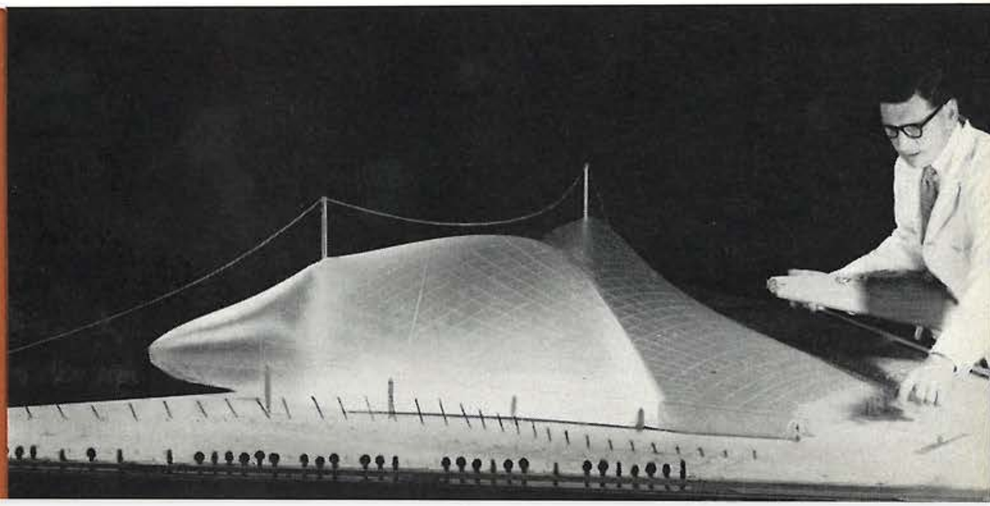
Even before the Division was founded, Australian scientists had shown that Australian eucalypt timbers could be used in pulp and paper making. The Division has from the outset supported its applied work with more basic research, and in the early days more fundamental investigations into the problems of paper making were started in collaboration with the pulp and paper manufacturing companies.

In 1936, when the Division moved to its present building in South Melbourne, it had become organized into sections of wood chemistry, timber seasoning, timber preservation, timber physics, timber mechanics, wood structure and timber utilization. Later, a plywood investigations section was established.

On the retirement of Mr. Boas in 1944, Mr. S. A. Clarke became Chief. He in turn retired in 1960 and was succeeded by the present Chief, Dr. H. E. Dadswell.

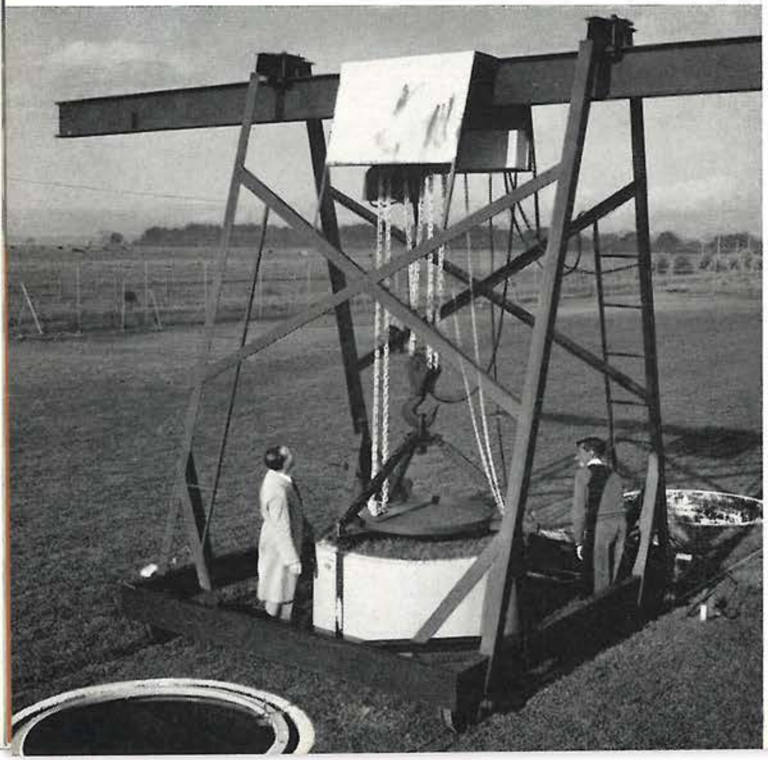
The Division's work has already made a great impact on the Australian timber industry. Large-scale manufacture of good quality kiln-dried hardwood has followed improved kiln design arising from its research. Many of the problems incurred in using local hardwoods instead of imported softwoods for building have been solved. The work of the timber preservation section has enabled the life of such things as telegraph poles and railway sleepers to be greatly extended—the Postmaster General's Department alone estimates its savings from this work at £2,000,000 per year. Improved plywood, new information on timber engineering design, efficient use of short lengths of timber—all these are further examples of industrial applications born of the Division's applied research.

The Division functions as an information centre for all matters affecting wood use, handling some 12,000 enquiries in a year. An increasing amount of the Division's work is being sponsored by industry, which is at the present time contributing twenty-five thousand pounds a year for research.



Aluminium coated plywood panels were used for the Sidney Myer Music Bowl in Melbourne. A model of the bowl was built in the Division for determining stresses in the structure.

Experiment in forced ventilation of tobacco crop for prevention of blue mould.



meteorology

C.S.I.R.O.'s Division of Meteorological Physics is almost unique in that it is purely a research unit divorced from the obligation of providing weather forecasts.

The need for a meteorological research group was foreseen by the present Chairman, Dr. F. W. G. White, and his colleagues on the C.S.I.R. Executive Committee during the last years of the Second World War. In 1946 Dr. C. H. B. Priestley, a scientist from the British Meteorological Office, was brought out to Australia to establish C.S.I.R.'s Meteorological Physics Section.

Dr. Priestley's first tasks were to establish laboratories in Melbourne, to decide on a research policy, and to recruit staff. Like many other C.S.I.R. groups in the post-war era, the meteorologists had to make do with temporary quarters until 1953 when they moved into their new laboratories at Aspendale, an outer Melbourne suburb. Associated with the laboratory is a small field station at Edithvale, a couple of miles away. The appointments of research staff began in 1947.

Micro-meteorology, the study of the atmospheric layer within 100 metres of the earth's surface, was chosen as the major field of research. This, the lowest atmospheric layer, is of great importance since it is here that the atmosphere derives its energy through heat exchange and evaporation from the ground, and it is here that the atmosphere dissipates its energy through friction between the ground and the air. As Australia is an island, set in an ocean hemisphere, the processes of air mass modification which take place at surface level occur strongly, and are of governing importance in controlling our weather. It is in this near-surface zone, too, that plants and animals live, and micro-meteorological knowledge is important in a primary producing country like Australia. The importance of this work has gradually been realized by other Australians, within and without C.S.I.R.O., working in such disciplines as plant physiology, plant pathology and ecology.

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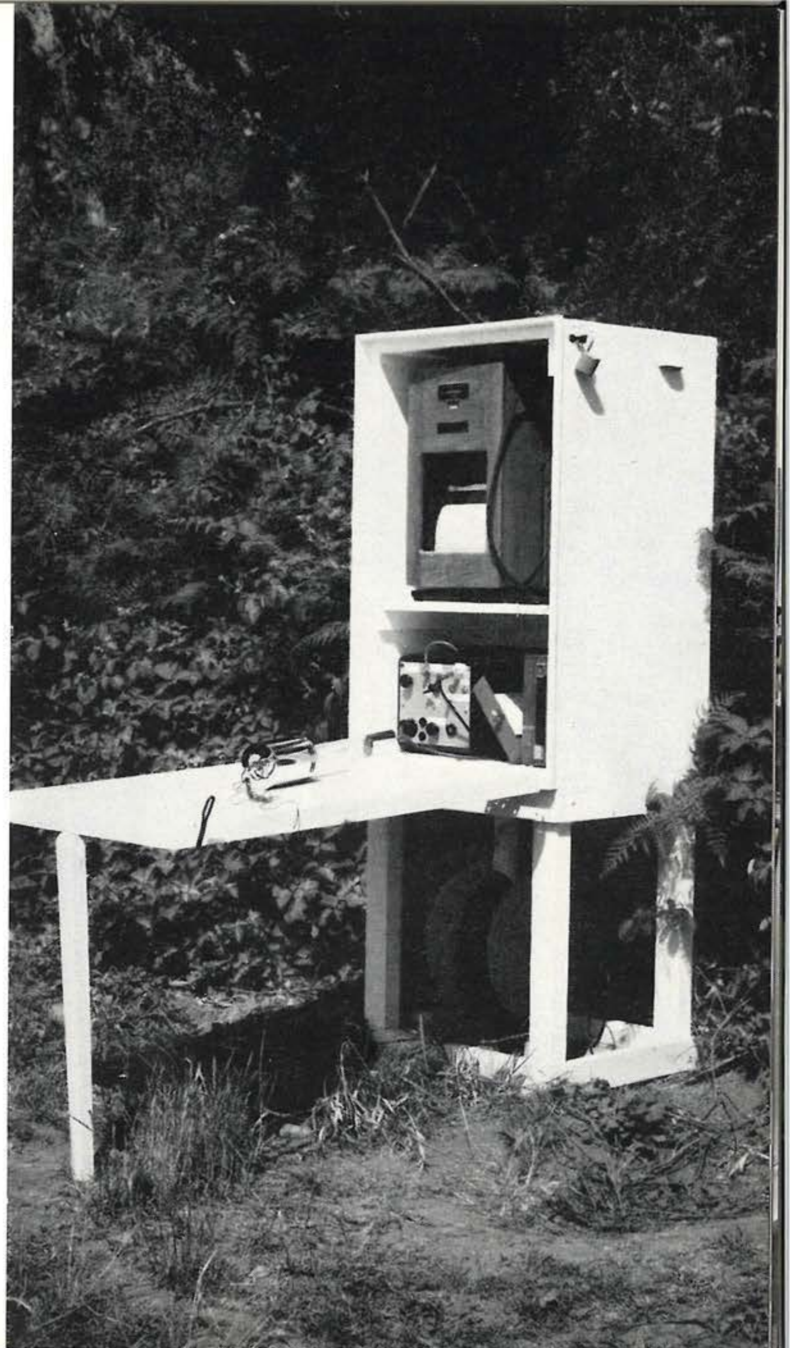
The micro-meteorological work has led to a much better understanding of the basic heat and energy exchange processes which take place between the air and the ground. On the more practical side, it has led to considerably improved methods of frost prevention, and an understanding of the problems of calculating and controlling evaporation from water surfaces.

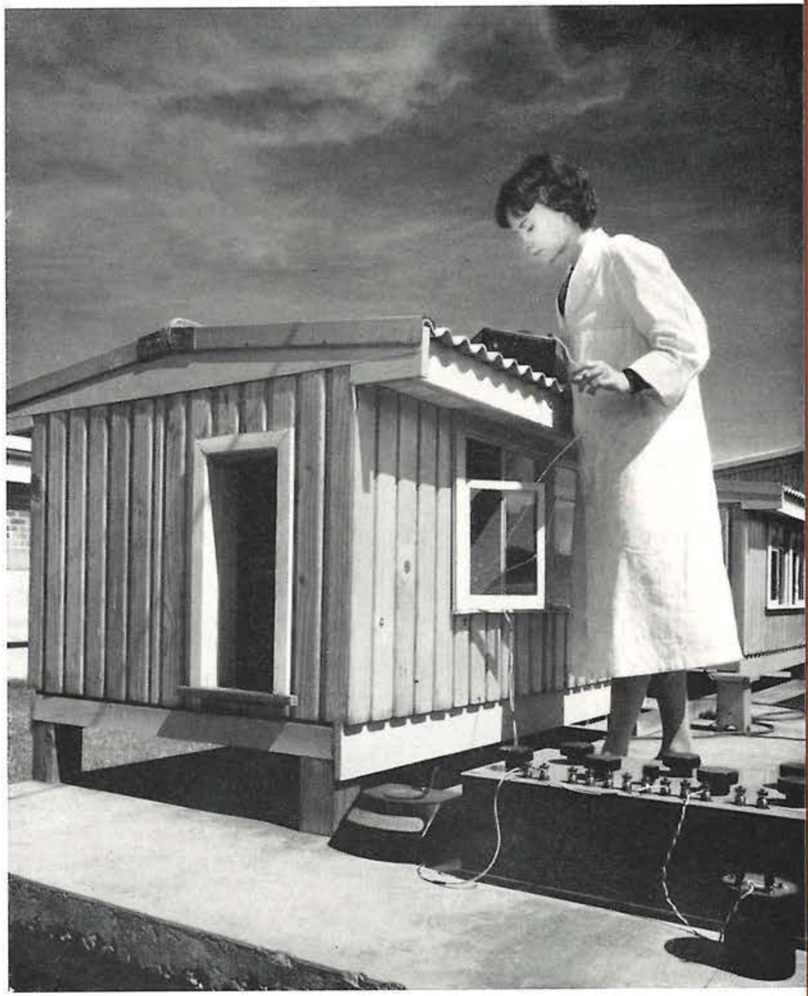
This work has also led to the development of a number of sensitive instruments for measuring such variables as temperature, humidity, net radiation and evaporation. A sensitive weighbridge has been developed, capable of detecting variations of a few ounces in a mass of earth weighing six to eight tons. Another invention is a remote recorder, which can be left unattended for many months, and which can record measurements made by other instruments.

The Division's second important field of research is dynamic meteorology, the attempt to understand in physical terms the behaviour of weather systems. This work is aimed at a better understanding of the problems facing the weather forecaster, and at solving such questions as "Why do droughts occur?", and "Is our weather changing?". Much has already been learnt about the "cool changes" which characterize climate in south-eastern Australia, and which have now been found to constitute a multiplicity of discontinuities in wind direction, temperature and squall lines.

Apart from its major research interests, the Division is the Australian centre for ozone research, and is also equipped for the calibration of air flow meters. In the future, it is hoped to extend the micro-meteorology work to the air masses over the sea, and to develop weather buoys to provide information from the ocean wastes.



Remote recorders for field meteorological studies.



building research

A Section was established in 1945 to undertake research into building materials and their uses. This work was complementary to that of the Commonwealth Experimental Building Station which was established in 1944 to experiment with new ideas in building construction. The Building Materials Research Section became the Division of Building Research in 1950, with Mr. Ian Langlands, the founder of the Section, as the first Chief. The laboratory is situated at Highett, a suburb of Melbourne.

The Division has built up a programme of research into the properties and uses of bricks, stone, tiles, concrete, glass, building boards, fibrous plaster, insulating materials, and organic materials. An architectural physics laboratory concentrates on acoustics and the more basic problems of heating and cooling buildings. Ever since 1945 an information section has been needed to cope with a flood of enquiries (now some six thousand five hundred a year) from the building trade and manufacturers of building materials.

The Division has already achieved some notable successes. It has, for example, discovered that some Australian clays and shales can be processed and then used as aggregates for concrete.

The product is much lighter than the sand and stone it replaces, with the result that the concrete is lighter and more useful as a building material. The Division is also seeking to provide the technical background for the manufacture in Australia of aerated concretes and mortars.

Since Australia is extraordinarily rich in gypsum reserves, scientific and technical investigations are being made into the use of gypsum as a building material, particularly in the form of fibrous plaster, an extensively used lining material unique to Australia.

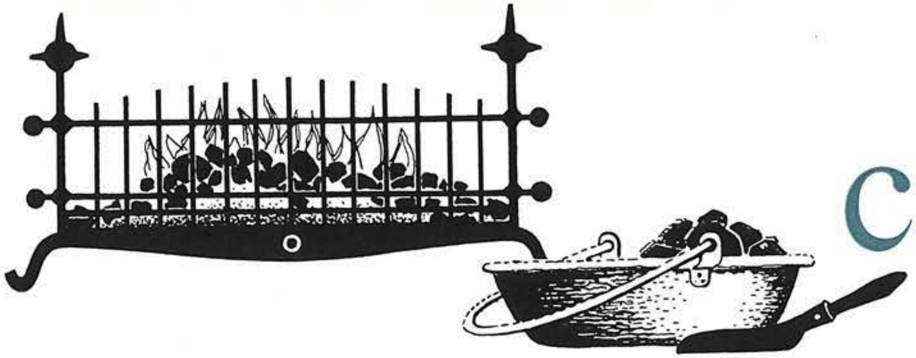
Acoustics research has led to the successful design and construction of sound reinforcements systems in large halls and in open spaces, such as the Sidney Myer Music Bowl.

A good deal of the Division's work is investigating the causes of defects in buildings and ways of overcoming them. It has, for example, made a valuable study of the expansion of bricks and has published recommendations for preventing consequent damage to brickwork. Work on bituminous roofing materials has provided the answers to many of the problems which were previously encountered with bituminous flat roofing.

In many different ways the Division helps the builder and manufacturer. Realizing this, the building materials industry is now sponsoring research in the Division by contributing several thousand pounds each year.

FAR LEFT — *Model houses used in research on domestic heating.*

RIGHT—*A bank of loudspeakers used in research on sound reinforcement.*

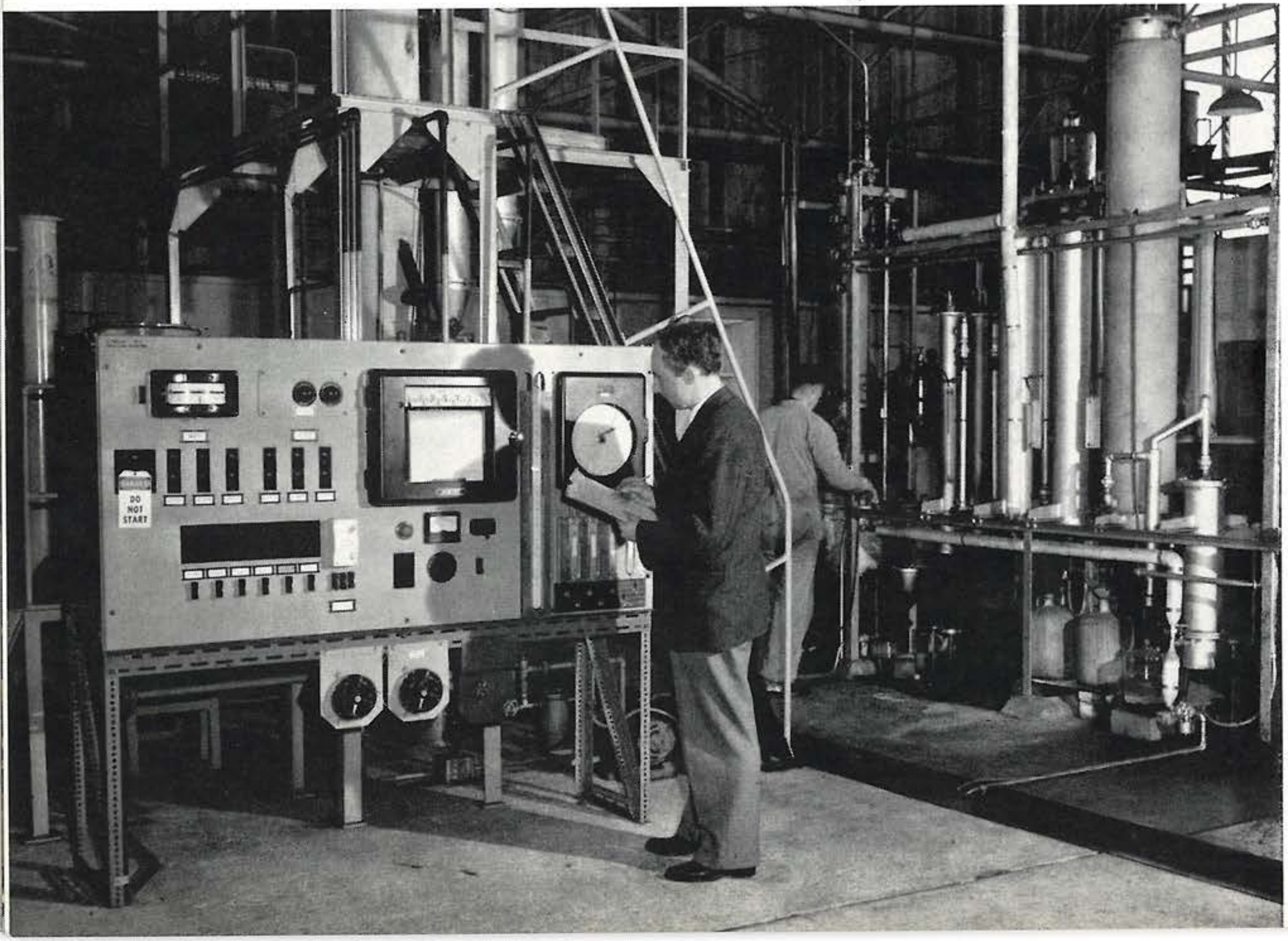


coal

DURING the second world war it became obvious to the Federal Government that there was a notable shortage of information about Australia's coal resources, and how these resources might best be utilized. Just after the war, an inter-departmental committee was asked to advise the Government on what steps it should take to remedy this situation .The Committee recommended that C.S.I.R.O. should make a physical and chemical survey of the coal resources of Australia, and in 1947 an expert Coal Utilization Research Committee proposed a research programme for the guidance of the Executive.

In 1948 Mr. H. R. Brown, from the University of Leeds, took up duty in Australia as the first Officer-in-Charge. In the following year a site was acquired at the Sydney suburb of North Ryde, and in 1950 laboratory investigations commenced.

The Division's main continuing project is an assessment of the physical and chemical characteristics of Australian coals. Already all the major seams in



An experimental low-temperature fluidized bed carbonization plant in the Division of Coal Research.

New South Wales have been examined. Brown coal from Victoria, lignite from South Australia, and sub-bituminous coal from Western Australia have been studied, and attention is now being directed to the Queensland mines.

Coal is studied from many different points of view. Coals which can be made into strong metallurgical coke are needed by the steel and foundry industries, so the Division investigates the variables in the coking process, and the selection, blending, and preparation of coals for coke-making. Since the microstructures of coal and coke are important in their utilization, petrologists and physical chemists study coal and coke from this aspect.

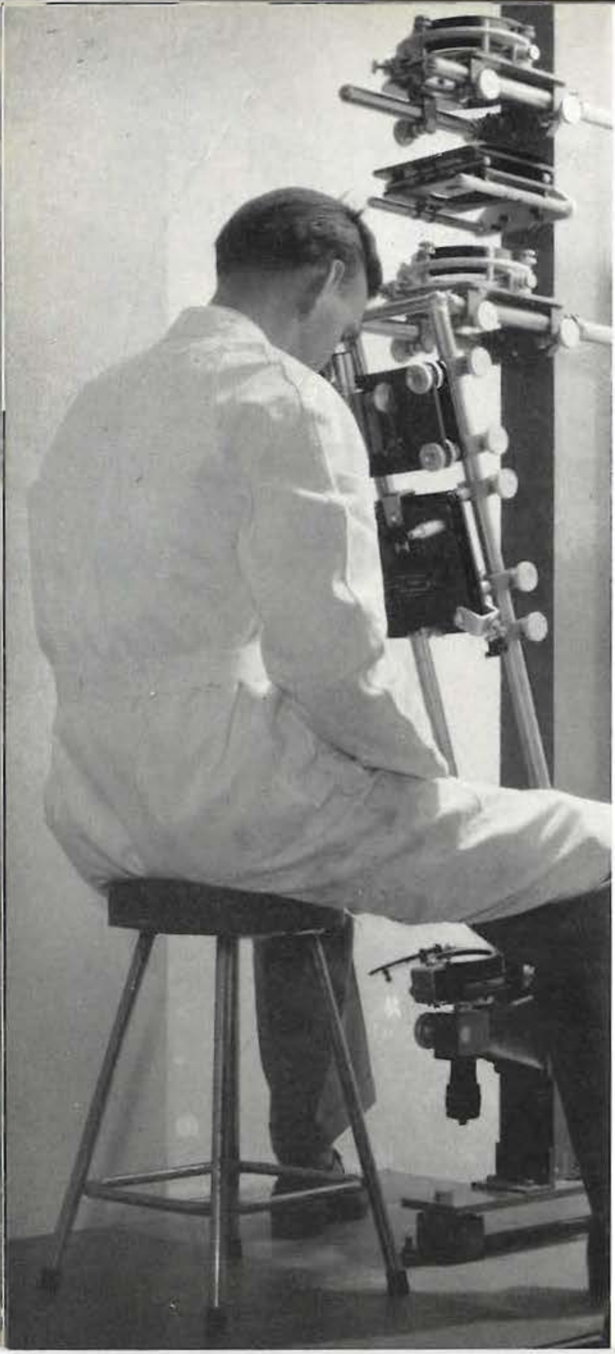
The greater part of the coal mined at present is burnt to produce energy, and most of the troubles associated with its combustion are due to the presence of mineral matter—for example, atmospheric pollution, deposits and slags in boilers, corrosion of refractories. The Division therefore looks carefully at the mineral matter in coal and its distribution, and its behaviour in industrial processes.

Useful by-products, such as tars and pitches, are obtained during the manufacture of coke and gas. The modification of these products for industrial use (for instance, pitch for electrode manufacture in the aluminium industry) is another research topic.

The Division has turned its attention to a number of other industrial problems. Work on coal cleaning provided the information on which was based the design of numerous industrial plants washing coal for export—for example, to Japan. A microscopic study of spores in coal strata has been of interest to firms concerned in oil exploration.

Coal research, in C.S.I.R.O. and elsewhere, is showing how desired results can be obtained from a variety of raw materials. It is becoming possible to use poor quality coals for purposes which had previously seemed impossible. Industry, realizing the value of research, is currently subsidising C.S.I.R.O.'s coal research work by grants of £17,000 per annum, and is also financing complementary coal research through a co-operative venture called Australian Coal Association (Research) Ltd.

A differential thermogravimetric balance designed and built in the Division of Coal Research.



wool RESEARCH into wool production and the diseases of sheep dates from the early years of C.S.I.R.'S existence. It was not until after the war that the Executive laid plans for the establishment of laboratories to study wool as a textile fibre. Sir Ian Clunies-Ross, who had previously been Chairman of the International Wool Secretariat, urged graziers to provide funds for wool research, and these funds soon became available at a rapidly increasing rate.

In 1949 three laboratories, known as the C.S.I.R.O. Wool Textile Research Laboratories, were founded, The Melbourne laboratory, under the direction of Dr. F. G. Lennox, began a fundamental long-range chemical and biochemical study of wool fibres. The nucleus of the staff came with Dr. Lennox from the Biochemistry Unit of the Division of Industrial Chemistry, where investigations into fellmongering had been going on for some years. In Sydney, a Physics and Engineering Unit was set up under the direction of Mr. V. D. Burgmann. The Sydney laboratory was concerned with the fundamental physics of wool and wool processing. The third laboratory at Geelong (Victoria) concentrated mainly on research projects which might be expected to solve some of the problems of immediate concern to the textile industry. Dr. M. Lipson, a C.S.I.R.O. officer with experience in the wool industry and wool testing as well as in research, became Officer-in-Charge of the Geelong laboratory.

During the first decade of their existence the Wool Textile Research Laboratories, supported by the wool industry, grew steadily in size and stature. In 1958 they were accorded the status of Divisions, and were known respectively as the Division of Protein Chemistry, the Division of Textile Physics, and the Division of Textile Industry.

In the Division of Protein Chemistry, scientists are undertaking a long range research programme to elucidate the structure of wool, which is the most complex of all the textile fibres. Use is made of many modern physical and chemical

An optical diffractometer used to study the conformity of proposed molecular structures with observed X-ray patterns.

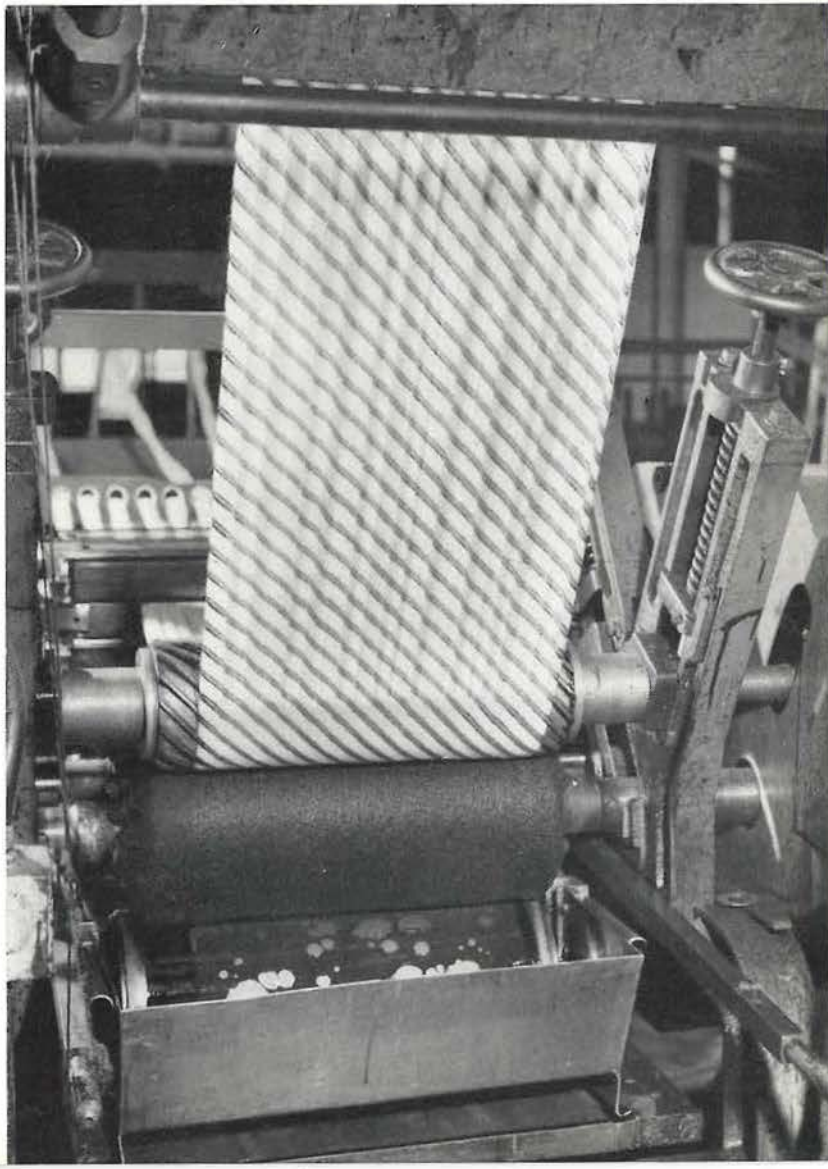
techniques such as X-rays, the electron microscope, chromatography and polarography. Much has been learnt of the structure of the wool fibre at the cellular, sub-cellular and molecular levels. It has been found, for example, that two main types of protein occur in the wool fibres, one of which is concentrated in microfibrils, and the other in the surrounding matrix.

Although this research is of a fundamental nature, some of the knowledge gained has proved to be of value to industry. It has led, for instance, to a new method for recovering wool from skin pieces, and to improvements in the carbonizing process used for removing plant material, such as burrs, from scoured wool. Research on woollen blankets has shown that wool is not a major source of cross-infection in hospital wards. In the course of this work a detergent has been developed in which shrink-proofed hospital blankets can be boiled without discolouration or damage. Work is also in hand on low temperature dyeing of wool. Another project is aimed at finding out why white wool turns yellow when washed or exposed to sunlight.

At the Division of Textile Physics, the physical properties of wool fibres are studied to see how they will behave in manufacturing operations, and how they will perform when made into a fabric. Basic studies have been carried out on the stretching and contraction of fibres. The electrical properties of wool have been investigated, and likewise the effects on wool of ultra-violet irradiation, particularly in increasing uptake of dyes. Wool will absorb a good deal of water, so the penetration of water into wool fibres has been closely studied. Water penetration has been found to have interesting effects on such fibre properties as electrical conductivity, torsional rigidity, and dimensional stability. The reverse process, drying of wool, has also been carefully studied; this has provided knowledge which will have useful application in future design of industrial dryers.

Apart from new basic knowledge, the fruits of the Textile Physics research

In the melange printing process, dye is roller printed on to wool, so that each fibre has dyed and undyed sections. An improved process, developed at Geelong, considerably reduces the processing time.



lie in the field of instruments and apparatus. One new development, for example, is an apparatus for the rapid measurement of moisture regain in wool, and another is a device for measuring the evenness of a moving yarn. A third invention is a modified pressure-coring sampler which is now used as a convenient instrument for taking representative samples from bales of wool.

The aims of the Division of Textile Industry are twofold. Firstly, much of the work is devoted to the improvement of wool and wool products, and secondly, the Division is trying to improve the textile manufacturing operations in woollen mills. In the other two Divisions basic work sometimes leads to results of industrial use. At Geelong the reverse is true—the study of applied problems sometimes paves the way for research of a more fundamental nature.

The applied work has been spectacularly successful. An economic method of mothproofing wool, using the commercial insecticide "Dieldrin", has been developed and is now used in many countries. Chemical treatments for wool have been devised which can make fabrics shrinkproof, resistant to "balling" or "pilling", and which confer "wash-no-iron" properties. Perhaps the best known of such processes is the "Si-Ro-Set" process for permanent pleating or creasing, which is now used by many clothing manufacturers in Australia and overseas.

A number of notable improvements in textile processing have also been achieved. The introduction of a sheep branding fluid which is removed from the wool in normal processing has overcome a major problem due to "tar" in the Australian clip. A new process has been developed for solvent degreasing of wool (replacing soap-soda washing) and is now operating on an industrial scale. A control instrument which has been invented for the Noble comb is now widely used by the wool combing industry. Industrial operations such as "carding", spinning, dyeing and sizing are also studied with a view to improving conventional procedures.

Formic acid dyeing using laboratory scale equipment.

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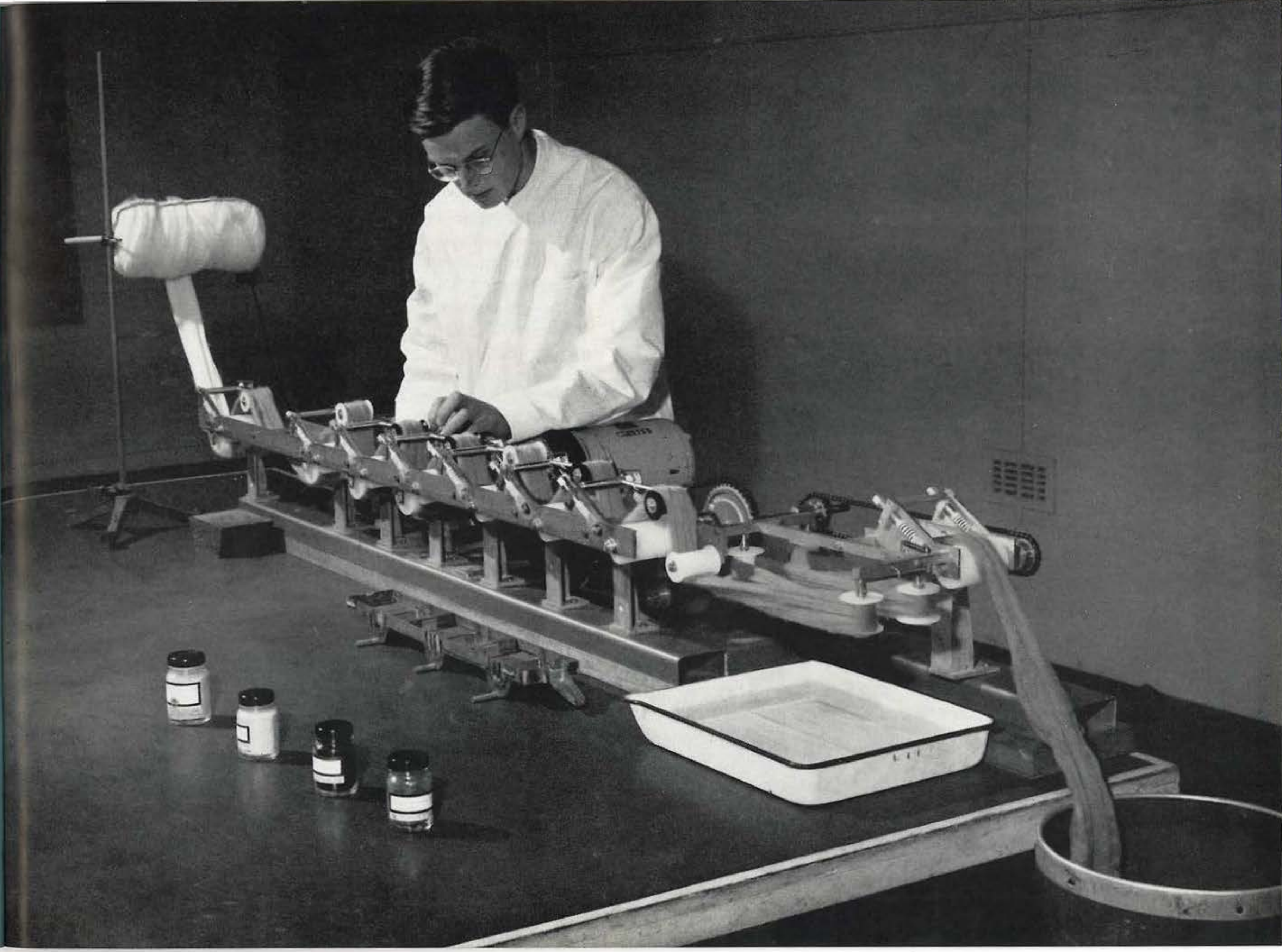

mining

WITHIN the grounds of the University of Melbourne are two small C.S.I.R.O. Sections which are primarily occupied in serving the needs of the mining industry. They are called the Mineragraphic Investigations and Ore-Dressing Sections.

Mineragraphy is the study of ore materials in polished surfaces by microscopic, spectrographic, X-ray and other techniques. C.S.I.R.O.'s entry into this field dates back to 1927, the second year of its existence, when Dr. F. L. Stillwell was appointed to initiate the work. Mineragraphy has been applied to a very wide range of mining and ore-dressing problems. It has been used, for example, to get information about the association of different minerals in ores and to detect losses of valuable minerals in mill wastes and tailings and furnace products. It has also been used in conjunction with petrological investigations to study the gangue minerals and rocks associated with ore-bodies and problems of ore genesis, and the composition of economic beach sands. The content of mine and other dusts has been studied in order to assess their possible hazards to health.

Mineragraphic, mineralogical and petrological techniques have also been applied to scientific problems not associated with mining. They have, for example, been used to study the drift of sands on the ocean floor; the "opal phytoliths" which are formed in plant tissues and cause wear of sheep's teeth; and the mysterious objects of impure silica glass called "tektites" which come from outer space. Many of the Section's substantial contributions to mineragraphy have been drawn on for the compilation of a standard text called "The Texture of Ore Minerals and Their Significance" by Dr. A. B. Edwards, who was Officer-in-Charge of the Section from 1953 to 1960.

The Ore-Dressing Section began in 1934, when the Commonwealth Government granted £5,000 per annum for research at three centres—the Universities of Melbourne and Adelaide and the Kalgoorlie School of Mines. The work at Adelaide ceased in 1948.

The Section studies the recovery of minerals from ores by many different methods, including cyanidisation, amalgamation, flotation, leaching and pressure leaching, and by gravity, electrostatic and magnetic methods. Most of the work is stimulated by requests from mining companies which need help in the concentration and refining of crude ores. Help has been given to many people, ranging from small prospectors to giant companies.

The topics of investigation in both Sections have changed in step with the fluctuation in economic importance of metals. In the early 'thirties the emphasis was on gold, gradually shifting to lead and zinc. In the post-war years uranium ores were the centre of attention, giving place in turn to the titanium and zirconium minerals found in beach sands.

Much of the work of the Ore-Dressing Section has been assisted by contributions from industry, which has benefited a great deal from its work. Methods worked out by the Section for the recovery of many important minerals, including scheelite (containing tungsten) and ilmenite (containing titanium) are now in use by Australian mining companies.

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An apparatus in the Ore-Dressing Section for electrostatic separation of minerals.

In the planning of a new harbour at Portland, Victoria, mineragraphic techniques were used to study the movements of sand on the ocean floor.

standards

For many years after the foundation of the Commonwealth of Australia, the States continued to be the custodians of their legal standards of weights and measures.

The establishment of a National Standards Laboratory was first advocated in 1912 by Sir John Madsen, who was then Professor of Electrical Engineering at the University of Sydney. But it was not until 1937 that the report of a Secondary Industries Testing Research Advisory Committee (of which Sir John was a member) led to the setting up of a National Standards Laboratory within C.S.I.R. It was decided that the Laboratory should consist of the Sections of Metrology, Physics, and Electrotechnology.

In 1938 leaders of the three groups were chosen. Mr. N. A. Esserman (later the first Director of the Laboratory) came from the Munitions Supply Laboratory to take charge of Metrology, and two Sydney University men, Dr. G. H. Briggs and Dr. D. M. Myers, were appointed Officers-in-Charge of the Physics and Electrotechnology Sections. A year later, construction of the Laboratory began in the grounds of the University of Sydney.

When the war broke out in 1939, the three Officers-in-Charge were overseas, where they had been looking at standards research and seeking standards equipment. Fortunately, some equipment was obtained, and when the Officers-in-Charge returned from overseas it was possible for the Laboratory to commence functioning and devote its entire effort to defence work. The Metrology Section certified gauges, made micrometers, slip gauges and measuring equipment, and provided a calibration service for the Ministry of Munitions and the inspection branches of the armed services.

Optical glass had not been produced in Australia before the war, and the Physics Section was called on to advise on its manufacture for lenses and prisms for such instruments as telescopes and range finders. The Physics Section became involved in many other problems, ranging from the development of aircraft-spotting goggles to the production of jewelled bearings for instruments.

The Electrotechnology Section worked on "degaussing", a means of neutralizing or counteracting magnetic fields, which was of great interest to the Navy. Another of the Section's projects was concerned with the prevention of deterioration in hot and humid climates of radios and optical and electrical instruments.

After the war, the Sections were raised to Divisional status, and for the first time the Laboratory was able to concentrate on its original objectives. In 1948 the Commonwealth Government passed a Weights and Measures (National Standards) Act which made the Laboratory, on behalf of C.S.I.R.O., the custodian of the legal standards of the Commonwealth. "In 1961 Metrology and Electrotechnology were merged in a new Division of Applied Physics".

The Division of Applied Physics has maintained the standards of length, mass and volume, and all the secondary standards, such as area and density, which are derived from them. Since 1960, when the units of length were defined in terms of the wave length of an isotope of the gas krypton, it has been possible to define the metre accurately to within one part in ten million. Working standards of mass can be compared to a standard platinum-iridium kilogram on a balance accurate to more than one part in ten million.

There have been many useful applications of the metrological work. It has, for example, been largely instrumental in the establishment of

The Division of Applied Physics has developed improved facilities for the accurate measurement of large gears.

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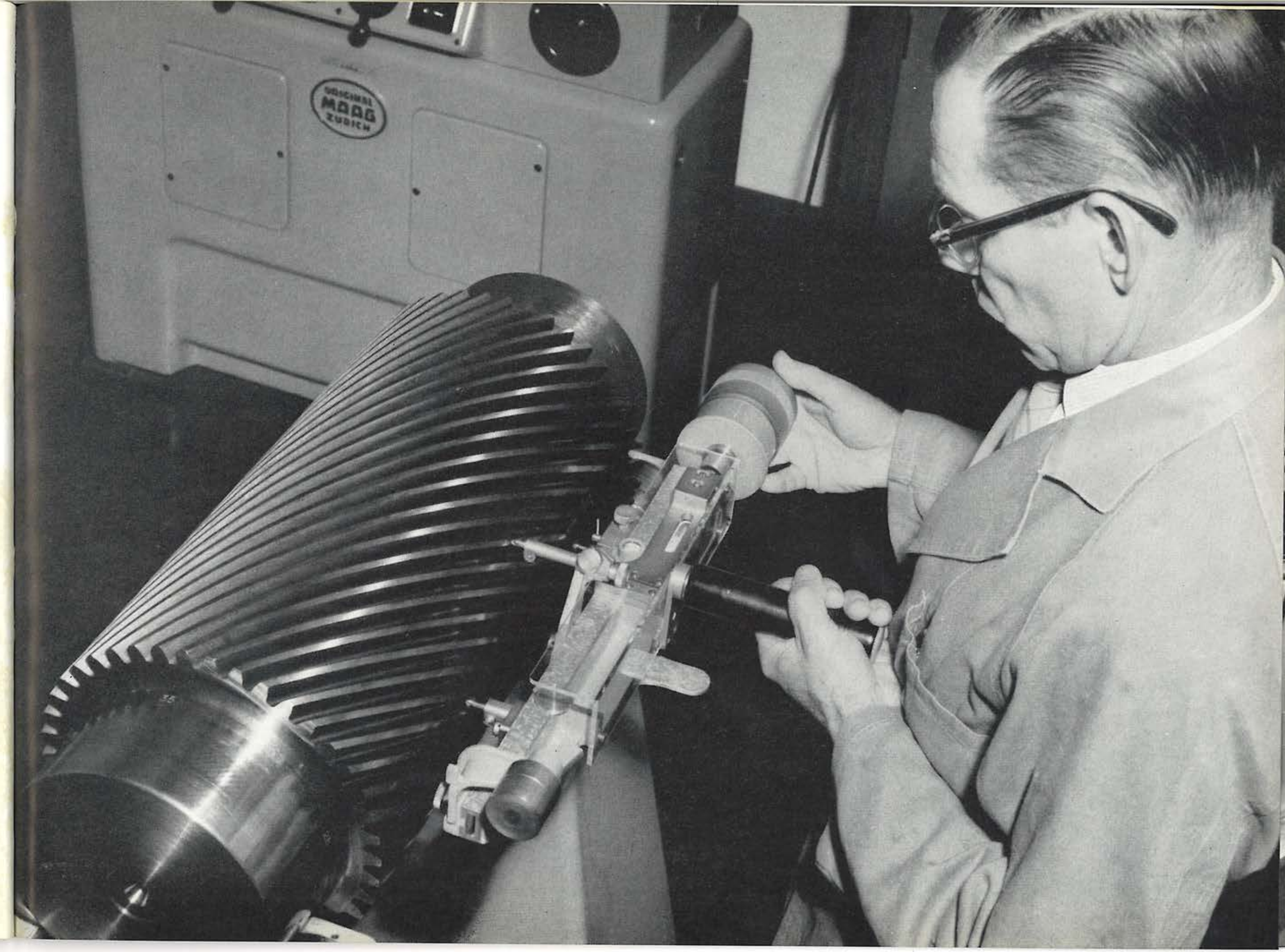


an Australian scientific glassware industry. Research has led to the ability to produce very true flat surfaces, and this in turn has led to the invention of ingenious techniques for doing such things as sharpening microtome knives and hypodermic needles. It has also been possible to show industry how to make very flat plates for precision condensers. An applied mechanics group in the Division has developed new ceramic machining tools from Australian materials, and has worked on the isolation of vibration.

The Division is also responsible for the maintenance of the standards of electrical and magnetic quantities. It maintains the Commonwealth standard of frequency in conjunction with the Mount Stromlo Observatory, and other standards derived from frequency, resistance, and electromotive force. As part of its service to industry the Division calibrates a wide range of electrical instruments and equipment, including resistors, bridges, potentiometers, capacitors and wave meters.

Fundamental research in electrotechnology has been concerned with the improvement and extension of electrical measuring and standards facilities, the dielectric properties of insulating materials and the microwave spectra of gases. A recent outstanding achievement has been the construction of a capacitor, the value of which can be calculated from its dimensions. With this as a starting point it is possible to determine the absolute value of the ohm.

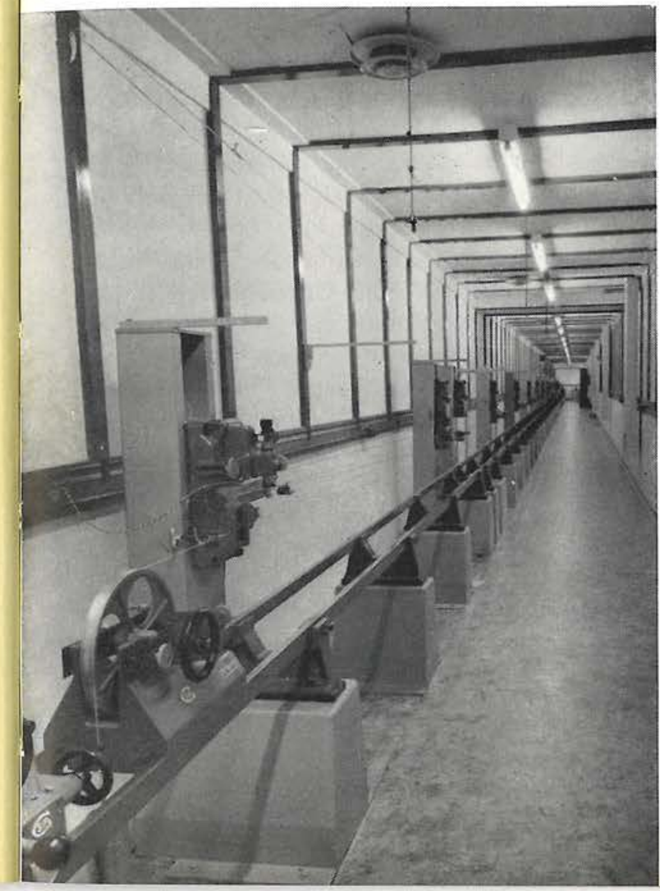
The Division of Physics is responsible for the standards of temperature, photometry, hygrometry and viscometry, and it also maintains the International Temperature Scale. A number of ingenious and novel techniques and instruments have been devised for measuring these quantities. A typical example is a fast, accurate and convenient hygrometer which can be used to obtain relative humidity readings

◀ *A magnetic test bench at the Division of Applied Physics.*

within two minutes. The Division's officers visit industrial establishments to calibrate thermometers and pyrometers *in situ*. Well-attended courses in temperature control are held for technicians from industry.

Fundamental research includes work on solid state physics and solar physics. The solid state programme is designed for the study of the physical properties of both metallic and insulating substances, and the inter-atomic forces which determine these properties. The solar physics work is aimed at finding out how corona flares and other visible changes in the sun's surface are related to phenomena directly affecting such things as radio communications on Earth.

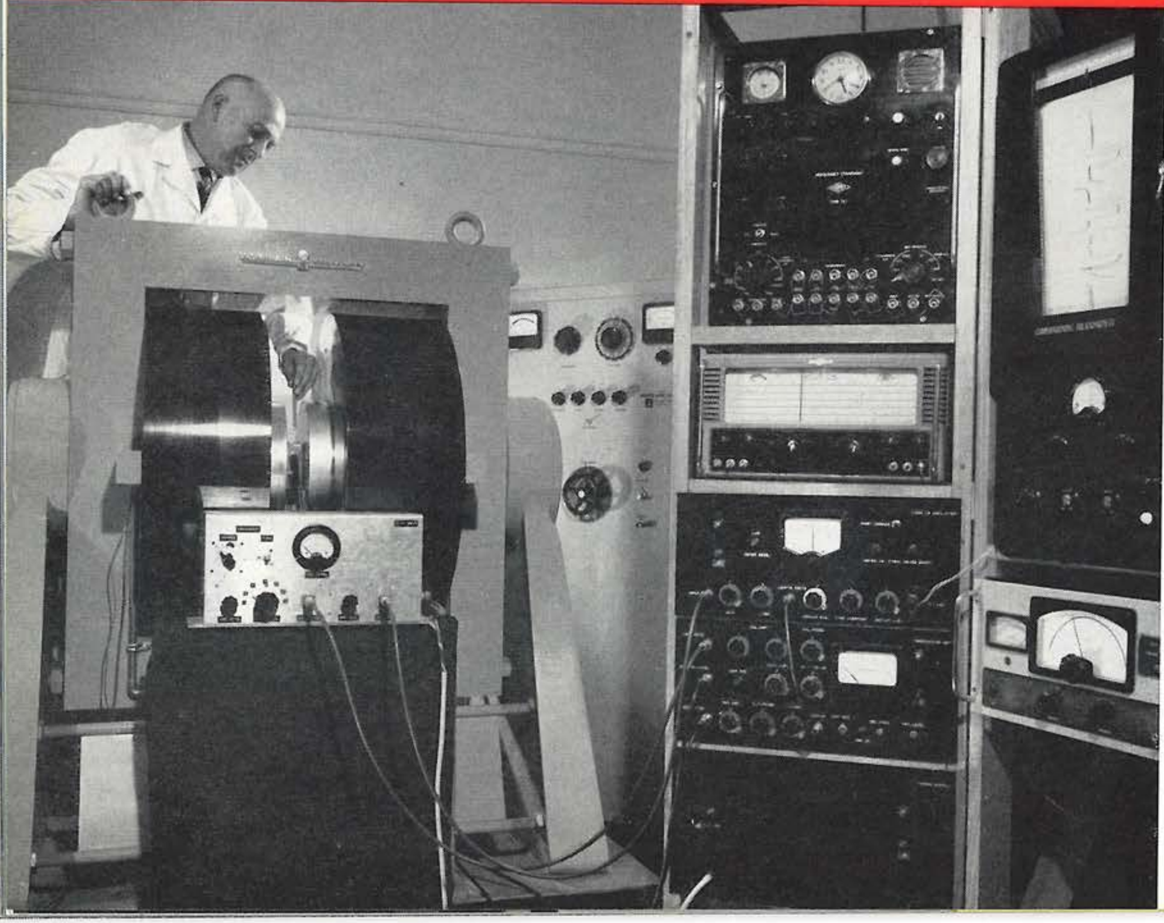
A Geodetic Base, 50 metres long, for the calibration of surveying tapes to an accuracy of between 2 and 3 parts in one million.



The Division of Physics calibrates mercury-in-glass sub-standard thermometers against platinum resistance thermometers.

tribophysics

The nucleus of an atom has a spin which is affected by magnetic and electric fields. A nuclear magnetic resonance spectrometer measures this effect using a 2½ ton magnet and considerable auxiliary electronic equipment. The results give information about the movement and distribution of atoms in many substances.



WHEN the Second World War broke out in 1939 Dr. F. P. Bowden, F.R.S., a noted Cambridge physical chemist, happened to be in Australia. At that time, Australia was in the process of establishing an aircraft industry. There was, however, nobody in the country familiar with the problems of manufacture of aircraft bearings and the Government of the day persuaded Dr. Bowden to stay in Australia to initiate studies in this field. Dr. Bowden was lent by his University to C.S.I.R., and soon established a small group which was called the Lubricants and Bearings Section, housed in the Department of Chemistry of the University of Melbourne.

Out of the group's war-time work emerged much of our present-day knowledge of the nature of friction. Special techniques for bearing manufacture were worked out, and bearings were actually produced at the University under the supervision of C.S.I.R. officers. The Section tackled several other important projects of practical importance to the war effort. One important achievement was the development of an electronic device for measuring the muzzle velocity of shells from big guns.

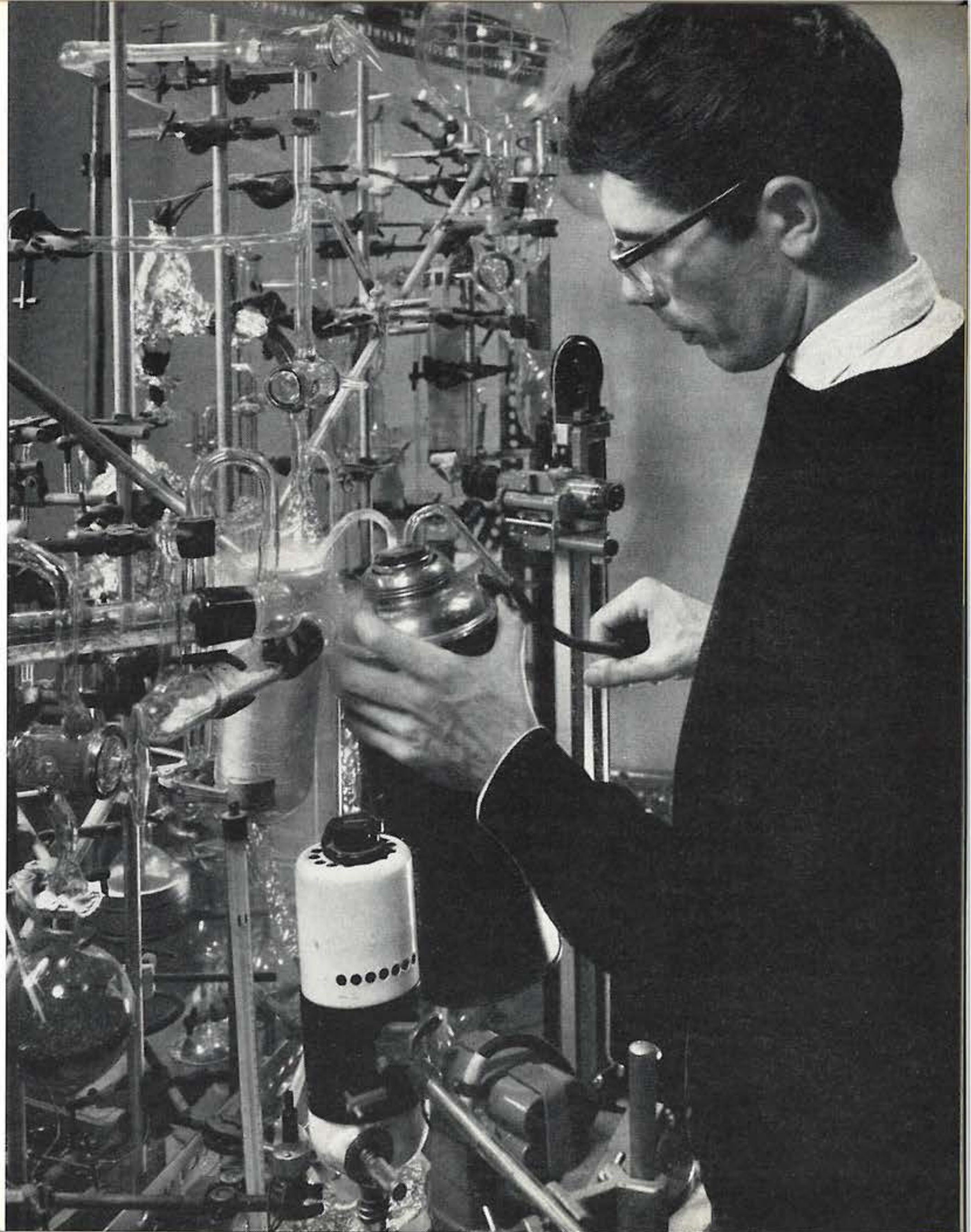
After the war, Dr. Bowden returned to England, and Dr. S. H. Bastow became Officer-in-Charge of the Section. The study of lubricants and bearings was extended to cover all aspects of the study of metal surfaces, and a new name, "Tribophysics", meaning "rubbing physics", was coined to describe the Section's work. By 1949, when Dr. Bastow was appointed to the C.S.I.R.O. Executive, the group had grown into a full-scale Division. Dr. W. Boas, an eminent metal physicist, became the Chief of the Division, which moved into a new laboratory in the University grounds four years later.

The Division has made, over the last ten years, an impressive contribution to our knowledge of the structure of metals and the properties of metal surfaces.

Ingenious experimental techniques have been used to obtain an understanding of the crystal defects in metals, and how these are related to the strength, deformation, "working" and annealling of metals. In the study of the physics and chemistry of solid surfaces, particular emphasis is laid on their shape or profile. This work has led to better understanding of surface catalysis and adsorption and, of course, friction. An oil company is currently supporting a research project on solid lubricants.

The Division's expert knowledge of many branches of metallurgy is widely recognized by the engineering industry, and the Division's officers are frequently called upon to supply the answers to industrial problems.

Apparatus for the measurement of the adsorption of gases on metals. In this case the amount of krypton adsorbed on a silver specimen is a measure of the surface area which is found to be different from the apparent area because of the porous nature of the specimen.



chemistry

THE main centre of chemical research is at Fishermen's Bend, Victoria, where C.S.I.R.O. has established its Chemical Research Laboratories. The Laboratories were formed in 1940, following the report of a committee which recommended the expansion of C.S.I.R. research into fields of importance to secondary industry. The group was originally called the Division of Industrial Chemistry, but was re-organized in 1958 and styled the Chemical Research Laboratories, with Divisions of Chemical Physics, Mineral Chemistry, Physical Chemistry and Organic Chemistry, together with Sections of Cement and Refractories and Chemical Engineering. There are also two smaller groups which offer useful services to industry; these are a Microanalytical Laboratory situated at the University of Melbourne, which performs analyses of organic compounds for government, university and industrial laboratories, and, situated at the Royal Melbourne Institute of Technology, a Foundry Sands Laboratory which offers an advisory service to foundries. The interests of the Laboratories have not been limited to fields of importance to secondary industry; much of the work bears directly on primary industry.

The research activities of the Division of Industrial Chemistry began in a few rooms of the Chemistry department of the University of Melbourne. The first Chief was Dr. I. W. Wark (now a member of the C.S.I.R.O. Executive), a physical chemist noted for his important contributions to our knowledge of the separation of minerals from ores by "flotation" processes.

The Division moved into its own new premises in 1941. During the war years much of the Division's time was spent on the immediate problems imposed by the war, but a number of lines of fundamental work were established and these were carried on and expanded after 1945. It was necessary to study means of extracting uncommon metal derivatives from our minerals. Titanium tetrachloride, for example, was needed for smokescreens and cerium oxide was needed as a polishing powder for optical lenses. The Division worked on a host of chemical problems, including the construction of laminated aircraft propellers, prevention of "crazing" of plastic aircraft windows, concentration and drying of foodstuffs, the preservation of leather boots in hot and humid climates, and many more.

When the war was over, the Division settled down to develop the lines of fundamental work established during the war, and to start new lines of work.

The need for fundamental work was recognized from the outset and in 1944 a group equipped with modern physical facilities for the investigation of chemical problems was set up. This group, under the leadership of Dr. A. L. G. Rees, and now known as the Division of Chemical Physics, is concerned primarily with basic researches and these have yielded results of great practical importance. For example, spectroscopic studies led to two new techniques; one for producing light of high spectral purity; and the other for carrying out chemical analysis by means of atomic absorption measurements. Instruments based on these techniques are now manufactured under licence to C.S.I.R.O., by overseas instrument manufacturers and are widely used throughout the world.

Studies in the diffraction of light and of electrons have led to a major advance in physical optics, whilst X-ray methods have been used to determine the structures of several complicated molecules. Electron microscopy, applied to studies of such materials as muscle, plant chloroplasts, protein crystals and wool, has yielded important new biological knowledge.

A knowledge of the solid state is of basic importance in many industrial processes and, as a contribution to this knowledge, investigations have been made of some of the electronic processes involved in diffusion, oxidation, luminescence and the chemical reactions of solids.

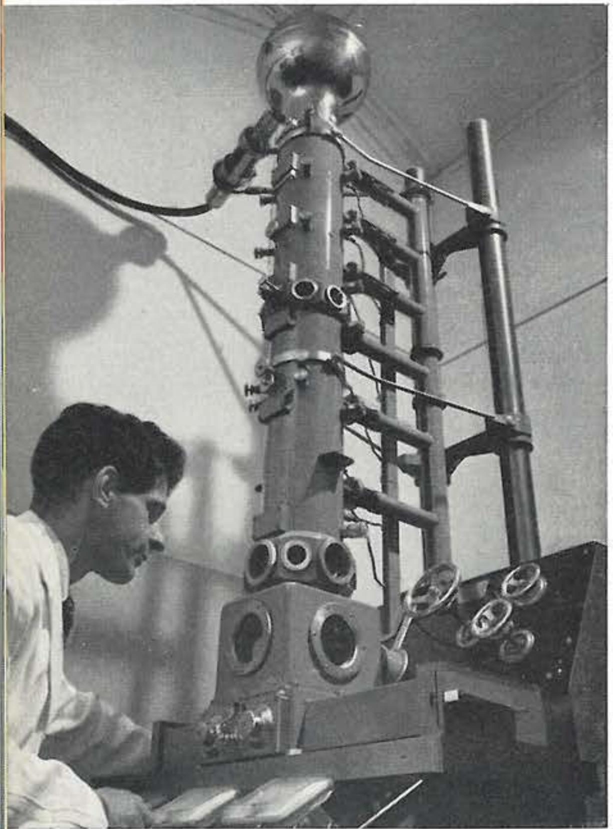
In addition to its research programme, the Division of Chemical Physics has stimulated and assisted in the production of scientific instruments in Australia.

The Division of Physical Chemistry was originally concerned mainly with flotation and surface chemistry. The group's work was enlarged and diversified in the early 1950's to tackle several problems basic to Australia's needs. An attempt was made to find a means of restricting the evaporation of water from dams and reservoirs. Success was achieved in the "Mansfield" process, in which a very thin, cheap chemical film can be spread upon the surface of a reservoir, and markedly reduce the degree of evaporation. Basic investigations into the properties of materials under very high pressures have produced results of great scientific interest. It was shown, for example, that non-metallic substances like sulphur and iodine can assume the properties of metals at very high pressures. Among the Division's other activities are the study of industrial separation processes based on adsorption (applicable to the purification of such widely different substances as penicillin and uranium), the control of bushfires, and the formation of ice crystals in clouds.

The study of minerals was one of the Division of Industrial Chemistry's earliest activities. It was started in 1940, when Mr. R. G. Thomas (the first Chief of the Division of Mineral Chemistry) came over from Adelaide, where he had been a geochemist with the Division of Biochemistry and General Nutrition. During the war Mr. Thomas initiated a study of the ores of the less common metals, such as titanium, zirconium, hafnium, cerium, thorium, lithium, germanium, and uranium, many of which occur in the beach sands of eastern Australia. In the postwar era the group's pioneer work has been of great value to the mining industry, as one after another of these metals has proved to be of industrial importance. A notable achievement was the development of a process for separating zirconium, a metal used in the construction of nuclear reactors, from hafnium, which contaminates it.

Apart from its interest in the more uncommon metals, the Division of Mineral Chemistry has undertaken sponsored work on the extraction of copper and the cyanidisation method of refining gold.

Facade of the main building of the Chemical Research Laboratories at Fishermen's Bend.



An electron diffraction camera designed and built in the workshops of the Chemical Research Laboratories.

The Division of Organic Chemistry has sought to find uses for materials which occur abundantly as virtual waste products in Australia, materials such as wool wax and sugar cane wax. A Sugar Research Laboratory has recently been set up to find new uses for sugar itself, as we can produce much more of it than we can use or sell. A fascinating line of work is the search for new drugs and alkaloids occurring in Australia's unique flora. During the war a pharmaceutical company, aided by the Division of Plant Industry, produced the drug hyoscine, specific for sea-sickness, from the plant *Duboisia* and most of the Allied supply was provided by Australia. Many more interesting alkaloids have been isolated and sent to pharmacologists for testing. Some of these alkaloids have proved to be poisonous to stock, a circumstance which has led to collaboration with the Division of Animal Health.

The study of cement began in the earliest days of the Laboratories, when manufacturers offered to support research into the problems of cement production and utilization, and a Cement Section was formed. At that time there had been some spectacular failures of overseas concrete structures attributed to a chemical reaction between the cement and the aggregates. The group was able to show how failures could be avoided by proper selection of aggregate. After the war, the Section entered the field of ceramics and demonstrated the suitability of Australian clays for whiteware manufacture. Shortly afterwards, one of Britain's largest tableware manufacturers set up a factory in Melbourne.

Since then, most of the work on orthodox ceramic products has been transferred elsewhere, and the section's second interest is now in refractories and allied materials. The Section has accordingly been renamed the Cement and Refractories Section.

The Chemical Engineering Section is concerned among other things with the development of chemical processes for industrial use. A typical project is the production of gas of high calorific value by combining hydrogen with brown coal. Another group in the Section studies the basic physical and chemical reactions which are fundamental to the developmental projects. Yet another activity of the Section is a study of the separate operations that go to make up chemical engineering processes. Common to many industrial processes, for example, are such operations as grinding and the separation of fine particles according to their size.

The Section also maintains a Process Equipment Laboratory with a wide range of pilot plant which is available for use by government organizations and private industry. The Section has a specialist knowledge of many facets of Chemical Engineering and is frequently consulted by other C.S.I.R.O. laboratories and by outside organizations.

A view of some of the equipment in the process equipment laboratory, Chemical Engineering Section.

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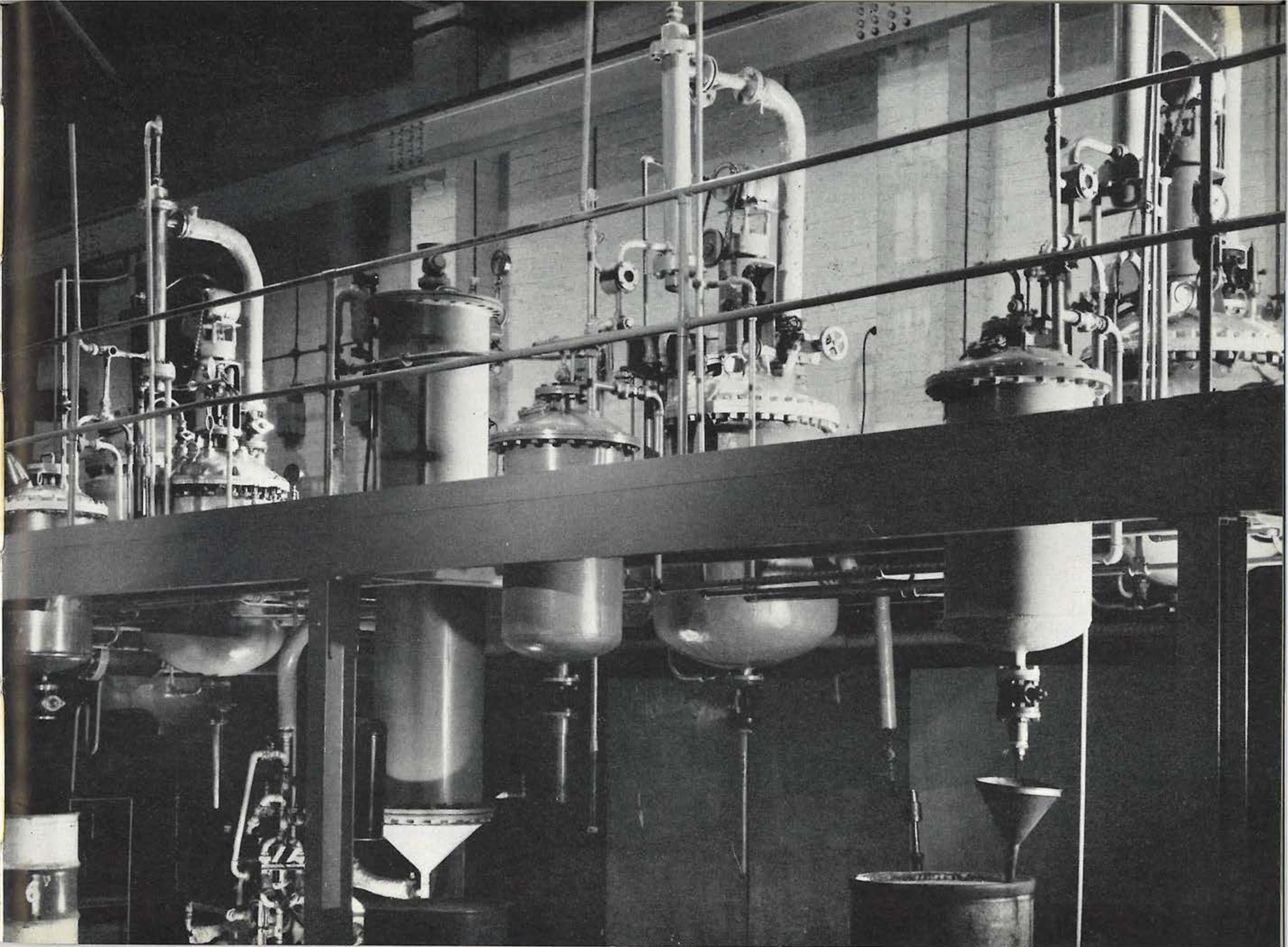

tropical pastures

THE Division of Tropical Pastures studies the pastoral problems of northern Australia. It was a part of the Division of Plant Industry until 1959 when it became an independent Division with Dr. J. Griffiths Davies as Chief. Pasture research for northern Australia has undergone considerable development in recent years, and there has been a growing awareness of the enormous undeveloped pastoral potential of this region.

The pastoral industry of northern Australia is almost wholly based on native or induced pastures. These have a short summer growing season, when the pastures make good growth and have quite good feeding value. There is a longer autumn to early summer period when the pastures make little active growth and feeding value declines. Thus, by the late winter, animals on these pastures lose weight. The pastures have no significant legume component and the protein content of native grasses, which is only moderate in period of active growth, falls to deficiency levels by late winter.

The Division of Tropical Pastures is engaged in a comprehensive programme which aims to supplement and replace the native pastures with more productive sown pastures, and fodder and protein grain crops. Close collaboration is maintained with the regional research group of the Division of Soils which provides valuable information on the distribution and characteristics of the soils of pastoral regions.

The Division's headquarters are at the Cunningham Laboratory in the grounds of the University of Queensland, St. Lucia, Brisbane, and there are facilities for experimental work at several regional centres.

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A stand of sorghum almum, a pasture species which is being introduced into Queensland.

dairy research

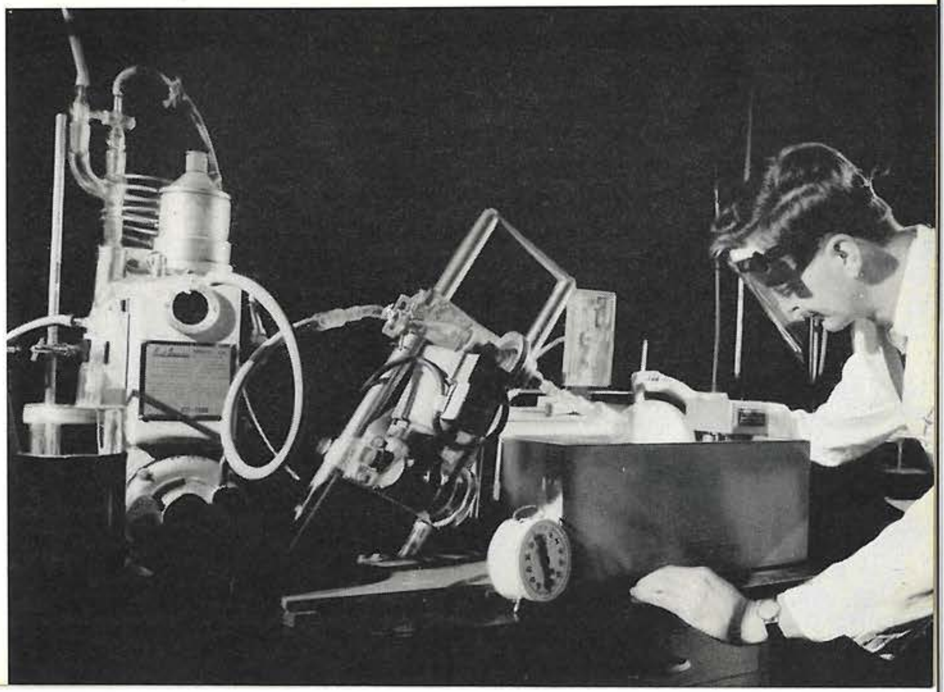
C.S.I.R.O.'s interest in dairy research dates from 1929, when a travelling scholarship was granted to enable an Australian scientist to undertake work at the National Institute for Research in Dairying at Reading, England. During the 'thirties the scientist, Dr. W. J. Wiley, investigated the characteristic taint found in butter packed in pine wood boxes.

In 1938 a start was made to build up a Dairy Research Section, and in 1940 a second group in the Division of Industrial Chemistry began a study of the chemical engineering aspects of dairy manufacture. After the war Dr. Wiley resigned, and the two groups were amalgamated into the Dairy Research Section, under the leadership of Mr. G. Loftus Hills.

The Section has built up a comprehensive research programme into problems related to dairy manufacturing. Fundamental research has been carried out on the oxidation of butter fat, the microstructure of dairy products, the chemistry of flavour compounds and the structure of milk proteins. Applied work has dealt with such matters as the control of bacteriophage in cheese factories, the modification of milk powder for special cooking purposes, and the technology of casein manufacture. A major achievement already proving its worth in industry has been the development of automatic machinery for cheese manufacture.

Two events of the 1950's enabled the Section to extend its range of activities. The first was the provision of fine new buildings at Highett, Victoria, in 1955. The second was a decision of the dairy industry in 1959 to levy itself to provide funds for research, some of which are allocated to research in dairy manufacture.

Studies on the oxidation of butter fat.



statistics

The Division of Mathematical Statistics co-operates with the University of Melbourne in the operation of CSIRAC, an electronic computer.

THE use of mathematical statistics in the planning of experiments and the analysis of their results is found in almost every field of modern science. Within ten years of the founding of C.S.I.R. a small service group, known as the Biometry Section, was set up. Its staff gave assistance to any of the Council's officers who required statistical help and advice in their work.

Inevitably, as the Organization began to grow, the demands on the Section increased. In 1940 a headquarters laboratory was established in Melbourne and Dr. E. A. Cornish (the present Chief of the Division of Mathematical Statistics) became leader of the group. In November, 1944, the University of Adelaide, which was anxious to promote a close liaison between the Section and its own Department of Mathematics, offered to house the Section in its grounds. Ever since then the group has been closely associated with the University, and Dr. Cornish now combines the office of Professor of Mathematical Statistics with his C.S.I.R.O. post.

The Section of Mathematical Statistics became a Division of C.S.I.R.O. in 1954. Nowadays the Division has officers stationed at Melbourne, Sydney, Canberra, Brisbane, Perth and Armidale, N.S.W., contributing through their statistical knowledge to many different research programmes.

In addition, the Division has developed a number of fundamental research interests of its own, particularly in theoretical and meteorological statistics and in the expanding field of digital computing.

This equipment, designed and built in the Engineering Section, distils and dries refrigerant and delivers it in measured quantities for charging into refrigerating systems.

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engineering

In 1945, an engineer was appointed to the C.S.I.R. staff to help the Head Office and the Divisions with their engineering problems. Some of these problems were concerned with the engineering services of laboratories, and some involved the design of new research equipment. The engineer, Mr. R. N. Morse, soon found it necessary to have the assistance of two more professional engineers, and the small team became involved in a large number of projects, ranging from the installation of gas turbine testing equipment for the Division of Aeronautics to the development of flow metering devices for irrigation research.

In the immediate post-war era, manufacturing facilities in the engineering industry were in heavy demand, and in 1949 C.S.I.R.O. was obliged to set up its own manufacturing establishment, known as the C.S.I.R.O. Central Experimental Workshops. The Workshops, situated at Maribyrnong, Victoria, undertook the design and construction of all kinds of novel apparatus and experimental plant.

The group soon began to develop research interests of its own, and in 1955 its name was changed to the Engineering Section. By 1957, when it moved to Highett, Victoria, it had an established programme of research into solar energy utilization, air conditioning and artificial climate control. The work on climate control has found application in the Division of Plant Industry's phytotron, for which the Section carried out the engineering development and general design. Although the Section still assists other C.S.I.R.O. groups with their engineering problems, it is now mainly preoccupied with its own research programme, which has been extended to such fields as agricultural machinery, electronics, refrigeration and solar distillation.


THE CUNNINGHAM LABORATORY
BREEDING POULTRY
Industrial Research
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SAVING WATER IN DAMS
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Industrial Research
Acoustic Tiles for
DROUGHT FEEDING OF SHEEP
WOOL TEXTILE RESEARCH IN C.S.I.R.O.
C.S.I.R.
and the WOOLGROWE

communicating results

C.S.I.R.O. communicates the results of its research through scientific journals, semi-popular publications, and films. Together with the Australian Academy of Science, the Organization publishes eight scientific journals which are highly regarded by scientists throughout the world.

There are two liaison sections which disseminate the results of research by means of publications, organized conferences and tours, and personal liaison.

In the rural industries it is the responsibility of extension officers in the State Departments of Agriculture to advise farmers how to make best use of new research findings. One of the main objects of the Agricultural Research Liaison Section's work, therefore, is to present the results of C.S.I.R.O.'s agricultural research to State officers in a clear and comprehensible manner, and with minimum delay.

The Section publishes a quarterly journal called "Rural Research in C.S.I.R.O." which circulates mainly to extension officers and to others concerned with servicing the rural industries. Many "Rural Research" articles are reprinted in country newspapers and are used by other mass media, and in this way C.S.I.R.O. research is brought to the notice of large sections of the farming community. Other publications are also produced as occasion demands.

The Agricultural Research Liaison Section also organizes specialist conferences and liaison tours. Studies are made of the techniques by which research results can be passed on to the rural community.

The Industrial Research Liaison Section promotes the use of research results by manufacturing industry in a number of ways. In a bi-monthly leaflet called "Industrial Research News" it presents C.S.I.R.O. secondary industry research in simple non-technical language. "Industrial Research News" circulates to 3,500 industrial concerns and excerpts from it are widely reprinted in Australian and overseas trade journals. Special publications, giving a comprehensive picture of C.S.I.R.O.'s work for different industries, are produced from time to time.

The Section encourages co-operation between industrial firms by helping them to establish trade research associations, and with C.S.I.R.O. by negotiating agreements whereby firms sponsor research in the Organization's laboratories.

The number of patents arising from C.S.I.R.O. research is substantial. Some hundreds of patents and patent applications are current, of which the majority are the subject of licence agreements. One of the Section's major tasks is to encourage manufacturers to make use of these patents.

C.S.I.R.O. maintains a Film Unit at its Head Office which has produced over sixty films on all sorts of research topics, from radio astronomy to natural history. These are made available to interested groups through State Film Centres and other distributing agencies throughout the Commonwealth.

A scene from "The Mallee Fowl", one of the sixty scientific films produced by C.S.I.R.O.'s Film Unit.