S.H. MENDELSOHN
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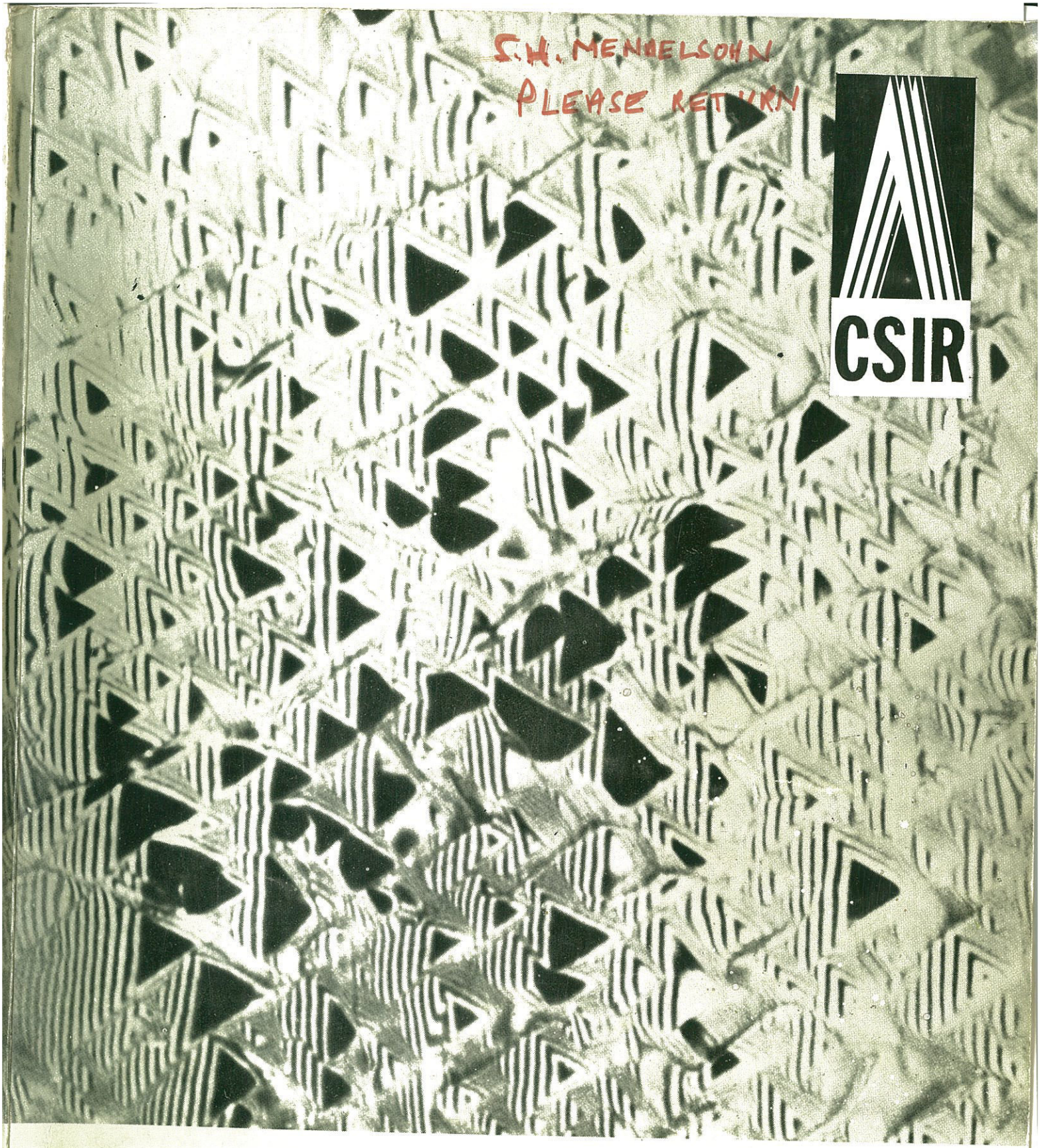

CSIR

ANNUAL REPORT 1967

P.O. Box 395
PRETORIA
1st June, 1968.

Sir,

I have pleasure in presenting to you the Twenty-third Annual Report of the Council for Scientific and Industrial Research. This Report covers the period 1st January, 1967 to 31st December, 1967.

Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1967, certified by the Controller and Auditor-General, are included.

Yours faithfully,
S. M. NAUDÉ

President: Council for Scientific and Industrial Research

Dr. the Hon. Carel de Wet, M.P.
Minister of Planning
Private Bag 9034
CAPE TOWN

A dark-field electronmicrograph of a diamond shard which has been thermally etched by means of electron radiation. The thermal etching has produced pyramidal etch pits, about 2000 Å deep, on the surface. This treatment produces a surface which can be strongly bound to any matrix in which the diamond is fixed. Diamonds thus treated are less liable than untreated ones to break loose from grinding wheels.

Photo: Dr. R. J. Murphy, Electron Microscopy Division N.P.R.L.

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Scientific and Industrial Research
P.O. Box 395
PRETORIA

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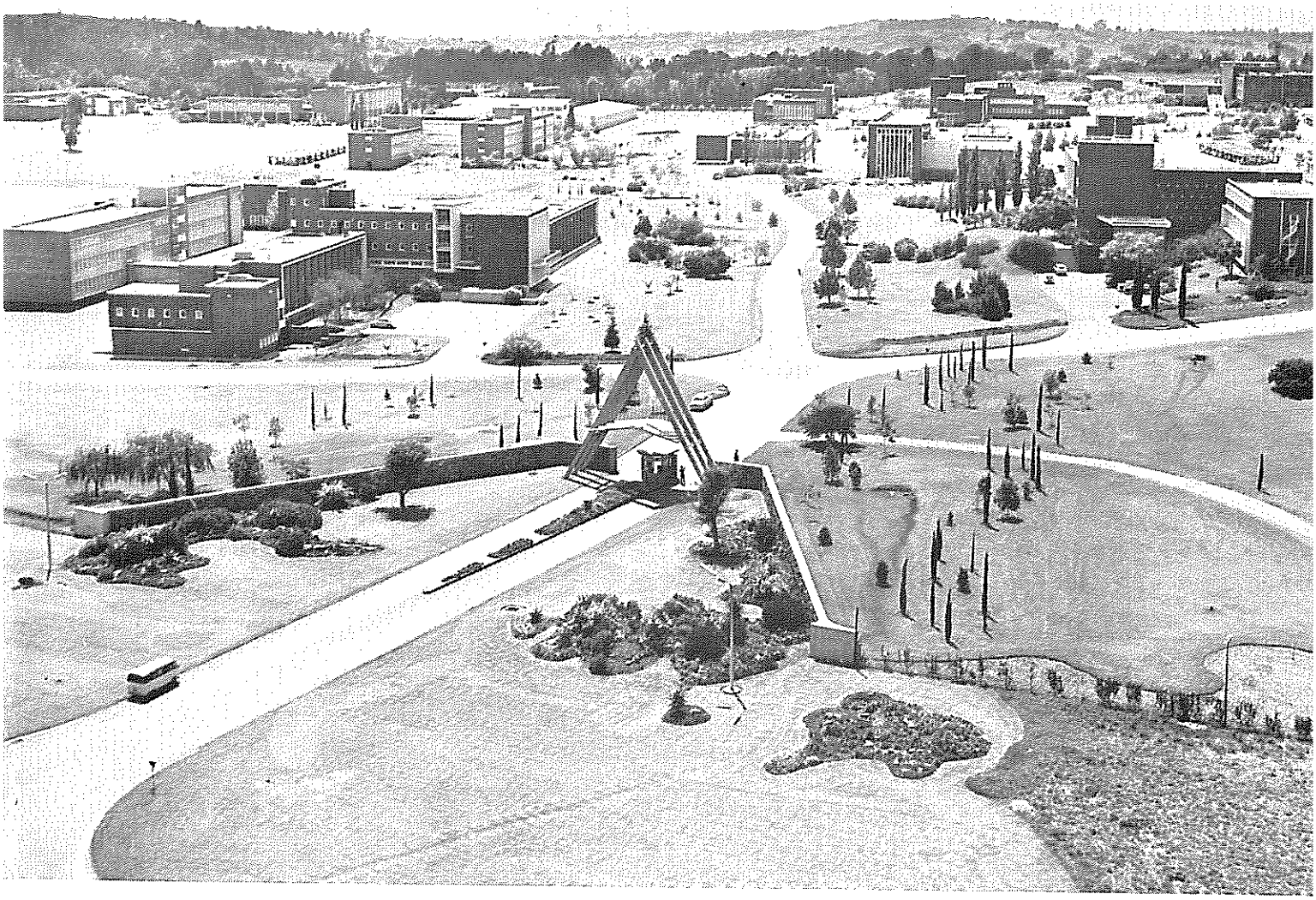
CSIR

TWENTY-THIRD ANNUAL REPORT

1967



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Annual Report S.Afr. C S I R, No. 23, UDC 5+6]:061.6.055.5] (680) Pretoria, South Africa, 1967.

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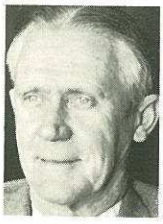

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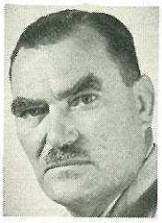

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Head, Department of Chemical Engineering,
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Members of the Executive Committee of the Council for Scientific and Industrial Research as at 31st December, 1967: Dr. S. M. Naudé (Chairman), Mr. F. G. Hill (Vice-Chairman) and Dr. R. L. Straszacker (with Dr. B. Gaigher, Prof. S. F. Oosthuizen and Dr. H. J. van Eck as alternates to Mr. Hill and Dr. Straszacker).

EXECUTIVE OF THE CSIR

Dr. N. Stutterheim, Deputy President.

Dr. S. Meiring Naudé, President.

Dr. W. H. Craib, former Vice-President responsible for medical research, who retired in October, 1967.

Dr. F. J. Hewitt, Vice-President.

Prof. C. v. d. M. Brink, Vice-President.

CONTENTS

GENERAL INTRODUCTION

World-wide attention focussed on the scientific scene in South Africa late in 1967 when the world's first heart-transplantation was carried out in Cape Town. This achievement, and the success of the second transplant, probably succeeded, more than any other single development, in stimulating public interest in science in South Africa, and it is hoped that it will lead to a better understanding of the vital rôle that scientific research is playing in many other fields.
With this in mind, the C S I R 's annual report for 1967 has been designed to show how closely scientific research can influence economic planning and development and virtually every aspect of daily living.

As in the previous report, the first section is devoted to applied research for specific sectors of the national economy. This section illustrates the "service" aspect of the C S I R 's work and the extent to which specialized services and facilities at the C S I R are used by government departments, other official bodies and industry. Applied research not related to economic sectors, and long-term fundamental research, are described in the second section of the report, where a chapter is devoted to each of the national institutes and laboratories and other sections of the C S I R. Research-related activities, such as the dissemination of information and technical support services, are also dealt with in this section. Another major function of the C S I R — that of promoting university research in the medical and natural sciences — is illustrated in an addendum which lists the projects supported by the C S I R at South African universities.

RESEARCH ON BEHALF OF SPECIFIC ECONOMIC SECTORS

INTRODUCTION

The C.S.I.R.'s activities cover virtually the entire spectrum of economic activity in South Africa. In this chapter those research projects undertaken in the laboratories and institutes of the C.S.I.R. with a view to advancing particular economic sectors are reviewed. The projects are grouped according to the economic sector benefiting from the results.

An overall picture of the amount of research undertaken in each sector can be gleaned from the table on the next page, which indicates the C.S.I.R.'s research expenditure on behalf or each economic sector for the financial year 1966-67.

A number of economic sectors (especially those in which government activities play an important role) are served by national research institutes which concentrate their activities almost exclusively on the interests of the relevant sector. The economic sector "Construction" is, for example, served by the National Building Research Institute and the National Institute for Road Research. Much of the work of the National Institute for Water Research benefits the economic sector "Electricity, Gas and Water", while the National Institute for

CSIR EXPENDITURE ON APPLIED RESEARCH AND DEVELOPMENT PER SECTOR OF THE ECONOMY DURING THE FINANCIAL YEAR 1967/68

Sector of the economy	Expenditure per sector R.	Percentage
1. Agriculture, forestry and fisheries	104,519	3.9
2. Gold mining (including uranium)	181,440	6.7
3. Coal mining	4,508	0.2
4. Other mining and quarrying	33,983	1.3
5. Processed foodstuffs (excluding beverages	149,662	5.6
6. Beverages and tobacco	85,867	3.2
7. Textiles	290,643	10.8
8. Knitting mills	1,250	—
9. Clothing	1,250	—
10. Footwear	1,250	—
11. Wood and wood products (excluding furniture)	97,150	3.6
12. Furniture and fixtures	1,874	0.1
13. Pulp and paper products	70,242	2.6
14. Printing, publishing and allied industries	1,250	—
15. Leather and leather products (excluding footwear)	6,635	0.3
16. Rubber products	1,250	—
17. Basic industrial chemicals	80,949	3.0
18. Miscellaneous chemical products	125,321	4.6
19. Products of petroleum and coal	20,410	0.7
20. Non-metallic mineral products	22,724	0.8
21. Basic iron and steel industries	50,885	1.9
22. Non-ferrous metal basic industries	7,600	0.3
23. Metal products (excluding machinery and transport equipment)	10,727	0.4
24. Machinery (excluding electrical machinery)	92,350	3.4
25. Electrical machinery and equipment	167,479	6.2
26. Transport equipment (excluding motor vehicles)	33,350	1.2
27. Motor vehicles	1,250	—
28. Miscellaneous manufacturing industries	30,200	1.1
29. Construction	728,368	27.0
30. Electricity, gas and water	211,168	7.8
31. Trade (wholesale and retail)	1,250	—
32. Motor trade and repairs	2,094	0.1
33. Transport and communication	79,750	3.0
34. Miscellaneous services	1,250	—
Total Expenditure	2,699,898	100.0

NOTE: The notation — indicates that the value is less than half of one unit of the measure employed.

Road Research contributes to the progress of the economic sector "Transport and Communications". The activities of the National Mechanical Engineering Research Institute cover a wide field and are reflected in sectors such as gold, coal and diamond mining, iron and steel industries and machinery, etc.

In terms of the Water Act No. 54 of 1956, industrial effluents have to comply with specific quality standards. Certain industries find it difficult to attain these standards, and some of these are being assisted by the National Institute for Water Research on contract basis.

A number of economic sectors which are dominated mainly by private enterprise also have their own research institutes. Some of these are co-operative research institutes financed partly by the C.S.I.R. and partly by the industry concerned, while others again are of the national research institute type. Examples of the former are the Fishing Industry Research Institute, which serves the economic sector "Agriculture, forestry and fisheries"; the Leather Industries Research Institute, which covers both the economic sectors "Footwear" and "Leather and leather products"; and the Sugar Milling Research Institute, which serves the sector "Processed foodstuffs". The work of the South African Paint Research Institute mainly benefits the economic sector "Miscellaneous chemical products". An example of a sector which is served by a national research institute is that of "Textiles" which relies on the South African Wool Textile Research Institute.

Other sectors for which no fully-fledged institutes exist, can count, however, on the specialized research facilities made available within the organizational structure of the C.S.I.R. The "Timber and timber products" sector is for example served by the Timber Research Unit at the C.S.I.R., while the sector "Non-metallic mineral products" benefits from the activities of the Materials Division of the National Building Research Institute. The Department of Food Technology of the National Nutrition Research Institute serves the "Processed Foodstuffs" sector.

Specialized facilities are found in the Electrical Engineering Research Department of the National Research Institute for Mathematical Sciences, which undertakes projects in the interests of sectors such as "Electrical equipment and machinery", "Electricity, gas and water", "Transport and communication" and various mining sectors. The same Institute also participates on the theoretical side in various projects which other institutes undertake in a variety of sectors.

Apart from the work of the above groups, i.e. both research institutes and specialized departments serving particular sectors, the C.S.I.R. also undertakes a series of investigations on behalf of industries in various sectors. Some of these are done on a contract basis, i.e. at the initiative of the industrial enterprise, while others are undertaken at the initiative of the C.S.I.R.

SECTOR 1

AGRICULTURE

The following items illustrate research related to agriculture and animal husbandry undertaken by the C.S.I.R. during the year under review. This work was done in collaboration with the Department of Agricultural Technical Services.

Digestion in ruminants

This joint project of the *National Chemical Research Laboratory* (N.C.R.L.) and the Veterinary Research Institute at Onderstepoort has continued to yield important results. It has been shown previously that there are a number of different types of extremely important bacteria responsible for cellulose utilization in the rumen and that the predominant type depends upon the diet. A detailed study has recently been made of changes in the relative numbers of different types of cellulolytic bacteria when a sheep fed a low protein diet, e.g. teff hay, is given supplements of pure protein such as egg albumen or of urea.

An account of the apparatus developed for continuous culture of anaerobic micro-organisms has now been published, and the apparatus is being used to study certain cellulolytic bacteria found in the rumen.

The value of biuret as a safer supplement than urea for low-protein diets is rapidly becoming more widely recognized, not only in South Africa, but also in the U.S.A. and elsewhere. The rumen digestion research group is engaged in a fundamental study of the mode of utilization of biuret in the rumen, with the assistance of staff seconded by the South African manufacturers of biuret.

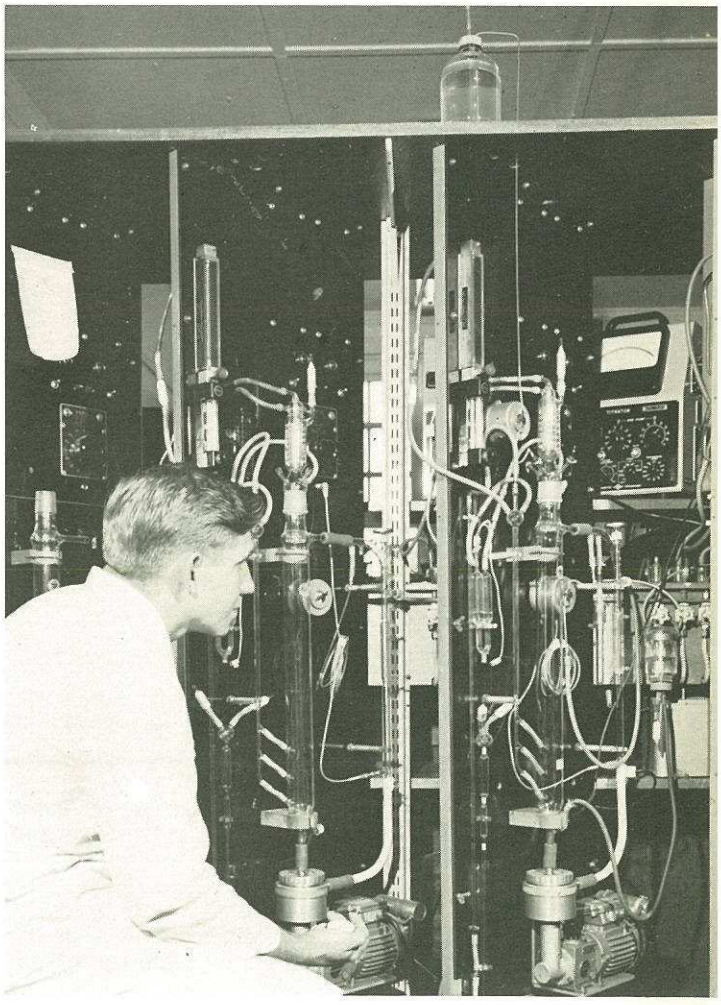
In collaboration with the N.C.R.L. the *National Research Institute for Mathematical Sciences* (N.R.I.M.S.) evolved mathematical formulae for use in studying the metabolism of ruminants.

Utilization of maize starch

This work is being carried out in the N.C.R.L. under sponsorship of the Maize Industry Control Board. A survey has been made of various possibilities of utilizing dry-milled maize starch in the paper industry, since this industry is one of the main consumers of industrial starch in the Republic. A search for reasonably cheap starch derivatives for use in the same industry is also in progress.

Starch digestibility in maize

The N.R.I.M.S., in collaboration with the *National Nutrition Research Institute* (N.N.R.I.), conducted a statistical analysis of data collected by the Agricultural Research Institute at Potchefstroom in order to establish the dependence of starch digestibility in maize on the maize variety and the region in which it was cultivated. It was found that starch digestibility differed significantly in different varieties.



A section of the apparatus used at Onderstepoort to simulate the digestive processes of ruminants.

Milk

The *National Research Institute for Mathematical Sciences* (N.R.I.M.S.) assisted the Animal Husbandry and Dairy Research Institute of the Department of Agricultural Technical Services with the statistical evaluation of tests for assessing the hygienic quality of milk.

As in previous years, the N.R.I.M.S., on behalf of the Mara Agricultural Research Station, continued its analysis of data to establish the influence of a large variety of factors on the production of milk and butter-fat.

Mills

For the Maize Board, a programme for determining the optimum economic distribution of the annual maize harvest to various mills has been redesigned and extended by the N.R.I.M.S.

Farmers' monthly returns

On behalf of the Division for Agricultural Production Economics of the Department of Agricultural Economics and Marketing, the N.R.I.M.S. planned a very extensive continuous data storing and processing system to be used in conjunction with monthly economic returns by farmers; the system is being programmed for an electronic computer.

Grading and selection of South African hides and skins

In order to promote South Africa's hides and skins industry, worth an estimated R28-million annually, the Livestock and Meat Industry Control Board has set up a quality grading scheme at the main abattoirs throughout the Republic. Reports from the tanning industry have indicated that the correlation between the grading of hides of freshly slaughtered animals and the quality of the tanned leather has not warranted the price differentiation between grades. Large-scale investigations carried out by the *Leather Industries Research Institute* (L.I.R.I.) have revealed the causes of this lack of correlation and a special sub-committee of the Board is investigating means of improving the grading.

Transport of hides in plastic bags

Small-scale investigations carried out by the L.I.R.I. have indicated that the ideal method of preparing cured hides for transportation through the tropics is to add certain antiseptics to the salt, and then to seal the hides in polythene bags after treatment. This method of preparation was confirmed on a large scale when 400 cured hides were shipped to Europe and back, and then assessed after tannage at a local tannery.

Alternative uses for hides and skins

In view of increasing competition from leather substitutes, it is envisaged that numerous hides and skins will be used for other purposes. The L.I.R.I., assisted by the Livestock and Meat Industries Control Board, has equipped a modern fundamental protein research laboratory to carry out basic research into the properties of the proteins in hides and skins to find new uses for leather. A number of papers on this subject have been published in the scientific literature and have attracted wide overseas interest.

Determination of elements in plant materials

X-ray fluorescence techniques have been used successfully in the *National Physical Research Laboratory* (N.P.R.L.) for the determination of the major elements — phosphorus, potassium and calcium — and for the minor elements — iron and manganese — in plant materials. The technique is being extended to include further elements.

SECTOR 1

FORESTRY

New market for wattle extract

In view of the increasing use of synthetics and rubber in the sole leather field, which is the natural market for wattle bark and wattle extract, the wattle industry is sponsoring a programme of investigation at the *Leather Industries Research Institute* (L.I.R.I.) aimed at finding alternative outlets for these products.

Adhesives

One of the most promising outlets is in the use of wattle extract as a raw material for adhesives required by the world's growing chipboard and plywood industries. L.I.R.I. scientists are developing methods of modifying wattle to improve its suitability for this very large potential market. Chipboard manufacturers in South Africa and Europe are carrying out trials of wattle adhesives under manufacturing conditions.

Drilling for oil

Drilling for oil provides another important outlet for wattle extract as a lubricant. Modified wattle products have already been used successfully in drilling operations in South Africa. A special ferrochrome wattle derivative has been developed by L.I.R.I. to operate under saline drilling conditions.

These applied uses depend on fundamental research into the chemistry of the wattle extract, which lies in the field of the flavanols and the anthocyanins, the latter being the coloured pigments of many flowers. The fundamental research work carried out in this field by the L.I.R.I. has established an internationally recognized leadership through many publications in the overseas scientific literature.

SECTOR 1

FISHERIES

Determining the permeability of plastic bags used for packing fish meal

The following survey of the past year's activities of the *Fishing Industry Research Institute* (F.I.R.I.) gives an indication of the role it is playing in promoting the South African fishing industry.

Condensate for fish-smoking

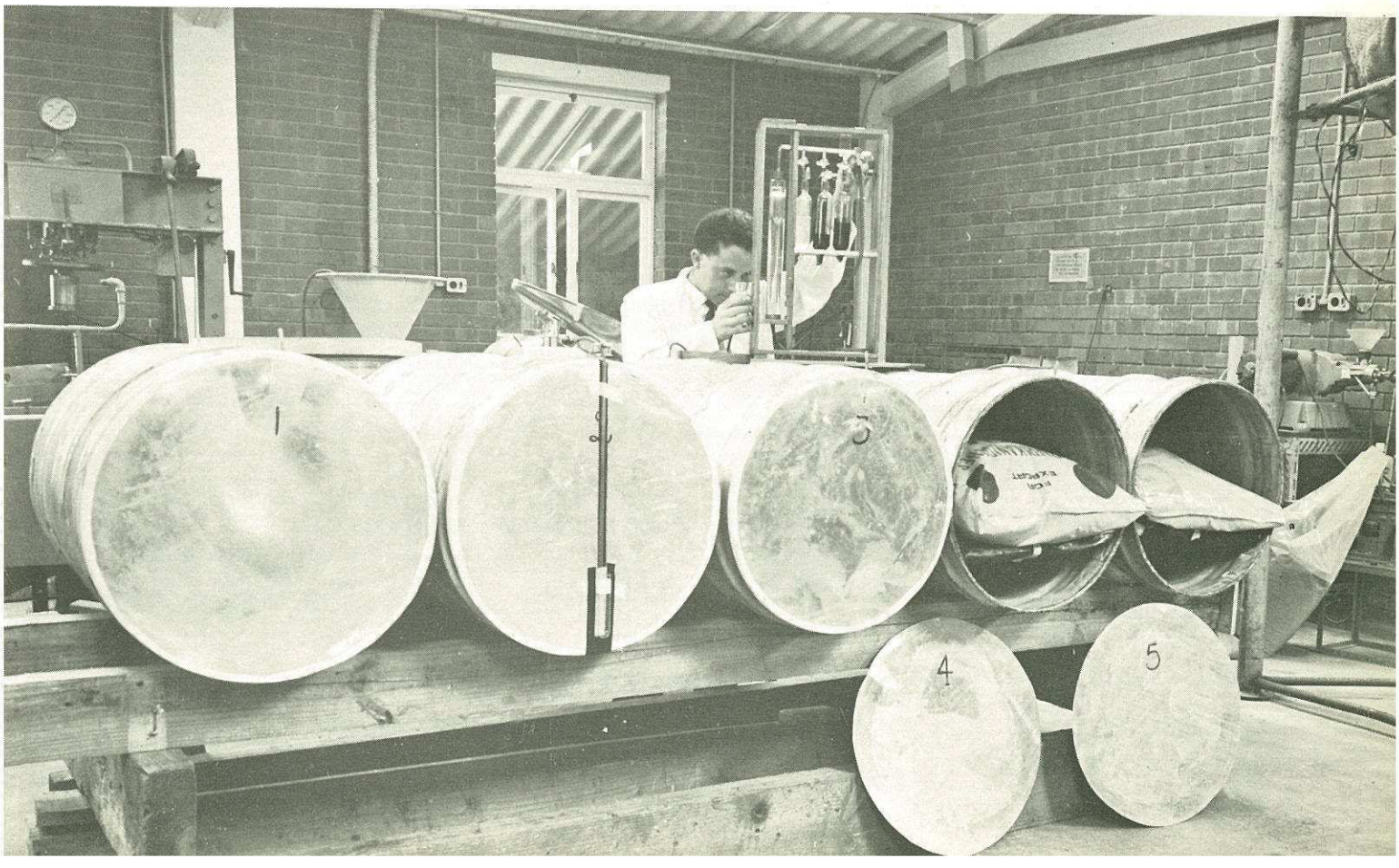
A delicate and pleasant smoke flavour has been imparted to hake in the laboratory by means of a smoke condensate, thus avoiding the labour and costs of hanging the fish in a smokehouse. A short period of drying is needed in order to produce the desired surface texture before dipping. Industrial application has not yet been attempted, but it is hoped that this will not be long delayed.

Salting and smoking of snoek

Technical problems concerning the salting and smoking of fish are manifold and are continually being studied. Work during the year has shown that in order to minimize the risk of infection of salted snoek by halophilic or salt-loving bacteria and moulds, it is essential to use sterilized salt, as well as small amounts of mild preservative.

Fresh and frozen fish

The quality of fresh and frozen fish products may be influenced by the fish struggling in the nets, as this induces biochemical changes after death. Most of the quality deterioration of fresh fish is due to bacterial action. Instances are known, however, where tissue softening is caused by an enzyme which, while harmless to human beings, nevertheless renders the fish difficult to process. To reduce microbiological spoilage of fresh fish to a minimum, rapid and uniform cooling is imperative. Laboratory tests and commercial experiments have indicated ways of improving the freezing of fish. Recently it was shown that superchilling — cooling below 32°F but avoiding



the formation of ice crystals in the fish — may considerably extend the shelf life of chilled hake, provided accurate temperature control is maintained. In conjunction with this investigation, methods for objectively determining the freshness of fish have also been studied.

Canning

The Institute has assisted in developing new products, including various sauces for fish canning (e.g. mustard, curry, soy, pepper). Many problems in connection with canning have in the past been investigated, including brown discoloration and bitterness in tomato sauce, cracking of pilchards, "medicinal" taint in canned pilchards, and can corrosion. In 1961, investigations were begun on the pinholing of cans and a considerable amount of research was done on this problem in collaboration with other laboratories. The defect was eliminated by the adoption of a new type of internal lacquer and by increasing the thickness of the tin coating. A final report on the results of storage tests carried out by F.I.R.I. on cans treated in various ways is soon to be published and confirms the improvement due to the new lacquer.

Fish meal

Fish meal is an excellent source of protein in pig and poultry feeds; the problems that arise from its production, however, are many and belong to different scientific disciplines. One of the first and most important improvements in the fish-meal manufacturing process was the recovery, concentration and incorporation in fish meal of the stickwater, which formerly was allowed to run to waste. The utilization of stickwater enriched the finished fish meal with vitamins of the B complex, and increased the yield by about 25 per cent.

Work is in progress on the design of an after-drier, which will reduce fluctuations in the moisture content of fish meal. This, in turn, will minimize the hazards of mould growth, caking and spontaneous heating during storage.

A recent development has been the design of a new type of cooker-press combination which is less sensitive to variations in the condition of the raw material.

Fish meal made from oily fish is strongly reactive owing to the presence of residual oil, which is highly unsaturated. This means that it readily combines with atmospheric oxygen, resulting in the generation of considerable quantities of heat. If not checked, this heat generation can be so great that meal scorches. At F.I.R.I. this spontaneous heating of fish meal is studied by means of specially designed adiabatic and isothermal calorimeters. The risk of overheating can be overcome in several ways, for instance, by curing the fish meal in air before shipment; by using hermetically-sealed containers; by employing anti-oxidants; or by shipping the meal in an inert gas. The effects of various treatments, and the pros and cons of different packaging materials are being studied extensively, as are various aspects of bulk handling, including flow properties of fish meal, its pelletization as well as its protection against bacteriological contamination.

The F.I.R.I. code of practice for stowing and stacking fish meal has been accepted internationally and is in general use throughout the world today.

Fundamental aspects of bulk handling of fish meals and their flow properties have been studied in the year under review. Apart from such aspects as particle size and the height to which it is banked, the influence of air movement and of small amounts of anti-oxidant have been investigated. These investigations have resulted in the recommendation to the industry that very small amounts of anti-oxidant be added to the meal, thereby obtaining the major benefits of anti-oxidant treatment at minimum cost.

The F.I.R.I. has evolved the first really satisfactory odour abatement plant for fish meal factories, and this is in use today in a number

of fish-meal producing centres in South Africa and in many overseas countries.

Considerable attention is given to determining the nutritional quality of fish meal. The quantity of protein in a food is of little importance nutritionally unless it is of good quality. This work resulted in the development of an *in vitro* method for determining the protein value of fish meals. F.I.R.I. co-operates closely in joint projects with a number of research organizations in South Africa and overseas.

One aspect of the liberal use of fish meal in animal feeds is the risk of tainting of the animal products. Research has revealed that tainting is only evident when large quantities of fish meal are used, e.g., in stress feeding programmes, and the extent of tainting is affected by the degree of curing of the meal. Extensive chicken feeding tests have shown how the degree to which residual oil in fish meal is oxidized affects its tendency to taint the flesh.

Fish oil

While problems connected with the production and refining of fish oil have not in the past been a major subject for research at F.I.R.I. — other organizations in South Africa have devoted much time to this work — two projects have recently been undertaken at the request of the fishing industry and fish oil users. These concern the reasons for the high free fatty acid content of some fish oils and the possible reduction thereof, and for refining losses. A report on the latter is in preparation for publication.

Effluents

Considerable attention was paid to various aspects of treatment of effluents from fishing factories. Effluent clarification at Walvis Bay was studied in order to reduce harbour pollution. On behalf of the South West African Harbour Pollution Committee, F.I.R.I. checked the claims made for a purification plant by an overseas firm. These checks were carried out in F.I.R.I's laboratories, and, in collaboration with the National Institute for Water Research and the S.W.A. Administration, at Walvis Bay where a pilot plant was installed.

A separate investigation into the possibility of recovering solids economically from effluents in South African factories is being carried out. The work involves the evaluation of the recovered solids and fats.

Lipids in fish meal

A new method for determining the total lipids in South African fish meals is being investigated.

The influence moisture content of fish meals has on fat determination was quantitatively studied using hexane. Fat contents increased with moisture contents ranging from 4-12 per cent. These investigations formed part of an international co-operative programme of research on lipids.

Fish proteins

Tests were carried out to determine the relation between the degree of cooking of fish (time and temperature) and the aggregation of extracted fish proteins after the cooking process. In the hake, the mean deviation between the aggregation temperature and extracted proteins was small, and this method of estimating the degree to which fish has been parboiled seemed promising.

The Director and an Assistant Director attended the annual conference of the *International Association of Fish Meal Manufacturers* (I.A.F.M.M.) at Bergen. A programme was worked out for further international co-operation on an *in vitro* method for assessing protein quality in fish meals.

Rock lobster

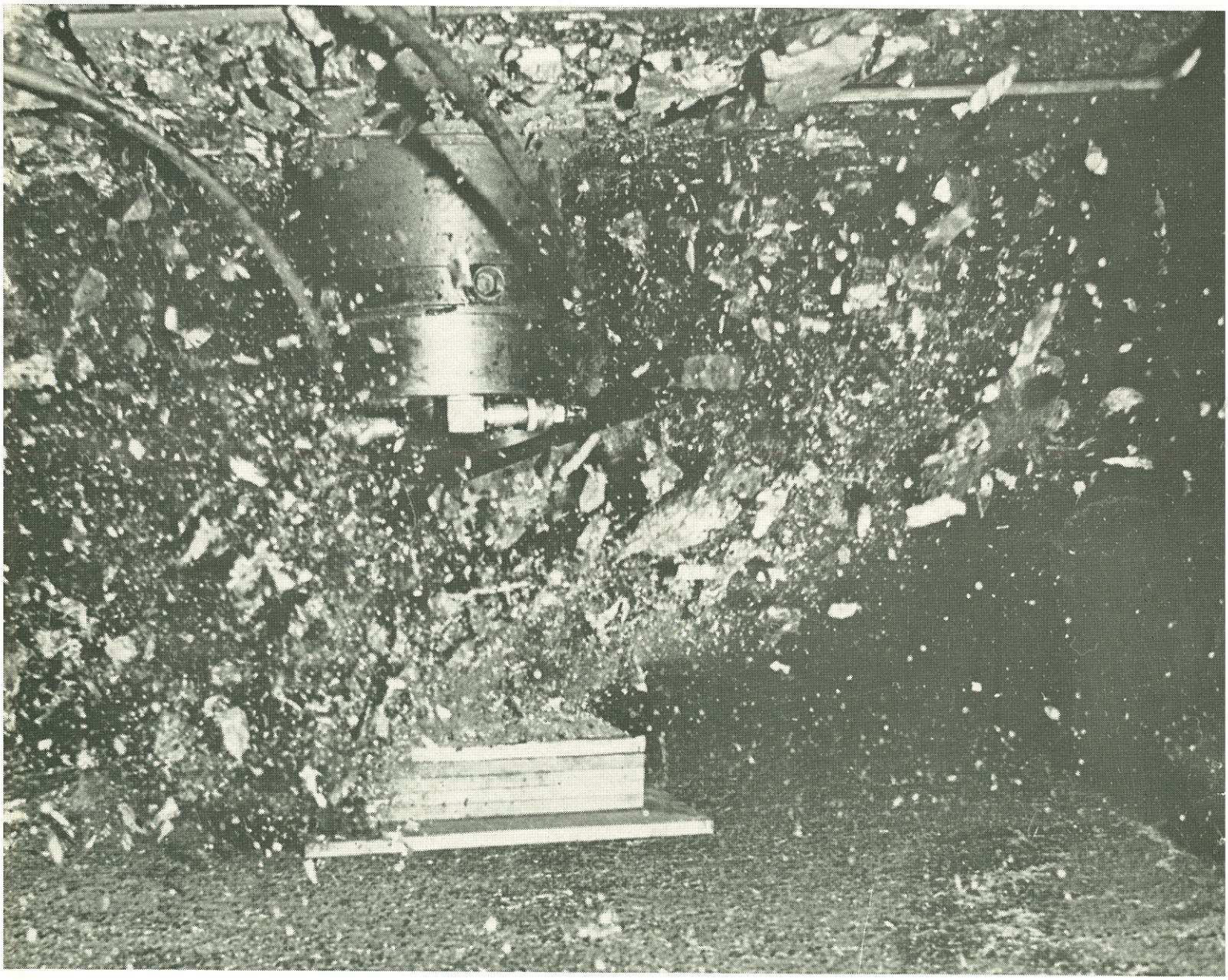
The Director of F.I.R.I. served on a Commission of Enquiry into the Fishing Industry of S.W.A., which investigated the implications of the official minimum size limit for rock lobster. Calculations showed that, under South West African fishery conditions, the imposition of a size limit is of dubious value as a conservation measure.

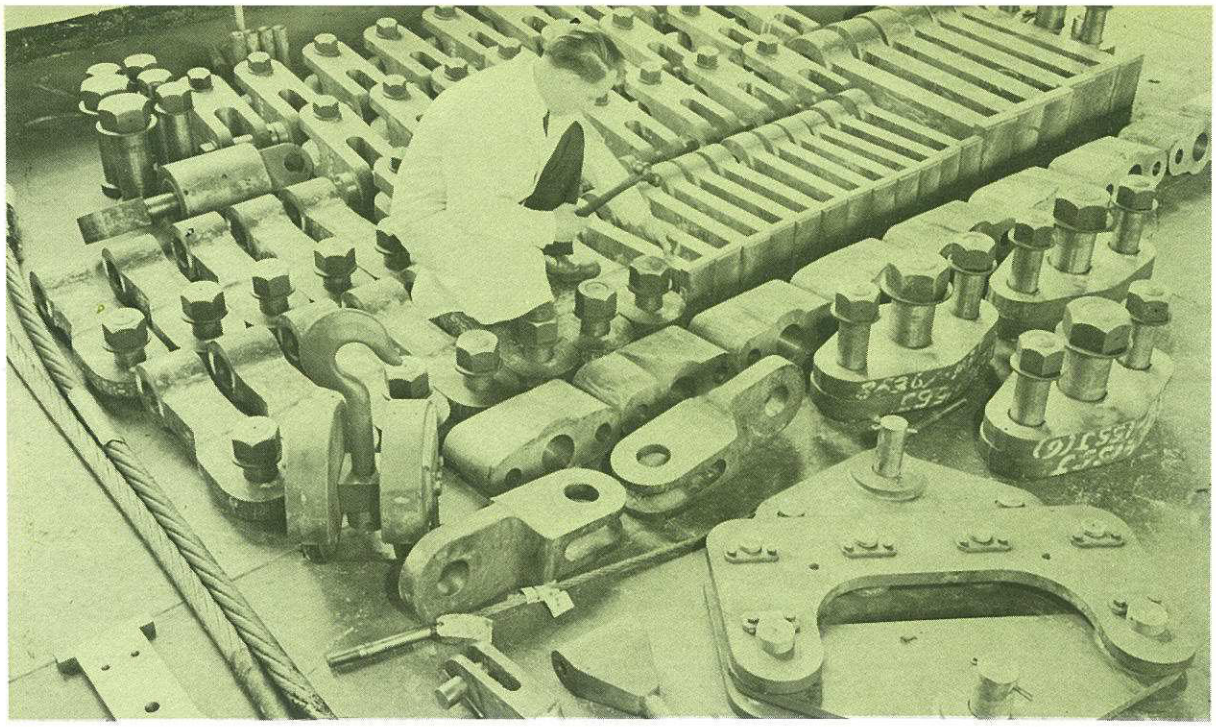
SECTOR 2

GOLD MINING

Below: A high-speed photograph of a small coal pillar specimen disintegrating under load during an in situ *test in a coal mine*

Right: Lifting tackle components being prepared for statutory tests at the Mine Equipment Research Unit at Cottesloe





Most problems associated with the mining industry are investigated in the laboratories of the various mining houses and bodies. Mining problems requiring more fundamental research are usually referred to the C.S.I.R. The activities during the past year of C.S.I.R. laboratories and institutes, which are equipped to carry out this type of work, are briefly outlined below.

Ore mills

An investigation by the *National Mechanical Engineering Research Institute* (N.M.E.R.I.) into the merits of different materials and designs for liners of rotary mills of different types used for grinding gold-bearing ore was completed. This investigation involved extensive field tests at numerous mines situated in the chief gold-mining areas of the Republic. A comprehensive report on the results was compiled in collaboration with Rand Mines Limited, and submitted to the Chamber of Mines of South Africa who sponsored the work.

Rock mechanics

Research undertaken by the N.M.E.R.I. into the problem of rock bursts in gold mines has tended in recent years to concentrate upon more fundamental aspects of the behaviour of rock under load. Recent research has yielded a satisfactory explanation of the mechanism of fracture and propagation of fracture of rock under static loading conditions. During the year this research was extended to include studies of the mechanism of fracture under dynamic loading conditions using an ultra-highspeed camera capable of photographing the progress of a crack at 1.6 million exposures per second. This work will provide useful information about what happens in rock when it is drilled, crushed or ground.

Equipment and techniques were also developed for studying the development of rock fractures around mining excavations. This research is particularly important in view of the increasing depths at which gold is being mined.

Underground cavities

In the Westonaria-Carletonville gold mining area, periodic investigations of boreholes, where cavities as a result of subsidences are suspected, are carried out by personnel of the *National Physical Research Laboratory* (N.P.R.L.) using the $1\frac{1}{2}''$ diameter borehole camera probe developed at the laboratory. A fire-proof cover for the camera probe has been built and is at present being tested by the South African Bureau of Standards.

Tests of mining equipment

The Mine Equipment Research Unit of N.M.E.R.I. continued to undertake statutory tests on steel winding ropes for the mining industry. Over 4,000 ropes were tension-tested to destruction.

In addition, numerous non-statutory tests on various machine components, such as anchors and crane hooks, were performed.

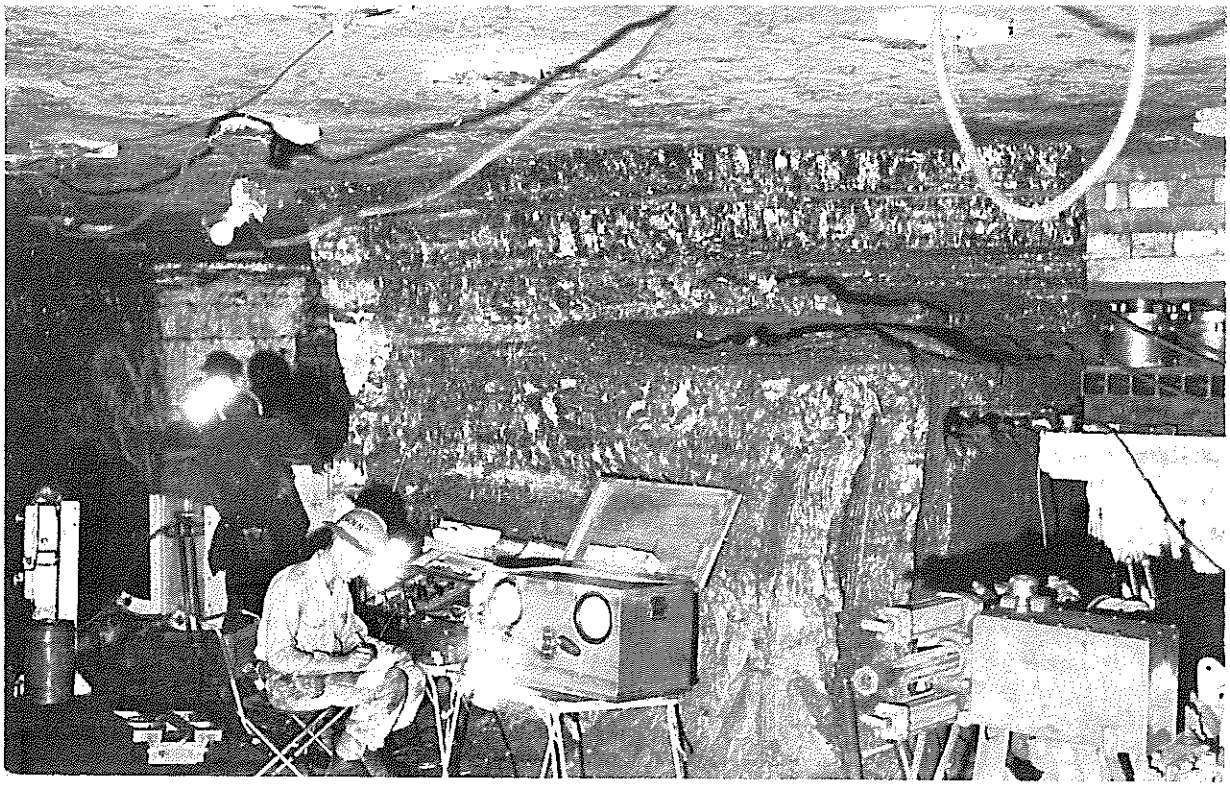
The stability of slimes dams

Several investigations have been carried out by the *National Building Research Institute* (N.B.R.I.) to assess the stability of slimes dams for gold mines and to advise on measures to increase their stability.

Since the flow of moisture and air through slimes dams can have a significant effect on their stability, research is also in progress to determine the modes of flow and the factors which influence the flow. The data obtained from this study should lead to recommendations for controlling the flow of moisture and thus add to the stability of slimes dams.

Extraction

In collaboration with the Chamber of Mines of South Africa, the thickening of gold-bearing pulps has been studied at the *National Chemical Research Laboratory* (N.C.R.L.) in a large model thickener six foot in diameter. Useful information has been obtained, and work will be continued at a mine in order to correlate the model results with those of a full-scale thickener. A study, using radio-active isotopes, has also been completed of the times taken by various fractions of pulp solids to pass through a thickener.



Stress measurements being made in a coal pillar underground

Miners' footwear

The incidence of foot discomfort among underground mine workers has resulted in the Chamber of Mines of South Africa ordering over a hundred specially developed foot measuring devices from the *Leather Industries Research Institute* (L.I.R.I.). These devices were designed after a survey of the shapes of Bantu mine workers' feet, and a study of the lasts used by manufacturers of miners' boots. By ensuring a more accurate fitting, the extent of foot rub and chafing is being reduced.

Heat stroke

A neuropsychological investigation of brain function during heat-stroke as occasionally encountered in mines is being carried out by the *National Institute for Personnel Research* (N.I.P.R.) with a view to establishing preventive and therapeutic measures.

Staff and management

The N.I.P.R. devoted a large proportion of its research to management and personnel problems of the South African gold mining industry. The implementation of recommendations made by the N.I.P.R. should promote greater productivity and well-being among mine workers.

Adaptability tests

The General Adaptability Battery of tests for the placement of mining recruits into the categories of manual, operative, and supervisory labour has been used by the mining industry for 18 years. Work in the N.I.P.R. has now been directed towards the re-standardization of the present Battery and the construction of a parallel one to replace it. This has become necessary because of the higher level of education of mine workers, and because the present Battery becomes familiar to candidates who have had previous mining experience and who have been tested before.

Assessment of selection techniques

The N.I.P.R. was approached to investigate the need for new tests to assess leadership qualities among Bantu mine workers, since it was felt that the existing tests had lost their predictive value and were no longer functioning effectively. The Institute has concluded that the reported ineffectiveness of the tests is due to faulty administration, and not to changes in the population to which the tests are applied or to changes in the validity of the technique itself. However, further research into leadership assessment techniques is necessary, and this is being undertaken.

Programmed mathematics course

A programmed mathematics course has been completed by the N.I.P.R. The course meets the requirements of a syllabus for apprentices and learner officials on the mines as laid down by the Department of Education, Arts and Science at the following levels: NTC I, II, III, IV and TI. These programmes were developed in order to try and alleviate the shortage of mathematics teachers and to assist students at centres where no mathematics teachers are available.

Communication systems

The N.I.P.R. studied communication systems as they affect the Bantu labour force, with particular reference to safety and productivity. This study, conducted on a sample group of Bantu mine workers, shows that two-way communication is important, i.e., downward communication by which management can make its intentions clear to the worker, and upward communication by which misunderstandings (e.g., of the functioning of bonus schemes) can be conveyed to management as they occur.

SECTOR 3

COAL MINING

The *National Mechanical Engineering Research Institute* continued its work into the stability of colliery workings on behalf of the Coal Mining Research Controlling Council.

Design code

During large scale *in situ tests* coal pillars cut in underground workings were loaded to destruction by means of hydraulic jacks to determine their strength. From the results obtained a Code for the design of bord and pillar workings was drawn up. This Code should be invaluable to colliery engineers in South Africa in the designing of colliery workings where a maximum extraction of coal can be effected, commensurate with adequate safety for the miners.

Ventilation

Resulting from completed research into air flow in mine shafts and tunnels, a Natal colliery was given technical advice regarding improvements necessary in the design of a bend in a ventilation shaft.

SECTOR 4

OTHER MINING AND QUARRYING

Manganese dioxide for batteries

Several deposits of manganese dioxide suitable for the manufacture of batteries have been found in the Republic. An increasing proportion of this material is being used for local manufacture, and an export trade has also developed. The requirements for a suitable ore are, however, very stringent, and it is difficult to devise suitable laboratory tests which can serve as a measure of their performance in practice. Several types of tests have been compared at the *National Chemical Research Laboratory*, and a greatly improved test method has been devised.

Slope stability

Model studies were conducted by the *National Mechanical Engineering Research Institute* to determine stability criteria for rock slopes in an open-cast copper mine. An experimental approach for studying slope stability in an open-cast diamond mine has also been worked out.

X-ray fluorescence and atomic absorption analyses

The X-ray fluorescence technique evolved at the *National Physical Research Laboratory* for the determination of the major elements in a wide variety of rock samples, has been extended to include the determination of minor elements and traces.

Atomic absorption methods for the analysis of silicate samples have been applied successfully to the determination of molybdenum, potassium, manganese, iron, magnesium, copper and zinc in silicate materials.

Both these procedures have the advantage of speed over the chemical methods in general use. Precision and accuracy of results are comparable with those obtained chemically, and in many cases, better.

SECTOR 5

PROCESSED FOODSTUFFS

Dissolution of starch in sugar cane juice

The diffusion method of extracting sucrose from sugar cane was recently introduced into South Africa and is being used in three factories. As the starch in cane juice affects the efficient filtering of raw sugar, the *Sugar Milling Research Institute* (S.M.R.I.) carried out an investigation to establish how much of it is extracted at various temperatures.

It appears that careful temperature control of the diffuser will enable juice of low starch content to be produced.

Determination of moisture in raw sugars

To determine the moisture content of raw sugars, some factories use the technique of drying the sugars in a vacuum oven instead of the method given in the Laboratory Manual for South African Sugar Factories.

Results obtained at the S.M.R.I., using the two drying techniques, showed appreciable differences. The variations also reflected significant differences between safety factors.

In view of the narrow limits between which the moisture content of sugars must be controlled for the Japanese market, it was concluded that the vacuum oven method was not suitable for determining moisture in this type of raw sugar.

Improved salt iodizing

At the request of the Department of Health, the *National Nutrition Research Institute* investigated the methods used in South African factories for adding the small proportion of iodate required to salt. It had previously been found that the iodine content of commercial iodized salt varied con-

siderably and frequently fell well outside the limit regulation. Guidance was given where necessary on methods of improving procedures.

Effluents from abattoirs and meat processing industries

The effluents and solid wastes of abattoirs, if released into sewage systems, greatly encumber municipal sewage works and can impair the efficiency of purification. Abattoir effluent also contains certain pathogenic organisms which are difficult to remove during the sewage water purification processes. The *National Institute for Water Research* (N.I.W.R.) has done extensive research into the disposal of abattoir effluents and has gained valuable knowledge.

A first draft of a guide to internal control of water and effluents in abattoirs and meat packaging industries, based on this knowledge, has now been drawn up. Meanwhile, research is being continued, *inter alia*, into ways of handling the paunch contents of slaughter animals.

Milk products

The N.I.W.R. has conducted a survey of water and effluent control measures in a number of milk processing factories and has compiled a guide. The survey revealed that up to 8 per cent of the milk can be wasted through careless processing, resulting in a substantial loss of income and increases in the costs of effluent treatment. The guide covers wastage comprehensively.

SECTOR 6

BEVERAGES

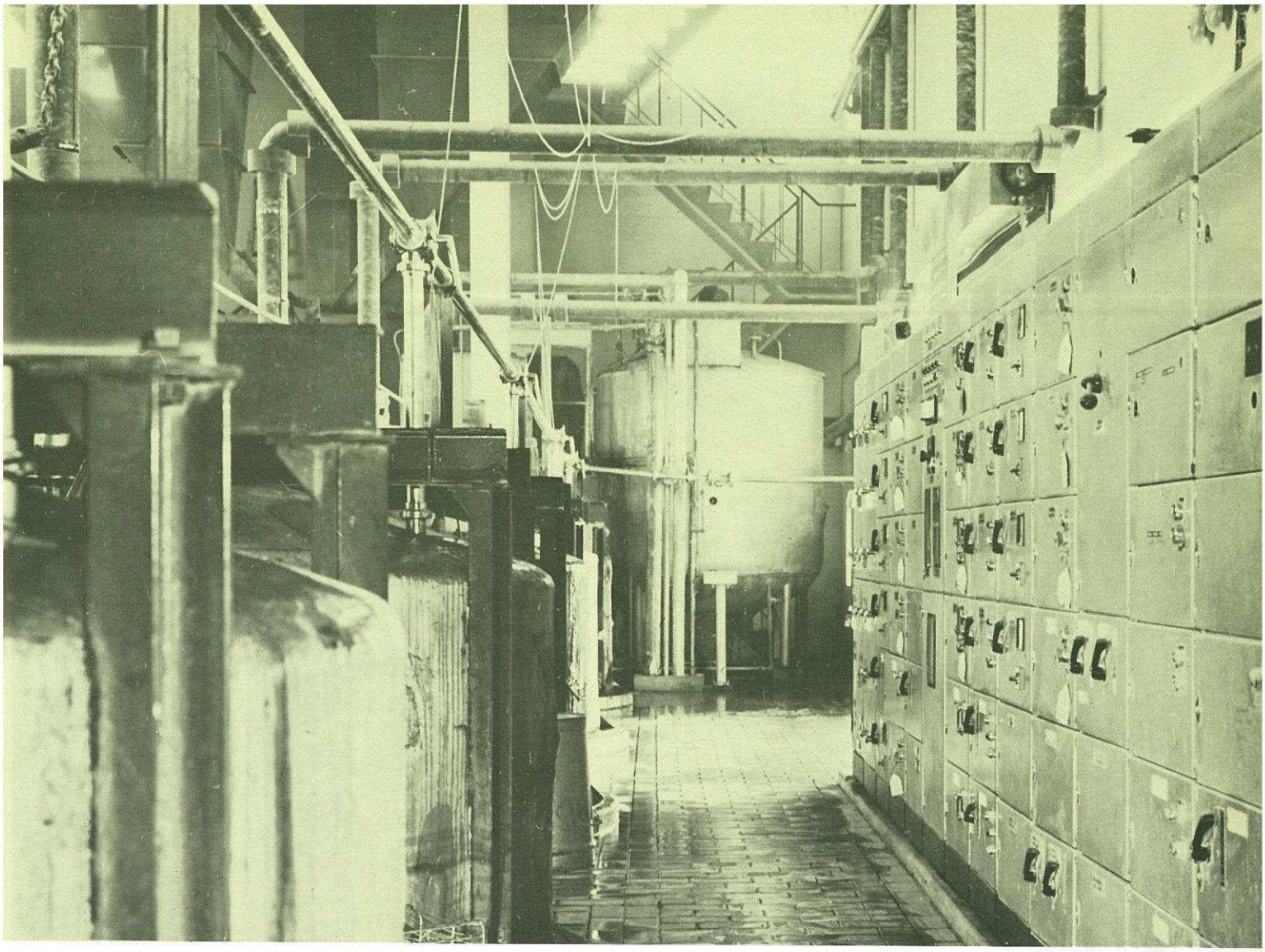
Bantu beer

The work of the Bantu Beer Unit of the *National Chemical Research Laboratory* (N.C.R.L.) is financed from a research fund administered by the Department of Bantu Administration and maintained by a levy upon sales of Bantu beer by municipalities.

It is noteworthy that, at a time when total sales of ordinary beer in the Republic are decreasing, the volume of Bantu beer sold by municipalities is increasing rapidly every year. This is largely due to research which has kept costs from rising and maintained a product of consistently high quality.

In the past year, a comprehensive microscopic study of changes which take place in kaffircorn grain during malting was completed, and improved methods for determining malt quality were tested.

An important factor in the brewing of Bantu beer is control of its lactic acid sourness, and a great deal of attention is being devoted to this. With the assistance of the Microbiology Research Group of the *National Nutrition Research Institute*, the micro-organisms responsible for souring are being studied, and the Chemical Engineering



The control panel and souring tanks at the Waltloo Brewery, Pretoria

Group has assisted by investigating control of the souring process in a large brewery.

Constituents responsible for taste and odour have been isolated and measured, and those with deleterious properties are being studied. Because of the high rainfall in 1967, the crop of kaffircorn has tended to show rather high infestation with moulds, some of which can produce toxic substances under favourable conditions of growth, such as experienced in the malting process.

For technical and economic reasons, the proportion of mealies used in Bantu beer has in recent years been greatly increased and that of kaffircorn reduced. Although this change has resulted in the production of a smoother, less fibrous product, to which the consumer has become accustomed, it has also resulted in a reduction in the vitamin content of the beer. The technical reason for the reduction in kaffircorn usage is connected with the relatively high wax and fat content of the outer layers of the grain. The *National Nutrition Research Institute* (N.N.R.I.) has commenced an investigation to determine the most effective and economical procedure and plant for decorticating or pearling the grain and thus obtaining kaffircorn of lower wax, fat and fibre content for brewing purposes.

Tartaric acid from wine lees

Work in the N.C.R.L. on production of tartaric acid from wine lees has advanced to the stage where a large pilot plant drier for lees has been installed with funds provided by the wine industry, and this will be followed by pilot plant production of tartaric acid.

Lactic acid-producing cultures

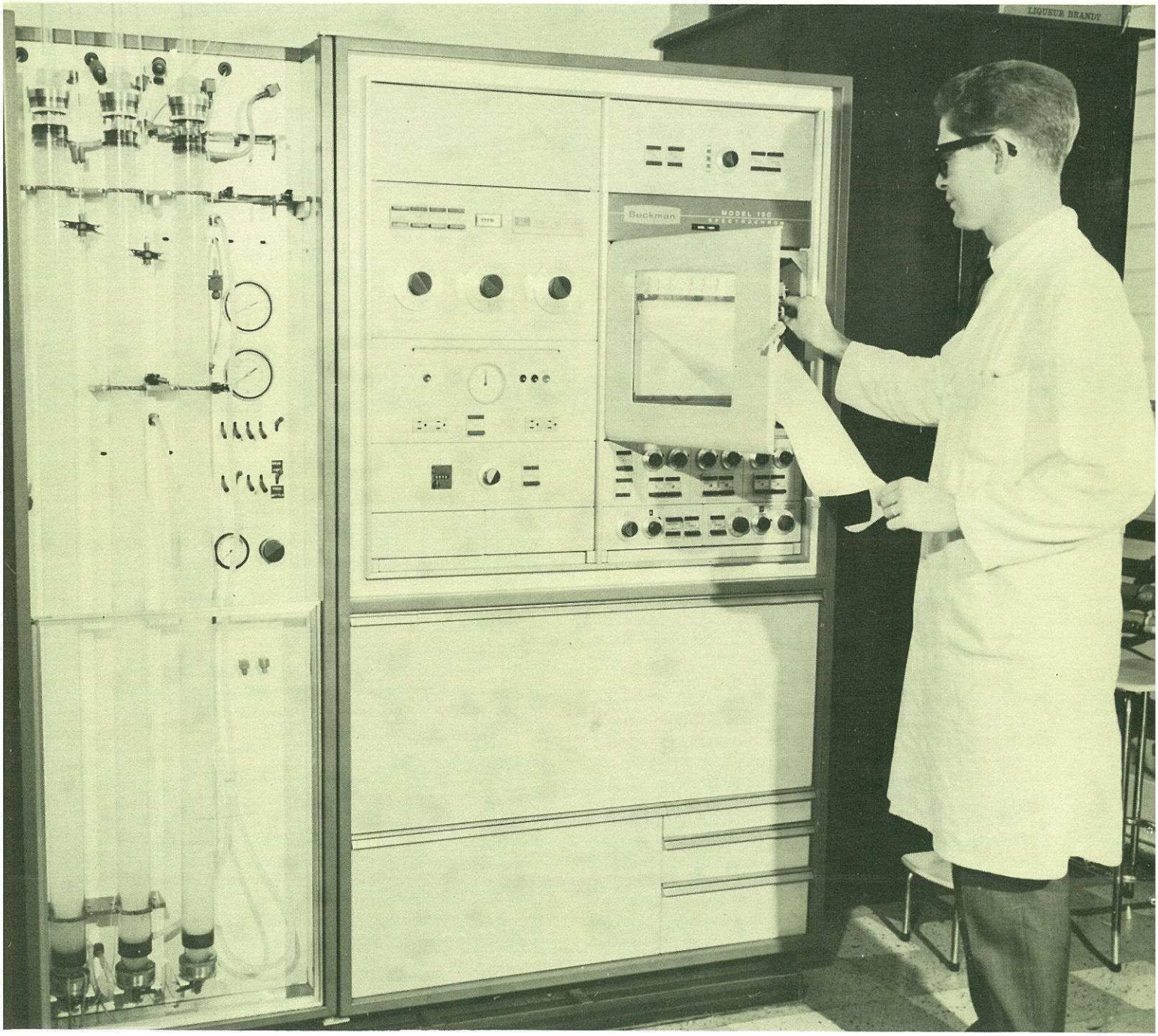
An important research project successfully completed by the N.N.R.I. for an industrial sponsor concerned the large-scale production and drying of lactic acid-producing cultures.

Winery effluents

The treatment of effluent from wineries in the Western Cape has always presented a problem. The organic pollution load is high and consequently the effluent cannot be treated in conventional sewage works. Research done by the *National Institute for Water Research* (N.I.W.R.) into the problem over a number of years has been brought to a successful conclusion. The work was done on a contract basis for the Paarl Municipality.

The treatment concentrated upon was that of anaerobic digestion. It was modified according to laboratory and pilot scale installations for the extensive treatment of the relevant effluents.

The Spectrochrom, an automatic device for the chromatography of wool proteins in use in an NCRL laboratory



SECTOR 7

TEXTILES

Introduction

Two factors, in particular, have recently dominated the South African wool and mohair market. Firstly, the clips clearly showed the effect of the extended droughts over the past shearing seasons. Secondly, the international slump in economic and industrial activity led manufacturers of man-made fibres to slash their prices in a move which could not fail to influence the price level of natural fibres.

Against this background, the international research effort on wool and mohair had to be increased to prevent synthetics from replacing natural fibres.

Well-equipped laboratories and extended processing research facilities are now available to an enlarged S.A.W.T.R.I. staff. These facilities are backed by excellent international co-operation, in particular with Australia and New Zealand, the other two partner countries of South Africa in the International Wool Secretariat (I.W.S.). This is augmented by I.W.S.-sponsored research in some seventeen wool processing countries. Research progress reports are discussed at the biannual meetings of the Research and Development Committee of the I.W.S. (where S.A.W.T.R.I. is represented by the Director) and information is made available on market surveys and product development undertaken by I.W.S. agencies.

It is realized by those concerned with the South African wool and mohair industries that the economical production of the animal fibres has to receive constant attention; that local processing of our clips on a larger scale and to an increased range of end-commodities is advisable and may perhaps be enforced by international economic and political developments; also that, as a consequence, S.A.W.T.R.I. will have to provide the necessary information and advice on the processing of the South African clips.

The following are some projects completed by the Institute. Conclusions and recommendations resulting from these projects have been passed on to the various branches of the wool textile industry. Other projects which are of a more extended nature requiring long term research are dealt with in the section covering *Research Laboratories, Institutes, Units.*

Fibre preparation

The apparatus for determining mean fibre length, developed by the *South African Wool Textile Research Institute* (S.A.W.T.R.I.) has been improved. In the first model of the meter, a graphical method of measuring fibre length was used. To simplify the use of the apparatus the *National Research Institute for Mathematical Sciences* has developed an electronic integrator which indicates the equivalent reading directly in digital form. Full patent rights on the apparatus for South Africa have been granted to the South African Inventions Development Corporation and an application registering the patent has also been filed in the United Kingdom.

The integrator also includes a meter which indicates the maximum stress in a bundle of fibres, and by taking two readings, the average fibre length can be easily and rapidly calculated.

Refining of wool grease

The refining of wool grease was studied at the request of the wool scouring industry. This industry is legally compelled to remove the grease from scouring effluent but the market for the raw product is limited.

The fairly dark industrial "cream" obtained by centrifuging wool scouring effluent was bleached with one per cent sodium chlorite which proved as effective as 10 per cent to 40 per cent hydrogen peroxide. The stable emulsion ensuing upon neutralization of the bleached wool grease which has a high acid value, could be broken by adding common salt (2 lbs. per 25 lbs. of neutralized grease). This rendered the entire process much more economical than peroxide bleaching or the breaking of emulsions by the addition of propanol.

Lanolin of B.P. quality has been produced by following the bleaching process mentioned above with a sulphuric acid treatment at about 94°C to decrease the ash value of the wool grease.

Mineralized effluent from textile factories

The mineralization of effluent from textile factories causes various problems as it must conform to quality standards laid down by the Water Act before it can be released into water courses. On a contract basis, the *National Institute for Water Research* (N.I.W.R.) advises various factories on effluent disposal methods. Methods of treating mineralized effluent through irrigation and spray evaporation are being investigated.

The N.I.W.R. is compiling a code of practice for handling water and effluent in textile factories under South African conditions.

SECTOR 10

FOOTWEAR

A heat setter designed by LIRI in operation in a South African footwear factory

Fittings

The extensive fashion changes in footwear toe shape in recent years and the numerous systems of marking footwear in sizes and fittings, have resulted in world-wide confusion. Consequently, an attempt has been made in Europe to establish an international standard system to be known as "Europoint". Research workers at the *South African Leather Industries Research Institute* (L.I.R.I.) are making an important contribution, particularly in evolving a width-fitting system to be used in conjunction with the proposed "Europoint" foot length or size system, and in producing a measuring device to enable factories and shoe last manufacturers to mark their lasts and shoes in terms of an international standard system which would be a great boon to the retailer and the consumer.

Heat setting

The process of "heat setting" the shape of shoes during manufacture, which has revolutionized the modern footwear factory by speeding up production and facilitating the use of conveyors, is still not being used effectively in many factories because incorrect temperatures are applied to the shoe surfaces during their passage through the heat setters. L.I.R.I. has developed a simple system of coloured wax capsules with a range of melting points to enable frequent factory tests to be carried out.

Fibre straightening and inter-fibrillar slip

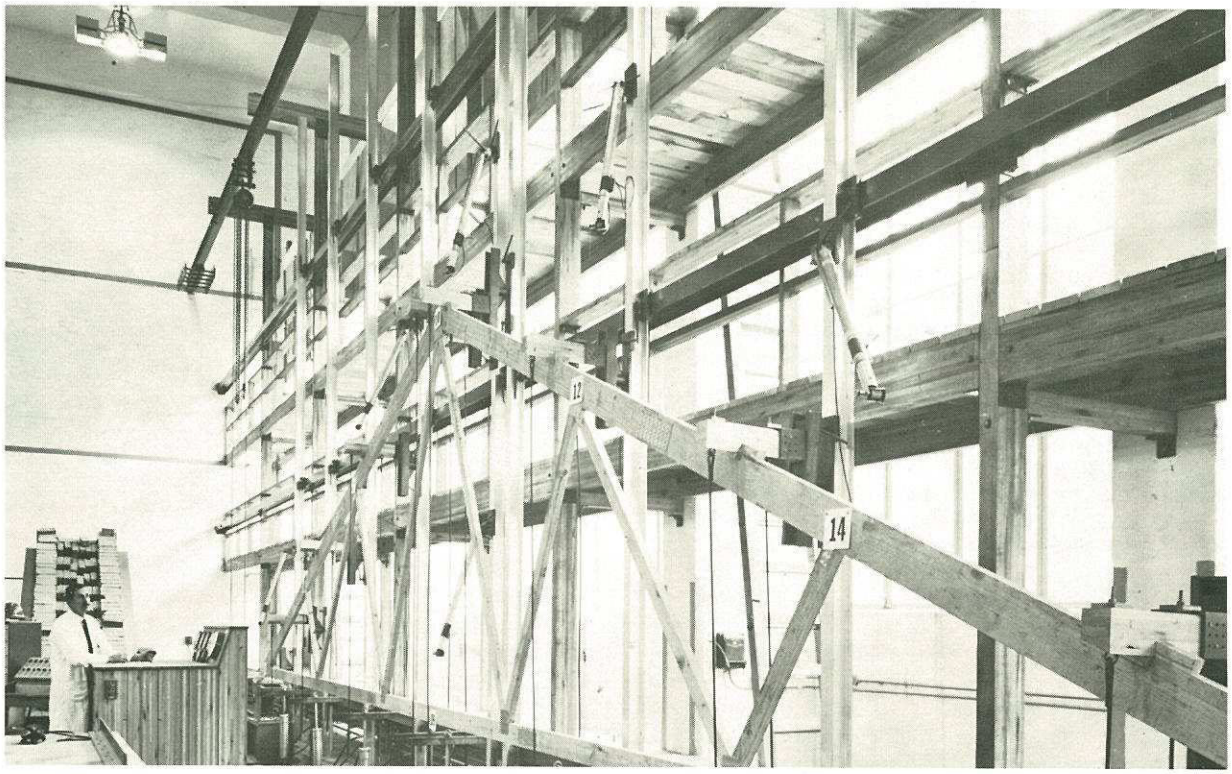
The forming of flat leather to the irregular shape of the foot is dependent on properties such as elastic and plastic stretch which are peculiar to the fibrous nature of leather. These properties are difficult to simulate in synthetic substitutes. Fundamental work carried out by L.I.R.I. has yielded useful knowledge on the mechanism of fibre straightening and inter-fibrillar slip which are the bases of these essential properties and on the influence of tannage, lubrication, wetting and temperature on the frictional properties of single leather fibres.

Predicted demand

A model to enable the demand for shoes to be forecast was evolved by the *National Research Institute for Mathematical Sciences* on behalf of a footwear manufacturer. The company will be further assisted when the techniques in question are to be used for controlling stocks.

SECTOR 11

TIMBER AND TIMBER PRODUCTS



The timber truss testing apparatus at the CSIR's Timber Research Unit. This apparatus, one of the largest of its kind in the world, simulates roof loads on timber trusses having spans up to 70 feet

Introduction

The C.S.I.R.'s *Timber Research Unit* (T.R.U.) concentrates its research on structural timber and pulp and paper. These products consume the bulk of the logs from growing forests. (See also reports under headings Paper and Paper Products and Timber Research Unit.)

The T.R.U. has established that a potential additional market for structural timber exists in industrial, commercial and agricultural buildings. The use of timber in these fields, however, depends on structural timber becoming a dependable engineering material with a known and consistant quality so that it can be confidently specified by architects and used by engineers in designs; and on the saw-milling industry becoming market-orientated, i.e., it should manufacture to the consumer's demand.

Timber properties

More than half the T.R.U. projects are aimed at assisting the industry in evaluating the properties of timber. Research is carried out to reduce seasoning defects such as warp. A stress-grading method is being developed to establish mechanically the strength of each piece of timber tested. This grading will guarantee the strength of the timber and will enable designers to make more effective use of the inherent strength of South African grown structural timber. Better methods of jointing are being developed to ensure a balance of strength in timber structures such as roof trusses. All the above research is co-ordinated and the results used to design more effective timber structures.

Testing facilities

A truss testing rig was designed and developed in the C.S.I.R. to test full-scale trusses and other structures with spans up to 70 ft. Loads are applied hydraulically and the equipment measures load and deflections electronically. With the aid of this machine, one technologist can do the work of 12 people using conventional methods.

SECTOR 13

PULP AND PAPER PRODUCTS

Preservation of paper

The *Timber Research Unit* is assisting the State Archives in developing better methods of preserving important documents — the life expectancy of modern paper under normal storage and handling conditions is only 50 to 100 years. The work involves a study of the factors contributing to the deterioration of paper so that recommendations can be made regarding the preservation of existing documents and the manufacture of more permanent paper for future use.

Important initial findings are: the use of fibrous raw materials (such as wood pulp) in the manufacture of paper has a negligible effect on the ageing rate of paper; heat and the presence of certain gases increase the rate of deterioration; high initial strength in paper ensures longer life, and paper with a life span many times that of presently used paper can be manufactured at little additional cost.

The T.R.U. is now developing methods of deacidifying paper and laminating it with plastic sheets as reinforcement. It is also investigating storage of documents under controlled atmospheric conditions. In addition the local pulp and paper industry has been asked to investigate the feasibility of manufacturing paper with a longer life expectancy. (See also report under heading: *Timber Research Unit.)*

Effluent treatment

The *National Institute for Water Research* assists manufacturers of paper and pulp, on a contract basis, to improve and dispose of their effluents. Investigations are aimed at treating effluents and improving water utilization in factories.

In a few cases, the investigations undertaken concerned the discharge of industrial effluents into the sea. In these instances comprehensive preliminary studies were carried out of the sea conditions in the vicinity of the discharge point. Follow-up studies are also made. It is anticipated that a code of practice will be compiled later for water and effluent control in pulp and paper factories.

Aerobic processes for breaking down solid waste material from pulp and paper factories are also being investigated. Through these processes worthless waste material can be converted into compost.

LEATHER AND LEATHER PRODUCTS

The South African tanning industry is generally regarded as a world leader in research on the tanning of shoe sole leather. This reputation can be maintained only by continuous research and this is the function of the *South African Leather Industries Research Institute* (L.I.R.I.), one of the co-operative industrial research institutes established jointly by the C.S.I.R. and the industry.

Tanning effluents

Disposal of tanning effluent is an urgent problem facing the industry throughout the world. The *Leather Industries Research Institute* has developed a method of paddle aeration which, in conjunction with the use of manganese salt, enables tanners to eliminate the evil-smelling sulphide which is the most difficult constituent to remove. The method, which is being applied successfully by a number of South African tanners, has been described in the overseas technical literature.

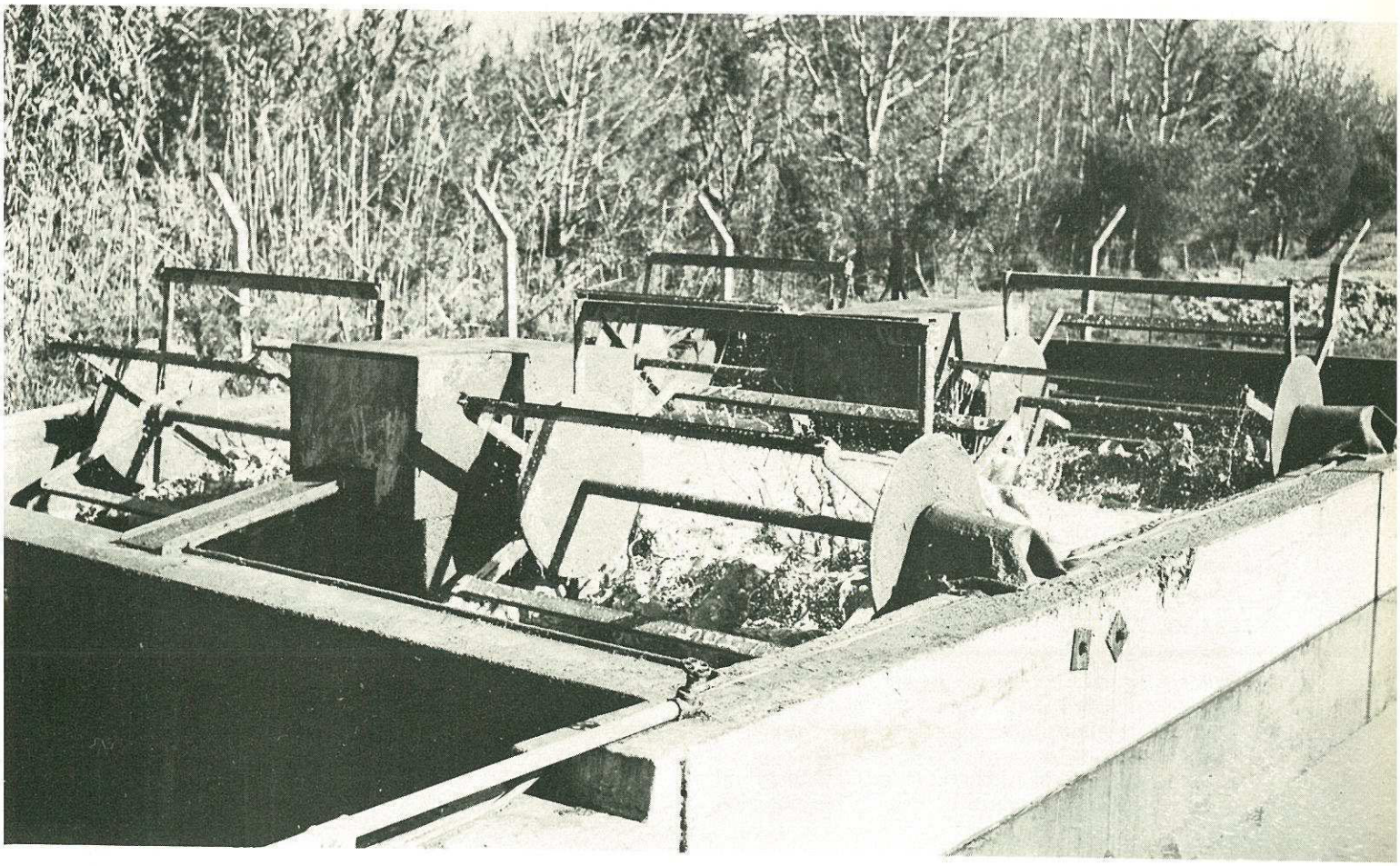
Among other developments and processes relating to effluent improvement which are being successfully applied on a large scale, are the following: a rapid no-effluent sole leather tannage, a rapid no-effluent chrome tannage for upper leathers, the re-use of exhaust chrome tannage for upper leathers, and the re-use of exhaust chrome tan liquors.

Mechanism of tannages

Results of investigations into the mechanism of vegetable and zirconium tannages have been published in the overseas literature.

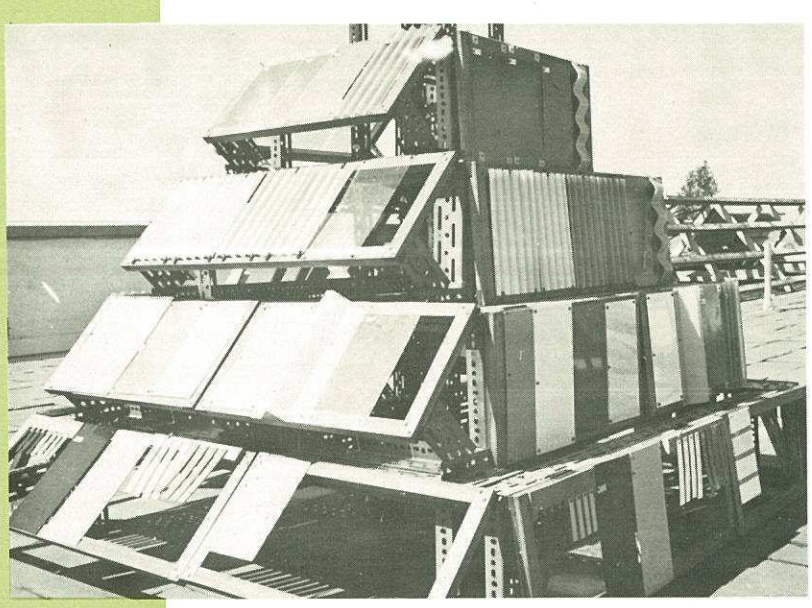
The paddle aeration system developed by LIRI for the large-scale destruction of sulphide in the effluent from a South African tannery

SECTOR 15



SECTOR 17

BASIC INDUSTRIAL CHEMICALS



Exposure tests on various plastics and related materials that are being offered for use in building

Paint

The work of the *South African Paint Research Institute* (S.A.P.R.I.) which is supported by the paint industry and is mainly responsible for research in this field, is described elsewhere in this report. (See p. 117). The *National Building Research Institute* (N.B.R.I.) is also interested in paint and related products applied for decorating and protecting buildings, structures and building materials. Research is done in connection with the development of new paint systems and paint application techniques for exposed metal, for cement products such as asbestos cement and for wood and wood products.

Plastics and rubber

Plastic and rubber products are finding new uses daily. The N.B.R.I. is studying their durability and special properties, preparing for a greater demand for plastics and rubber in the building industry.

The possibilities of accelerated exposure through the use of frames which follow the sun are being investigated and important durability data in connection with the influence of direction of exposure have already been obtained. These tests have been extended to Johannesburg, Windhoek and Walvis Bay during the past year.

Fertilizer industry

Investigations were carried out by the *National Building Research Institute* to assist the fertilizer industry in safely disposing of its waste products from the manufacture of phosphatic fertilizers. These investigations concerned the stability of waste dumps and prevention of pollution of ground and surface water by sealing the dumping areas.

SECTOR 19

PRODUCTS OF PETROLEUM AND COAL

Waxes in polythene

Further work has been done for Sasol by the *National Physical Research Laboratory* (N.P.R.L.) on the study of polythene samples containing various waxes. The waxes contribute to the strength of the plastic.

Oil prospecting

In connection with oil prospecting, the N.P.R.L. has carried out a survey for Soekor which consisted of 78 deep electrical soundings of the chalk basin over an area of 1,200 square miles in the vicinity of Port Elizabeth. Further surveys are to be undertaken in other areas.

Training of process workers

The possibility of training chemical process workers in petroleum refineries by means of programmed teaching is being studied by the *National Institute for Personnel Research.*

SECTOR 20

NON-METALLIC MINERAL PRODUCTS

Burnt clay products

Research into clay products is being done by the *National Building Research Institute* (N.B.R.I.) with the object of utilizing clay deposits in the Republic and South West Africa for the building industry and of improving and developing ceramic products such as bricks, floor and wall tiles and enamels.

The N.B.R.I. has given attention to strength development during the burning process; the influence of the rate of burning with the aim of developing rapid burning processes; the development of enamels; and the colouring of bricks. It has been found, for example, that bricks which burn to an undesirable colour can be dyed economically. An investigation is also being made into the availability and suitability of clay for brick-making in Ovamboland.

Cement

The N.B.R.I. does research on hydraulic cement and lime with the object of utilizing raw materials, dealing with manufacturing problems and ensuring the efficient use of cements. Research on the expansion behaviour of cement under accelerated hydration has been completed. Cements which expand during accelerated hydration can cause problems when used in the manufacture of cement products such as concrete and asbestos cement plates cured under steam pressure. Research into local blast furnace slag which can be used for cement production is being continued.

Valuable information based on research by the N.B.R.I. is made available to interested parties. This information relates to heat generation and hydration of cement and the determination thereof; also the amount of heat generation which can be expected in large concrete structures such as dam walls, and the determination of the blast furnace slag content in blast furnace cement and the ageing of the cement during storage.

IRON AND STEEL INDUSTRIES AND NON-FERROUS METALS

SECTOR 21, 22

General

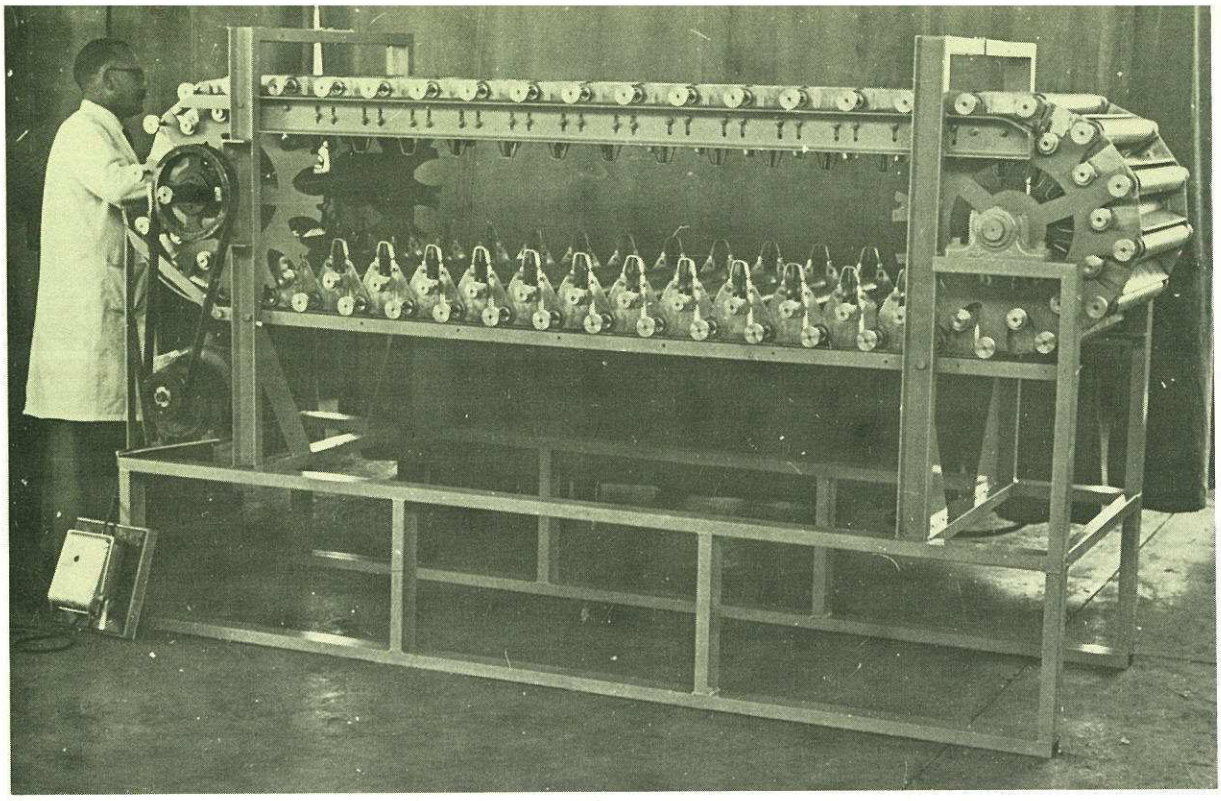
A survey of the research and information needs of the metals engineering industry was completed. It was established that the industry could benefit considerably from production engineering research aimed at developing more economical small-scale manufacturing techniques.

Foundry materials

The *National Mechanical Engineering Research Institute* continued with basic research into the technological problems confronting South Africa's foundry industry. The work included an investigation of typical defects in casting which occur when local foundry sands and other mould materials are used.

A comprehensive report on the properties of moulding materials at high temperature was issued as a result of the research and should be a valuable manual to foundry operators in the Republic.

A one-day symposium on Research and Technical Services for the Foundry Industry in South Africa was held at the C.S.I.R. in March and was attended by foundrymen from all over the Republic.



The prototype potato size-grading machine made for the Potato Board, with side panels and chutes removed

SECTOR 24

MACHINERY

Testing facilities for heavy machinery

In collaboration with the South African Bureau of Standards, a detailed study by the *National Mechanical Engineering Research Institute* (N.M.E.R.I.) of the facilities required in the Republic for testing heavy rotary machinery and for carrying out research into testing methods was completed. This study was undertaken as such facilities are a prerequisite to further development of the heavy machinery manufacturing industry in South Africa.

A study of the need for centralized facilities for testing large fans was also made by the Industrial Economics Division to determine what facilities were necessary for promoting heavy industry in South Africa. The survey showed that a need exists for a central experimental station which could undertake both development tests and acceptability tests for fans.

These studies resulted from the need of the industry for adequate proof testing of the large pumps and fan units currently in use to establish whether they were meeting the requirements of their design specifications.

Detailed recommendations resulting from these studies were made to the Councils of the South African Bureau of Standards and the C.S.I.R. for future action.

Potato grading machine

The Potato Board has requested the *National Mechanical Engineering Research Institute* to bring a potato grading machine in which the Board has patent interests, to the production stage. The detailed design of the machine was worked out and the first prototype built by the *Technical Services Department* of the C.S.I.R. The prototype operated satisfactorily and is capable of exceeding its design capacity of 1,000 x 37½ lb. pockets of potatoes per normal working day.

Numerical control of machine tools

The merits of numerically controlled machine tools have been studied by the *National Research Institute for Mathematical Sciences* (N.R.I.M.S.) and the C.S.I.R.'s *Technical Services Department*, and a numerically controlled milling machine has been purchased and installed in the workshops of the latter department.

This machine will be controlled by means of a very large and powerful computer programme known as A.P.T., which has been commissioned on the electronic computer of the C.S.I.R.

Numerical control is a branch of automation which will find ready application in the Republic where small batches are usually manufactured for relatively complex component products and where skilled labour must be conserved.

SECTOR 25

ELECTRICAL EQUIPMENT

Thin-film micro-circuits

Research in the *National Research Institute for Mathematical Sciences* on the manufacture of thin-film micro-circuits was successful in so far as the first working circuits were produced. As a start, the technology of manufacture of a specific digital circuit was studied. The stages involved in the manufacturing process are as follows: circuit layout, mask manufacture, thin-film deposition in vacuum, photolithography, etching, testing, transistor bonding, wire bonding and encapsulation.

Voltmeter for noise measurement

To facilitate noise measurements on transistors as used in small signal amplifiers a special digital voltmeter was developed during the previous year. With the aid of this voltmeter, further noise measurements were made; in the case of some transistors, these disclosed an unexpected phenomenon not previously reported in connection with transistors, namely, an anomaly in the anticipated noise spectrum at low frequencies.

Transistors

Studies were carried out to determine the possible applications of certain special transistors, such as M.O.S. transistors.

New monitor

A new type of monitor was developed for measuring the thickness of thin-film layers during deposition, by means of ultrasonic surface waves.

Electro-narcosis apparatus

An electro-narcosis apparatus was developed for a psychiatrist. When this apparatus is used, it appears that any detrimental after-effects of treatment seem to be of far shorter duration than those experienced after treatment with commercial types of apparatus.

Special audiometer

A special audiometer was developed for a Rand doctor to meet the need for a piece of equipment which can be used to determine as soon as possible whether a baby with a suspected hearing defect has in fact such a defect or not, and to estimate the degree of deafness.

Operational survey

An operational survey, followed by the introduction of selection procedures was carried out by the National Institute for Personnel Research on behalf of a firm manufacturing and assembling electronic equipment.

For the same firm, work has started on the development of a supervisory training manual for front-line supervisors. In the light of present requirements for higher productivity, this project should prove invaluable.

SECTOR 26

TRANSPORT EQUIPMENT

Aeronautics

Further progress was made on the design and construction of the prototype of the two-seater autogyro under development in the Aeromechanics Division of the *National Mechanical Engineering Research Institute* (N.M.E.R.I.). It is hoped to complete the prototype during 1968. The main aim of this project is to provide experience for what is, in effect, the nucleus of South Africa's first aircraft design and research group.

Wind tunnels

The installation of a subsonic wind tunnel with a 7 ft. by 5 ft. working section was completed, while modifications were made to the 18 inch square trisonic wind tunnel.

When these tunnels are fully operational they will greatly increase the research potential in the field of aeronautics in South Africa.

Aircraft noise

The disturbance caused by aircraft noise can be limited by suitable planning of residential areas near airports. The Aeronautics Division of the N.M.E.R.I. has been studying the problem and a report on a method of calculating noise contours and estimating existing and possible future noise climates at major South African Airports was issued. This work on aircraft noise was associated with a collaborative programme instigated by an interdepartmental committee appointed by the South African Government to study the aircraft noise problem.

The Head of the Acoustics Division of the *National Physical Research Laboratory* also serves on this committee.

SECTOR 29

CONSTRUCTION INDUSTRY

Industrialized building systems

As a result of the prominence given to industrialized building, many new types of preconstructed building components and systems are appearing. Many of these are being investigated by the *National Building Research Institute* to determine their suitability for South African conditions. Research is also being undertaken to develop new or improved evaluation techniques for thermal performance, resistance to wind-driven rain and the strength of building components and especially the joints between components.

Research is also being carried out into industrialized building techniques based on the use of fired clay products. This work is subsidized by the South African Brick Association and has led to preliminary development work on a mechanized system for the prefabrication of brick wall panels.

Proposals for organizing a formal procedure for the evaluation of new forms of construction on a nationally recognized basis were submitted by the Building Research Advisory Committee to the Government, via the C.S.I.R. The Government has accepted in principle that an organization be established for this purpose.

Very high buildings

The advent of 'high-rise' or 'tower' buildings in South Africa has brought with it design and construction problems not covered by current local building regulations. The *National Building Research Institute* is assisting planners and authorities in the formulation of rational requirements for plumbing, ventilation, lighting and fire protection and control in such buildings.

The briefing process in building

A key procedure in the building process is the design brief and a study is under way to provide a briefing system that will correlate the expectations of the client with the kind of information required by the architect for interpretation in terms of planning. A briefing system has been devised which should in time influence procedures adopted by clients embarking on building projects.

Building management

In conjunction with the *National Building Research Institute, the National Institute for Personnel Research* undertook a study to determine where research could contribute most significantly to the efficiency of building management. The N.I.P.R. recommended that in order to improve managerial efficiency, an active and integrated attempt should be made by all members of the building industry to systematize managerial practices and to adapt them to current and future demands.

Building apprentices

In view of the inadequate number and unsatisfactory standard of apprentices entering the building trade, the opinions of building trade employers

SECTOR 28

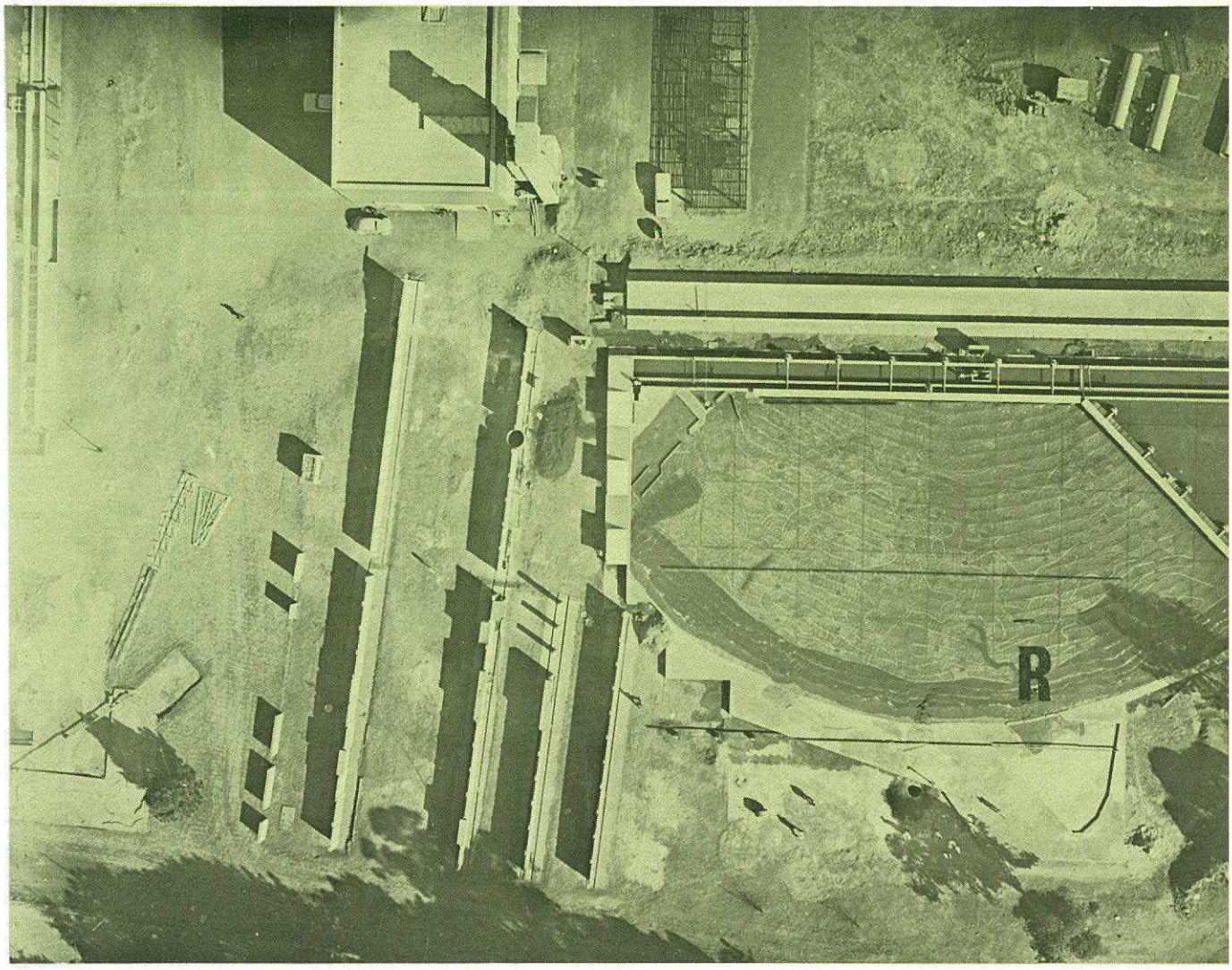
MISCELLANEOUS MANUFACTURING INDUSTRIES

Rock stresses

The "doorstopper" rock-measuring equipment developed by the *National Mechanical Engineering Research Institute* (N.M.E.R.I.) is being manufactured under licence by a South African organization specializing in scientific equipment.

The "doorstopper" equipment enables engineers to determine rock pressure and should enable mining operations to be carried out at much greater depths. It should also enable much larger structures such as dam walls to be built on rock foundations.

The equipment is being used not only in South Africa, but also in Canada, Australia, the U.S.A., the United Kingdom, Zambia, Italy and Sweden.



A model of Table Bay harbour on the CSIR site in Pretoria showing the location of the proposed fishing harbour at Rietvlei (marked 'R')

regarding the problem, were studied in order to determine the possible causes. A questionnaire survey was carried out by the *National Institute for Personnel Research,* and this will possibly be followed by an interview study.

Acoustics

During the past year the Acoustics Division of the *National Physical Research Laboratory* has assisted with the planning of new buildings to ensure satisfactory acoustics and has also improved the acoustics of existing buildings.

Tests of the acoustical properties of various building materials are carried out on a routine basis.

Raw materials for the building industry

Research into factors which influence the efficiency of grinding processes, particularly of cement clinker, were continued in the *National Mechanical Engineering Research Institute* (N.M.E.R.I.) The results of research already conducted have indicated ways and means of significantly reducing grinding costs in the cement industry.

Air conditioning

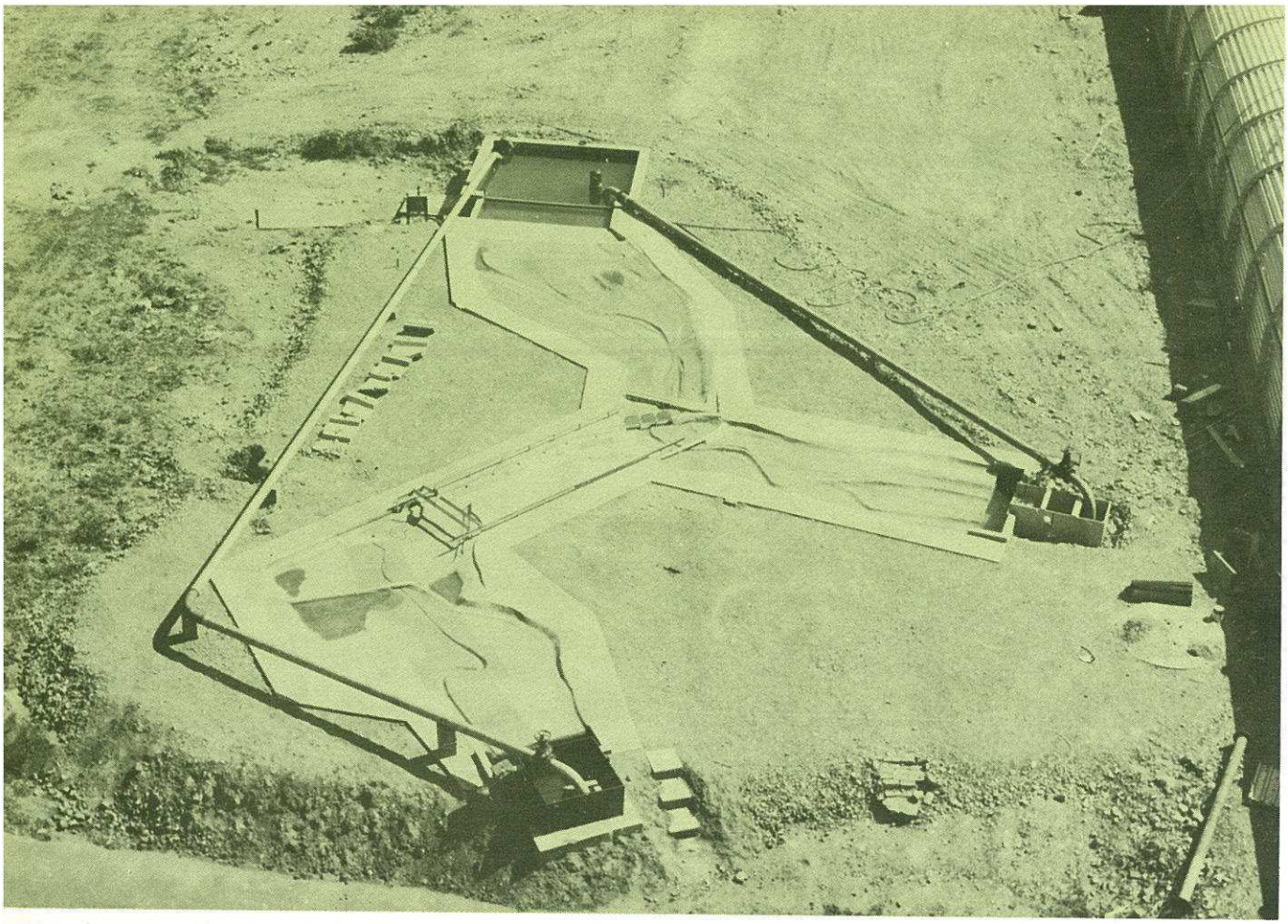
The N.M.E.R.I. has prepared a manual on climatological data for the Republic and South West Africa, which can be used as a basis for the design of air conditioning equipment.

Coastal engineering

The investigation being conducted by the N.M.E.R.I. on behalf of the Fisheries Development Corporation into the best siting and layout of a fishing harbour and possible ship building facilities at Rietvlei in Table Bay continued during 1967 with an extensive programme of tests on a hydraulic scale model specially constructed for this purpose.

Advice was given on means of stabilizing the St. Lucia estuary, based on data obtained from earlier research conducted by the N.M.E.R.I. on a scale model.

Further model investigations were made of the coastline at Gansbaai and recommendations made



A model of the Isipingo River being used to determine the most suitable method of diverting the river for the development of a proposed industrial township

on the most suitable layout of the harbour and its entrance.

Advice was given on coastal engineering problems at Still Bay and to the operators of diamond mine workings along the coast north of Oranjemund, South West Africa.

The large underwater sand mound being built offshore at Durban on the recommendation of the C.S.I.R. remained remarkably stable under all weather conditions. It is designed to protect the Durban beaches against erosion.

Recommendations for the research required to establish the best breakwater layout for the proposed harbour at Richards Bay were submitted to and accepted by the South African Railways Administration.

A study to determine the causes of erosion of the Algoa Bay coastline which resulted in part of the new national road north of Port Elizabeth being washed away, was undertaken for the Department of Transport. Protection schemes were also suggested.

A nation-wide programme of wave recording and analysis began during the year. This programme is aimed at accumulating information about the entire South African coastline. The information gained will be invaluable for future harbour and coastal development work.

Design of sand dams

A start was made on the field work involved in a study, sponsored by the South West Africa Administration, to determine the design requirements for optimum performance of sand dams.

River hydraulics

Model studies were started to determine the most suitable method of diverting the Isipingo River to make way for a proposed industrial township.

Dam design and hydro power station

Advice was given regarding the most suitable site for an underground power station for the Ruacana Water Scheme and the design of a dam on the Sanddrift River.

Discharge of effluents into the sea

A contribution dealing with the hydraulic design of submarine outfall systems was compiled for a monograph on the disposal of effluents along the Natal coast.

Overloaded vehicles

The increase in heavy traffic, e.g. vehicles transporting cane to the sugar mills, on some rural Natal roads, is causing problems. Surveys in Southern Natal have shown that a percentage of the wheel loads are above the permissible limit — and could have a destructive effect on the roads. It has been estimated that over 100 miles of road in this particular area have failed.

Road building materials

Good road building materials are scarce in Southern Natal. Research into the location of materials through studies of aerial photographs and knowledge of the geology and geomorphology of districts can result in economic benefits.

Control of construction procedures

It is essential that adequate control be carried out in the field to ensure that roads are constructed according to specification. Techniques developed by the N.I.R.R. will allow the available engineering manpower to be most effectively employed in carrying out control procedures.

However, the shortage of engineers in Roads Departments hampers communication of the latest results and the promotion of the economic benefits flowing from research.

Axle load meter

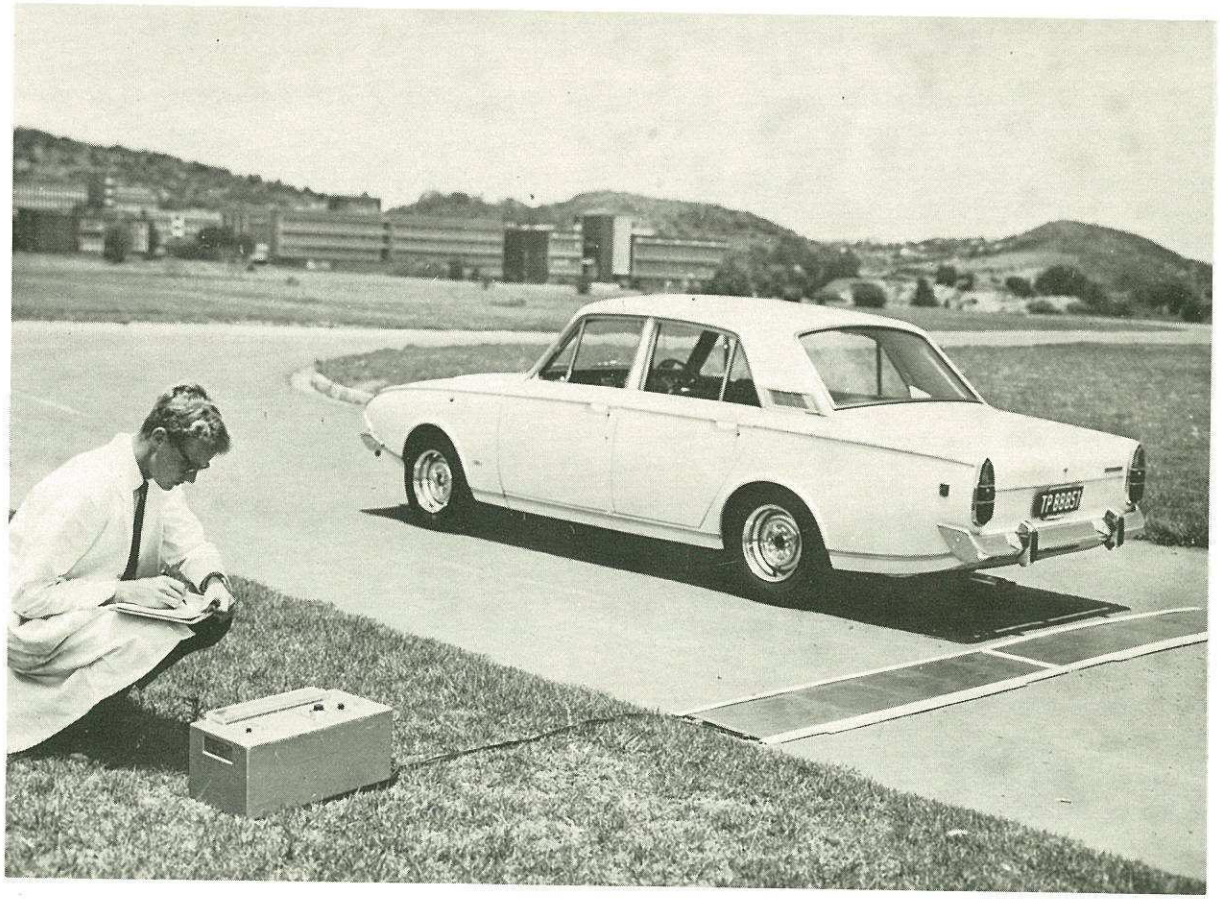
A portable instrument for measuring the axle loads of road vehicles is being developed by the Institute. The instrument can also record overloading on vehicles, thereby assisting the authorities to control the damaging effect overloading has on roads.

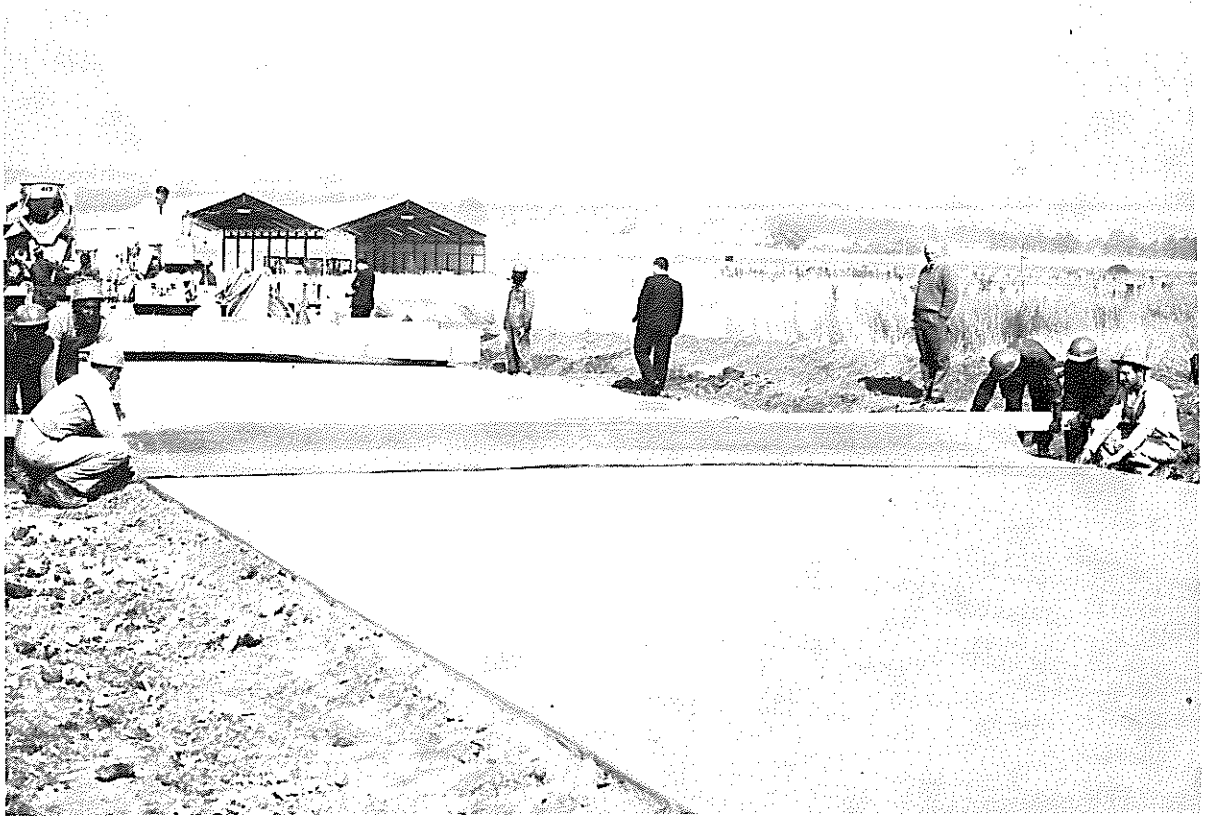
Extending the life of existing roads

Blacktop roads which are more than 25 years old will soon have to be reconstructed. The large increase in traffic, which at the present rate probably doubles itself every 10 years, has rendered these roads obsolete — not only because of the inadequate surfacing and deficiencies of curvature and grade, but also because the foundations have worn through cracking or deformation. To exploit to the full whatever salvage value may exist in these roads, it is necessary to know the thickness and quality of the existing material. Economies could also be achieved if road sections which merely require a thin overlay to carry traffic for the next twenty years could be differentiated from sections where failure could occur within a short while. For this purpose a quick but comprehensive method of evaluating existing road pavements is required.

By applying overseas research, the Institute has been able to develop many road assessment techniques — such as one for measuring deflection by means of the Benkelman beam. A curvature meter has been developed for assessing the

A portable instrument developed by the NIRR for measuring axle loads of road vehicles





A section of an experimental concrete road being laid at the NIRR's test site in Pretoria

rigidity of existing structural pavements. These types of apparatus are being employed by Roads Departments and yield information which could be used in calculating the thickness of overlay to upgrade the standard of a road to modern requirements.

New instruments utilizing dynamic test techniques, developed by the Institute, are being tested in co-operation with Roads Departments to produce further information needed for the structural design of roads.

'Crusher-run' bases bound with cement or bitumen

Most rural road authorities use a base of "crusher-run" rock for heavily trafficked roads. When covered with a thin bituminous surfacing this type of base generally performs adequately under traffic conditions which can be considered relatively "light" by overseas standards. With the large increase in the number of vehicles and the proportion of heavy vehicles, the practice in this country is to stabilize crushed rock bases with cement where the aggregate is of marginal quality, and bitumen-stabilized bases have recently been used for road construction in Natal. The Institute is working on this subject to obtain factual data which will be of assistance to road authorities in deciding when to use stabilized bases for major roads.

A small-scale road base experiment at the Institute's Test Site (constructed in co-operation with the bitumen and tar industry) and an experimental strip on a heavily trafficked road in Johannesburg (constructed in co-operation with the City Council of Johannesburg), are yielding useful results in this connection. These experiments are described in another section of this report.

Concrete roads

Numerous questions regarding the use of local materials and the influence of local climatic and soil conditions on concrete roads require investigation.

A short experimental length of concrete road, 22 ft. wide and 6 in. thick has been laid by the Portland Cement Institute at the N.I.R.R. Test Site for the purpose of investigating the following: the effects of various foundations under the concrete road; the durability of Portland cement, Portland blast-furnace cement and a 50/50 mixture of Portland cement and ground granulated slag; the curing effect of a membrane curing compound and membrane curing compound together with damp hessian; the use of a neoprene joint sealer in conjunction with joints at various spacings; and the effects of three different methods of producing surface texture.

ELECTRICITY, GAS AND WATER

Reclamation of purified sewage effluent

Approximately three years ago the *National Institute for Water Research (N.I.W.R.)*, in collaboration with the Municipality of Windhoek, developed a process for the reclamation of purified sewage effluent to supplement the city's supplies of drinking water. The N.I.W.R. has subsequently continued to refine the process, especially as far as its economic applicability is concerned. Considerable improvements have already been introduced and the prospects for further improvements are promising.

The reclamation cost at this stage amounts to approximately 22 cents per 1,000 gallons, which compares favourably with the price currently paid by municipalities and industries, and will most probably be reduced as the process is further refined.

As the development of water resources becomes progressively more expensive, the reclamation of sewage effluent will become more acceptable. The increased demand for water, related to the population growth and industrial development of the Republic, will eventually necessitate large-scale reclamation of sewage effluent.

The N.I.W.R. plans to erect a pilot plant with a capacity of 1 million gallons per day, with which a thorough economic evaluation can be made and which may serve as a model for the planning of full-scale reclamation plants.

During 1967 the N.I.W.R.'s regional laboratory in the Western Cape continued its investigation into the reclamation of purified sewage effluent for industrial use. The principle on which this investigation is based, is that maturation pond effluent is allowed to seep into the sandy soil of the Cape Flats and subsequently withdrawn.

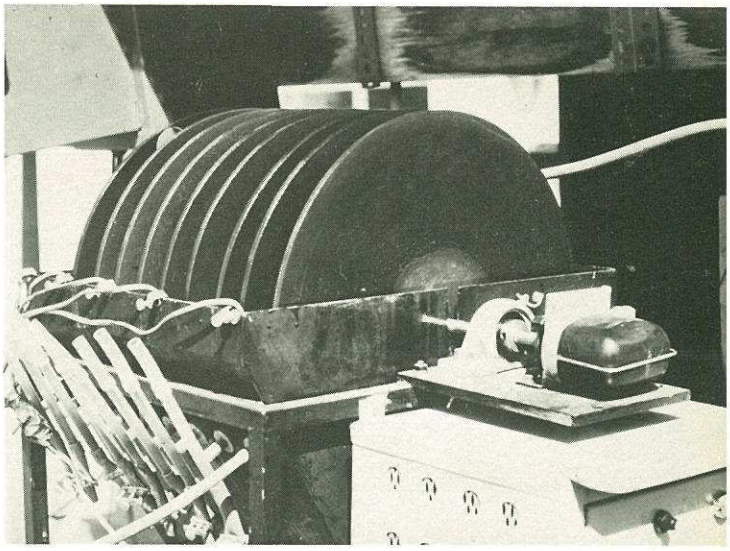
The use of pond systems in the purification of sewage effluent

Since its establishment the N.I.W.R. has paid much attention to the use of pond systems in the purification of sewage effluent. The knowledge thus gained has now been collected in a guide entitled *A guide to the use of pond systems in South Africa for the purification of raw and partially treated sewage.*

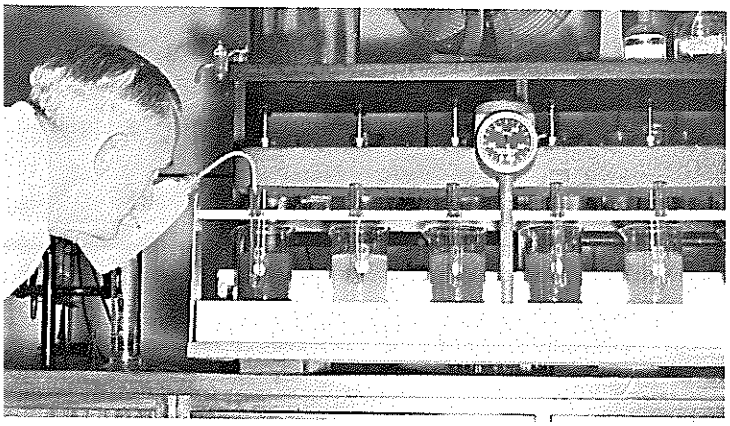
The guide will fulfil a need as it will eliminate many existing misconceptions in connection with the design, construction, maintenance and application of pond systems. Pond systems can be used for the purification of raw sewage (stabilization ponds) or as a further step in conventional sewage purification (maturation ponds). Stabilization ponds are inexpensive purification systems which can be used by smaller communities who may be unable to afford conventional ones; and also as a temporary measure prior to the construction of conventional systems. Maturation ponds which function in conjunction with conventional purification works not only bring about advanced purification, but also act as a buffer in stormy weather when purification works are usually overloaded.

Prevention of secondary pollution

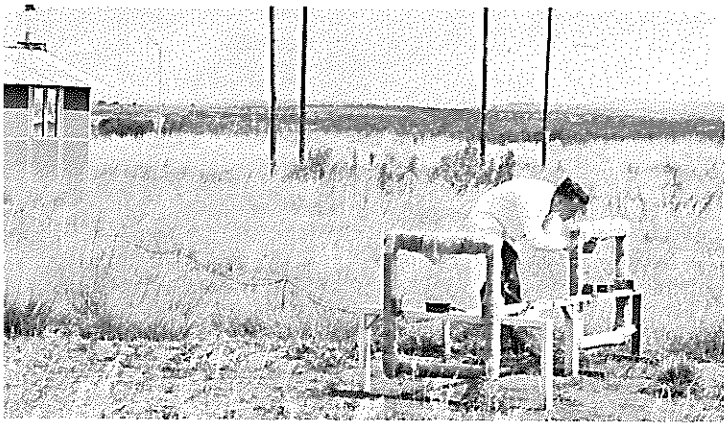
The effluent from sewage purification works contains relatively high concentrations of phosphorus (in the form of phosphates) and nitrogen (in the form of nitrates and ammonia). If these effluents are released into water courses, as they generally are, the phosphorus and nitrogen serve as a nutritional source for algae which then develop



An experimental unit, developed by the NIWR, which utilizes algae to remove excessive nitrogen and phosphates from effluent. The discs rotate in the effluent being treated, and the algae, which grow in the discs, metabolize the nutrients in the water



Tests being conducted to determine the type of flocculant required for the most efficient process for clarification of river water containing suspended materials



A lightning recording station in the veld

in large quantities. The algae have a detrimental effect on the further utilization of the water since they block filters and, when dead, organically pollute the water. The N.I.W.R. is investigating methods to combat this problem known as secondary pollution.

Purification of river water

The N.I.W.R. has continued an investigation into the classification of river water according to the substances it contains in suspension and in solution. Research revealed that the minerals present in the suspended material, as well as the organic material of natural origin (responsible among others for colour) influence the flocculation process in water purification. Furthermore, they determine the type of flocculant required for the most efficient clarification process.

A publication was compiled as a guide to the broad classification of methods of treating river water in the Republic. Successful application of the principles in this guide can lead to the design of more efficient water purification installations and reduce purification costs.

Earth resistivity measurements

Research done by the *National Research Institute for Mathematical Sciences* (N.R.I.M.S.) in connection with earth resistivity measurements was aimed at providing facilities which will eventually enable an earth resistivity map of the Republic to be compiled. Suitable instruments had to be developed; with these accurate measurements can now be made under all conditions, likely to be encountered in the field. A study of the connection between the measured resistance of various types of earthed electrodes and the resistivity of the earth in which they are placed, was initiated by making measurements on a copper earth conductor placed under the foundations of a house.

Measuring probe and recorder

Development by the N.R.I.M.S. of a measuring probe and recorder for measuring the thermal resistivity of earth has reached a stage where approximate measurements can be made with the aid of portable equipment.

Lightning recording

One of three projected direction-finding stations for making measurements of lightning discharges has been completed by the N.R.I.M.S. The information obtained in this way will be used to evaluate the performance of various types of lightning counters and to determine possible relationships between lightning and the occurrence of hail. A ratio meter was developed as an auxiliary device for the lightning counters. A cathode-ray tube is used for determining the geographical direction of the strokes. Simultaneously, photographs of the actual lightning discharges are

made, using a sky-scanning camera developed by the *National Physical Research Laboratory.* This camera covers the entire sky, and can also be used to calibrate the direction-finding apparatus.

Surge voltages

The N.R.I.M.S. is currently equipping a mobile laboratory for investigating impulse voltages in power lines. A counter circuit has been developed to distinguish between various classes of impulse voltages according to degree of amplitude, pulse length and polarity. The counter can also count and classify over-voltages occurring in low tension direct-current and alternating-current power sources, and this will enable the conditions to be determined to which transistors, controlled rectifiers, diodes and other semi-conductor elements are subjected.

Experimental transducers

In the course of research into the applications of semi-conductor techniques in power electrical engineering, experimental converters, involving the use of controlled rectifiers and diodes were designed and constructed. These converters were built by the *National Research Institute for Mathematical Sciences* to study the techniques and functional characteristics of alternating-current systems with adjustable frequency, fed from direct-current or alternating-current circuits. Other investigations include the possibility of low-voltage AC/DC/AC transmission, and the design characteristics of machines and transformers when these are to be suitable for use with non-sinusoidal power sources with adjustable frequency.

Transmission pylons

A method of positioning transmission towers with the aid of an electronic computer has been considerably refined and expanded by the *National Research Institute for Mathematical Sciences* with a view to future use.

Salinification of water

The *National Research Institute for Mathematical Sciences* has developed equipment for use by the *National Institute for Water Research* at Gross Barmen, South West Africa, where an experiment is being carried out to study the salinification of sub-surface water caused by evaporation. The first part of the electronic control apparatus for the preliminary recording of data on graph recorders was installed during 1966. In the final data system use will be made of a punched tape recording system.

Lightning protection for pipeline

On behalf of a contractor, research was carried out by the *National Research Institute for Mathematical Sciences* in regard to the provision of suitable lightning protection for a main water pipeline between Riversdale and Johannesburg. The pipeline is 28 miles long and has variable diameters ranging from 60 to 84 inches. On conclusion of the investigation, certain measures were put into effect. A five-mile section of the pipe was taken into service during the last lightning season and lightning discharge close to the pipeline did not cause any damage.

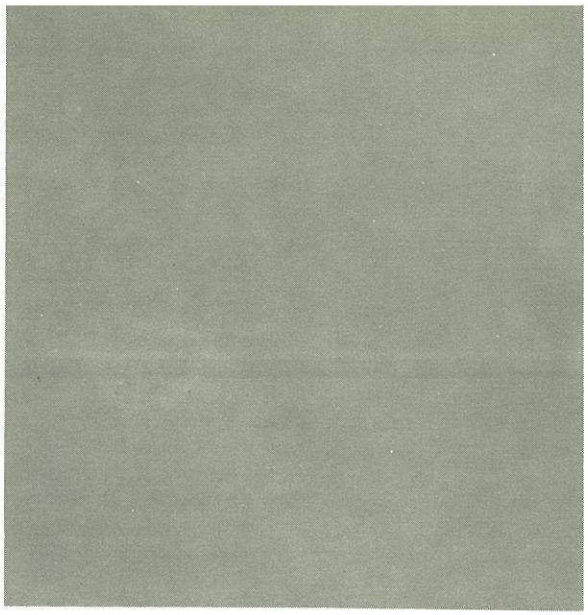
SECTOR: 33 TRANSPORT AND COMMUNICATION

Road traffic studies

In co-operation with the *National Institute for Road Research* statisticians of the *National Research Institute for Mathematical Sciences* (N.R.I.M.S.) are carrying out statistical analyses and help to plan research projects on road traffic and safety. As a preliminary study, it is intended to carry out traffic counts in Natal. Six points in Natal have been chosen.

Computer analyses for traffic planning were undertaken for the Pretoria Municipality and computations in connection with the analysis of traffic surveys were carried out for the University of the Orange Free State.

NATIONAL RESEARCH LABORATORIES, INSTITUTES AND UNITS



Dr. T. L. Webb, Director of the National Building Research Institute.

THE NATIONAL BUILDING RESEARCH INSTITUTE

In South Africa about 900 million rand is spent annually on building and construction (excluding roads) and the chief objectives of the National Building Research Institute (N.B.R.I.) are to serve the industry and the professions behind this multi-million-rand investment. The N.B.R.I. is in essence a practical, applied research organization maintaining close contact with the building and construction industries and related professions and organizations. Its research is directed towards improving building design and services, structural and foundation engineering, lighting, ventilation, heating and cooling in buildings. Another aspect of the work undertaken is the bettering of the performance of building materials such as concrete, stone, paint and plastics and research which will bring about a better understanding of the effect of climate and weather on both building materials and the environment within a building. Special service is rendered to the community by research applied to the planning of schools, hospitals and housing for all population groups. Investigations were also carried out in the broad fields of management, organization and industrialization in the building industry. The N.B.R.I. earns between a quarter and a third of its budget by undertaking contract work for sponsors. Research findings are actively applied by means of publications, lectures and central and regional information activities.

The steadily growing demand by the building and construction industry, allied professions and public bodies for the Institute's services is making serious inroads into the long-term research work of the Institute. Most demands are for *ad hoc* investigations of a practical nature and for information on research findings. Over 130 contract investigations were made and about 20,000 enquiries dealt with during the year.

It is obviously in the national interest that such services should be promptly and effectively rendered but it is also necessary to carry out fairly long-term research into problems of general national importance. As a result of the demands of the industry, it is becoming increasingly difficult to keep a healthy balance between the two types of work and the Institute's manpower and financial resources are insufficient to meet the growing demand for its services.

There are now over 4,000 addresses on the Institute's mailing list and copies of new publications are distributed to these addresses approximately once a quarter. Numerous lectures and colloquia were held during the year and two very successful symposia were arranged. One on industrialized building, was specially arranged at the National Building Research Institute for Members of Parliament and the Senate. The other on plastic flooring, was held in Durban.

Highlights of 1967

Following a resolution recommending the establishment of a National Building and Construction Advisory Council, initiated by the Building Research Congress in 1964 and supplemented by the Building Research Advisory Committee, such a recommendation was made via the C.S.I.R. to the Minister of Planning. After Cabinet approval, the Minister of Public Works announced the formation of such a Council in June 1967. It will function under the aegis of the Minister of Public Works and it is envisaged that is will serve as a top-level advisory and co-ordinating body for the building industry, as a two-way communication channel with the Government and as an advisory body concerned with technical planning, training, education, labour and economic and other matters vitally affecting the industry.

Two members of staff were presented with the Publication Award for 1967 of the National Development Fund for the Building Industry, for their joint paper on the cost consequences of the use of passenger lifts in buildings during construction.

The Institute was also represented by three staff members, who presented seven papers, during the 4th Regional Conference for Africa on "Soil Mechanics and Foundation Engineering", held in Cape Town in December 1967.

The following items give some indication of the work carried out on a few of the more important projects during the year under review.

School buildings

The use of closed-circuit educational television has been intensively studied by the N.B.R.I. over several years, and during the year the Institute was concerned with an experimental development programme initiated by an educational authority. The Institute has accumulated a considerable amount of knowledge on planning schools which will employ new audio-visual techniques in education.

Hospital buildings

Three projects of the hospital research programme are nearing completion. These include research into operating departments, and the planning of out-patient and hospital laundry and linen services. Reports should be published within the coming year. In co-operation with the Government and Provincial departments concerned, a new agreement has been negotiated with the authorities whereby the hospitals research team will undertake research on a contract basis for individual agencies and organizations in the public and private sectors.

Housing

Shortage of skilled labour and other economic factors now require new labour practices and methods of construction in many fields of building, particularly in housing. Apart from work being done on industrialized building methods and into the greater use of mechanization in building, another project is concerned with a critical examination of all aspects of existing ways of constructing houses. The latter two developments may be described as an extension of industrial processes and techniques which could be applicable to most builders, rather than only to specialized construction firms.

The Institute is also collecting data on the problem of financing building in order to find out how the development of modern building techniques is influenced by financing, and how other countries are approaching the problem of financing residential building in order to ensure continuity of building contracts.

Another long-term project is concerned with reassessing housing standards for the urban Bantu population. The first stage of this research was undertaken in collaboration with the Institute of Social Research, University of Natal. Interview schedules for a socio-economic survey were drawn up, and after this the sociologists completed all the main field work in the sample areas — including Greytown, Witbank, Pretoria, Kwa-Thema, Daveyton, and the Soweto urban complex. A final report on this stage can be expected during the next year.

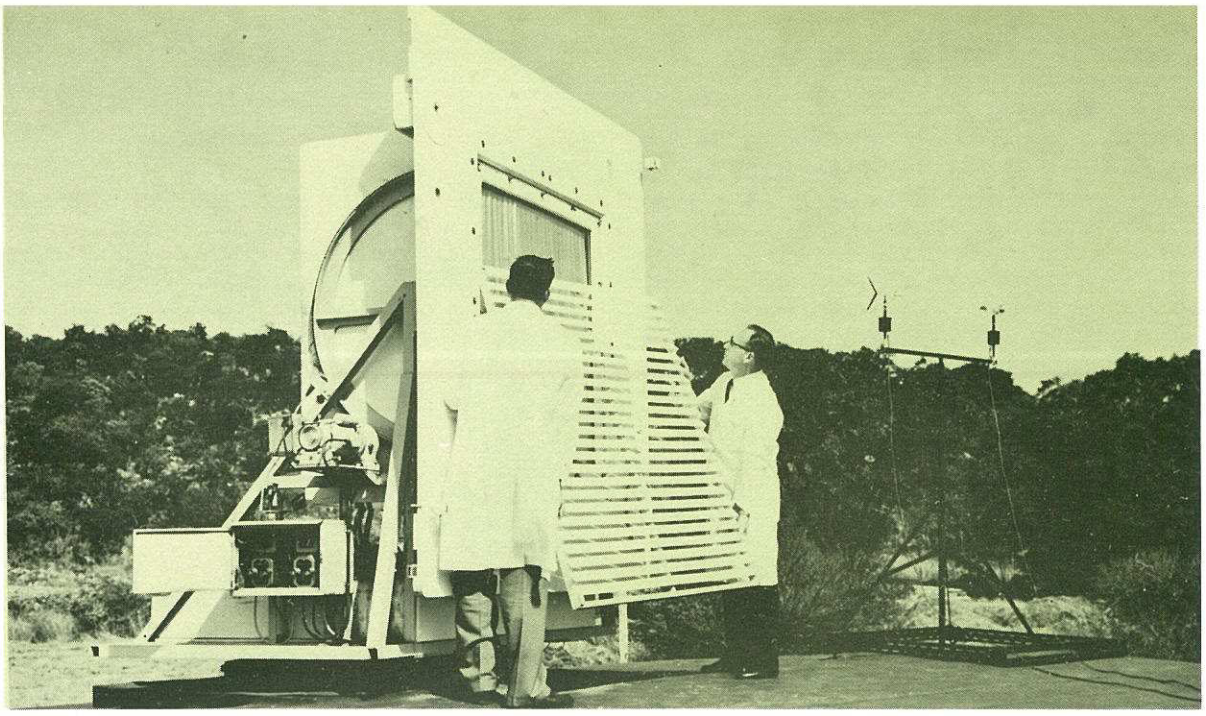
Mechanization in building

A preliminary investigation was undertaken in collaboration with the Building Industries Federation to establish the possible scope for mechanization of traditional building operations and to give an indication of the cost of using currently available mechanized equipment. This study has revealed that successful introduction of increased mechanization necessitates a reorientation of the basic approach to the design, organization and management of building operations. The capital structure of building firms, contract sizes, work continuity, technical interdependence of design and construction, and the training of labour to operate and maintain mechanical equipment are factors of cardinal importance.

Future studies in this field will be concerned primarily with detailed analyses of the labour content and cost of building operations, and relation of the results to the cost of performing the operations by machines. Aspects concerning education, training and the acceptance by industry of the fundamental change implicit in mechanization will also be dealt with.

Control of sun-penetration into buildings

Control of sun-penetration into buildings is a vitally important aspect of the functional design of buildings under South African climatic conditions. Although various types of diagrams are available for this purpose, their use is time-consuming. As a result, it was decided to make all pertinent information available —in tabular form,



A sun calorimeter which is used to determine the efficiency of different methods of window shading

and to make a film illustrating the principles of sun control.

Simultaneously, the effectiveness of various methods of sun shading was investigated with the aid of a sun calorimeter. Subjective laboratory tests were also carried out, to determine the influence of high glass temperatures on the comfort of people sitting near the panes. The results of these experiments formed the basis of a paper read at the third Australian Building Congress which was held in Melbourne in August.

Control of condensation temperature conditions in lightweight structures

Uncontrolled condensation of moisture in walls and other elements, especially in lightweight structures, can lead to serious weathering problems. Likewise, interior surface condensation and mould growth are sources of concern in certain parts of the country. Because of a serious lack of information on moisture conditions in occupied houses, preliminary measurements are being made in the Cape Peninsula. The information thus acquired will be of value later, when actual conditions are simulated in the laboratory during a more comprehensive and systematic investigation of the problem.

Houses built of lightweight materials are more affected than conventional heavy structures by the relatively wide daily fluctuations of air temperature and sun radiation. As a result, lightweight structures tend to be hot in summer and cold in winter. To determine how the thermal behaviour of such structures can be generally improved, a thorough investigation of a number of full-scale experimental houses is being carried out in co-operation with the Department of Community Development.

Lighting in houses

Regrettably, the design of buildings in relation to daylight is not always based on scientific findings. One reason for this is the shortage of basic design data. To meet this need, routine collection of sky luminance data is continuing. The information thus obtained was used to illustrate a paper on the distribution of sky luminance in warm, dry climates which was delivered at the 16th Sitting of the International Commission on Illumination, held in Washington in June.

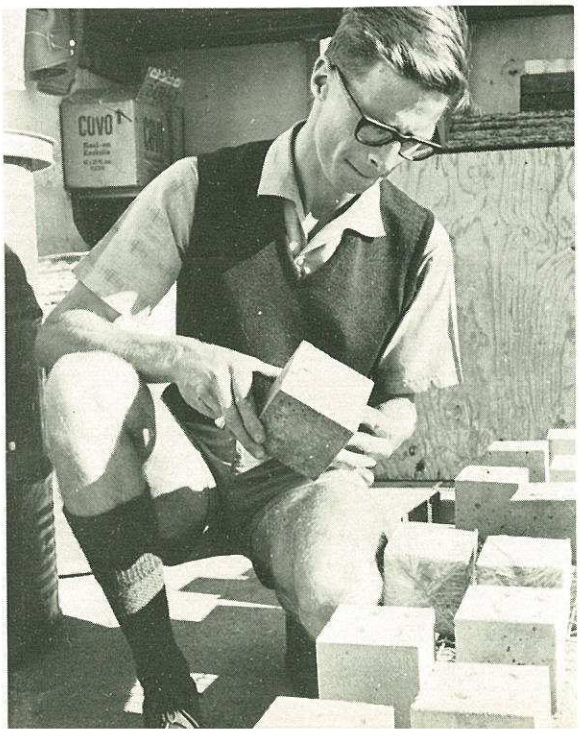
Fire research

Fire statistics obtained from fire brigades throughout the country are still being collected and analysed. Simultaneously, research is being undertaken into the behaviour of many new forms of construction when exposed to fire.

Concrete and aggregates

One factor affecting the production of economical concrete structures of adequate strength

The NBRI is carrying out investigations to establish the effects of the mica in sand deposits in certain parts of South West Africa on the concrete-making properties of these sands, and to develop simple tests which will indicate whether or not they are suitable for this purpose



is the curing that concrete receives after casting. In factory-produced, precast concrete components, steam curing is often employed to make possible the more rapid re-use of moulds and achieve greater productivity. On building sites curing is generally done by wetting the concrete with hoses. Research into both types of curing is being undertaken and findings of direct economic consequence to the industry have emerged.

Research is also being conducted into the phenomenon of surface cracking in concrete during the early stages of setting, i.e., during the first few hours after casting.

Other research is in progress to determine the composition and concrete-making properties of aggregates collected from numerous parts of the Republic and South West Africa. Sand deposits around the Windhoek area, for instance, contain mica and since even small amounts of certain kinds of mica have a detrimental influence on the strength of concrete, an attempt is being made to determine the mica content of these sands. At the same time, investigations are being carried out to establish the effects of different mica contents on the concrete-making properties of these sands and to develop simple tests which will indicate whether or not they are suitable for concrete making.

Deterioration of building materials

Many problems arise when concrete and clay products are weathered in environments where they may be attacked by chemicals, and exposed to mechanical wear and to erosion by the elements. The N.B.R.I. does research into the mechanism of such deterioration with the dual aim of developing products which are durable, and solving problems which may occur.

Studies are being made of the durability of organic surface coverings, joining materials, building elements, and adhesives and of the protection of metal components against erosion.

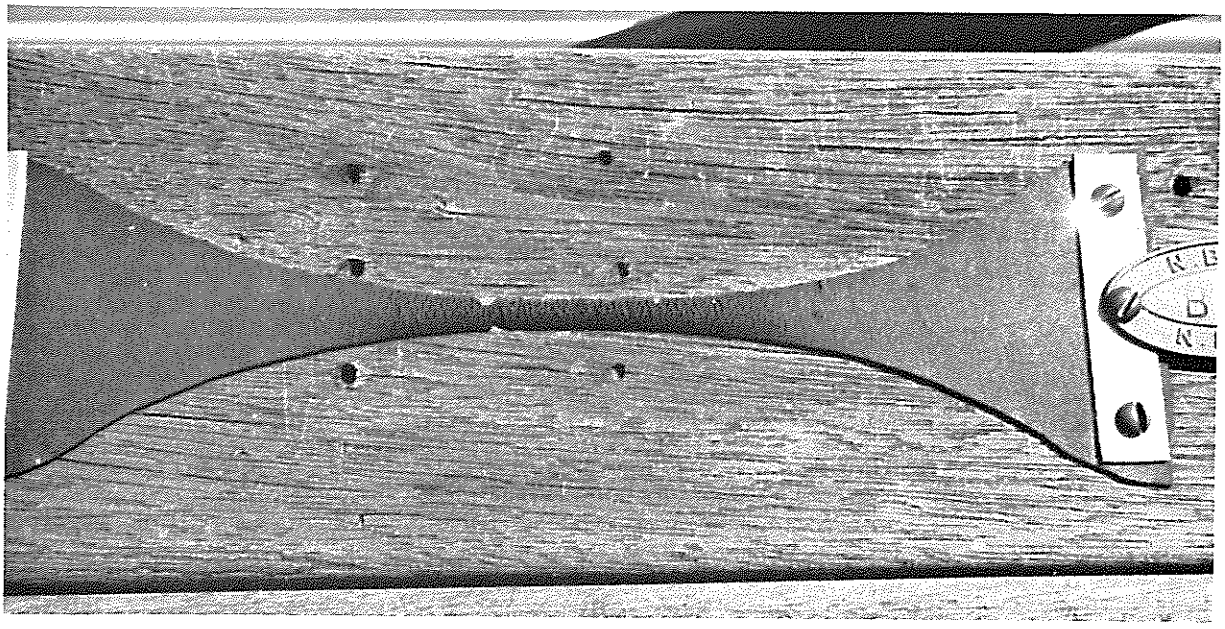
Corrosion in the Republic is a problem which annually necessitates immense expenditure for maintenance and replacement. However, organic surface coverings such as paint, lacquer, pitch, tar and various resins and plastic materials play an important role in curbing corrosion. Thus the N.B.R.I. investigates the anti-corrosive properties of organic surface coverings, as well as their durability and decorative properties. These aspects are investigated particularly in relation to problems encountered in coastal areas.

Soil mechanics and foundation engineering

This research programme is aimed at assisting the construction industry in dealing with problems of foundation design and with the design and construction of earth works. The problem of building on expansive soils is of vital economic importance as much construction will have to take place on these soils, and although damage to buildings caused by foundation movement has been reduced considerably by present techniques, these techniques have still to be improved. Studies of the development of soil profiles and their location, and of the movement of moisture in soils, are aimed at improving predictions about foundation soil behaviour. The strength characteristics of soils are basic factors in any foundation design and it is therefore necessary that these characteristics, and the influence of various factors on them must also be investigated.

Numerous site investigations are carried out in various parts of the Republic and South West

Specimens of different brands of butyl roofing sheeting are exposed to the weather during stretch tests in Pretoria. The specimen shown in this photograph has failed after only one year's exposure



Africa so that specific advice on construction projects may be given.

Sewer research

Research is being conducted into various aspects of sewer design and construction. This is aimed primarily at providing realistic design data for engineers and ensuring sound construction practice in the field. Specific aspects that are being investigated include the measurement of sewer flows in typical residential and industrial areas, the problem of stormwater inflow into sewers, sewer pipe jointing techniques and the field performance of plastic pipes and other new types of pipe.

The findings of the research into sewer corrosion which was resumed in 1964, have been published. The report contains a good deal of information on the problem of sewer corrosion and its control. It has been found, however, that literature on sewer corrosion does not always reach the people for whom it is intended, and that ignorance of this subject still prevails. Accordingly, a short film has been made to demonstrate to interested persons the problem and solutions to it.

Civil defence shelters

Among the projects which the Institute is undertaking on behalf of the Directorate of Civil Defence is an investigation of the structural and other requirements for civil defence shelters. An article describing how shelters can be incorporated in new buildings has been published.

International activities

The Director attended the 3rd Australian Building Research Congress held in Melbourne in August 1967, as a guest of the Australian Government. He delivered one of the main congress addresses and participated in an international panel discussion on building research. Two other papers by staff members were presented to the congress.

Two staff members were included in the South African delegation which attended the 16th Session of the International Commission on Illumination held in Washington in June 1967. A paper on daylight measurements in South Africa was presented.

Drs. R. F. Legget and J. C. Weston, the directors of building research organizations in Canada and the United Kingdom respectively, visited South Africa at the invitation of the Institute during July and attended a programme of discussions, lectures and technical visits in the Pretoria/Witwatersrand area.

Active assistance was given on various occasions to organizations in neighbouring states in connection with specific investigations or problems. One investigation, for example, involved a daylighting and sunlighting study of the proposed Houses of Parliament for a neighbouring state.

The Institute was invited to contribute three chapters for an international book on *Differential Thermal Analysis*, which is to be published in the United Kingdom.

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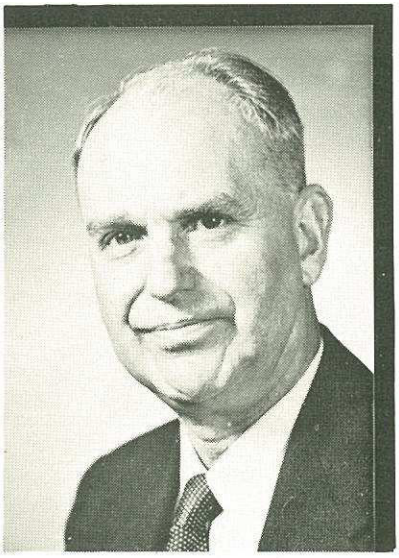
THE NATIONAL CHEMICAL RESEARCH LABORATORY

The National Chemical Research Laboratory (N.C.R.L.) serves as a centre where the latest developments in chemical science are brought to bear on problems of national significance.

The N.C.R.L. is organized into divisions of organic chemistry, biochemistry and physical chemistry, the last-named taking in physical chemistry proper as well as inorganic and analytical chemistry. The N.C.R.L. also supervises a chemical engineering group.

Without basic research, whereby fundamental or new knowledge is obtained, applied research cannot progress. Whereas most fundamental research workers, such as scientists at universities, can undertake basic research purely to obtain more knowledge on some particularly interesting subject, a national laboratory like the N.C.R.L. must limit its choice of fundamental study projects to those which may benefit applied research.

It is the N.C.R.L.'s policy to concentrate its fundamental research on fields where, for practical reasons, a demand for more knowledge exists. In accordance with this policy, the vast majority of research projects is carried out in collaboration with other research organizations which are directly concerned with the practical problems.



Dr. P. C. Carman, Director of the National Chemical Research Laboratory.

Proteins and enzymes

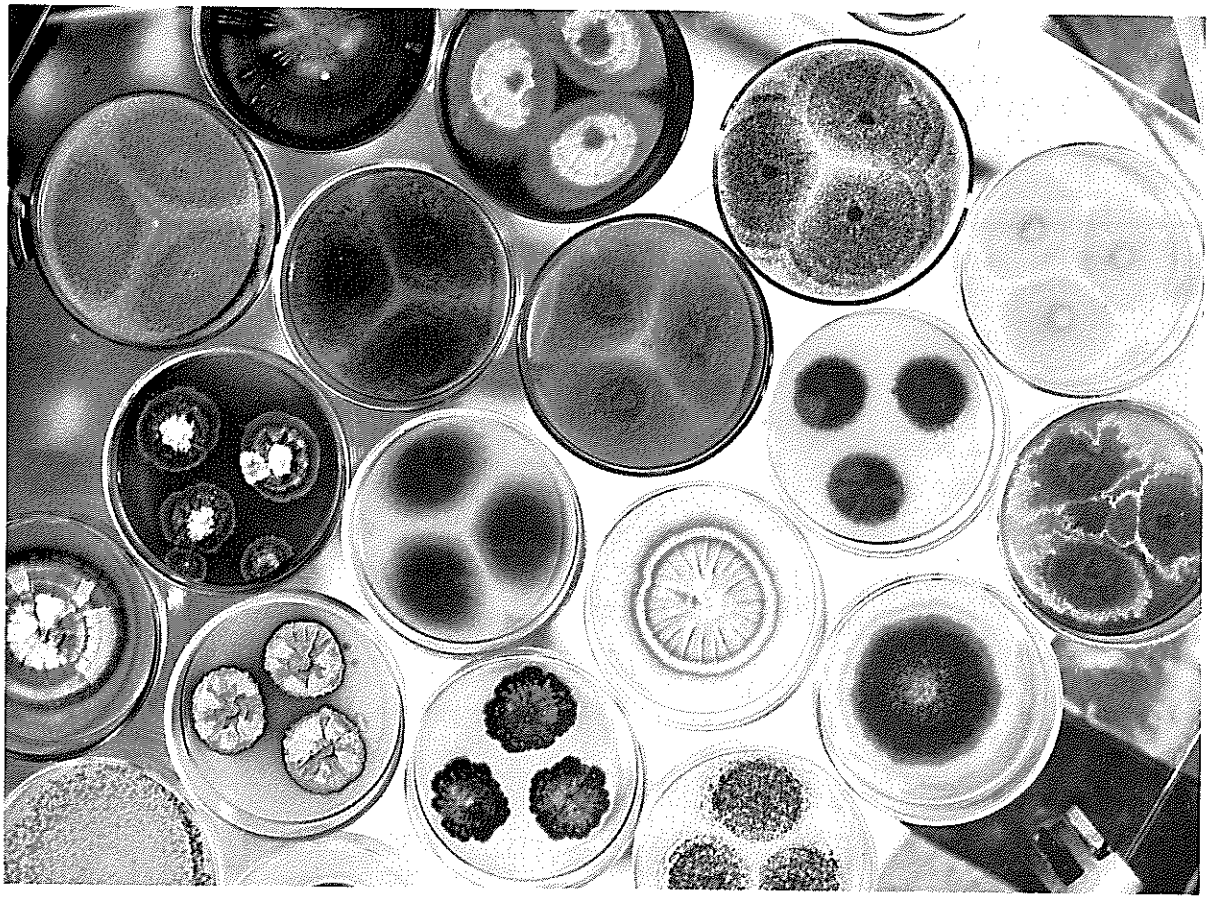
As mentioned elsewhere in this Report (see p. 100) the N.C.R.L. is fully equipped to study the complex proteins and enzymes in wool. The officer in charge of research in this rapidly advancing field has recently departed for a year to an overseas laboratory to familiarize himself with new techniques and new viewpoints. This will ensure that the future research programme will follow modern lines.

Recently, a project has been initiated on the analysis of the venoms of South African snakes. A good start has been made in the separation of purified toxins and highly active enzymes from these. In short they are a source of proteins of a very highly specialized and interesting nature and are worthy of detailed study, but research will be limited by the supplies of venom available.

Biosynthesis of proteins by living cells is another important project. Some recent discoveries were presented by the officer responsible at a Conference of the International Biochemical Union in Japan, after which he visited the more important laboratories working in the same field.

Analytical chemistry

For many years, much attention has been given to the use of ion-exchange columns for rapid methods of separation, concentration and determination of small amounts of elements. Among



Pure cultures of fungi recovered from cereal and legume crops

other things improved methods for separating alkali metals and for isolating carrier-free radioactive strontium and cadmium have been developed.

Gold and platinum chemistry

The preparation of complexes of gold, platinum and rhodium and the study of their reactions in solution have been continued. This fundamental research is important in the development of new analytical methods for these elements, and also for improved separation processes on an industrial scale.

Fungal toxins

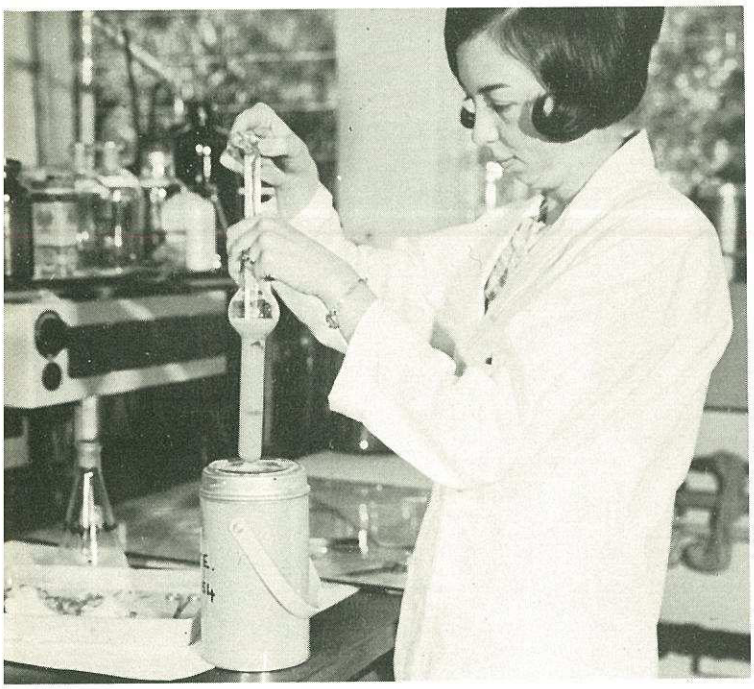
As discussed under the heading: *The National Nutrition Research Institute,* the C.S.I.R. has undertaken a broad investigation of toxic substances produced by certain moulds found on foodstuffs, such as cereals, groundnuts and beans. The N.C.R.L. is particularly well equipped to separate, purify and identify the very small quantities of these substances that are formed, and, where they are new to science, to determine their chemical structure and to synthesize them. This work has been strikingly successful and the tempo has been maintained in the past year. The success, however, must be attributed in large part to the fact that this is a team effort, since the chemical work is dependent upon the activities of the *Microbiology Group.* The work has further been assisted by secondment of a chemist from the Department of Agricultural Technical Services.

Pharmacological studies

The structures of several new alkaloids from South African plants have been determined during the year and a modified form of one of these has been synthesized for pharmacological testing. An interesting development is that certain extracts from South African plants have shown ability to inhibit cancerous tumours. An active programme is in hand for synthesis of steroids with possible pharamacological properties. Though tests have shown that some of the products show useful activity, this has not been sufficient to replace existing drugs.

Liquid ion exchangers

In extractive metallurgy, processes involving solvent extraction are gaining in importance, and liquid ion exchangers are frequently the most powerful and most selective solvents available. A systematic study of new types of liquid ion exchanger has been in progress for several years in the N.C.R.L., while the National Institute for Metallurgy is engaged in a special project on solvent extraction methods. It has now been de-



Carcinogenic studies are carried out on rat livers homogenized in a sucrose solution

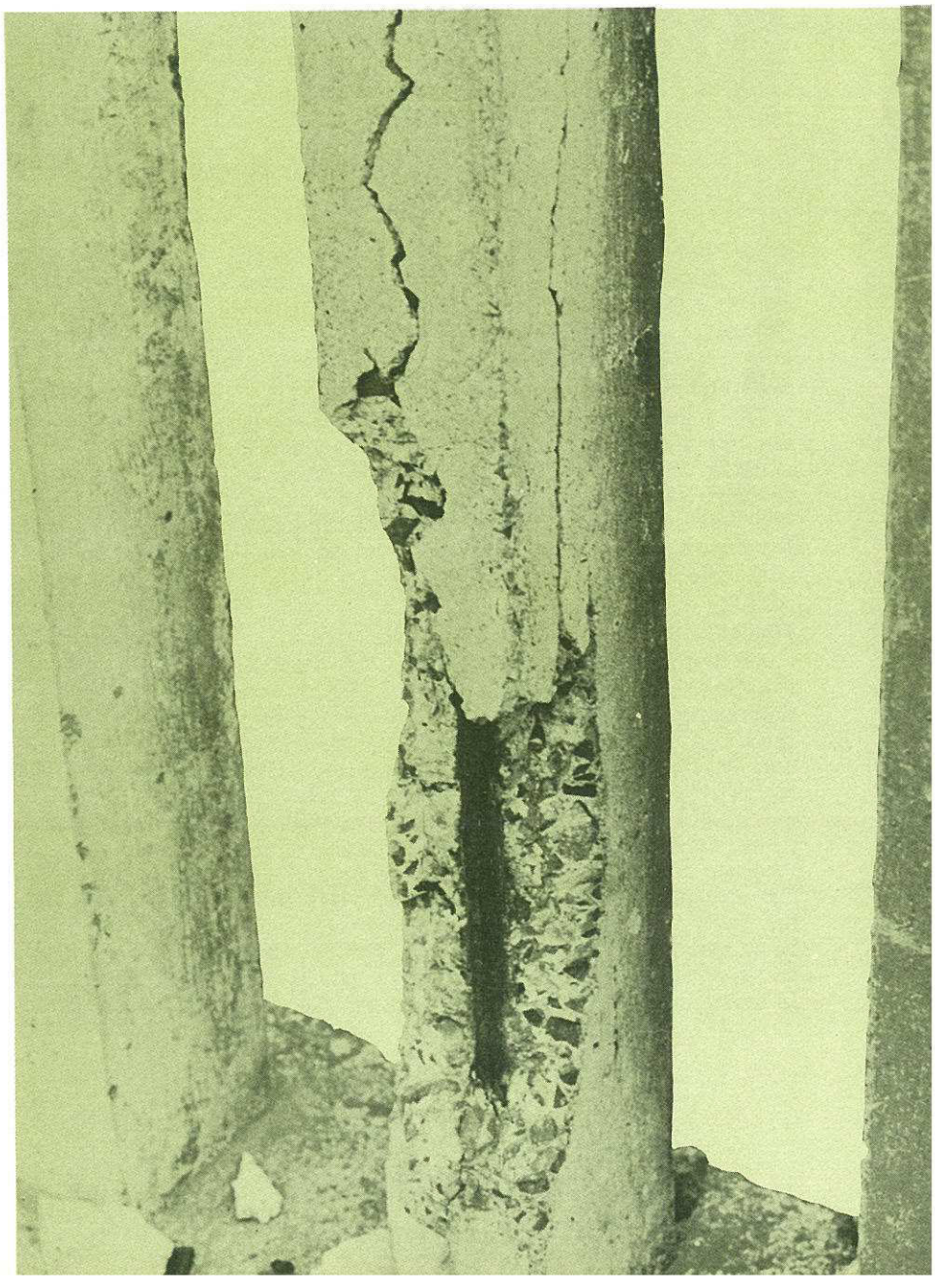
cided to set up a combined project so that the chemical and metallurgical aspects can be co-ordinated.

Photodegradation of plastics

In temperate climates, many uses are being found for plastics under conditions of outdoor exposure, especially in the building industry; but the high actinic intensity of sunlight under high-veld conditions generally limits the life of these materials. This can be improved by the addition of inhibitors, and a project has been started for development of more efficient inhibitors. A survey of known inhibitors has been made, and a technique has been worked out for comparing inhibitors under conditions of accelerated degradation.

Cancer biochemistry

This long-term project is concerned with the development of liver cancer when certain dyes are administered to rats. The mode of transport of the dye and significant biochemical changes produced shortly after its administration have been reported in previous years. In the past year,



Severely corroded pylons of a concrete railway bridge. The Corrosion Group is investigating methods for the cathodic protection of the reinforcing steel in such concrete structures

chemical changes undergone by the dye have been studied, and attention has been given to uptake of dye by liver cell nuclei. An improved technique for purification and fractionation of cell nuclei has been worked out. It has thus been possible to show that dye is preferentially taken up by nuclei of one type and that, after five weeks, this type shows a marked decrease in relative numbers. By disruption of nuclei, it was further shown that dye is preferentially bound by the active chromatin fraction, which directs the activity of the cell.

Pneumoconiosis research

The biochemical aspects of the work of the *Pneumoconiosis Research Unit* are carried out in the Biochemical Division of the N.C.R.L. For several years past, much of the work has been directed to changes in the activity of respiratory enzymes in the lungs of animals exposed to silica dusts to see if this could be related to the respiratory distress found in silicosis. The changes found, however, were small and of doubtful significance. More recently, attention has been given to the effect of silica dust in producing masses of nodules in the affected lung. These consist of collagen, the protein characteristic of scar tissue.

Air pollution

The N.C.R.L. assists the *Air Pollution Research Group* in matters concerned with chemistry and with chemical engineering. Techniques have been developed for the sampling of dusts from large chimneys under very adverse conditions, and these techniques have been applied recently to two electric arc furnaces. With regard to chemical control, regular sampling of the atmospheres in the main cities of the Republic is carried out, thereby enabling an assessment to be made of increases in pollution. Amounts found in our cities are comparable with those for cities in other parts of the world. A difficult problem which is being tackled is that of tracing and measuring odours which sometimes cause annoyance in large communities.

Corrosion

The work of the Corrosion Group is concerned to a large extent with practical problems. In the past year, much attention has been given to cathodic protection for the bases of tanks being built for large-scale stockpiling of petroleum products. A method of cathodic protection of reinforcing steel in a deteriorated concrete railway bridge at Ifafa has also been worked out. A long-term project on protection of reinforcing steel under severely corrosive conditions has been completed and the results prepared for publication. A number of other long-term projects are in progress, e.g., a study of corrosion of steel, alluminium and other metals in contact with wood, both treated and untreated, in connection with timber housing.

Apart from the considerable amount of work carried out for industry and public bodies in general, the Corrosion Group also carried out a large programme of research and technical assistance under contract with the Department of Defence.

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THE NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

Dr. A. P. Burger, Director of the National Research Institute for Mathematical Sciences.

The work of the National Research Institute for Mathematical Sciences is devoted to research in the mathematical and electrical engineering sciences. These two disciplines include especially the theoretical and experimental aspects of research in all scientific fields.

The Mathematical Sciences Research Department consists of divisions for mathematical analysis, statistics and numerical analysis. These deal with the various branches of mathematics and their application to research. Typical activities concern theoretical fluid dynamics, stress-deformation theory, operations research, statistical decision techniques and design of experiments, and numerical and non-numerical computations on digital computers.

The Electrical Engineering Research Department consists of divisions for automation, applied electronics, solid state electronics, electronic instrumentation and power electrical engineering. Work is done in such diverse fields as the application of digital techniques in data processing, analogue computing, the use of ultrasonics for analysis and processing of materials, semiconductor applications, microminiaturization and thin-film technology, and studies of problems peculiar to the Republic in heavy current applications.

N. R. I. M. S.

ELECTRICAL ENGINEERING RESEARCH DEPARTMENT

Automation

Analogue techniques are extensively employed in connection with process control, while digital techniques are used both for control and in the gathering of data by means of experimental set-ups. The work is now being extended to embrace the use of both techniques simultaneously in process control.

Control systems and analogue techniques: The "HEIDEN" analogue computer was employed during the year to investigate problems arising from development work in other Divisions of the Department. For example, the equivalent circuit of an aerial was simulated to enable a study to be made of the voltage and currents generated by lightning discharges.

Digital techniques: The National Building Research Institute and the Instrumentation Division are carrying out the routine operation of the automatic weather station developed and built by the Department to gather data on microclimates.

Progress was made in coupling further data processing units to the data processing system housed in the laboratory. This system was developed as an experimental model on which any planned system can be tested before a final design is made. The system has already been used for preparing computer data which involved a conversion of punched tape from one format to another. The development of a standard interface makes it possible readily to link up apparatus of different makes so that they can be used in various combinations. A paper on this standard interface was delivered at the Second National Conference of the South African Council for Automation and Computation (S.A.C.A.C.).

A study of the literature dealing with the controlled use of redundancy to increase the reliability of transmission of data through noisy channels was concluded by a paper on this subject, delivered at a symposium of the S.A.C.A.C.

The construction and installation of a digital type event-recorder was completed, and the system is working satisfactorily.

Process control: Work in the field of process control is still in the initial stage and of a preparatory nature. Time was devoted to a literature study and a visit was made to an industrial firm to discuss possible projects. Two members of the team are currently receiving training overseas, one in the U.S.A. and the other in the U.K.

Solid state electronics

Work in the field of solid state electronics includes studies of the use of semiconductor elements in circuits; the technology and manufacture of thin-film microcircuits; the application of microcircuits; ultrasonics and high-frequency heating.

Application of semiconductors: The electronic components of a radiation meter were designed on behalf of the Heat Mechanics Division of the

National Mechanical Engineering Research Institute. The meter is used to measure the surface temperature of a variety of materials under conditions that require a more sensitive measuring instrument than has been available hitherto.

A ratio meter was developed on behalf of the Power Electrical Engineering Division to gain more information on the ratio between the 5 kHz and 100 kHz components of the electromagnetic radiation which is observed during intercloud and ground lightning discharges.

Elsewhere in this report under the heading *Electrical equipment* (page 33) research on small-signal amplifiers and circuit applications of M.O.S. transistors is discussed.

Semiconductor technology: A co-ordinatograph was bought and is being used to make large-scale drawings which are then reduced photographically to produce masks for the manufacture of thin-film circuits, (the latter are discussed under *Electrical equipment).* An improved photo-emulsion spinner has been designed which produces more even layers of photo-emulsion. A clean work cabinet for photo-emulsion processing has been bought and installed to provide a dust-free working environment. Two ultrasonic bonding machines have been acquired. The ultrasonic bonding process is carried out at room temperature, and thus the components are not subjected to high temperatures; also a wider range of metals can be bonded by this method.

Ultrasonics: In the manufacture of thin-film circuits, measurement of the film thickness is a very important factor. Existing methods have various drawbacks. A new measuring technique has been developed which makes use of ultrasonic elastic waves. The evaporation of material on the substrate causes a reduction of amplitude of the ultrasonic surface wave which is generated and monitored by the transducer described under the heading *Electrical equipment.* This reduction of amplitude is dependent on the thickness of the layer and the material which is being deposited. A ratio meter (also described under *Electrical equipment)* has been developed to measure the degree of thinness. Comprehensive numerical results, obtained by means of the transducer, have been published.

Applied electronics

Some research projects in the C.S.I.R., although not concerned with electronics as such, require an important electronic contribution towards their realization. This is the field of applied electronics.

Solar radiation meter: In the study of the utilization of solar energy for the generation of electrical power, data on the total solar energy received by a given area are required. To carry out a country-wide survey, a simple integrating solar radiation meter is necessary.

Further research into a direct-reading radiation meter has been carried out. Tests were made to determine the influence of temperature and ageing of the solar cells on the accuracy of the readings and attempts have also been made to reduce the number of cells which provide power for the instrument. Through the use of a small nickel cadmium cell in the instrument the required power input has been reduced from six volts to one volt. Prototypes are now being built for field tests.

Voltage-controlled spark source: German and British patents have now been awarded for the voltage-controlled spark source which was developed in the laboratory for use in spectrochemical work.

Study of sparks, arcs and time-resolved spectroscopy: Work in this field by the National Physical Research Laboratory is continuing and a member of the Applied Electronics Division is collaborating on a full-time basis. During the past year most of the work done was concerned with the construction of a laser light source for spectroscopy. The project was successful and the apparatus is now being used to study this method of excitation.

Electronic instrumentation

Work in the Electronic Instrumentation Division embraces the maintenance of electronic apparatus at the C.S.I.R., the development of special electronic apparatus which is not available commercially and the training of electronics technicians within the C.S.I.R. In addition, technical and commercial information in regard to available electronic instruments is supplied to other institutes of the C.S.I.R. and to outside organizations.

Services rendered: As examples of the most important tasks undertaken, the following can be mentioned: The reconstruction of an ultrasensitive phase discriminating null detector for the Division of Precise Physical Measurement of the National Physical Research Laboratory; the construction of radiation meters for the National Mechanical Engineering Research Institute; and the design and construction of a standard frequency transmitter/receiver for the National Chemical Research Laboratory.

Sandwich course syllabuses: On the recommendation of the C.S.I.R. and the Atomic Energy Board, the Department of Education, Arts and Science appointed an *ad hoc* committee to revise the electronics courses and, if possible, to amalgamate different courses.

As there is also a need for a shorter electronics course, the C.S.I.R. proposed a three-level training scheme leading to a lower and a higher diploma as well as a master's diploma. Some of the characteristis of the new scheme are a com-

mon syllabus in the first year, a wider choice of subjects in the second and third years, and fewer compulsory subjects for those taking the lower diploma. The aims of introducing a wider choice of subjects in the second, third and fourth years were to make provision, in this one course, for all the specialized branches of electronics for which a demand already exists, besides facilitating any adaptation which may be found necessary when new requirements arise.

This proposal was very well received by the other organizations represented on the *ad hoc* committee. This committee has made specific recommendations with respect to the subjects to be taken during the first two years and the Department of Education, Arts and Science has indicated that syllabuses for the individual subjects would be revised as soon as possible in order to facilitate the implementation of the revised scheme.

Power electrical engineering

The main problems being investigated are related to the generation and distribution of electrical energy. Special attention is devoted to those aspects which arise when local circumstances differ considerably from those prevailing overseas.

Measurement of earth resistivity and investigations into possible faster methods of measurement: This work has already been mentioned under the heading *Electricity, gas and water.* The study is mainly aimed at initiating reliable methods of measurement and developing a technique whereby seasonal variations of soil resistivity (mainly due to the variable moisture content of the soil) can be predicted. Early delivery of a meter for the measurement of soil moisture content and density, in which a radio-active source is utilized, is expected; the instrument will be an important aid when rapid determination of earth moisture content variations in various types of soils and at various depths is desired, for correlation with measurements of surface resistivity.

Survey of the thermal resistivity of soil: The aims of the survey, *inter alia,* are to develop suitable measuring techniques and to enable the influence of soil types and their moisture content to be predicted.

The equipment already described under *Electricity, gas and water,* is, however, cumbersome and expensive, and, in collaboration with the Automation Division, attempts are being made to determine whether the measurements cannot be made electronically to give a direct reading on a small portable instrument.

Lightning observations and the development of stroke registering equipment: To enable the influence of lightning discharges on power installations to be predicted, a knowledge of the ground flash density is required. Available lightning stroke counters also register an unknown number of intracloud flashes; further, the effective range of the counters is not yet accurately known. The performance of a number of counters is at present being investigated by means of three direction-finding stations which enable lightning strokes to be observed and their precise geographical position determined.

As there were relatively few thunderstorms during the past season, only three full-scale tests of the direction-finding station (mentioned under *Electricity, gas and water)* were carried out and it could be confirmed that the system can function automatically and continuously while all photographic data can be completely identified. The establishment of three new direction-finding stations about 30km. apart is planned during the coming season and these stations will also be equipped for automatic recording.

As far as lightning counters are concerned, the major effort was directed towards improving the Malan ground flash counter; the improved design will be installed and tested during the next lightning season. A member of staff attended the meeting of the C.I.G.R.E. Study Committee No. 8: The international Study Group for Lightning Counters in Copenhagen in June 1967; he presented six contributions by South African research workers.

Survey of impulse voltages: The measurement of impulse voltages due to switching operations as well as lightning discharges, has not yet been carried out to any extent in the Republic. Initially it was planned chiefly to concentrate on the measurement of impulse voltages in 11 kV distribution lines, but as a result of an invitation extended by the Electricity Supply Commission to participate in the measurement of switching surges on the first 400 kV transmission line (120 miles long) to be brought into service in the Republic, the aims and emphasis of this project were widened. The tests carried out suggested the use of antennae and ferrite cores for gaining a knowledge of the conditions existing in extra-high tension transmission systems and to register the results of measurements electronically without the necessity for making physical contact with the conductors. The methods at present being used when making investigations of this nature necessitate the use of expensive apparatus at the terminals.

Conferences: The fortieth Annual Convention of the Association of Municipal Electricity Undertakings of Southern Africa was attended and a paper delivered dealing with research done in this Institute in the field of power electrical engineering and also with related research of importance to electricity undertakings carried out in this and other Institutes. Various enquiries on subjects mentioned in the paper have since been received and as a direct result of the paper a visit will be paid to Ladysmith (Natal) in connection with earthing systems. Three other municipalities have also been given advice on their problems.

N.R.I.M.S.

MATHEMATICAL SCIENCES RESEARCH DEPARTMENT

Mathematics and applied mathematics

Extensive theoretical studies in pure and applied mathematics are undertaken in an endeavour to solve problems encountered during research in other fields.

As an example of work which is of wide significance, may be mentioned a mathematical study of the behaviour of movements of the atmosphere over great distances. The necessary preliminary work is being done in collaboration with the Weather Bureau to enable the Republic to assume an ever-increasing share in handling and interpreting the meteorological data gathered for Southern Africa and the adjacent oceanic areas.

Mathematical statistics

Theoretical studies in mathematical statistics are being undertaken for the eventual practical solution of a variety of problems.

Examples of practical statistical analyses and the planning of experiments are discussed in the chapter *Research on behalf of economic sectors* (digestibility of the starch of mealies, hygienic quality of milk, preparation of meat, demand for footwear and road traffic and safety).

Mathematical statistics was also applied to a considerable extent in the field of public health. A few examples follow.

In collaboration with the Department of Medicine of the University of Cape Town and the Red Cross War Memorial Children's Hospital, Cape Town, a health and nutrition status survey was planned two years ago and carried out amongst very young Coloured children at Bonteheuwel in the Cape Peninsula. The data obtained were analysed statistically and significant differences in biochemical measurements were shown to exist.

Data collected during a survey of the occurrence of tuberculosis in Ovamboland were statistically analysed to determine whether a relationship existed between sociological factors and the occurrence of tuberculosis. The survey was carried out by a physician of the Administration of South West Africa.

A knowledge of the average development of the hand skeleton of a large number of children of specific ages makes it possible to estimate the age of individual children from X-ray photographs of their hands. These so-called skeletal ages, which were determined by a South African medical researcher by comparing them with an overseas chart, were statistically analysed, together with various details of the bones of the hand. The children were divided into groups according to sex, age and race (Whites, Bantu, Coloureds and Indians) and the data were analysed to determine differences between the groups.

Data gathered by the National Institute for Water Research were statistically analysed to determine how the activity of a bacterial colony in water decreases with an increase in the thickness of a film on the surface of the water, and also how rapidly the population of such a colony decreases under the influence of radiation.

The Pneumoconiosis Research Unit determined the weight of the left and right ventricles and also the total weight of the heart in the case of a large number of "normal" persons. The results were compared with a similar set of data published by a group of researchers in Japan. It was possible to show that the two groups under test differed significantly in respect of the total weight of the heart and the weight of the right ventricle.

The following statistical analysis was also completed on behalf of the Pneumoconiosis Research Unit. The total ventilation (air volume consumed) of individuals was determined every minute for 15 minutes while they performed physical work under controlled conditions. The relationships between ventilation, weight and work speed were determined; the results make it possible to estimate the ventilation of a patient even when he (or she) is unable to perform the work for the whole of the 15 minute period. Such studies are valuable when diagnozing lung abnormalities.

Numerical analysis

Computer centre: The N.R.I.M.S. provides a centralized computer service for the C.S.I.R. Such services are currently regarded throughout the world as indispensable for carrying out research programmes.

The previous electronic computer, an IBM 704, which became inadequate for handling the computing needs of the C.S.I.R., was replaced in February 1967 by a new computer (an IBM System 360/40). Although this computer is more powerful than its predecessor, the increase in the computing requirements of the research programme of the C.S.I.R. has been such that very soon the provision of further facilities will have to be considered. A good deal of the computing work is, in fact, already being done after hours.

During the past year the National Institute for Personnel Research in Johannesburg daily transmitted data by telephone for computation to the N.R.I.M.S. in Pretoria, the results being sent back to Johannesburg in the same way. In this way, useful experience was gained with the transmission of data by means of telephone lines between cities. The landlines were dependable and it is expected that this type of transmission for enabling remote computers to be utilized, will become of increasing importance in the future.

Programming and research: Further examples of this work are mentioned in the reports on the various economic sectors.

In collaboration with the University of Hamburg, an investigation involving the numerical solution of parabolic differential equations has been started and is continuing.

The following are further examples of completed tasks: Involved analyses of economic time series for the South African Reserve Bank; the preparation of a map of magnetic declinations for the Magnetic Observatory in Hermanus; and the development of a very comprehensive management game for simulating competing companies, for the Industrial Economics Department of the University of South Africa.

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* Staff members of the N.R.I.M.S.

THE NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Dr. H. G. Denkhaus, Director of the National Mechanical Research Institute.

The activities of the *National Mechanical Engineering Research Institute* (N.M.E.R.I.) are devoted to the development of new ideas and techniques in mechanical engineering, and to the improvement of machines and materials used in the industry. The Institute is also active in fields such as those of rock mechanics with the aim of improving efficiency and safety in mining. The Institute has testing equipment and machines, instruments and qualified personnel for research in the fields of metallurgy, strength of structures, process development, rock mechanics, aeromechanics (including aeronautics), hydromechanics (including harbour and river engineering) and heat mechanics (including air-conditioning and refrigeration).

The N.M.E.R.I. is at present installing two new wind tunnels for aerodynamic research. The Mine Equipment Research Unit at Cottesloe, Johannesburg, is part of the N.M.E.R.I. and deals with investigations related to mine ropes and winding equipment.

The following is an account of the activities of each of the Divisions and Departments.

METALLURGY DIVISION

Stress corrosion

An investigation was started to determine the influence of steel composition and structure on the susceptibility of mild steel to intercrystalline stress corrosion in both nitrate and caustic soda solutions. Since carbon and nitrogen are known to be principally responsible for rendering mild steel susceptible to stress corrosion, several steels containing varying proportions of these elements were selected. Different heat treatments were applied to precipitate the carbides and nitrides in various forms. The influence that the form of the precipitates has on the difference in susceptibility to stress corrosion by the two corrodents was studied.

Research into the intercrystalline cracking of various steels in molten babbitt was continued and was directed towards the study of time and heat treatment. Tests indicated that the penetration of the babbitt into the steel is more dependent upon stress than time.

Technological foundry problems

A.C.S.I.R. one-day Symposium on Research and Technical Services for the Foundry Industry in South Africa was held during March 1967. Several speakers from the foundry industry read papers on foundry techniques and on problems encountered in iron and steel foundries. Three papers were also read by staff members. The total attendance by persons from all over the Republic was 140, which reflected the great interest taken in the subject.

Research was undertaken into the use of resins as mould-binders in foundry work and into the shell-mould process. The advantage of using these materials is that, after curing, they act as a reinforcement of the core for a certain time after the liquid metal is poured.

Investigations were also done to determine the suitability for foundry work of wattle extract, which contains large amounts of natural phenolic resins.

A comprehensive report on "Properties of Moulding Materials at High Temperatures" was compiled and issued to members of the Foundry Research Foundation. The high temperature properties of different South African moulding clays, mixed with different sands, were compiled in data-sheet form for eighty different sand mixtures. The data are invaluable to foundrymen for evaluating results obtained on plant mixtures or new materials.

Metallurgical aspects of rotary mill liners and grinding media

This project is referred to in the first part of the report. (See Ore mills, page 19).

STRENGTH MECHANICS DIVISION

Impact properties of metals

This project involves a study of the effect of impact on small metal specimens and the effect of the rate of loading on the yield point of steel.

From these studies it is hoped to establish data for the design of components which are required to undergo high rates of loading such as drill rods used in percussion drilling machines.

Creep of metals

An extensive creep testing programme will shortly be commenced. A complete testing programme, for which equipment is now available, is being drawn up and it is anticipated that the first tests will soon be made.

Development of high temperature strain gauging techniques

The aim of this project is to obtain knowledge of problems associated with the application of strain gauges at high temperatures.

Stress analysis and material testing

Numerous technical enquiries were received from the private and public sectors of industry. Most of these enquiries led to investigations such as the following and were undertaken on behalf of various sponsors.

Comprehensive testing programmes in connection with railway rolling stock and permanent-way equipment were carried out. Extensive tests to determine the drawbar forces in a tractor pulling various types of agricultural machinery were undertaken in collaboration with the manufacturers, to enable them to obtain data for use in future designs.

A wide range of fatigue tests was undertaken.

PROCESS MECHANICS DIVISION

Comminution and grinding in the cement industry

Studies conducted during the year threw light upon the effect of liner configuration on ball behaviour and slip. They suggested the possibility that slip is a desirable feature in promoting grinding, and tests to confirm or refute this are to be undertaken.

Heavy machinery testing (See page 32).

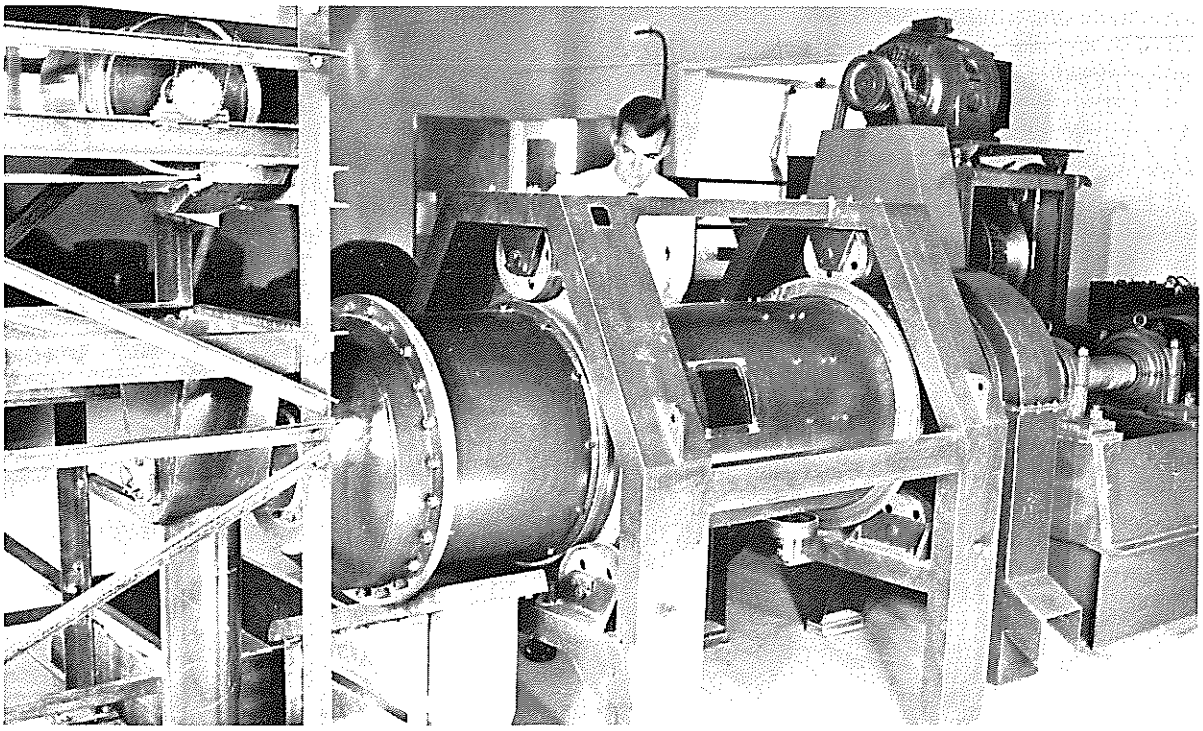
At the request of the Committee on Facilities to further the development of Heavy Industries in South Africa, a design study was made during 1966 with the aim of establishing a central pump testing station in the Republic, which would be capable of testing single units up to 3,000 hp. When a report on this study was completed, the Committee requested that the study should be extended to include units using up to 12,000 hp.

A report was drawn up on the extended study, which included full details of equipment, buildings and staff required, and the financial implications. This was submitted, after consideration by the Committee, to the Councils of the S.A.B.S. and C.S.I.R. with the Committee's recommendations.

Potato sizing machine

This project resulted from a request by the Potato Board to bring to the production stage a potato grading machine in which the Board had patent interests. (See page 32 for further details).

An experimental ball mill used for research into grinding procedures in the National Building Research Institute



ROCK MECHANICS DIVISION

(See also p. 19)

Research into rock mechanics problems was continued on behalf of the Chamber of Mines of South Africa and the Coal Mining Research Controlling Council. In addition, important investigations were conducted on behalf of the Department of Water Affairs as well as other civil engineering and mining groups in South Africa and abroad.

Properties of rock

The purpose of this project is to compile a catalogue of strength and deformation characteristics of South African rocks, for use in rock mechanics. Much progress was made during the year under review and the first draft of the proposed catalogue, listing data on some 250 rocks, was prepared.

Measurement of stress in elastic rock

This project was aimed at the development of methods and instruments for the measurement of stress in rock. The so-called C.S.I.R. "doorstopper" equipment for the measurement of stresses in elastic rock was released to industry and is being commercially manufactured for South African and foreign markets. (See p. 34). A mobile unit for measuring rock stress was completed, to make possible *in situ* measurements at short notice. A new technique and equipment known as the C.S.I.R. triaxial cell was also developed for measuring, in a single borehole, the complete state of stress in rock.

Fracture mechanism of rock

An important phase in this project, which was aimed at establishing the mechanics of brittle fracture of rock under conditions of static stress was completed during the year. Several important advances in the understanding of brittle fracture were made and this project holds considerable promise for the future. An ultra-high speed camera capable of filming 1.6 million frames per second was used to investigate the velocity effects during brittle fracture propagation in rock.

Large-scale testing of rock and coal

The object of this project was to determine the strength and deformation characteristics of coal *in situ*, for use in the design of bord-and-pillar coal workings. Considerable progress was made during the year under review. As a result, a pillar strength formula for designing bord-and-pillar workings in South African collieries was proposed. This work was conducted on behalf of the Coal Mining Research Controlling Council.

Fracture development around excavations

Equipment and techniques were developed during the year for studying the development of fractures around mining excavations. Preliminary results indicate the practicability of the approach adopted. A theoretical analysis for determining the stress distribution and potential fracture zones around mine excavations was completed and a computer programme was prepared for this purpose.

Stability of rock slopes

Model studies were conducted to determine the stability criteria for rock slopes in a copper open cast mine. An experimental approach for studying slope stability in a diamond open cast mine was also worked out.

Behaviour of rock masses as structural foundations

This project entails studies of the stability of rock foundations which would apply particularly to dams and underground power stations. Two important investigations were completed, namely, stress analysis tests to determine the best design for Sanddrift River Dam "B" (on behalf of the Department of Water Affairs) and a rock mechanics investigation aimed at choosing the most suitable site for an underground power station in the Ruacana Water Scheme (on behalf of the South West Africa Branch of the Department of Water Affairs).

HEAT CONTROL DIVISION

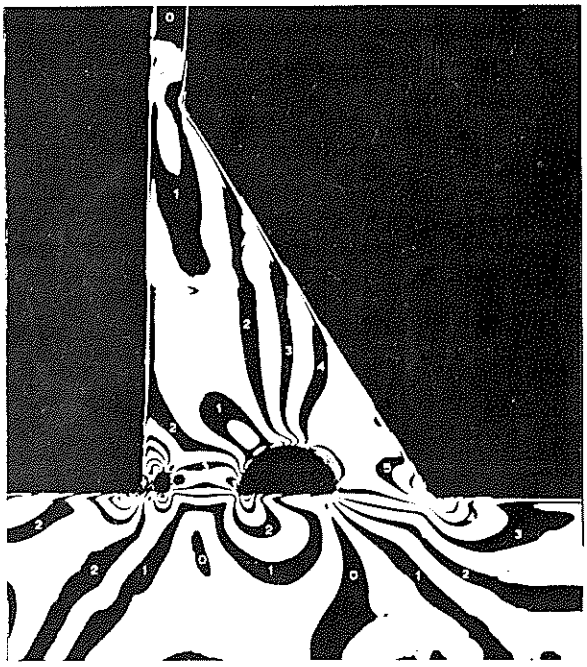
Direct measurement of heat loss from a human body

The development of instruments for the direct measurement of the convective and radiative heat losses from a human body was successfully concluded on behalf of the Chamber of Mines of South Africa. The instruments were extensively used for animate studies carried out in the 10ft. x 10ft. x 10ft. climatic chamber of the Human Sciences Laboratory of the Chamber.

Heat exchangers

Numerous enquiries about the design of heat exchanger equipment were dealt with. In particu-

Photo-elastic fringe patterns obtained in a model of the proposed wall of the Sanddrift River dam subjected to stress tests in the laboratory



lar, the design was investigated of heat exchanger elements having good heat transfer characteristics and a low pressure drop on the air side.

Climatological data for designing air-conditioning equipment

Charts were published on which various climatic parameters for summer conditions are shown in the form of "isothermal" lines on maps of the Republic. These were applied to various problems. The information included in the charts is of considerable interest to architects, consulting engineers and similar specialists. Numerous requests for the relevant information have been received.

Air-conditioning and refrigeration problems in South Africa

Basic investigations into the economics of abattoir refrigeration facilities were continued. In particular, the effect of environmental conditions of air temperature, humidity and air movement on carcass weight losses were studied. In addition, performance tests were carried out on actual abattoir refrigeration installations. Numerous enquiries related to the design of comfort and process air-conditioning systems, were dealt with, particularly for textile mills and greenhouses.

Coal-burning gas turbine

The main object of this investigation is to determine the practicability of a coal-burning gas turbine of the comparatively simple open cycle type for power generation in South Africa.

The advantages of such a unit for generating power are its simplicity of operation, rapid starting characteristics and low capital cost, coupled with the fact that it operates on cheap fuel and does not require water for its operation.

One of the major problems connected with the use of the open cycle gas turbine is, however, the erosion of turbine blades by fly ash.

To determine the severity of the problem, which could be aggravated by the low-grade bituminous coals mined in the Republic, tests are being conducted on a pressurized combustion chamber designed for the purpose and incorporating special ash-separation features.

Satisfactory progress was made with the tests during the past year. It is hoped to establish definitely by the end of 1968 whether the open cycle gas turbine is practicable or not.

AERODYNAMICS DIVISION

Low-speed aerodynamic measuring instruments and methods

General routine instrument calibration, mainly on vane-anemometers, thermo-anemometers and pilot tube flow meters, was carried out on behalf of various organizations.

Air-flow resistance in mine shafts and tunnels

Technical advice on improvements to be made to a ventilation shaft bend in a coal mine was given to a colliery in Natal.

Low-speed wind tunnels

It was decided to develop a small water tunnel which will be used in conjunction with the 7ft. x 5ft. low-speed windtunnel. The use of water as a working medium is ideal for flow-visualization studies; it leads to a better understanding of aerodynamic phenomena and consequently to more expeditious and economic wind tunnel testing.

Fan design and development

This project is concerned mainly with gathering fundamental data on two-dimensional plate aerofoils in cascade. Such data provide a basis for improvements in the design of axial flow fans.

GAS DYNAMICS DIVISION

Blow-down wind tunnel

After the trisonic blow-down tunnel had been erected, extensive calibration tests indicated that the Mach Number distribution in the test section was not satisfactory, and flow visualization studies indicated undesirable shock waves originating from the bottom flexible wall of the tunnel. A thorough investigation into the nozzle design, originally carried out by the firm which supplied the tunnel, indicated that some improvements could be made. An entirely new set of nozzle contours was calculated and the cams operating the flexible walls of the nozzle were redesigned. While awaiting developments in connection with the improved design the tunnel was used for some preliminary test programmes, since — in spite of the above-mentioned problems — it is already a fully serviceable tunnel.

High-speed wind tunnel instrumentation

The manufacture of a rig for the calibration of high-speed wind tunnel balances was completed and associated computer programmes, required for calibration work, were developed.

AERONAUTICS DIVISION

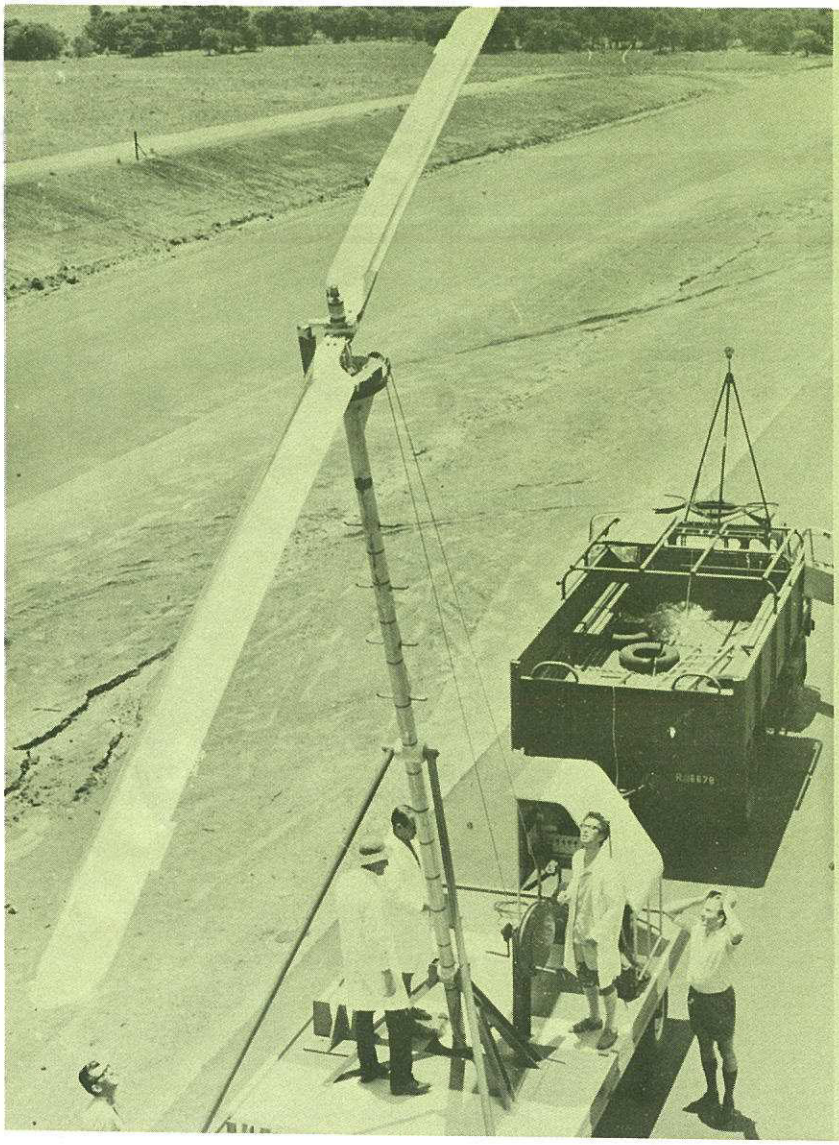
Aircraft propulsion (See p. 33)

In order to obtain data for calculating aircraft performance, some theoretical performance analyses were done on the engine intended as a propulsion unit for the autogyro which is being developed by the Aeronautics Division.

Further analyses of results for comparative tests of shrouded and free airscrews were carried out and it was found that the gain in static thrust which theory predicts for shrouded airscrews can indeed be achieved in practice with properly designed shrouds.

Aircraft noise (See p. 33)

In South Africa the disturbance caused by aircraft noise may still be limited by effective planning of residential areas near airports. Work on aircraft noise problems was undertaken mainly from this point of view. An improved method of calculating an "index of noisiness" in the vicinity of an airport was devised on the basis of known aircraft noise contours.



Testing the lift characteristics of the rotor of the two-seater autogyro being developed in the Aeromechanics Research Department. The rotor is mounted on a trolley which is towed by a lorry

Rotating wings (See p. 33)

A test programme on full-scale auto-rotating rotor blades, aimed at establishing autogyro rotor performance, was satisfactorily concluded and a comprehensive report on this work was issued.

Experimental wind tunnel studies of a more fundamental nature were carried out on model auto-rotating rotor systems. Further studies of the aerodynamic theory of auto-rotating rotors were also made.

Aircraft design and construction (See p. 33)

Good progress was made with the general structural design of the autogyro at present being developed by the Aaronautics Division. Personnel was made available by the Atlas Aircraft Corporation to assist in the manufacture of the first prototype aircraft.

HYDRODYNAMICS DIVISION

Instrument calibration and development

Various instruments required for coastal engineering measurements and for use in models were developed under this project. The first beach profiles were measured with a prototype pressure type depth sounder.

An inverted echo-sounder wave recorder was developed to eliminate the cable problems experienced with the normal type of instrument in which the sensor unit, placed on the sea bottom, is connected by a cable to the recorder on the shore.

HYDRAULICS DIVISION

Coastal engineering (See also p. 35)

Measurements of littoral drift were made along the Table Bay shore at Rietvlei. Fluorescent tracers were placed at short intervals in the swash zone by divers and in the main breaker zone by S.A.A.F. helicopters. Samples were continuously collected along the shore and in the breaker zone. Very clear patterns of sand movement were discerned.

A first survey to trace the movements of river silt in the sea was carried out on behalf of SANCOR and the results indicated that the silt-

laden fresh water floats on the sea-water for a considerable distance offshore.

The instrumentation required for basic research on the stability of tidal inlets was completed. Further advice was given on alternative proposals for the stabilization of the St. Lucia estuary.

The first meeting of the Committee for the preservation of the country's lakes and lagoons was held at Knysna. The Committee felt that a survey of the status quo and recommendations for improvements should be made; and because no funds could be found for the establishment of the proposed Sediment Research Group of the Cape, it was recommended that a firm of consulting engineers be approached to undertake this work. The second meeting, which dealt mainly with zoning problems, was held at Saldanha Bay.

Wave force measurements will be made on the Gansbaai breakwater in collaboration with the contractors constructing the breakwater and with VISCOR.

Representations by the Town Clerk of Still Bay East and the Secretary for Planning have led to a preliminary investigation of the coastal engineering problems at Still Bay. It was found that the mouth of the Kafferskuil River had reached a stable cross-section but further migration to the west should be halted. Extensions to the existing fishing harbour were not recommended.

At the request of the Director of the Diamond Research Laboratory, the diamond mining operations along the shore north of Oranjemund were inspected. Minor improvements to the shore workings were suggested.

Further work was done on the Gansbaai fishing harbour model. Tests were made with a radio-controlled model boat to investigate the navigability of the various designs for harbour layout.

River hydraulics

A Symposium on Hydraulic Research in Civil Engineering was held in Pretoria on 12th October, 1967. The Symposium was organized jointly by the C.S.I.R. and the Division of Hydraulic Engineering of the South African Institution of Civil Engineers. Papers read at the Symposium dealt mainly with river problems and development of water resources.

Marine disposal of effluents

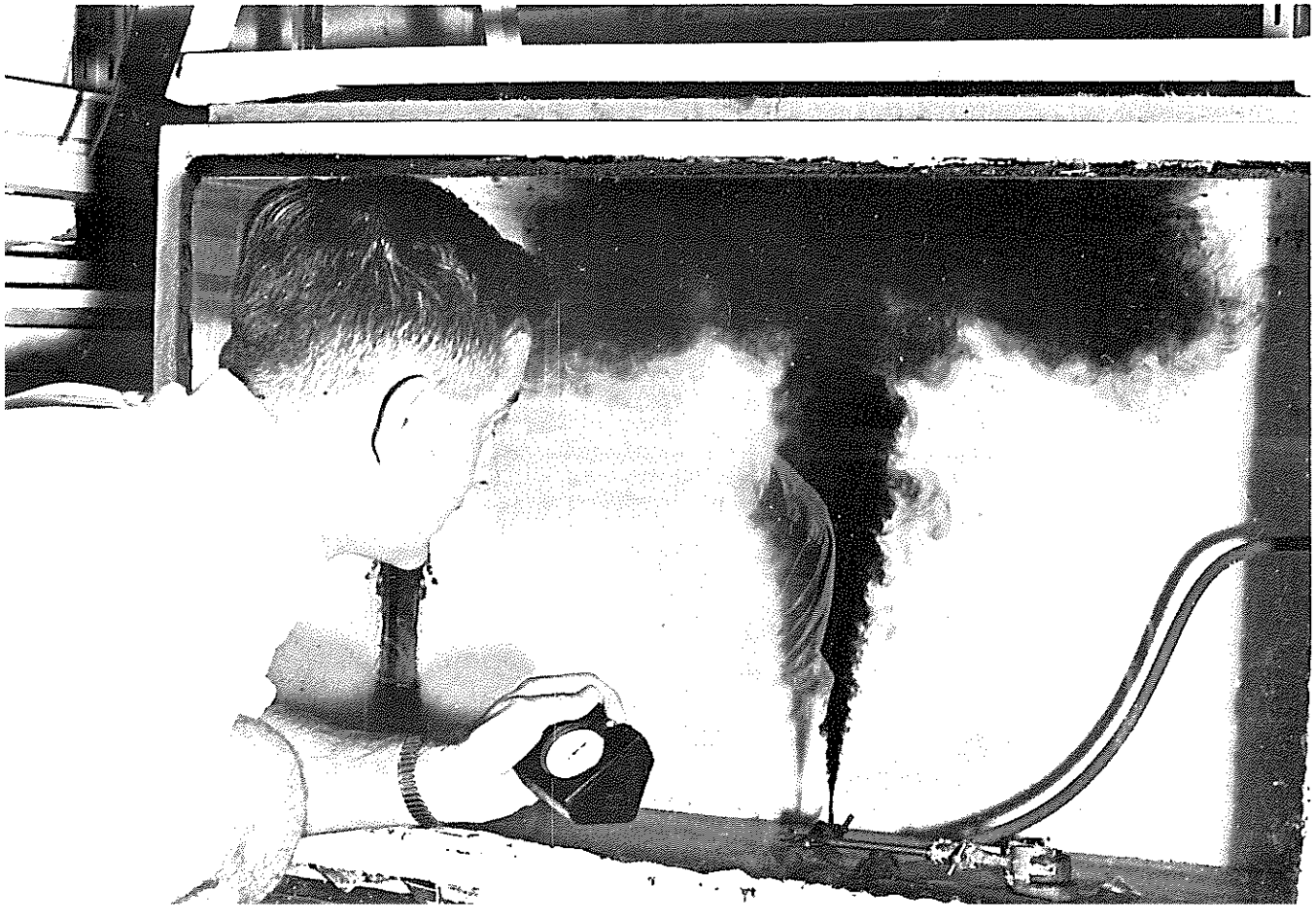
A literature survey of the important theories of eddy diffusion in the sea was completed. Full-scale monitoring tests are being planned by the National Institute for Water Research and it is expected that the data becoming available from these tests will assist in a better definition of the diffusion parameters.

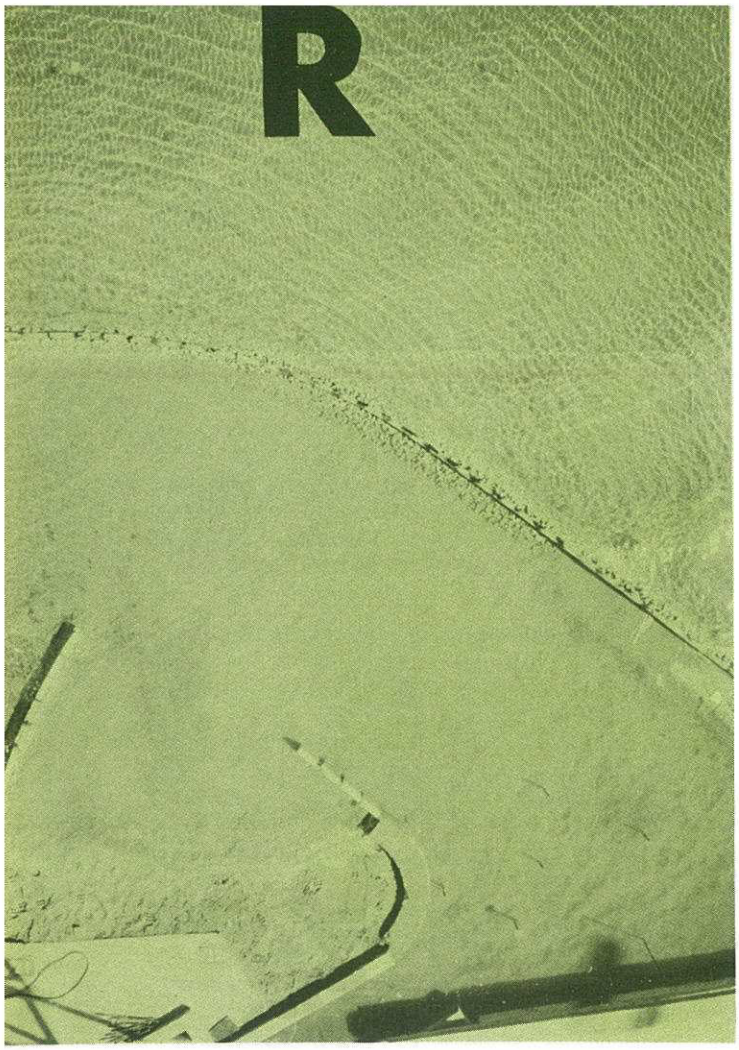
Durban harbour siltation and beach erosion

As a result of extensive research, which was aimed at the improvement of Durban's beaches, it was recommended that use be made of available dredger spoil to build an underwater sand ridge opposite the beaches, approximately 3 miles long and about 4,000 feet offshore. A start was made with the construction in June 1966 and some 2 million cubic yards of sand have already been dumped over the mound.

The portion of the underwater mound which has so far been completed (about one-fifth of the whole) remained remarkably stable under all weather conditions. This result compares very well with the model predictions. However, no further sand will become available from the work on Pier No. 1 in the Durban Bay and further progress with the construction of the mound may therefore be seriously hampered unless another source of sand is found.

The diffusion of effluent in water is being studied by scientists of the National Mechanical Engineering Research Institute. Knowledge of this diffusion process is important for the disposal of industrial effluents in the sea





A photograph of wave patterns produced in the model of the Rietvlei fishing harbour in a proposed lay-out of the harbour entrance

Richards Bay

Early in the year under review, proposals for research on the layout of the breakwaters for the proposed harbour at Richards Bay were submitted to the S.A.R. Administration. The proposals for model tests were accepted by the Administration during September 1967, and these tests will be completed in $3\frac{1}{2}$ years.

A start has since been made with a comprehensive measuring programme which will include wave conditions, currents, wind, sand movements, tidal records and flood rates.

Rietvlei harbour siltation and wave studies

This investigation was undertaken on behalf of the Fisheries Development Corporation. The purpose of the study is to determine the best layout, in relation to wave and coastline conditions for the proposed new fishing harbour at Rietvlei, Table Bay.

A hydraulic model was constructed to a horizontal scale of 1 in 200 and a vertical scale of 1 in 72. After extensive model testing, a harbour entrance was established which would function very effectively under the conditions of waves in the entrance and in the harbour basins. Tests are now being conducted to determine the effect of the breakwaters on the stability of the coastline of Table Bay.

Sand dam research

The purpose of this study is to determine data which can be used to secure optimum design and functioning of sand dams. The work is sponsored by the S.W.A. Administration.

Ocean wave research

A nation-wide programme of wave recording and analyses was started during the year. The ultimate aim is to install about ten wave clinometers along the entire South African and South West African coasts. Records are already being obtained from wave clinometers installed at St. Lucia, Richards Bay, Durban, East London, Mossel Bay and Cape Town. In addition, recording instruments will be installed at Richards Bay, Durban, Port Elizabeth and Cape Town.

Available records for the Natal and Cape Town areas have been compiled into a report. Future analyses will, to a large extent, be done by computer for which programmes have already been prepared.

MINE EQUIPMENT RESEARCH UNIT

Statutory testing of wire rope (See p. 19)

The statutory testing of winding ropes was continued, and for the 11-month period of 1 November, 1966 to 30 September, 1967, 2,022 tests were made on ropes of over $1\frac{1}{4}$ inch nominal diameter, and 2,168 on smaller ropes, the total being 4,190 ropes.

Shaft steelwork

A special skip for measuring shaft guide alignment was completed, tested, and handed over to the Chamber of Mines.

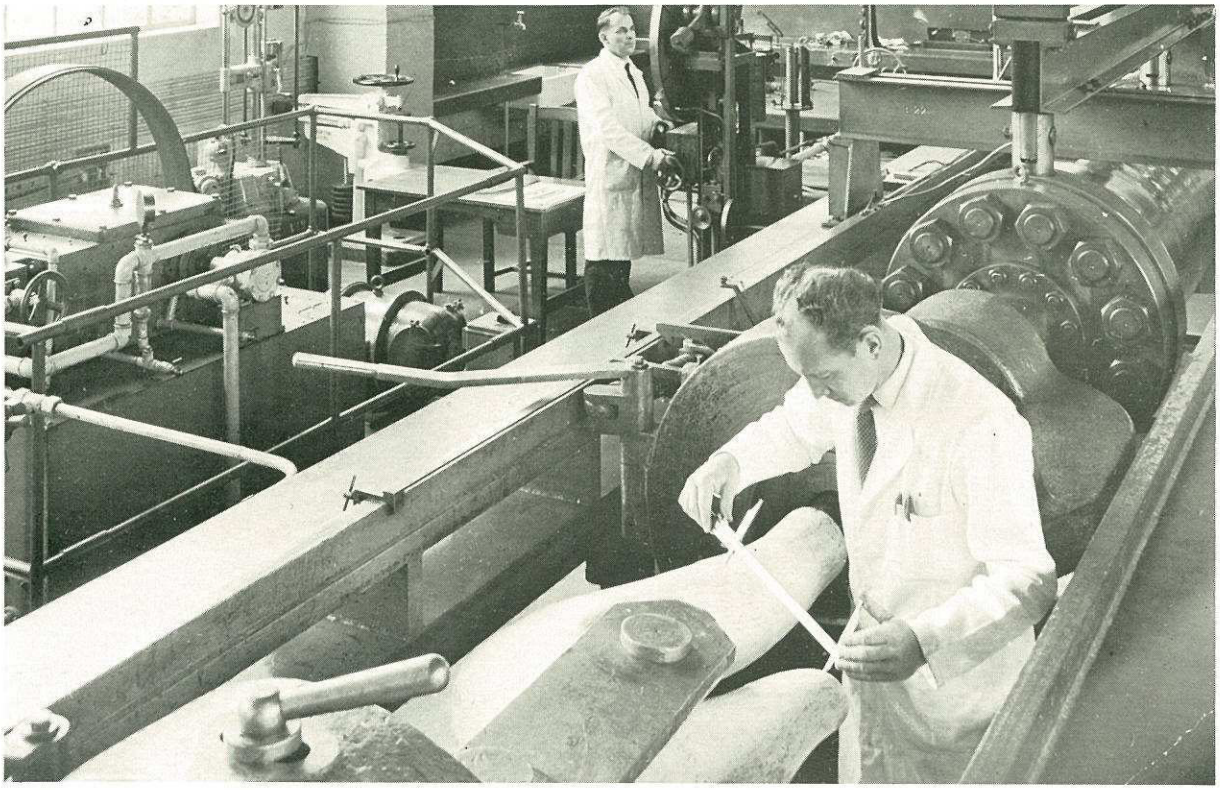
Properties of wire ropes

Preliminary tests were carried out to determine the "visco-elastic" properties of ropes. Efforts are being made to refine the measuring techniques before a test programme is begun.

Non-statutory testing of equipment

At the request of the Chamber of Mines of South Africa, a new Sub-Committee of Non-Destructive Testing was formed. A primary function of this committee will be to collate information on all forms of non-destructive testing of mine winding ropes, and to co-ordinate all development work being carried out in this particular field in the Republic.

With the introduction of ultra-high tensile wire ropes on the mines, much difficulty was experienced in carrying out the statutory testing on these ropes. When prepared as normal ropes, the great majority of ultra-high tensile wire rope specimens broke at low loads in the white metal grips. A new technique for preparing the ultra-high tensile wire rope specimens is being developed. This technique has also been successfully tried on widening ropes of larger diameter (i.e., of over 1-inch diameter).



Testing a crane hook in the 500-ton tension testing machine at the Mine Equipment Research Unit at Cottesloe

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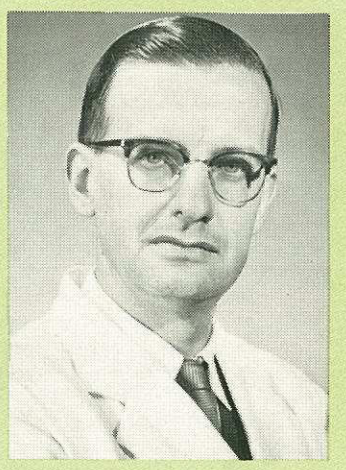
THE NATIONAL NUTRITION RESEARCH INSTITUTE



Dr. J. J. Theron, Director of the National Nutrition Research Institute.

The National Nutrition Research Institute (N.N.R.I.) is concerned mainly with applied research aimed at improving the nutrition of the South African population, and advises Government and other authorities on ways of combating malnutrition.

The activities of the Institute include investigations into the nutritional status of all groups of the South African population; the study of methods for combating malnutrition and controlling deficiency diseases; research on the nutritional value and improved utilization of foods produced in South Africa; research on the harmful substances found in some foods; research on food processing, including investigations on behalf of private industries.

Biological evaluation of foodstuffs

The nutritive value of a diet or of an individual food depends on the nutrient content of the diet or food, the availability to the body of these nutrients, the dietary context within which the food is used, and the freedom of the diet or food from toxic ingredients.

Since diets as well as individual foods can differ considerably from one another in one or more of the above respects, the assessment of their nutritive values, and, therefore, of their relative merits as protectors and enhancers of the health and vitality of the consumer, is one of the Institute's main tasks.

Apart from undertaking chemical analysis of foods, the Institute studies foods and food mixtures, using experimental animals, to assess the biological availability of proteins, minerals and vitamins in foods, as well as the balance of nutrients in certain dietary contexts.

Because of the relative importance in all good diets of high-quality proteins and the protein inadequacy of cereal diets, much attention has been given to testing the protein qualities of ordinary foods and experimental and commercial food mixtures, and to improving available techniques for protein evaluation.

Since the conventional techniques employed in this type of work are both time and labour consuming, the possibility of simplifying and shortening these techniques has been investigated extensively. Protein digestibility can now be determined biologically within 18 days as compared with the 42 days required previously. An improved metabolism cage for use during these tests reduces labour and the use of these cages enables more accurate results to be obtained on the nitrogen consumption of the experimental animals, as it automatically separates the urine and faeces of the animal, and excreta is kept free from food particles.

Biological investigations into problems associated with the balance of nutrients in diets are also being made. Two such problems receive special attention, *viz.*

(i) dietary imbalance as a cause of kidney-stone formation (nephrocalcinosis); and
(ii) iron contamination of foods as a cause of siderosis (deposition of large quantities of iron in the liver and other organs).

As regards (i) it was established that a dietary imbalance of calcium and phosphorus at a specific calcium intake level is highly conducive to stone formation.

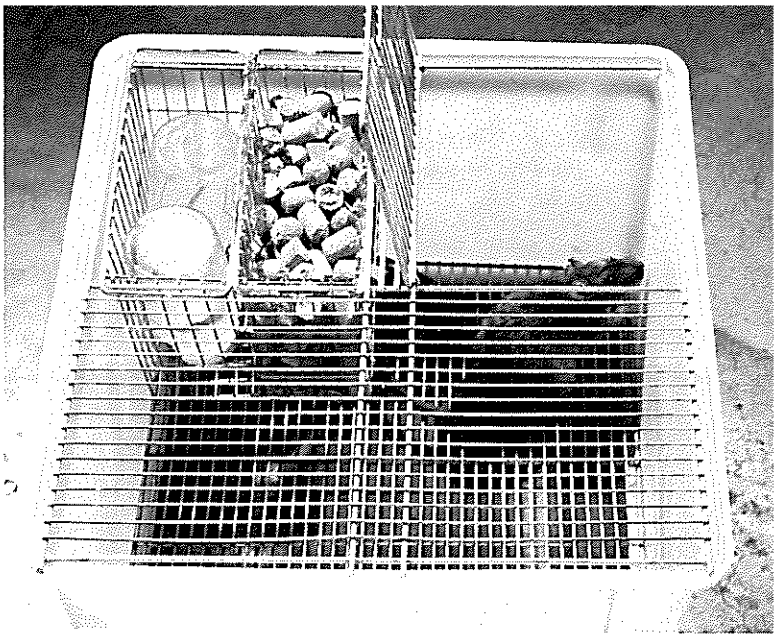
Of equal interest is one of the results obtained in connection with problem (ii). It appears that iron particles (of the type originating from the food milling equipment) are more siderotic than an organic iron salt, particularly in the case of young animals receiving a predominantly maize diet.

A food mixture for the combating of malnutrition

Attempts to combat malnutrition through fortification of staple foods have failed for various reasons, the main reason being that the predominating deficiency, *viz.* protein in maize diets, cannot be remedied easily without impairment of the acceptablity of the maize.

The N.N.R.I. therefore approached the problem of supplementation of inadequate diets from another angle: in the course of the past seven years it has developed a highly-concentrated food mixture which can be used either with a meal or as an ingredient of meat dishes, soups, sauces, etc. according to the user's preference. Work in connection with the chemical composition, nutritional efficiency, acceptability and keeping quality of the mixture has now been completed.

The mixture consists mainly of ordinary foodstuffs, all of which can be produced in the Republic. The various ingredients were selected not only for their nutritional properties but also with a view to creating a stable market and stimulating production of the foods that should be consumed in greater quantities if the country's main nutritional problems are eventually to be solved.



The improved metabolism cage developed by the National Nutrition Research Institute for biological determination of protein digestibility using experimental animals

The results of extensive trials in the laboratory and the clinic indicate that the nutritional status of maize-eating children in the kwashiorkor age group can be maintained or raised to a satisfactory level by using one ounce of the mixture per child per day. In addition to proteins the mixture contains vitamins and minerals (including iodine) in quantities sufficient to render it suitable for combating other types of malnutrition such as pellagra and possibly endemic goitre.

Extensive field trials were conducted in six different centres and the results indicated that the mixture is acceptable to the population groups amongst whom malnutrition is prevalent.

The keeping quality of the supplement is good, considering the complexity of the composition of the mixture. Under highly unfavourable conditions (high temperature, high humidity) test samples kept in polythene bags remained sound for six months and, under more favourable conditions, for a period exceeding one year.

Mycotoxin investigations

One of the most remarkable aspects of human cancer is that the incidence of certain types of cancer varies greatly in different population groups. Thus liver cancer is extremely common amongst the Bantu but relatively rare in Europeans in South Africa. This observation indicates that most types of cancer have a definite cause which may be associated with the environment in which the susceptible population is living.

The concept that particular environmental factors can produce cancer in man has provided great impetus to research because it is obvious that, if an environmental carcinogen can be identified, steps can be taken to eliminate it from the human environment. This approach has yielded particularly

satisfying results in the field of industrial carcinogens.

In the particular case of liver cancer in Africa a wide variety of environmental factors has been suggested, including such diverse causes as virus infection, bilharzia and plant poisons.

For various reasons hypotheses involving these factors are not tenable, with one exception. Mycotoxins (toxins produced by moulds) contaminating the food of populations with a high incidence of liver cancer could explain the difference in the incidence of this disease mentioned above. This hypothesis was developed from three observations, namely that liver cancer occurs in areas where the climate is likely to favour mould growth; that underdeveloped populations with a high incidence of liver cancer have poor food storage practices likely to favour mould growth; and that some mycotoxins are highly carcinogenic.

Investigations to ascertain whether mycotoxins are responsible for Liver cancer are being carried out by the N.N.R.I. in both the laboratory and the field. In the past few years several mycotoxins have been discovered and isolated and certain aspects of the toxicity and metabolism have been described. This report deals with the work undertaken during the last year.

Laboratory work

The object of laboratory studies was to characterize the mode and site of action of mycotoxins. The first task was to prepare and purify quantities of toxin adequate for use in biological studies. Moulds were grown on maize meal and the toxins elaborated were extracted and purified. Over one ton of maize meal was used and large quantities of four toxins were prepared. Samples were also supplied to South African and overseas research workers and analysts.

In addition, progress was made by the C.S.I.R.'s Microbiology Research Group in defining the most suitable artificial media for toxin production, thereby simplifying cultivation and purification of the toxins. The biogenesis of two toxins was studied, providing a method for introducing radioactive markers to label toxins thereby simplifying the study of their metabolic history.

The toxicity of several compounds was studied and important information on the site and mode of their action in the animal body was obtained. Interesting results include the production of tumours in experimental animals after administration of a few hundred micrograms of aflatoxins (i.e. approximately the same weight as a sugar grain) and the development in rats given ochratoxin of a lesion resembling that of glycogen storage disease. Sophisticated electron microscopical and cytological techniques were used to identify the changes produced in the animal tissues by the toxins.

Complementary to this work, biochemical studies to elucidate the biochemical mechanisms by which the substances exert their toxic action were undertaken. In particular the effects of ochratoxin on protein synthesis and on certain enzymes involved in carbohydrate metabolism have been studied.

As an adjunct to the work of defining the site of action of the toxins, a study of the method by which the body metabolizes the toxins was undertaken.

The importance of laboratory work for field studies is exemplified by the investigation of methods of analysing foodstuffs for mycotoxins. Methods for determining aflatoxin M (occurring in milk) and other mycotoxins have been developed. Collaboration with the International Union of Pure and Applied Chemistry in establishing methods of assaying aflatoxin in groundnuts and milk formed an important section of the work.

Field studies

The isolation of moulds from South African food products has continued with particular emphasis on the moulds occurring on sorghum. The next step in the study of these moulds was to assay them biologically for toxicity. Over 200 isolates (isolated by the C.S.I.R. and by the S.A.I.M.R.) have been tested for toxicity by means of the traditional test on day-old ducklings. A large number of these moulds have now been included in the Microbiology Research Group's fungal collection, which is the source from which fungi are selected for further examination.

A limited study of the distribution of aflatoxin M in the commercial milk supplies in the Transvaal has been completed. Traces of this potentially-dangerous toxin were found in 5 out of 20 samples collected in the Northern Transvaal.

A study of one of the bases for the hypothesis associating mycotoxins with liver cancer, namely that mycotoxins develop mainly in hot humid climates, was completed. In this study the relationship between the occurrence of aflatoxin in the groundnut crop and the weather conditions prevailing during the growing season, revealed that high rainfall and temperatures do not necessarily result in aflatoxin contamination of groundnuts. The observation, which revealed a basic weakness in the hypothesis mentioned above, has led to a new approach to the epidemiological study of human cancer.

This new approach involves intensive studies of small high-incidence areas of cancer, backed up by adequate laboratory services. In order to apply this concept, a laboratory was set up in East London to study possible causes of oesophageal cancer, which occurs in certain Bantu tribes at a higher rate than anywhere else in the world. A close study was made of the areas in which the disease was more likely to be associated with diet than with any of the other factors studied.

In the laboratory, food collected from cancer areas is being fed to a specially selected inbred strain of rats known to be susceptible to oesophageal cancer. In this way there is a possibility of showing whether naturally-occurring carcinogens are present in the basic foods of the Bantu population. If this is the case, considerable progress will have been made towards identifying the carcinogens responsible for the epidemic of oesophageal cancer. Once that has been estab-

lished, it may be possible to take meaningful steps towards the elimination of this type of cancer.

Nutrition and coronary heart disease

Coronary heart disease has been shown to be the largest single cause of death among the White population of the Republic of South Africa. According to Walker (1963), coronary heart disease was the cause of death of respectively 42.4, 40.5, 12.7 and 3.6 per cent of the White, Indian, Coloured and Bantu males in the age-group 55-64 years in Johannesburg. It is clear that there are large differences in the incidence of coronary heart disease in these four main racial groups in South Africa.

The association between the serum cholesterol concentration and the incidence of coronary heart disease has been illustrated in many studies. It was, therefore, most disconcerting to find that in the age groups 7-11 and 12-15 years, respectively, 13 and 9 per cent of White children in urban Pretoria had cholesterol values which could be considered to be abnormally high, whereas the incidence of high cholesterol values in children of the three non-White races in the same area was less than one per cent.

Atherosclerosis has generally been accepted to be of metabolic origin although investigators have differed as to the basic cause of the deranged metabolism. Some investigators maintain that atherosclerosis is a metabolic disease in which an altered cholesterol-lipid-lipoprotein metabolism plays a critical and decisive, although not exclusive, role. Others, however, concluded that an abnormal carbohydrate metabolism is the primary metabolic disturbance responsible for the abnormal lipid metabolism.

Research into this problem currently in progress in the National Nutrition Research Institute is being conducted both on experimental animals and on human subjects.

For the past eighteen months experimental animals (rabbits) have been fed a high-fat diet, and at regular intervals the glucose tolerance has been determined and the serum lipids and insulin assayed. The intention is to keep the rabbits on the high-fat diet until there is clear-cut biochemical evidence of abnormalities in the carbohydrate and fat metabolic processes, and pathologic evidence that atherosclerotic changes have occurred in the arteries of these animals. The animals will then be placed on a high-carbohydrate/low-fat diet for at least a year. The main purpose of the experiment is to determine whether the atherosclerotic lesions in these animals will react to the change in the diet. A parallel study on primates is to be started in the near future.

Studies of patients with coronary heart disease have indicated that the metabolic disorders demonstrable in these subjects are variable and can be classified into three categories, as follows:

(a) primary inhibition of the carbohydrate metabolism;
(b) apparently overactive carbohydrate and fat metabolism; and
(c) primary inhibition of the fat metabolism.

Diets have been designed for the experimental treatment of persons with each of these metabolic disorders. The effect of these diets will be tested on a representative group of men between the ages of 16 and 55 years. Currently these subjects are being studied to assess their metabolic status on the basis of biochemical and clinical evidence. The appropriate diet will then be prescribed for those showing metabolic disorders. This investigation is designed as a long-term study and the men classified as belonging to any of the three metabolic groups will be retested periodically. Once again, the main interest in this study will be in the response (biochemical, clinical and dietetic) of these men to the prescribed dietary regimen.

Field studies

If the nutritional and health status of a population is good, high productivity from its labour force with low absentee rates can be expected — with beneficial results to the economy of the country. Sound nutrition and health are therefore economic investments and the government should be kept informed about the population's nutritional status.

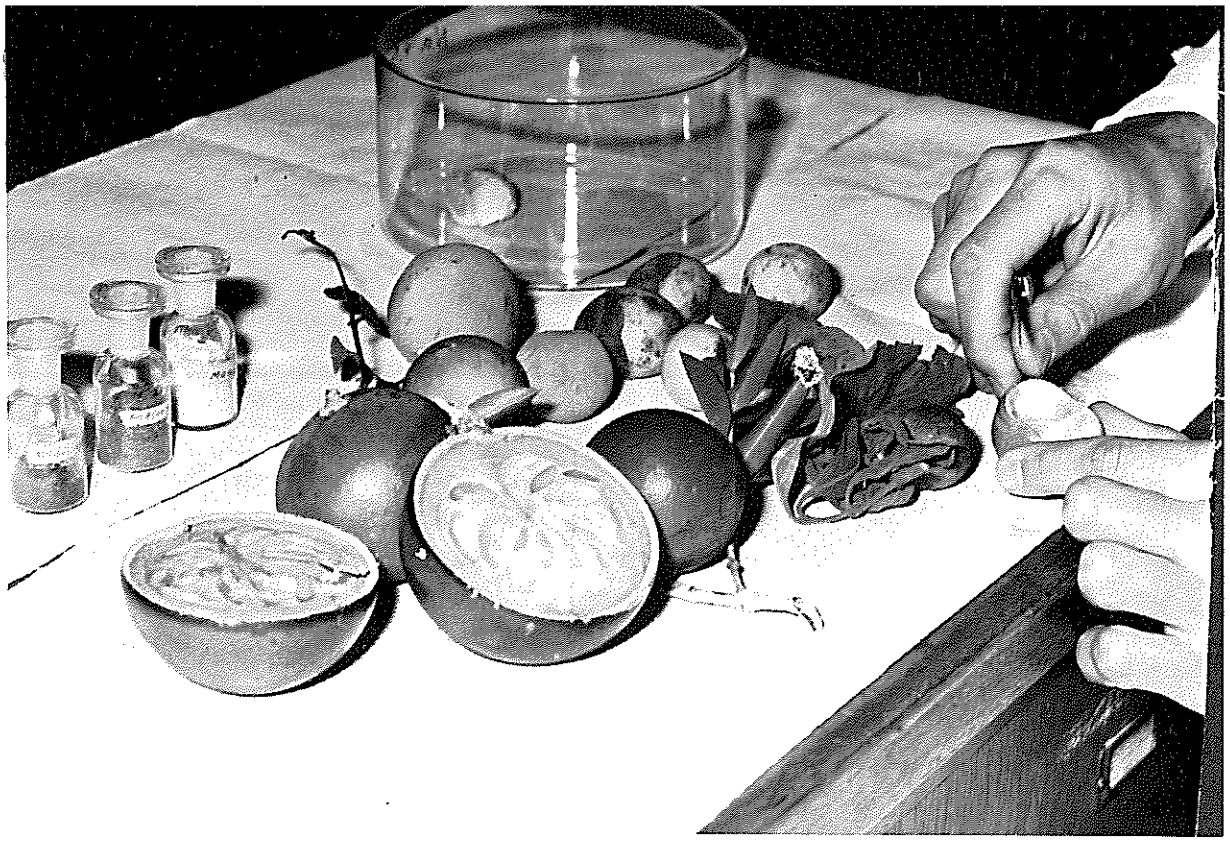
The Field Studies Division of the N.N.R.I. is endeavouring to systematize the collection of the data required to make an assessment of this status by carrying out surveys among the various population groups of the country, and by seeking methods that may be applied on a larger scale.

Assessing nutritional status is a most complicated task and part of the Division's work is to conduct basic research on methods and techniques for carrying out nutrition surveys and to interpret results thus gained. Dietary studies in themselves provide valuable information on the habitual food intake of individuals or of groups but cannot show conclusively whether the intake is adequate unless they are supplemented by studies of blood pattern, clinical signs, body build, etc. It is therefore necessary to take many facts into account and the relationship between these facts is expected to make the most significant contribution to successful assessment. Methods and techniques have now been recommended which may be regarded as being comprehensive in the light of the present knowledge of nutritional appraisal.

In the applied field (assessment of the nutritional status of populations) the Division during the past five years, has been engaged in extensive nutritional studies of samples of White, Bantu, Indian and Coloured school children living in Pretoria. Clinical, biochemical, somatometrical, dietary, radiological and socio-economic studies have been completed on each of approximately 2,200 children.

It was found that, on the whole, the dietary intakes of White children compared favourably with American recommended allowances. Abdominal and subscapular skinfold thickness of White girls was exceedingly high after the age of 12 years. indicating a marked tendency to obesity. This indicates a need for adjusting existing programmes for nutritional guidance and physical education.

As regards the Indians, the intakes of animal protein, niacin, calcium, riboflavin and ascorbic



A collection of veld fruits being prepared in the laboratory for chemical analysis in order to determine their nutritive values

acid were on the whole below American standards. However, no signs of caloric deficiency were noted.

The nutrient intake of Coloured children, according to the dietary study, was very similar to that of the Indians, except that the intake of protein of animal origin was even lower.

As for the Bantu children, the nutrient intake resembled that of the Indians and Coloureds, but vitamin A and C intakes were somewhat lower. Iron and thiamin intakes were higher than the recommended levels.

Industrialization and urbanization among our Bantu populations have today become a reality and it is essential to industry to know what human changes and adaptations take place when a labourer moves from a rural to an urban, industrialized way of life. The Institute is taking part in the Human Adaptability Project of the International Biological Programme in order to study man's physical adaption to rural as well as to urbanized environments. Studies of rural ethnic groups as well as of their urbanized counterparts are to be undertaken on a multi-disciplinary basis. Apart from the determination of nutritional status which will be done by this Institute, work capacity, work motivation, intellectual ability, pattern of disease, gene frequencies and anthropometric studies will be undertaken in collaboration with other research teams which are being co-ordinated by the Institute.

Studies of the nutritional status of primitive and isolated communities and also of their development, are most rewarding additions to investigations of human adaptability and survival. The first expedition has recently been successfully completed. It was undertaken, in collaboration with the Windhoek Museum, among the OvaChimba and OvaHimba of the Kaokoveld.

The nutritional composition of edible wild plants and fruits

It is known that edible wild plants and fruits play an important role in the diet of the indigenous tribes of the Republic and South West Africa. Even today, small tribes exist who are wholly dependent on the veld for their daily food.

Because so little is known of the nutritive value of veld fruits and plants, the N.N.R.I. is currently engaged in a comprehensive survey of the distribution and composition of these plants as well as the role they play in the daily diet of such tribes. This knowledge is essential for determining the nutritional status of these population groups in whose diet veld food is still important.

Some of these indigenous plants thrive in areas where better-known food crops cannot be grown and it may be possible to apply specializing farming techniques in these areas so that larger crops of these food plants can be obtained.

A further possibility is that some of these plants may possess properties of special value which could be improved by cultivation and genetic selection. Such improvement could lead to successful commercial exploitation of the fruit or plant. Examples of indigenous plants which could be cultivated and become popular are the wild cucumbers (e.g. *Momordica elimitidea* and *Cucumis metuliferus)* and the vitamin C-rich "amatungulu". These could become welcome additions to the

range of fruit and vegetables at present generally available.

Another potentially valuable fruit is that of the maroela with its high vitamin C content and its tasty nutlike pip kernels which are rich in both protein and oil and thus would be a nutritional asset if production could be sufficiently augmented.

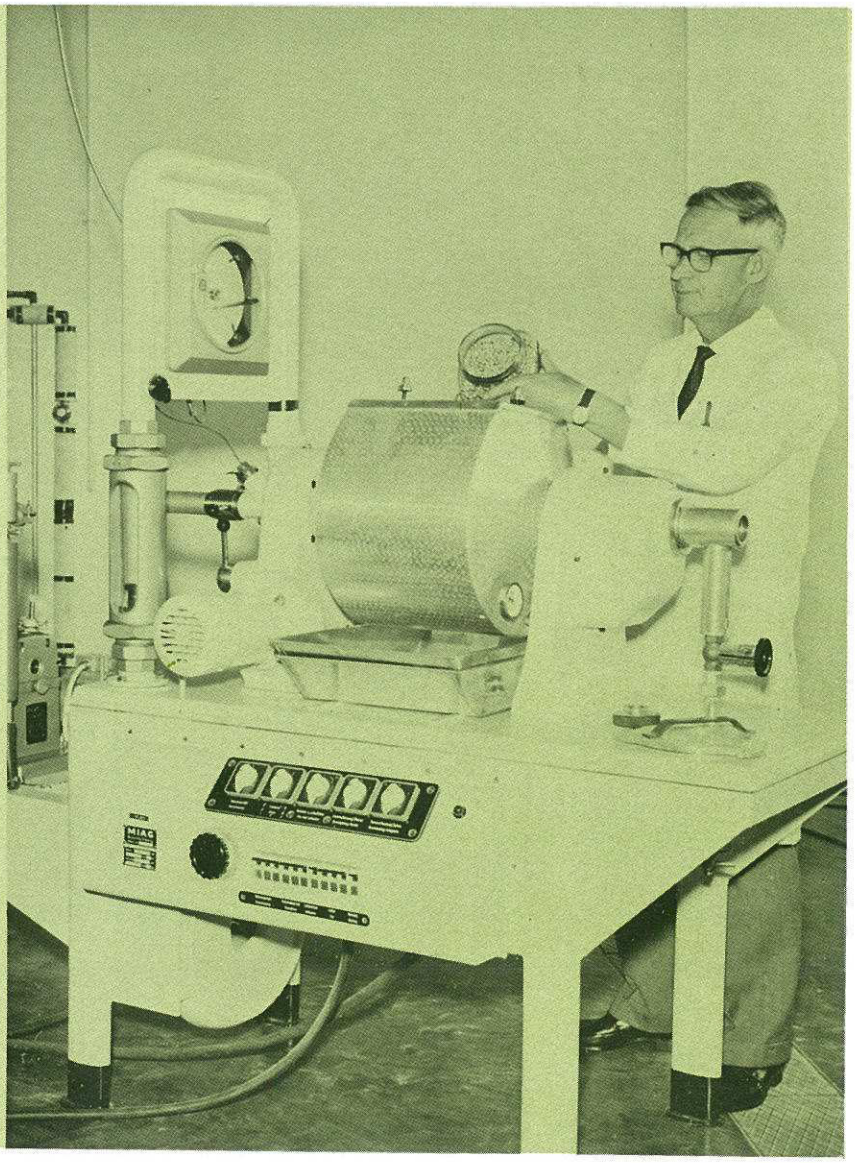
Veld food samples are being currently collected by members of the Institute or by local groups where this is not possible. Present activities cover parts of the Eastern Cape, the Northern Transvaal, the Western Kalahari and the northern parts of South West Africa. The samples collected are analysed to determine their nutritive values. Concurrently, information regarding the methods used for preparing these veld foods and the extent to which they are used by the population groups concerned is being obtained. The Institute co-operates with workers from Harvard University who are at present conducting research in this field among the K'ung bushmen of Botswana.

Flavour research

A very important aspect of food is its acceptability. No matter how nutritious a food item may be, it will not become widely used unless it is highly acceptable. Acceptability of foods may be considered as being the combined effect of appearance, texture and the taste and aroma which together comprise the flavour.

Those concerned with the preparation and sale of foods have devoted much effort to these ends and many standardized tests and procedures have been devised and adopted to ensure acceptability of the end product.

However, until the advent of techniques involving the use of the gas chromatograph, the flavour of foods could be assessed only by the reactions of consumers or tasting panels, and control or modification of this attribute was difficult and more or less arbitrary. Modern techniques now permit the separation of flavours into their individual components which can then be identified and their concentrations determined. The effects of



A grain-conditioning apparatus is used for toasting groundnuts to bring out the characteristic flavour. The National Nutrition Research Institute is at present conducting an intensive study of the flavour components of groundnuts and other foodstuffs

individual components on flavour can thus be studied.

In view of these developments it was decided to establish a flavour research laboratory which commenced operations during the year under review. The basic apparatus consists of gas chromatographs and an infra-red spectrometer. High vacuum stills of special design in which the product is cooled to very low temperatures have also been acquired and these are used to separate and concentrate the volatiles from the foods being examined. These distillates, or extracts of the food flavours obtained by other techniques, are then studied by means of gas chromatography, infra-red and ultraviolet spectroscopy and other physical and chemical techniques to identify and assay the various flavour substances.

At present this laboratory is engaged in the separation and identification of the substances responsible for the flavour of groundnuts. The extent to which the composition of the flavour is influenced by nut variety, growing conditions, post-harvesting processing (natural and artificial drying) and storage, and industrial processing will be determined. The development of off-flavours will also be studied so as to enable processors to obtain products with better keeping properties.

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THE NATIONAL INSTITUTE FOR PERSONNEL RESEARCH

Mr. D. J. M. Vorster, Director of the National Institute for Personnel Research.

The optimum utilization of labour resources is of the utmost importance in South Africa with its acute manpower shortage, especially in respect of skilled labour. For this reason, the National Institute for Personnel Research (N.I.P.R.) devotes considerable attention to this problem, and there is scarcely a sector of industry which has not benefited to some extent from its work.

In any work situation there are certain factors directly affecting the worker's productivity and happiness. The N.I.P.R. is concerned with these factors, which include the following:

- **Definition of the characteristics of work, i.e., physical and psychological demands on the worker, job description, the value of a specific task in relation to others, and the performance of duties.**
- **Selecting and placing the right man in the right job (by means of aptitude tests, interest tests, and others) and giving him the necessary training.**
- **Improvement of working conditions and equipment in order to suit the task to the worker and to eliminate unnecessary strain, fatigue and risk.**
- **Studying the socio-psychological aspects of work, e.g., manpower shortages, human relations in the work situation, work motivation and the worker's attitude towards his job, his fellow-workers and his superiors.**
- **Investigating problems arising from maladjustment to work, e.g., absenteeism, accidents, occupational disorders and group conflicts.**

Research in relatively young disciplines such as psychology or sociology is characterized by a lack of established methods. For this reason, the N.I.P.R.'s applied research activities must be supplemented by methodological and basic research into problems of personnel selection, management, general and social psychology. Basic personnel research can yield information that is not only of interest to one or more individual spon-

sors, but is also of value in the development of personnel practices and improved productivity and utilization of labour in many sectors of industry and public welfare in South Africa and her neighbouring countries.

The following is a selection of basic research projects carried out within the frame-work of the N.I.P.R.'s three research programmes of "Personnel Management", "Psychometric Studies" and "Experimental Psychology".

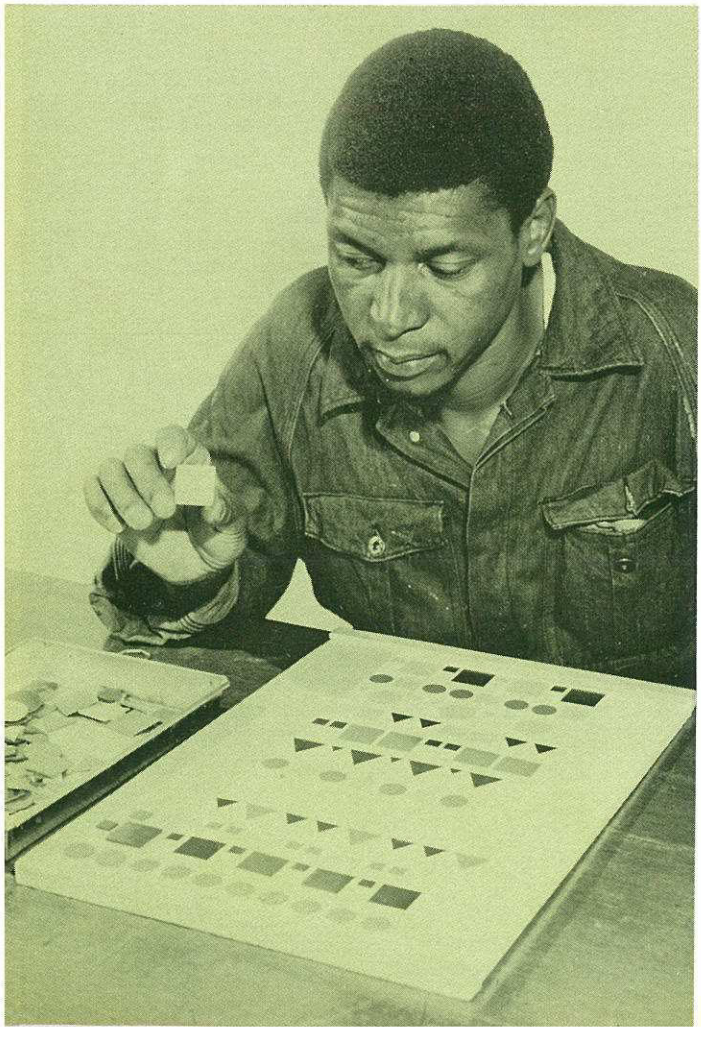
Personnel Management

Vocational guidance and selection testing continue to be in great demand. The data compiled from vocational guidance tests and tests of groups of applicants for certain categories of occupations provide an indispensable source of checking the validity, i.e., the prognostic value of the test instruments produced and used by the N.I.P.R.

Among the newly-developed test batteries is one for the selection of Bantu motor-vehicle drivers. It combines techniques for driver selection used by a South African transport organization with some specific techniques used in Europe. Its validity will be examined from follow-up data on drivers selected for the C.S.I.R. transport pool.

Another investigation of this kind, still in progress, concerns the validity of a test battery for the selection of artisans, which has been installed at a training centre in Lesotho.

A prospective mine worker concentrating on the Form Series Test, a test developed by the National Institute for Personnel Research in Johannesburg to determine the non-verbal reasoning ability of Bantu workers in industry. It was designed to complement the general adaptability battery of tests (GAB), already in use in mines



For purposes of job analysis and job evaluation (i.e., for assessing the degree of perceptual discrimination and manipulative skill required for various jobs), work study experts employ a technique of setting up predetermined time standards. Essentially, this involves the distinction and timing of separate components of work movements such as reaching for, gripping and transporting a mechanical part or tool. This technique and its implications have been scrutinized by means of special equipment which electronically times and records minute movement components. The results of the investigation have shown that some commonly made assumptions are incorrect including the assumption that movement components are constant and interchangeable elements of work activities. Clear differences in the time taken to perform the same movement component have been found, depending on the movement context of which this component was a part. This and other related findings of the investigation have implications for —

(a) the applicability of traditional work measurement techniques;
(b) training in industrial skills; and
(c) the development of tests of skill for predicting skilled work performance.

Two investigations are aimed at understanding specific manpower problems. One, partly completed, deals with the utilization of female labour in South Africa. Its purpose is to establish why the retiring age for women is usually earlier than that for men, despite the fact that a woman's life expectancy is, on average, longer than a man's.

The purpose of the second study, still in its initial stages, is to determine the differences, in regard to labour stability and productivity, between Bantu factory workers in urban areas and those in border industrial areas. The study has already indicated that certain differences often ascribed to peculiarities of the labour forces may be due to management differences.

The N.I.P.R. has also collaborated in an exploratory investigation of the prevalence and frequency of psychiatric disorders among urban Bantu; and of the relationship of such illnesses to genetic, environmental and social factors.

Psychometric studies

Work on the development of test instruments for assessing general and specific intellectual abilities and attitudes and personality characteristics has progressed.

For the purpose of collecting standardization and validation data, the following tests have been applied: the General Selection Battery of tests for selecting candidates for Graduate Business Schools; the new Mechanical Comprehension test; the new Afrikaans version of the Spiral Nines test; and the General Science Interest test.

Attitude scales to gauge an individual's social values, work morale, opinions and life goals have been constructed, applied, and analysed to verify their reliability.

Results obtained through applying the new additions to the General Adaptability Test Battery (G.A.B.) for mine workers, and work on the de-

velopment of tests for illiterates and people of low standards of schooling, have led to the formulation of an important research project, namely the relationship between intellectual development and acculturation. Guided by preliminary experiments, the Institute has made detailed plans for a contribution to the Human Adaptability Section of the International Biological Programme.

Tests constructed or under construction for this investigation into the organization of primary mental abilities of Bantu in cultural transition, as well as the plan of the study itself, have been well received by an international panel of psychologists. This project can be expected to produce the factual knowledge lacking and urgently needed for establishing training programmes suitable for the type of labour available in underdeveloped areas.

Training for specific tasks of a fairly complex nature by means of an electronic teaching desk has also received attention. Test data from a large sample of candidates using this desk have been compiled and await comparison with follow-up data.

Activities in the sphere of mathematical and statistical research have been restricted, in the period under review, by the change-over to a new electronic computer system. Priority has been given to converting existing statistical and psychometrics programmes in order to speed up the processing of accumulated data.

Experimental psychology

The increasing complexity and quantity of neuropsychological research data, resulting from the use of refined recording techniques and equipment, has necessitated the conversion of recorded data into digital form, suitable for computer processing. This change-over to automatic analysis techniques has presented problems which have temporarily slowed down other neuropsychological projects.

Evidence obtained from electroencephalographic studies of brain activity in relation to behaviour has been important in certain criminal court cases in South Africa, among others one Supreme Court case. The implications are likely to be relevant to the work of a Commission of Enquiry into the question of mental disorder in relation to criminal behaviour.

The study of the effects alcohol has on brain function and behaviour has been supplemented by recordings made on three adult males for a period of three hours after alcohol consumption. Large individual differences in brain activity and reaction time changes, due to alcohol, have again been observed and have confirmed the complexity of the problem, which is closely connected with road safety and public health in general.

An experimental study which has aroused great interest in South African and overseas medical and educational circles, has been the comparative study of the effect of antenatal decompression ("birth-suit") and normal antenatal treatment on infant development. The follow-up testing, at the age of three years, of 89 children born after decompression treatment and 90 children born after conventional antenatal care has been completed and a report submitted. The results show that no measurable significant differences between the two groups of children have been found up to that stage of their development.

Experimental investigations have been initiated and partly completed to test the hypothesis that the relative importance of the eye's and the ear's contribution to the orientation of humans in their environment may not be the same in different racial groups. If such differences in the relative efficiency of visual versus auditory perception were found, they would be of practical importance for the learning of visually and auditorily presented material and thus for certain aspects of school education. On the level of very basic perceptual functions, such as brightness and loudness discrimination or visual and auditory reaction times, no such relative superiorities have been found in groups of white and black South African students. This does, not, however, exclude the possibility that differences exist in the perception of more complex stimuli, like patterns, tunes, symbols, words, or other meaningful visual and auditory percepts. Further experiments to answer these questions have been planned.

Sensitivity Training, a group discussion procedure, aims at making a person aware of his impact on others; and makes him sensitive to emotional and motivational undertones in statements made by others, for example by those attending the same committee meeting. An experimental test battery has been compiled and applied to investigate the effect a full-time five-day sensitivity training course has on the participants' attitudes and behaviour; the possibility of assessing personality changes which might result from the use of sensitivity training; the possibility that some persons might benefit more than others from the technique and that this can be predicted on the basis of test information before undergoing a course. The results obtained so far support the hypothesis that sensitivity training tends to increase self-insight, adjustment, social sensitivity and effectiveness; they do not, however, indicate that certain personality types are more influenced by the course than others.

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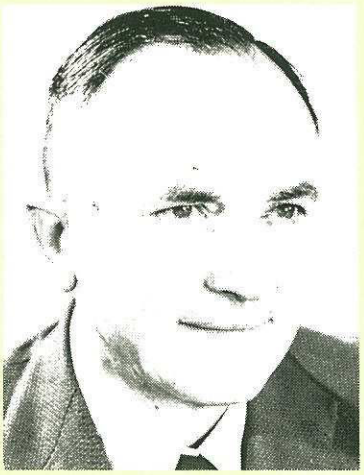


Dr. A. Strasheim, Director of the National Physical Research Laboratory.

The main function of the National Physical Research Laboratory (N.P.R.L.) is to contribute to the development of physical science in the Republic through research aimed at the adaptation of existing knowledge as well as the creation of new knowledge for the solution of technological and industrial problems of national importance. In addition the N.P.R.L. has statutory responsibilities for maintaining national standards of physical measurement for mass, length, electricity, radiation, etc.

Within the N.P.R.L., groups of research workers constitute a nucleus of research manpower for both basic and applied research in the following fields: optics, nuclear physics, solid state physics, acoustics, spectrochemistry, infra-red spectroscopy, electron microscopy, geophysics, electron spin resonance, geochronology, oceanography and high-pressure physics.

Introduction

In accordance with the principle of advancing the physical sciences in the Republic, both within the laboratory and without, personnel of the National Physical Research Laboratory have been active in South West Africa, the Eastern and Western Cape, the Eastern Transvaal, and Natal. Thus geophysical measurements were done in the Lüderitz and Port Elizabeth areas; micro-metereological studies were undertaken in connection with the siting of factories in Natal and in the Western Cape and further knowledge of the behaviour of the Agulhas current in the vicinity of Durban was acquired.

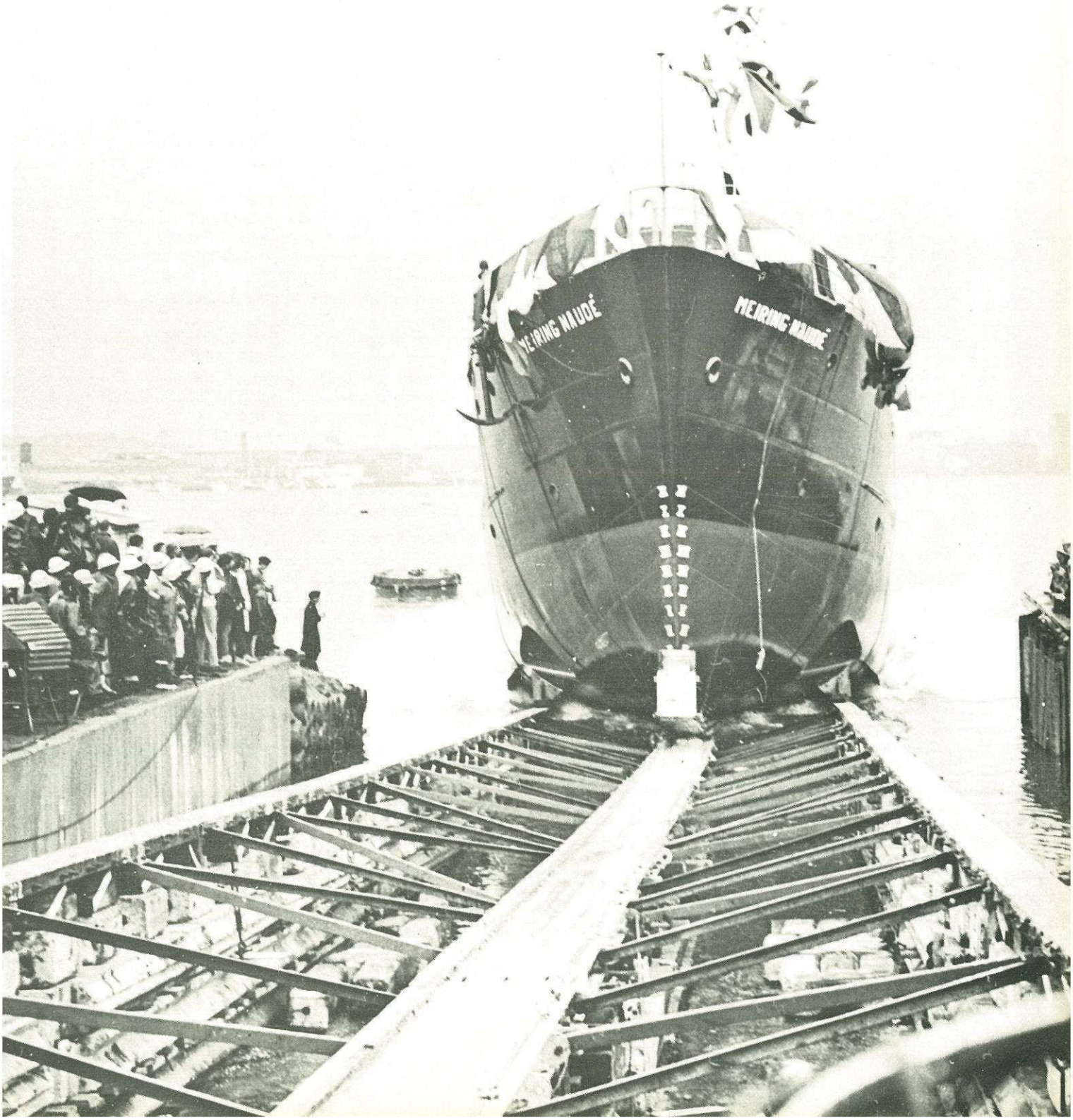
APPARATUS

Automatic X-ray crystal diffractometer

Money has been granted to the X-ray Diffraction Subdivision for purchasing an automatic X-ray crystal diffractometer. The acquisition of this instrument will again bring the apparatus of the X-ray Diffraction and Electron Microscopy Division up to world standard. It is anticipated that all

The NPRL research vessel, the Meiring Naudé, *was launched in November 1967. It is expected that the ship will be taken into service towards mid-1968*

THE NATIONAL PHYSICAL RESEARCH LABORATORY



crystallographers in the Republic will make use of this instrument.

Spark source mass spectrometer

The importance of the influences of micro-traces in materials is increasingly being realized. The purchase of a spark source mass spectrometer will be of advantage to the N.P.R.L. in determining elements in the parts per billion range. The technique is applied to semi-conductors, metals, and biological, chemical, and geochemical materials. One of the first projects to be undertaken with this instrument will be to determine certain indicator elements of importance in any oil prospecting programme.

Alterations to the cyclotron

In order that the life of the cyclotron may be extended, its auxiliary equipment should become increasingly sophisticated. The following measuring systems were made available to the Nuclear Physics and Radioactivity Division during the past year:

(i) A coincidence system for experiments on the external cyclotron beam; and
(ii) a unit for accurate gamma spectroscopy.

During the past year the energy of the external cyclotron beam was successfully lowered and energies of 6 to 24 MeV were used for experiments.

A germanium-lithium compensated gamma ray detector, with a volume of 1 cc and an energy resolving power better than 4.7 keV for the 660 keV gamma line of 137Cs, has been manufactured in the Nuclear Physics and Radioactivity Division. Such detectors are of exceptional importance in modern gamma ray spectroscopy, because of their outstanding energy resolving power.

Low activity instrumentation

During the year apparatus for the Low Activity Division was purchased and constructed. Purchases included, amongst others, an incinerator and a mass spectrometer for studying stable isotopes.

IMPORTANT RESEARCH RESULTS

Deep electrical soundings

A deep electrical sounding survey was carried out for Soekor in the vicinity of Port Elizabeth, with the following aims:

- to determine whether the deep sounding technique could be applied to great depths in order to trace deep-lying structures; and, if so,
- to determine the depth and structure of the chalk basin.

Measurements indicated that both objects could be achieved and the promising results obtained in this area have led to the further use of this technique on behalf of Soekor in other areas.

Age determination of rocks

Determining the age of rocks is an important facet of the study of the inter-correlations of the different geological systems found in the Republic. In studying regions where old rocks occur, as in the Eastern Transvaal, age determination is invaluable. Studies of the Barberton-Nelspruit granites and the Onverwacht lavas are also of importance to the Upper Mantle Project, which is at present being undertaken on a national basis. These studies have revealed the greatest age for any rock on earth ever determined by the U-Pb method, viz., 3,360 million years.

Air pollution

When the height of an industrial stack is to be decided upon, an equation is used to estimate the dissipation of the pollutants as they travel down wind from the stack. The constants in this equation need to be evaluated for South African conditions. The Air Pollution Research Group is working on a project, sponsored by the Department of Health, to determine these constants. A tracer element, emitted from the top of a mast, is collected in air samplers down wind of the mast. The emission rate and the ground level concentrations are inserted in the equation in order to determine the constants.

The Air Pollution Research Group has also joined in a study initiated by the National Centre for Air Pollution Control, U.S.A.

The primary objective of this study is to evaluate the suitability of the permeation tube technique as a standard method for generating calibration concentrations of sulphur dioxide in the air. The Group received two SO_2 permeation tubes and has determined their permeation rates. At certain intervals the permeation rates will be re-determined to establish the degree of reproducibility of the tubes. If the permeation tube technique is found suitable the tubes will be used to examine the accuracy of existing analytical methods for determining concentrations of sulphur dioxide in the air. They will also be used for calibrating commercially available SO_2 recorders.

Use of ventilation shafts of gold mines for studies of clouds

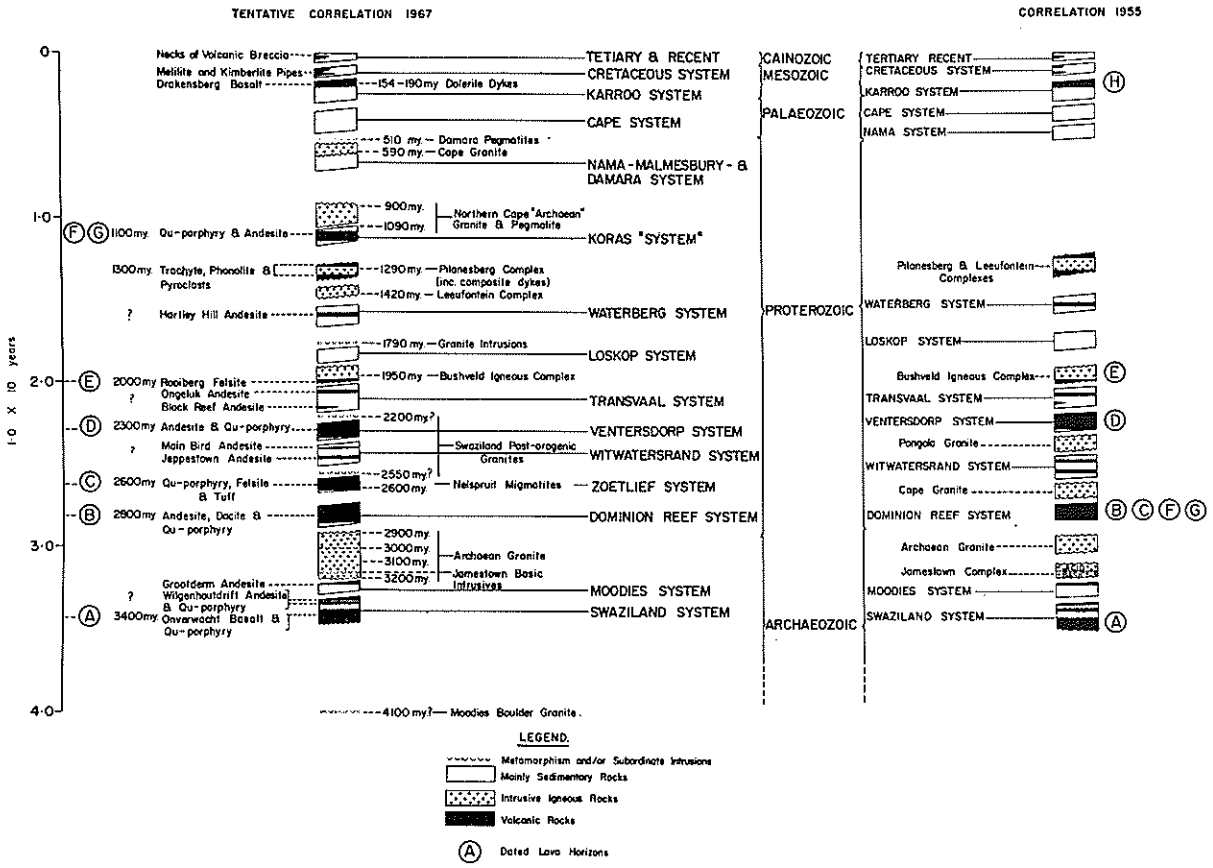
Moist air which comes in at the bottom of a mine ventilation shaft, is cooled and condenses in the process of being drawn up the shaft. The small droplets grow while rising in such a shaft and can reach the top as raindrops. It is hoped to make use of this — to some extent — ready-made facility for obtaining the relationships between drop-size distributions and parameters such as cloud nuclei content of the air, updraught and electrical charges on the drops.

Multi-element atomic absorption analysis

The atomic absorption analytical technique with its wide field of application, is still essentially a "single element" method. The Kranz arc has been found to be an outstanding primary light source for multi-element determinations, as the elements to be determined can be excited simultaneously in this light source. The reproducibility of the measurements is very good and a further advantage of the method is that it is possible to alter the atomic absorption working range by varying the concentrations in the arc solution.

Wave-front shearing interferometer

A wave-front shearing interferometer can be used to advantage for evaluating optical systems. The instrument has certain advantages over other interferometric methods in that deviations can be determined precisely and for each aberration a characteristic type of deviation is evident. An instrument, where adjustments of the different



A revised chronological sequence for the rock formations in South Africa compiled by the Geochronology Division of the National Physical Research Laboratory in the light of uranium-lead isotopic dating

mirrors are possible with no backlash, was successfully developed and various systems have already been tested with it; amongst others, the optical components of the Echelle spectrograph which was built in the Optics Division.

The interaction of laser light with crystals

The technique of focusing a laser beam inside a crystal by means of an optical microscope has created a new method of investigation for the electron microscope. The shock waves excited inside the crystal by a laser pulse cause micro-cleavage and the thin foils that are split off are approximately 1000 A thick and therefore suitable for study in an electron microscope. The method has been successfully used in preparing thin foils of crystals, including diamond, zircon, and tourmaline.

Electrical shark barriers

Further work has been done on electrical shark barriers for the protection of bathing beaches. Tests carried out at St. Lucia have shown the electrical barrier to be fully efficient. Reduced electrical fields are at present being tested and attempts are being made to decrease the cost of installations of this sort. In collaboration with the National Chemical Research Laboratory, corrosion problems have been overcome by providing special non-corrosive electrodes. Overall results are most promising.

ROUTINE SERVICES TO INDUSTRY

The building industry and other sectors of industry are gradually beginning to realize the importance of acoustical consultations during the planning stage. Outstanding success has been achieved in the acoustics of a church building in Pretoria which seats 1,500 people and a business centre in Johannesburg.

Large amounts of Na^{22}, Sr^{85}, Be^{7}, Cd^{109} and Cs^{139} are still being exported. These isotopes are also made available in purified form for internal use. Various enquiries in connection with protection problems during the use of diagnostic X-ray apparatuses have been dealt with.

As in the past, industry has made use of the special analytical services of the Spectrochemistry Division.

GENERAL

During the refresher course for science teachers arranged by the Transvaal Education Department, the teachers paid a one-day visit to the Laboratory. Six lectures were given by staff members to enable the teachers to acquire background knowledge for the elucidation of their syllabus. To enable one teacher per high school to attend the lectures, the course had to be repeated five times.

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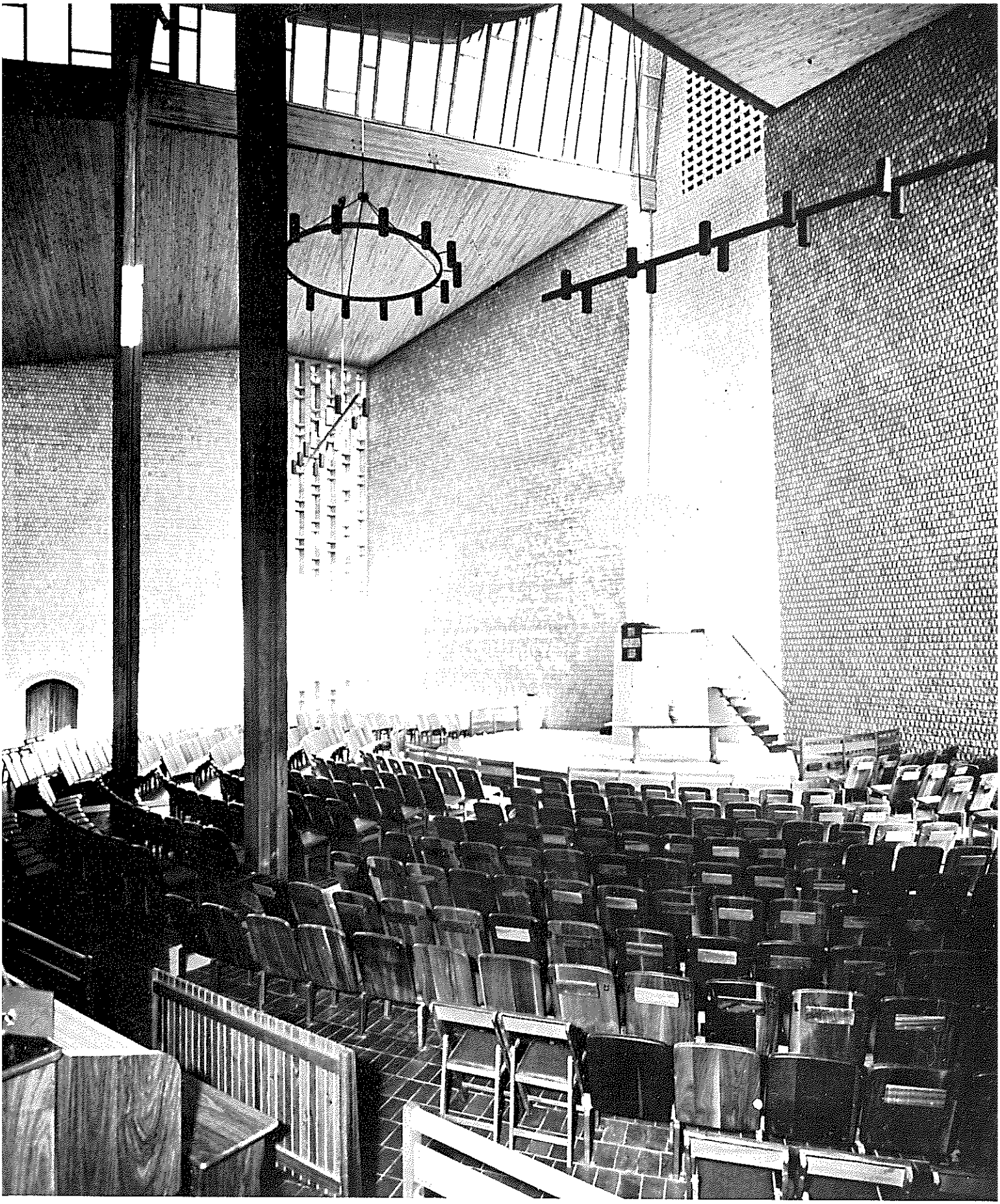
* Members of other institutes.

This interferogram of a 250 mm, f4.5 lens was obtained with a versatile wavefront shearing interferometer. The aberrations of the lens are depicted as departures from a straight line. In the example shown, this amounts to about a wavelength of fifth-order spherical aberration



Universiteitsoord Church, Pretoria (Photo: Vic. V. Jacobs). The NPRL acted as acoustic consultants for this church which has a seating capacity of 1,500. Speech intelligibility is good at all positions without the use of sound amplification. Acoustical conditions for church music are also excellent

REPUBLIC OBSERVATORY JOHANNESBURG

Mr. J. Hers, Acting Director of the Republic Observatory.

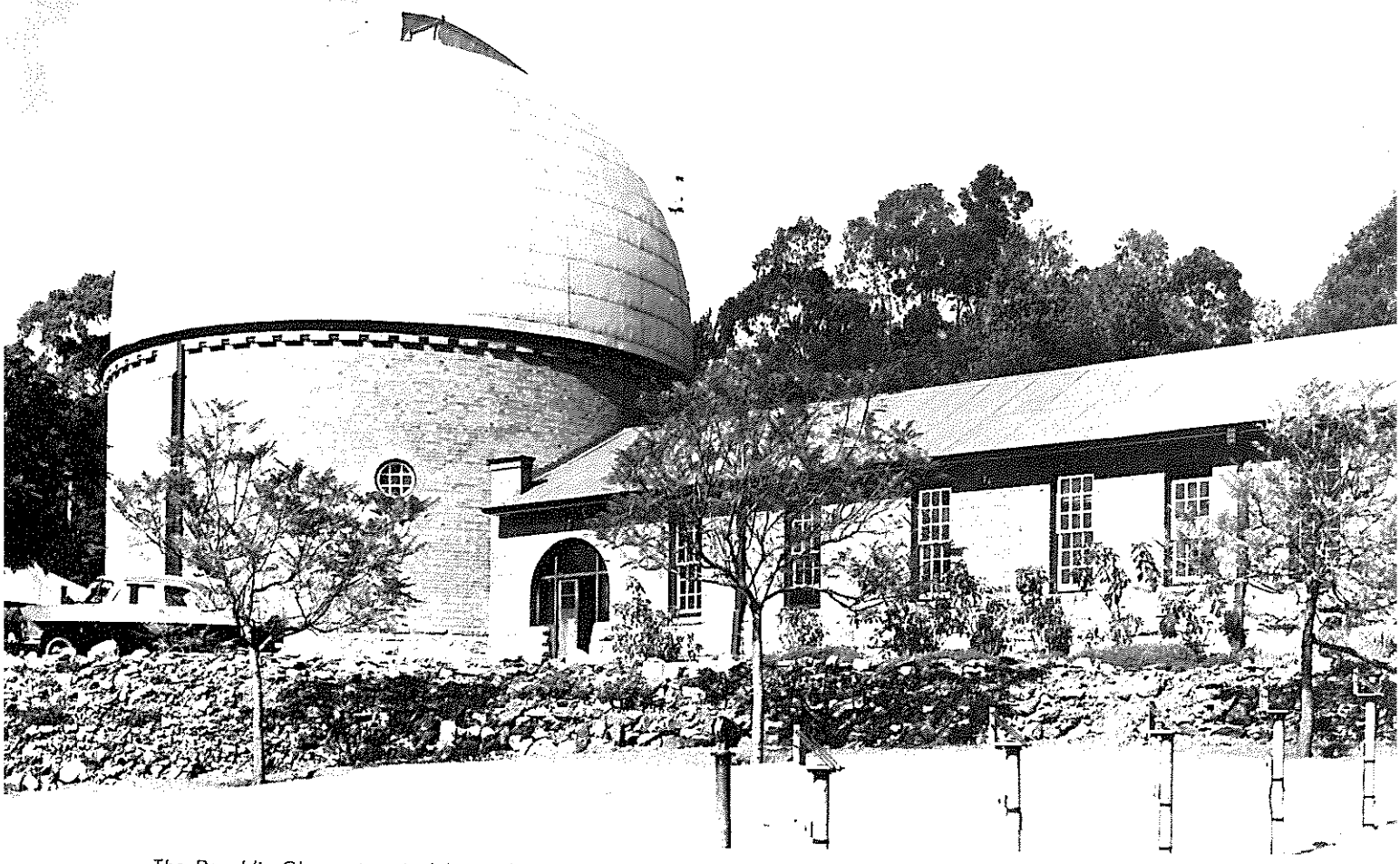
The Republic Observatory is not limited in function to pure research, but also performs duties of a civil nature, in the field of astronomy in particular, the maintenance of the national time service. This is made available to the public by the time signal and standard frequency transmitters ZUO (one, of low power, operated by the Observatory, and another, of high power, by the Post Office). In addition, these signals are distributed by land line to the Post Office, the S.A.B.C. and other public institutions.

The principal long-term programmes of the Observatory comprise observational and theoretical research in the field of visual double stars (recently extended to include eclipsing binaries) and photographic observations of minor planets and comets. For half a century the Observatory has been identified with these programmes to such a degree that they have almost become international commitments. The programme for investigating minor planets and comets has led to the discovery of several new comets and more than 500 new minor planets, many of which have been given typical South African names like Pretoria, Transvaalia, Nerina, Gaika, Umtata, Outeniqua, etc.

The short-term projects of the Observatory have included the successful search for Proxima Centauri, our nearest known stellar neighbour apart from the sun, the detection and measurement of the rotation of the minor planet Eros, the "splitting" of Nova Pictoris, the publication of a photographic star atlas of the southern sky, and a series of colour photographs of the planet Mars.

Astronomy

The programme of interferometer observations of double stars was continued and the $26\frac{1}{2}$-inch refractor was used for micrometer observations of double stars. Minor planets and comets were observed photographically by means of the Franklin Adams telescope at the Hartbeespoort Annexe. The 9-inch refractor was used for photoelectrical observation of eclipsing variable stars.



The Republic Observatory in Johannesburg. Within the dome shown in the photograph is the 26½ inch Innes refractor telescope with which South African astronomers have been scanning the skies for more than 40 years

Binary stars

Current astronomical research increasingly supports the view that the double star system, far from being abnormal as once believed, are the rule rather than the exception. It is certain that more than half the stellar population consists, not of single stars like our Sun, but of binary or multiple systems. They are therefore of fundamental importance in any study of stellar evolution.

The Republic Observatory has taken a special interest in this branch of astronomy from the date of its establishment in 1903. Its first director, R. T. A. Innes, had already acquired a considerable reputation as a double star observer, and had compiled and published a Reference Catalogue of Southern Double Stars in 1899.

Observations in Johannesburg were commenced when a 9-inch telescope was installed in 1906, and three years later an order was placed for a 26½-inch refracting telescope, intended and designed specially for double star observations. When it was delivered in 1925 an immediate start was made on a systematic research programme for the discovery of new double stars, as well as for routine measurements of those already known. This survey listed approximately 4,000 new double stars. In 1927 a new Southern Double Star Catalogue was published, and today an exhaustive card catalogue listing all published observations of southern double stars is continually kept up-to-date. The telescope, which is small by modern standards, is today still the largest which the Observatory possesses, and remains in constant use, its scope having been extended in recent years by the development of the Finsen eyepiece interferometer.

More than 64,000 double stars are known today, and in the southern hemisphere the Republic Observatory is almost wholly responsible for keeping them under regular observation. This programme is of a fundamental and long-term nature, and seldom yields dramatic results, but it provides basic data of the most essential kind for modern theoretical astrophysics.

Time service

The accuracy and stability of present-day atomic clocks has spotlighted the inadequacy of the conventional methods of comparison in which high-frequency radio time signals are used. Low-frequency and very-low-frequency radio signals have been used to make measurements of relative time over long distances accurate to within about 1 microsecond, but the measurement of absolute time differences has remained a problem. At present the best solution is provided by portable caesium atomic clocks, ("Flying Clocks") which can easily be carried from place to place in normal passenger aircraft. It was in this manner that the clocks at the Republic Observatory were compared with similar standards in the U.S.A. and elsewhere in September 1967 with an absolute measuring accuracy of 1/10 microsecond. Such close co-ordination has made possible numerous other experiments involving time over large distances.

THE NATIONAL INSTITUTE FOR ROAD RESEARCH

The work of the National Institute for Road Research (N.I.R.R.) is orientated towards developing methods for the economic construction and maintenance of better and safer roads in the Republic. This covers research in various fields such as soil mechanics and road foundation, bituminous binding material and road coverings, instruments for accurately controlling different road building processes, road building economics, traffic engineering and road safety.

The Institute collaborates closely with national, provincial and other bodies in various problems encountered in designing, building and maintaining roads and streets. These bodies, including the South West Africa Administration, provide virtually all the funds for road research, the National Transport Commission being the main contributor.

Dr. P. J. Rigden, Director of the National Institute for Road Research.

Road base experiments

The 52 small-scale sections of base laid in the form of a test loop during August/September 1966 at the Institute's Test Site have yielded useful information, but further trafficking is required before firm conclusions on the performance of the different test specifications and mixtures can be drawn.

Most sections were laid in the form of wedges which are 3 inches at one end and 6 inches thick at the other. Control sections with a constant thickness were also included. Different types of specifications were included, like those for "crusher-run" stone bases, waterbound and penetration macadam, and bitumen-stabilized sand. The "crusher-run" stone bases, consisting of different types of aggregate were also bound with cement, bitumen and tar. The sections of base were surfaced with a thin layer of premix and were then trafficked with a truck with a 14,000 lb. axle load, 10,000 passes having been completed so far.

During trafficking precise level observations were carried out to measure any deformation. The flexural performance of the bases was assessed by means of "static" Benkelman beam deflection and radius of curvature measurements and dynamic measurements were made with a specially developed portable apparatus. This apparatus enables both wave propagation and impedance measurements to be carried out non-destructively. From the wave propagation measurements the Young's moduli of the different layers in the construction can be evaluated, while the overall stiffness and dynamic deflection can be calculated from the impedance measurements.

In co-operation with the City Council of Johannesburg, a base experiment of limited scope was commenced on a heavily trafficked city street. The three sections laid consist of unbound "crusher-run" base and sections bound with cement and tar. The same methods as those used in the above small-scale experiment are being used to assess the performance of the sections. Similar materials and specifications were used in both experiments to enable useful comparisons to be made.

The test loop road on the test site of the National Institute for Road Research under construction. The performance of different road bases and surfacing materials can be evaluated here

Stabilization of sand with bituminous binders

Follow-up work has been carried out on the 18 sections of bitumen-sand base laid in the one-mile experimental length on the road between Tsumeb and Ondangua in Ovamboland, South West Africa. The shear strengths of all the mixtures have shown a big increase since they were laid down, and generally the traffic (which includes a high percentage of heavy trucks) is being carried without its causing excessive deformation. The encouraging results obtained from this experiment confirm that bitumen-stabilized Kalahari sand could be used to build roads, and the Institute is currently undertaking an economic study of different bitumen-stabilization methods which could be used in practice. Because of cost considerations, conventional methods are being used to construct the adjoining road, but the results from the experiment could be applied in the future.

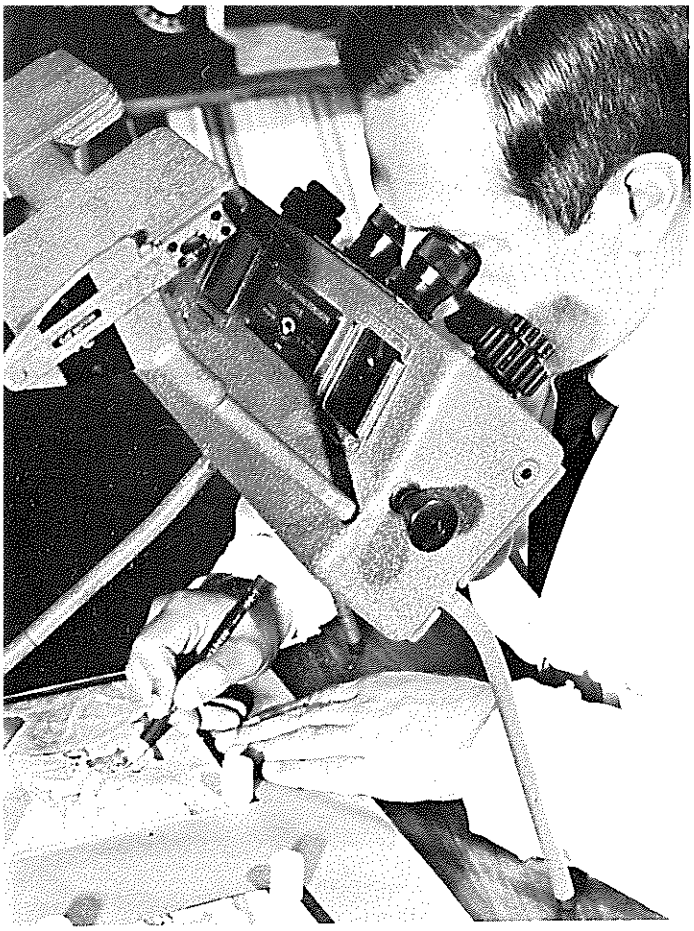
Communicating research results to practice

The application of suitable research findings to practice has, in recent years, been recognized increasingly as a task of the first importance. One way of achieving this is by means of bulletins and other special reports on particular projects. In pursuance of this objective, a series of bulletins is being prepared to review the Institute's extensive road surfacing experiments, which began in 1951.

A bulletin reviewing road priming experiments carried out between 1961 and 1964 has been published. Most different types of prime available locally were tested in the experiments. It was demonstrated that, while all the different types of prime tested could be used successfully for priming dense crusher-run and cement-stabilized gravel bases, some of the primes were clearly unsuitable for certain specialized applications — such as enabling the base to carry light traffic without disintegrating and ravelling. The experiments also indicated that it is undesirable to use heavy applications of prime on dense crusher-run bases, as they can result in excessively long drying times and other problems.

Soil engineering mapping and storage of data on terrain

A bulletin published in 1964 marked the end of the first stage in this project and showed that it is possible to use the techniques of air-photo interpretation for producing soil engineering maps. These maps can be used economically for locating materials used in road construction projects. The maps were normally on a scale of 1:30,000 and



A scientist studying air photographs through a stereoscope. The National Institute for Road Research has shown that it is possible to use the techniques of air photo interpretation for producing soil engineering maps which can be used economically for locating road building materials

referred to specific road projects. Air-photo interpretation has been developed in Australia for stocktaking of natural resources in undeveloped terrain on a scale of 1:1,000,000, the recognizable patterns being delineated to form Land Systems.

Recent work in the Institute has been aimed at producing a scheme for storing data on terrain. The scheme contains the following:

(a) A Type Index giving generalized types of Land Systems (of which there may be 2,000 to 3,000 in the world).

(b) A Terrain Index relating to particular localities defined by air photos, and a generalized block diagram of the kind already found useful in soil engineering mapping.

(c) A Data Store, containing information of a soil engineering nature, designed for easy retrieval of information relating to road design and construction, and location of materials. In future this may be found useful also as a framework for storing information of a geomorphological, hydrological and agricultural nature.

At present a large area between Pretoria—Johannesburg and Brits—Bronkhorstspruit is being studied in order to define Land Systems, and to work out details of the storage mechanism for each type of Index mentioned above. A large mosaic of air photos has been prepared for this area and about 15 Land Systems defined. Many soil profiles have been investigated and several hundred soil samples tested.

When the work is completed, the Karroo System, which might possibly contain 20 Land Systems, and which covers a very large portion of the country, will be studied.

Airport foundations and surfacings

Over the past few years the Institute has been requested to investigate several problems that have arisen on some of the major airports in the Republic and South West Africa. The main problems concern uneven runways which affect landing and take-off, and surface cracking.

(i) **Port Elizabeth**

The Department of Transport requested assistance in its investigation of the runways. Work undertaken by the Institute included 50-ton plate-bearing tests, precise levelling observations, a study of vibration rolling and special dynamic impedance and wave propagation tests. The results of this work aided the Department in its selection of a thick bituminous overlay as the best means of strengthening and improving the riding quality of the main runway.

(ii) **Bloemfontein**

The Institute assisted in an investigation into the causes of cracking and deformation on the airport runways. An important question was whether the recent introduction of the Boeing 727 aircraft with much heavier wheel loads had affected the condition of the surfacing and foundations. Plate loading tests revealed that, in general, the runways were not being severely overstressed, but further difficulties might arise in cracked areas owing to the effects of water, both in softening the underlying soil and in causing heaving of the active clay.

(iii) **Alexander Bay**

In the early stages of planning the runway, it became apparent that foundation and surfacing problems would be encountered if local materials were used in the interests of economy. As construction was a matter of great urgency, the Department of Transport's consultants were assisted with the experimental work on a bitumen-bound base. This work consisted of extensive field tests involving wheel-tracking under simulated aircraft loads travelling at 30 m.p.h. The final construction, consisting of local sands stabilized with bitumen, is performing very satisfactorily.

(iv) **Windhoek**

At the request of the S.W.A. Administration, the Institute carried out an investigation into the cracking of portions of the new runways. The results indicated no obvious reasons for cracking nor could fault be found with the design or construction. Under the extreme conditions of climate at

the airport, and with very little traffic, thermal expansion and contraction may have been a major cause of cracking.

(v) **Jan Smuts**

The Institute carried out skid-resistance tests on experimental sections along the main runway, after complaints by pilots that it was slippery when wet. The Institute also advised on problems associated with painting large white areas of runway.

Calcretes as roadmaking materials

Calcretes (surface limestones) form an important source of materials for roadmaking in Southern Africa. Calcretes, which are formed by a precipitation of calcium carbonate in the soil, vary from a fine powder to a hard rock-like mass, depending on their stage of development.

Much confusion has been caused in the past by the rather indiscriminate use of the term "calcrete". Work done by the Institute has enabled the range of engineering properties of "calcrete" to be established, and a system of nomenclature suitable for road and general engineering use has been suggested. The system is based on the stage of development of the calcrete, subdivided according to its engineering properties.

A useful correlation between the Mohs' hardness of calcretes and their aggregate crushing strength has been established, and a new field test for calcrete gravel road materials has been developed.

Methods of locating calcrete deposits have been investigated and it is concluded that the combined use of air-photos, vegetation indicators and a special rapid probing device offers the best solution at present.

Portable apparatus to measure axle loads

Before a new road is designed, it is essential to have information on the number and distribution of axle loads that it is expected to carry over its design life. Various methods can be used to measure the axle weights of existing traffic: these include "loadometer" surveys, and static and dynamic weighbridge surveys. The main disadvantages of these methods are their high cost and the number of personnel required for continuous operation.

The Institute has developed a portable apparatus for weighing axles that is comparatively cheap and, being automatic, requires a minimum of staff to supervise its operation. The apparatus comprises a neoprene rubber pad which is placed on the road to "sense" the pressures applied by vehicles passing over it, and a portable electronic recording instrument.

A number of different types of sensing pad have been investigated and finally a capacitive-type pad has been selected as the most reliable and suitable for the purpose. The application of an axle load alters the spacing between electrodes embedded in the pad and consequently the capacitance between the electrodes. The change in capacitance is converted into a pulse which is classified into one of 12 equivalent weight groups depending on the pulse amplitude. The number of axles in each weight group that have passed over the pad in a given period can then be directly read off automatic counters.

Extensive field tests have been carried out in Natal and the Transvaal to calibrate the instrument, and to determine the influence of various possible sources of error. The apparatus measures the dynamic weights of axles and has indicated a random deviation from the static weight of about 30 per cent. Consequently, an appreciable difference between the static and dynamic axle weight distribution of traffic exists.

Systematic errors in the measurements have been observed at different sites and for single wheels compared with dual wheels, and further investigation is needed to establish the cause of these errors and to find means of eliminating them, if possible. As the number of loads, particularly heavy loads, that can be measured with the present pads is limited, further work is being directed towards increasing the life of the pads.

The cost of road accidents

A motor insurance company, the South African Railways and the Pretoria Municipality co-operated with the Institute in making available information on the cost of damage to road vehicles involved in accidents. The insurance company also provided information on the costs resulting from injuries to those involved. These data have been used for estimating unit costs, which provide a basis for the estimation by synthesis of the costs of road accidents at particular road localities. A knowledge of these costs is essential in assessing the economic feasibility of improving hazardous road localities.

The average cost per casualty (all races) of fatal, serious and slight injuries were calculated to be R1,570, R1,230 and R185 respectively, while the average costs per vehicle damaged for motor cars, lorries and buses were R325, R146 and R36 respectively.

The total cost of all road traffic accidents in 1962 is estimated at R70 million, which gives an average cost for each accident of approximately R570.

Rural four-way stops

Four-way stops, which are intersections with stop sign controls on all four approaches, have been used extensively in the United States of America to reduce accidents at intersections. Some of these have been in operation for many years, but in South Africa they were introduced in the

One of the several four-way stop streets in the Transvaal. The NIRR has recommended that numerous dangerous intersections be provided with such four-way stop signs

early 1960's on the rural roads of the Southern Transvaal. At the request of the Transvaal Provincial Roads Department an investigation was made at six intersections into the effectiveness of four-way stops in reducing accidents, their observance by road users and the delay which they cause to traffic.

In regard to accident reduction, these six four-way stops have led to a considerable drop in fatal and serious injury accidents since their introduction. Comparison of figures from one year before with those from one year after their erection, shows that the total number of fatal and serious-injury accidents dropped from 15 to only 1. However, there was no significant difference between the numbers of slight-injury and no-injury accidents that occurred during two-way and four-way operation.

Generally the public seem to obey these stops, but with a good open field of vision for an approaching vehicle there is up to a 6 per cent chance that the driver will risk it and go through without even slowing down very much.

With this type of stop street, major as well as minor road traffic has to stop. Because of this the major traffic flow is delayed, which is not the case with the usual two-way stop. However, the delay is not excessive compared with that caused by a traffic light, and more flexibility is allowed as the driver is given the opportunity to use his own judgment as to what movements are possible at a given instant.

In general, the four-way stop seems to be a useful means for reducing fatal and serious-injury accidents at selected rural road intersections.

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THE NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Basically, the work of the National Institute for Telecommunications Research (N.I.T.R.) embraces the study of natural phenomena and their effects on radio waves, and the development of radio and radar systems for specialized applications. In addition, the Institute operates the Radio Space Research Station at Hartebeesthoek.

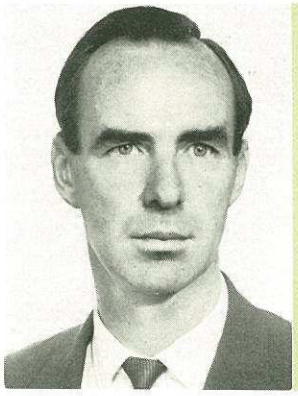
Since its inception the N.I.T.R. has carried out a programme of research into the ionosphere and its effects on the propagation of radio waves. As part of this programme the Institute issues monthly bulletins of ionospheric data and predictions of optimum frequencies for use in short wave radio communication. During the past year research has been directed mainly at the effects of particles precipitated into the ionosphere from the outer Van Allen radiation belt. This work is of particular significance to the Republic because of its situation near the region of enhanced particle precipitations known as the South Radiation Anomaly.

Research into the use of radar for studying clouds and precipitation has continued. This work can possibly be applied to measuring rainfall by means of radar, which could be of great importance in the development and control of the country's water resources.

A project of special significance in regions of high lightning activity is the development of a radio system to locate and to study lightning processes.

For some years a programme of radio astronomy has been carried out at the Radio Space Research Station, using the 85-foot antenna of the Deep Space Instrumentation Facility. Radio astronomical observations are limited to periods when the antenna is not required for tracking operations and this imposes severe limits upon the scope of the programme. However, significant contributions are being made.

A large part of the Institute's activity is devoted to the development of radio systems of distance measurement and position fixing. Since the invention of the "Tellurometer" principle of distance measurement in 1955, continued research and development by N.I.T.R. has enabled the Republic to maintain its leading position in the production of such instruments. The most recent development by the Institute was a "Tellurometer" instrument operating at a wavelength of 8 millimetres. Early this year the South African firm which is producing this equipment reported on field tests carried out by the Trigonometrical Survey. These showed that in addition to its long-range capability, the new instrument was eminently suitable for cadastral or engineering applications at short ranges.



Mr. R. W. Vice, Director of the National Institute for Telecommunications Research.

The development of an instrument for measuring distance by means of a modulated infra-red beam is now practically complete. It is expected that with this system it will be possible to measure distances of up to one kilometre to within a few millimetres.

Space tracking

The Institute has continued to operate the Radio Space Research Station (R.S.R.S.) on behalf of the United States' National Aeronautics and Space Administration (N.A.S.A.).

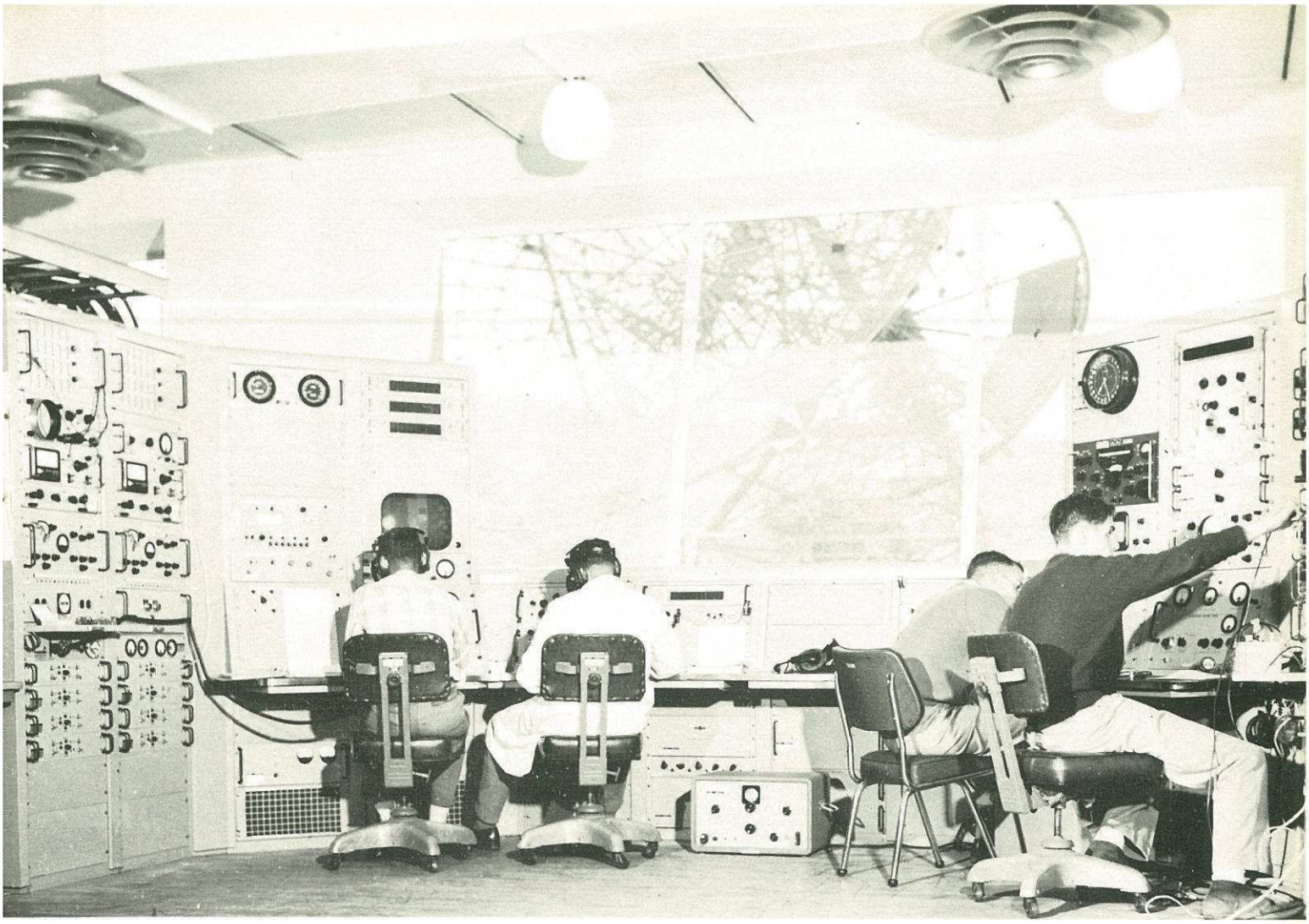
The station has played a prominent role in a number of space projects, and the staff have demonstrated their ability to meet the exacting technical standards required of them.

The R.S.R.S. is preparing to undertake a new commitment by co-operating with N.A.S.A. and the United States Coast and Geodetic Survey in the establishment and operation of a South African station which will take part in a world-wide programme of satellite geodesy.

Lightning research

The National Institute for Telecommunications Research is developing a radio system to locate the source of radio noise associated with lightning.

The system operates by measuring the relative



The control room of the Deep Space Instrumentation Facility at Hartebeesthoek.

times of arrival of the noise at a number of spaced receivers. An initial experiment has shown that an accuracy to within some 300 metres can be achieved. This makes it possible not only to locate the position of a lightning strike as a whole, but also to study its fine structure in space and time. It is intended to augment the radio measurements by radar and optical observations.

An important application of this system lies in the calibration of other systems for locating or counting lightning strokes. (Cross reference: N.R.I.M.S. lightning project.)

Satellite geodesy

Following a recently signed agreement between the C.S.I.R. and the United States National Aeronautics and Space Administration (N.A.S.A.), the National Institute for Telecommunications Research is preparing to take part in the United States' programme of satellite geodesy in which N.A.S.A. is co-operating with the United States Coast and Geodetic Survey.

Observations of geodetic satellites will be made at a South African station which will shortly be set up at the Radio Space Research Station at Hartebeesthoek, and which will form one of a world-wide network of similar stations. This station will be operated and manned by the C.S.I.R.

The objectives of the programme are to determine the size and shape of the earth and to provide a world-wide reference net to which all geodetic data can be related. The results will be made freely available to the geodesists of the world.

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TORR, D. G. Precipitated electrons as a cause of the irregular behaviour of the F_2 region. *Nature.*

Dr. G. J. Stander, Director of the National Institute for Water Research.

THE NATIONAL INSTITUTE FOR WATER RESEARCH

The National Institute for Water Research (N.I.W.R.) is one of the C.S.I.R.'s most diversified institutions. Research is done on a wide front and involves various disciplines such as chemistry, botany, zoology, microbiology, civil engineering, chemical engineering and geology. The projects undertaken by the Institute are generally based on specific problems rather than specific scientific disciplines and are often tackled on a team basis.

Apart from the main laboratory in Pretoria, the N.I.W.R. also maintains regional laboratories at Windhoek, Bellville and Durban as well as a limnological research group at Rhodes University. The regional laboratories concern themselves mainly with problems specific to the areas in which they are situated.

A review of the N.I.W.R.'s activities during 1967 is given below.

Management and purification of industrial effluents

As all industrial effluents have to conform to certain quality requirements laid down by the Water Act, industries are compelled to give attention to the handling of water and effluents. Many industries do not possess the technical knowledge necessary to meet these requirements and request the C.S.I.R. to assist in solving their problems. During 1967 assistance was rendered to factories representative of the following: pulp and paper, textile, yeast manufacturing, brewery, canning and chemical industries, and also of wineries and abattoirs. More details concerning these projects are given elsewhere in this publication, in reports for the relevant economic sectors.

There are certain principles of water and effluent management which apply, irrespective of the nature of a specific industry, and the N.I.W.R. propagates these principles with industries. To achieve this, the Institute is compiling a comprehensive guide on the subject, the first draft of which is already complete. The guide will eventually be distributed to all interested parties throughout the Republic.

Reclamation of sewage effluent, improvement of techniques for the purification of water and sewage

An important part of the N.I.W.R.'s research activities is aimed at the reclamation of sewage effluent for various purposes (including drinking purposes) and the improvement of techniques for sewage and water purification. More particulars on these activities appear under "Electricity, Gas and Water" in the chapter *Research for specific economic sectors.*

Discharge of effluents into the sea

The discharge of municipal and industrial effluents into the sea is an economical method of disposal, but one which can cause serious pollution of the sea and beaches. This is particularly so in densely populated areas, which may be popular tourist resorts and where pollution not only adversely affects the tourist industry by aesthetic offences, but also has a detrimental effect on public health. For this reason the N.I.W.R. has for some time carried out surveys along the Natal coast in respect of sea currents, and wave and wind action. On the basis of information thus obtained, predictions can be made of the extent to which effluents will disperse if they are discharged in specific places. Observations have also been carried out when pipelines have been laid to evaluate the extent to which pollution has taken place.

In addition, background information is collected on the chemical, bacteriological and biological conditions of beaches along the Natal coast. With the aid of these data it will be possible to determine in advance the extent to which the discharge of waste matter into the sea will affect the beaches. The N.I.W.R. has already established pollution criteria for Natal beaches so that it is possible to determine whether or not a beach is already polluted.

Research into sea pollution is done under contract for the Natal Provincial Administration, the Durban Corporation and a number of industries.

Anaerobic digestion of waste matter

Anaerobic digestion of organic material is a process applied on a large scale in treating organically polluted effluents. In practice it is often found that imbalances which occur in the process are not easy to explain. The process is complicated and influenced by many variables. Consequently, the N.I.W.R. concentrates on basic research into the process. It is hoped that the information obtained will enable anaerobic digestion to be operated on a more reliable basis. During the past year, the N.I.W.R. has issued many publications on this subject.

The utilization of solid waste materials

The injudicious disposal of solid waste material can lead to water pollution. For this reason the N.I.W.R. is paying attention to this problem. A solid waste product which causes various problems is the paunch contents of slaughtered animals at abattoirs; the N.I.W.R. is currently trying to develop a suitable process to convert these into compost. A pilot plant for this purpose is operating at Onderstepoort. The composting of solid waste from a paper and pulp factory is also being investigated.

Disposal of mineralized effluents

Mineral pollution of water constitutes a more serious problem than organic pollution, since organic material can be effectively broken down through biological processes to simpler compounds such as water, carbon dioxide and methane. An accumulation of salts in water has an adverse effect on the utilization of the water and, in addition, desalination is still an expensive process.

The N.I.W.R. is currently investigating the disposal of mineralized effluent through irrigation. At test sites, experiments are carried out to determine the reaction of various growths to the mineralized water and to determine the long term effects of irrigation on soil structure. It is well known that certain soil structures, and accordingly their productivity, can be adversely affected by the application of mineralized water. Simultaneously, experiments are carried out to determine the effectiveness of various soil amendments in counteracting brack formation in the soil under irrigation.

A second method being investigated by the N.I.W.R. to eliminate mineralized effluents is that of evaporation. These effluents can be evaporated from open dams (which require large surface areas however) or by spray evaporation. The second method in particular is being investigated at present.

Effluents from textiles and paper and pulp Industries and from leather tanneries are involved in these investigations.

Service to provincial administrations, state departments and local authorities

The N.I.W.R. does research on behalf of the Provincial Administrations of Natal, Transvaal, Orange Free State and South West Africa on a long-term contract basis. The Institute is also often requested by provincial and local authorities as well as by state departments to solve *ad hoc* problems of sanitation, water supplies and effluent control.

Pathogenic bacteria, viruses and parasites in water

The N.I.W.R. is making a study of the presence of pathogenic bacteria, viruses and parasites in the effluents from hospitals, in raw sewage, in purified effluents and in water courses. Little is known in this connection and much remains to be done, for example, in the adaptation and evaluation of qualitative and quantitative techniques. One of the most significant findings already made is that the polio virus is more resistant to chlorination than the bacterium *E. coli*, which is generally accepted as an index for determining whether water is virus and bacteria free.

River research

The flow in most South African rivers is either weak or intermittent and constant guard has to be kept against pollution, since dilution cannot be depended upon to reduce the degree of pollution. It is therefore desirable that thorough chemical and biological surveys be made of the important rivers in the Republic as soon as possible, to provide a record against which the extent of future pollution can be measured. The N.I.W.R. has already made such surveys of all the rivers of the country which are economically important (at this

A N.I.W.R. scientist collecting samples of aquatic life along the banks of a Natal River.

stage), with the exception of the Caledon, the Orange and the Fish Rivers. Surveys of the last named rivers have already commenced.

During 1967 the N.I.W.R., in co-operation with the Natal City and Regional Planning Commission, published a series of reports on the water quality of Natal rivers. The reports cover all the river systems in Natal with the exception of those in northern Zululand — which are now being studied by the N.I.W.R.

A survey of the Berg River in the Western Cape was completed some years ago, and the N.I.W.R. is at present engaged in carrying out a follow-up survey to determine the extent to which the condition of the river has since changed.

Research into water fauna and flora

Since there is a definite relationship between the types of insects and diatoms which occur in water and the chemical quality of the water, a thorough knowledge of these organisms can be invaluable in discovering the incidence of long-term pollution. The N.I.W.R. is consequently doing basic research into the taxonomy and physiology of water organisms.

The Transvaal Provincial Administration is investigating fish farming as a source of protein food for Bantu in the Northern Transvaal. In order to effect the most advantageous conversion of other foodstuffs into protein, knowledge must be gained of such aspects of the problem as food chains in dams where fish are bred, and of the food consumption and tempo of growth of the fish. At the request of the Provincial Administration, the N.I.W.R. is carrying out research into these aspects.

Effect of dieldrin on the water environment

In co-operation with the Department of Agricultural Technical Services, the N.I.W.R. is carrying out research into the effects of dieldrin on the water environment, since the knowledge will be required if dieldrin is to be applied for large-scale combating of pests. One aspect being investigated is the toxic effect of the dieldrin on various types of fish and the degree to which water chemistry affects the toxicity. Another important aspect is the eventual fate of the dieldrin used for spraying. This entails investigation into the concentrations of dieldrin which build up in ground, in water and in the bottom sediments of dams and rivers. The tempo at which dieldrin breaks up under natural conditions plays an important role in this regard and therefore requires thorough investigation.

Solar distillation of saline water

The application of solar distillation as a desalination technique is being investigated by the N.I.W.R.'s regional office at Windhoek. This technique can be utilized advantageously, particularly

in South West Africa, where available water is often unsuitable for domestic use because of its high mineral content — and other methods for obtaining fresh water are generally very expensive.

Experimental units for sun distillation have been erected at a test site at the Gross Barmen hot water springs and at the C.S.I.R.'s experimental station next to the Swakop River. Units of varying design, and three different sources of energy are used: solar energy, hot water from a hot water mineral spring, and the waste heat of a diesel generator.

Influence of evaporation on the salinity of water in sand beds

Salinity of water in South West Africa is an essential problem, and one which occurs particularly in the case of water flowing in sandy riverbeds. This phenomenon is very prominent in the lower reaches of the Swakop River, for example. At the request of the South West Africa Administration, the N.I.W.R.'s regional laboratory in Windhoek commenced evaporation experiments with sand mixtures representative of conditions in the Swakop River.

In the experiments, which are carried out in identical tanks, water of a constant chemical composition is used while the nature of the sand mixtures is varied. Automatic electronic equipment constantly registers data on temperature, humidity and water level.

Water map for South West Africa

At the request of the South West Africa Administration, the N.I.W.R. is compiling a map of underground water in South West Africa. The map is based on the chemical quality of underground waters and thus can be used as a guide for the establishment of industries and communities, since the quality of available water is then an important factor. Possible relationships between the chemical quality of water and the geological formations where it occurs can also be deduced from the map; such relationships will be of great geological value. The map can also help to isolate areas where toxic elements generally occur in the water.

Research into the influence of evaporation on water salinification is carried out with the aid of these underground tanks at Gross Barmen in South West Africa.

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THE SOUTH AFRICAN WOOL TEXTILE RESEARCH INSTITUTE

Dr D. P. Veldsman, Director of the South African Wool Textile Research Institute

The South African Wool Textile Research Institute (S.A.W.T.R.I.) is concerned with the behaviour in processing of the South African wool and mohair clips, with the improvement of current methods of processing and the development of new ones. It also carries out research on "easy-care" properties that can be introduced into end-commodities manufactured from these natural fibres. S.A.W.T.R.I. thus assists the entire line of industries responsible for South Africa's major agricultural product.

Its research programme covers the entire field from fibre to fabric and includes fundamental and applied work. Separate departments, which work in close co-operation, have been formed for protein chemistry, textile physics, mechanical processing and dyeing and finishing, whilst a special section deals with enquiries from the wool textile industry.

In the processing field, aspects of scouring, carding, gilling, combing and knitting are investigated. These activities are being expanded to include drawing and spinning as well as weaving. Closer collaboration has been established with the Technological Division of the S.A. Wool Board which has a pilot laboratory on the same campus.

The training of textile technicians and technologists is undertaken by the Technical College and the new University of Port Elizabeth with the assistance of S.A.W.T.R.I. staff and facilities.

The South African Wool Textile Research Institute's new R700,000 building complex at Driftsands, Port Elizabeth, was officially opened on June 20th, 1967. This brought to a close an inevitable period of relative unproductivity in the research effort.

New equipment

A range of new machines has been installed so that wool and mohair can, for the first time, be processed from the raw state to the woven or knitted fabric without the assistance of the Institute's industrial subscriber firms. Further items of equipment have been received or are expected to arrive shortly to complete the range of processing and finishing machines.

Detailed study of local fibre clips

Fibre identification

Fibre blending has become normal practice in the textile manufacturing industry and, consequently, the need has arisen for routine analytical techniques to distinguish fibres of different types. This has recently become important as cases of adulteration of mohair textiles with cheaper long wools have been detected.

Chemical and histochemical techniques are ineffective in detecting differences between closely related animal fibres.

Recent microscopical studies of fibre profiles have shown that the pronounced differences between fibre types can be used to differentiate between mohair and such wools as Wensleydale, Leicester, Lincoln and Buenos Aires. This qualitative method of identification of fibres is a tedious procedure not suitable for routine quantitative analysis of blends, although it can be applied with a degree of accuracy to individual samples.

New use for karakul hair

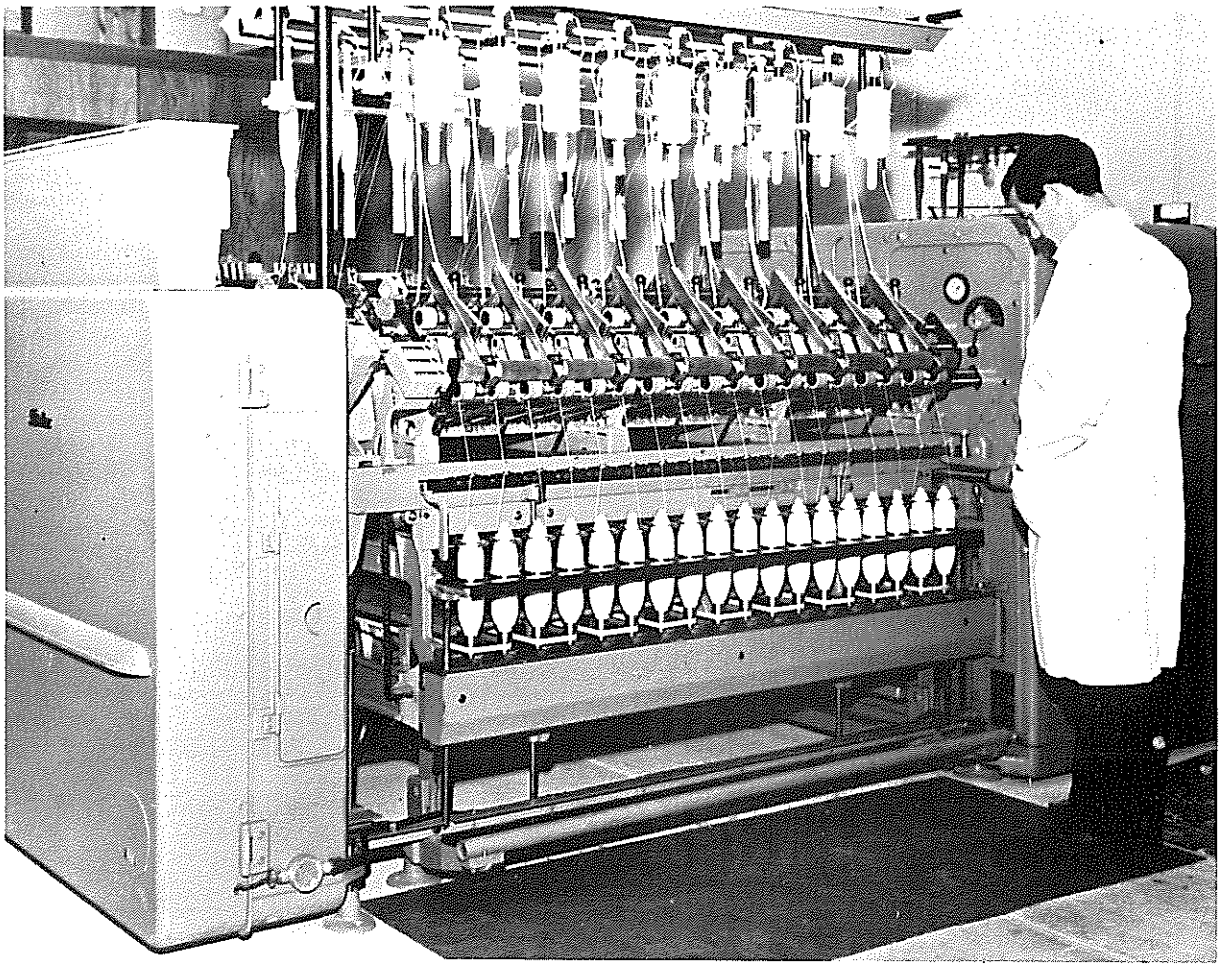
S.A.W.T.R.I. was requested to investigate possible uses for the coarser, more kempy types of karakul hair. Despite consumer opposition to the coarseness of end-commodities manufactured from this type of hair, tufted karakul carpets are still receiving attention as a possible manufactured commodity.

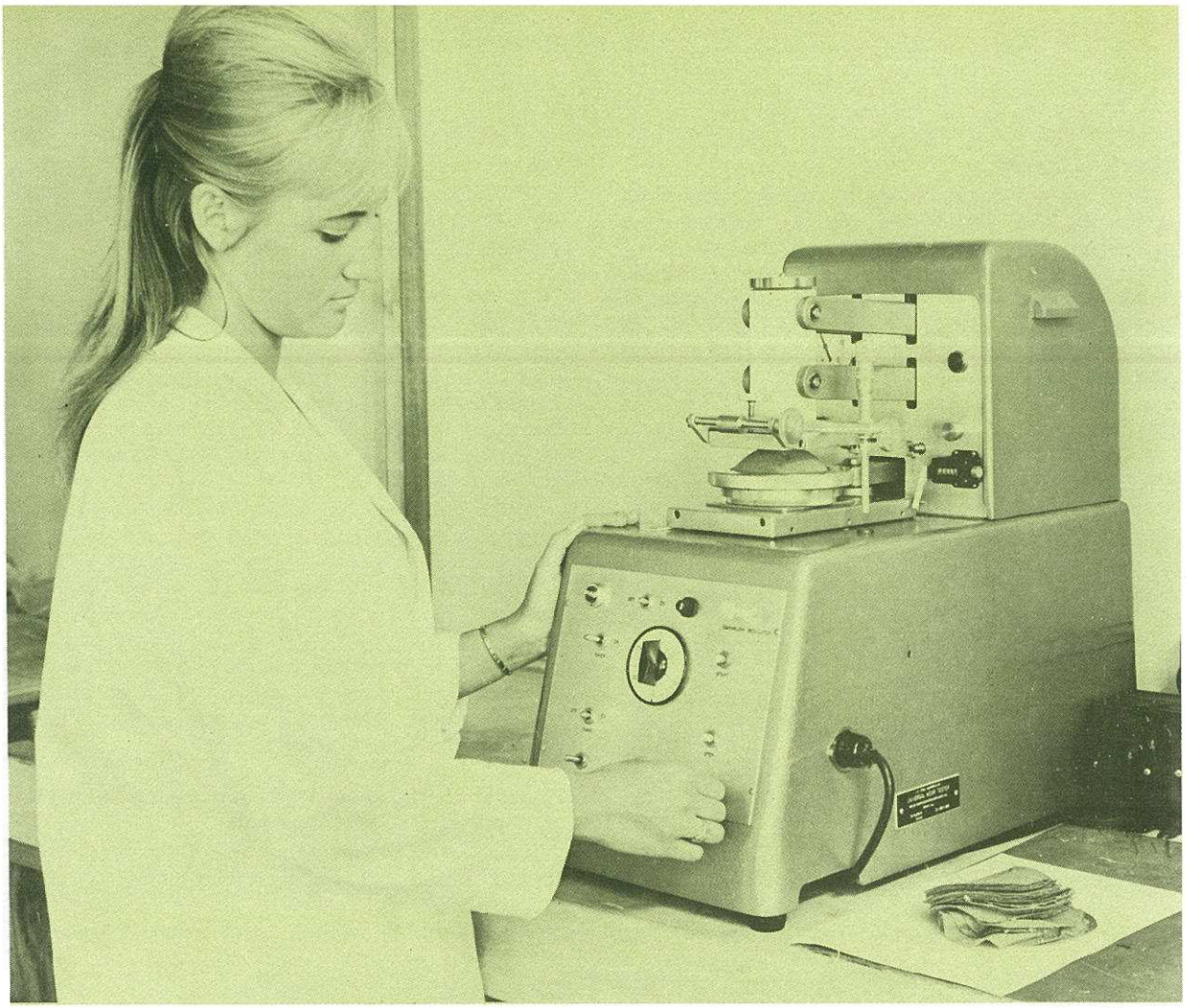
As a result of the slump in the carpet wool market even the softer, more "woolly" types of hair could no longer be sold profitably. S.A.W.T.R.I. in collaboration with the Department of Technical Services of the South African Wool Board, is working in this field. Various blends of naturally pigmented soft karakul hair have been processed into upholstery fabrics and blankets of acceptable quality, whilst additional outlets in the knitting industry are being investigated.

Physical characteristics and processing behaviour of South African Merino wools

The South African clip consists of wool from various breeds of sheep raised under differing

A small-scale worsted spinning frame (36 spindles) in operation at the South African Wool Textile Research Institute.





Abrasion-resistance testing of woven and knitted wool samples.

geographical conditions. Nutritional differences between the grassland pastures of the Highveld, the Karoo bush of the arid zones of the Cape Province and grazing in the winter rainfall area may be expected to influence the chemical composition of the fibre. In addition, genetic factors peculiar to breeds such as the pure Merino and German Merino will cause differences in the wool of these sheep. Within a particular breed, e.g. the pure Merino, different fleece types such as the "tiger stripe" with its abundance of grease on the fibre tip and the drier "white tip" type occur. In its study of the South African wool clip S.A.W.T.R.I. is investigating the influence of these nutritional and genetic factors on the processing behaviour of the particular wools.

Research has shown that numerous properties of processed wool are related to single fibre crimp or, more precisely, to the multiple co-variable single number of crimps per inch times fibre diameter; for instance, the cystine content of the fibres, the resistance to compression of a randomized mass of scoured or combed wool, the bending length of a worsted cloth (and consequently the texture and drape of the fabric), and the felting propensity of wool knitwear can all be correlated with the co-variable mentioned above.

South African wool producers should therefore take cognizance of this effect of crimp on the performance of the end-commodity and its bearing on the good quality of our wool.

An interesting development in the study of the processing behaviour of South African wools has been the construction of a relatively inexpensive instrument for rapidly determining the mean fibre length of carded and combed slivers. The method depends on determining the maximum force required to pull a sliver apart. The fibre length distribution for tested slivers can also be calculated. This instrument has been patented in the Republic through the South African Inventions Development Corporation and a patent application has been filed in the United Kingdom.

Wool chemistry

Owing to the elaborate and highly specialized facilities for the study of proteins available in the *National Chemical Research Laboratory,* a small section of the staff of the *South African Wool Textile Research Institute* has been seconded there permanently to study the chemical nature of the wool molecule. By means of controlled degradation, it has been possible to prepare pure fractions which can now be further studied to determine the detailed structure of at least part of the complex wool molecule.

Properties of double piqué knitted fabrics

The most popular knitting structures for ladies' outerwear (dresses, costumes, etc.) are Swiss double piqué, Punto di Roma and Piquette. The characteristics of these fabrics were studied to assess their wearing properties. This was done through laboratory testing for relaxation and felting shrinkage, pilling, sagging and wrinkle recovery.

Fabric characteristics depend on fibre and yarn properties as well as on the method of cloth manufacture, structure and finishing procedure. S.A.W.T.R.I. has paid special attention to the specific influences of machine setting and cloth structure on the dimensional properties and wear performance of these fabrics.

Continuous dying of wool top

Continuous treatment of textiles is often more advantageous than batch processing. S.A.W.T.R.I. has paid particular attention to the development of a satisfactory continuous dyeing process for wool top when using reactive dyes. The process is based on a recently published Australian technique which utilizes a concentrated urea solution. This agent is preferred to formic acid because the latter is more expensive, necessitating recovery of the volatile acid.

In a range of wetting agents studied as auxiliaries in this process, Tergitol TMN was found the most satisfactory for pad dyeing in urea solution, followed by steaming to achieve dye fixation.

Easy-care properties for wool products

S.A.W.T.R.I. is contributing to a world-wide effort directed towards imparting to wool end-commodities properties such as wrinkle resistance and recovery, dye fastness to light and washing, shrink resistance, permanence of pleats, self-smoothing ability, etc.

Following upon the successful treatment of German Merino wool with dichloroisocyanuric acid (DCCA) to achieve machine washing stability of knitwear, this process has now also been applied to 64's and to 56's Merino wool. Two crêpe yarns from the finer wool and a 4/12.5's worsted yarn from the stronger type were rendered completely machine washable by DCCA treatment with negligible loss of strength and abrasion resistance.

Considerable research was done on dyed woollens with the object of achieving a high level of fastness to light and to washing. For this reason attention was paid to various aspects of the dyeing of wool with reactive dyes. Because of their particular chemical properties, these dyestuffs react with keratin and become attached to the fibre through a covalent chemical bond. Consequently the dyed material possesses a very high fastness to washing. The more fundamental aspects of reactive dyeing and the use of certain auxiliaries to achieve level dyeing are being studied.

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THE TIMBER RESEARCH UNIT

Dr. D. L. Bosman, Head of the Timber Research Unit.

The C.S.I.R.'s Timber Research Unit offers a wide variety of specialized research and technical services to both producers and consumers of forest products.

More specifically the aims of the Unit are:—

- to promote effective utilization of South African timber resources;
- to assist in developing satisfactory products;
- to assist in developing and improving manufacturing processes, and
- to promote effective use of timber products.

For the successful achievement of these objectives the T.R.U. has undertaken a survey to determine the most important requirements of the forest products industry at present and to define its technical problems in an economic context. From the information gleaned in this way research projects have been initiated which are aimed at:—

(i) devising an effective and practical method of classifying structural timber into grades, each of which has safe, reliable and realistic design stresses assigned to it, in order to utilize the full strength-range of the available structural timber efficiently; and because of the economies achieved by its more efficient use, consolidating and extending the markets for structural timber;

(ii) providing technical data which will pave the way for the manufacture of finger joints of consistently high quality and for the efficient use of these joints in structures. The eventual goal is an S.A.B.S. standard specification, based on research findings, for finger jointing directly applicable to South African grown timbers;

(iii) developing more efficient and economic designs for roof trusses for use with South African grown timber. Such designs will greatly increase the economic scope for timber roof trusses in this country and thus open up new markets for structural timber. (See also report under heading *Timber and Timber Products);*

(iv) studying the causes of degradation in timber when exposed, and developing a method whereby the volume of timber rejected on grounds of warp can be reduced;

(v) determining the relative durability under conditions of exposure to the weather of South African manufactured fibreboards, chipboards, plywoods and blockboards used as external cladding for houses;

(vi) providing the basic information necessary to ensure sound gluing practice in the wood products industries. This entails the establishment of proper techniques for gluing under local conditions and advising industry on the particular problems which they encounter in practice;

(vii) determining the relationships between pulp quality and various wood and fibre properties so that criteria can be established for growing improved wood for pulping;

(viii) the more efficient utilization of South African grown pulpwood and the technical and economical improvement of chemical and mechanical pulping, bleaching and refining processes;

(ix) conducting research into the manufacture, use and preservation under local conditions, of paper used for documents. (See also report under heading *Pulp and paper.)*

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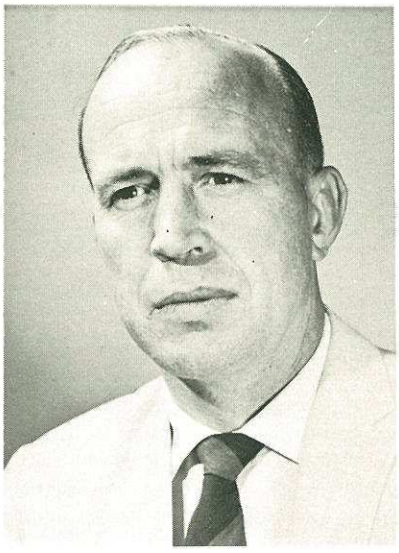
INFORMATION AND RESEARCH SERVICES

In addition to research conducted in its own national laboratories, research institutes and units, the Council is responsible for fostering the development of scientific research in general and industrial research in particular. The Council is also required to provide facilities for the collection and dissemination of scientific and technical information and to maintain liaison with scientific research organizations in other countries. For the discharge of these functions, the Council has developed a number of specialist divisions under the Information and Research Services; these work in close collaboration with the C.S.I.R.'s research laboratories and institutes, the universities and other research organizations.



Mr. D. G. Kingwill, Director of Information and Research Services.

INDUSTRIAL RESEARCH DEVELOPMENT

Advisory Committee

The Council's Advisory Committee on the Development of Research for Industry (A.C.D.R.I.) meets from time to time to review the progress and financing of the four industrial research institutes supported by the Council as well as the research needs of and research facilities available to other sectors of the manufacturing industry.

Techno-economic surveys

The Committee's review of existing research facilities is based on surveys undertaken by the Industrial Economics Division. These surveys are of two kinds; the first kind reviews the entire economy to establish which sectors of the economy are of great potential economic significance but not adequately served by research, while the second kind (techno-economic surveys), reviews each such sector in detail in order to determine the exact nature of its research needs. During the year under review the Division was engaged upon surveys of the second kind and completed a techno-economic survey of the metals engineering industry, made good progress with a survey of the packaging industry and completed preparatory work for a survey of the chemical industry.

A.C.D.R.I. endorsed the main conclusion arrived at after the survey of the metals engineering industry, viz that there is a need for development of a specialist research group in the field of 'manufacturing engineering'.

The metals engineering survey was, in fact, an extension of a survey of the motor component manufacturing industry which was completed the previous year and which was reviewed by *an ad hoc* committee of leaders in the industry concerned and other interested bodies.

Another techno-economic survey which has led to further developments was the survey of the research needs of the textile industry (completed in 1965). Acting on the recommendation of an *ad hoc* committee of leading personalities in the textile industry and government agencies, the C.S.I.R. convened a symposium on textile research which was held at the University of Port Elizabeth on June 20th and 21st, 1967. Among the distin-

guished guests at the symposium were Sir Federick White, Chairman of the Australian C.S.I.R.O., Prof. J. B. Speakman, formerly of Leeds University, and Mr. E. G. Carter of the International Wool Secretariate in London, and Dr. C. H. Fisher, Director of the Southern Utilization Research and Development Division, United States Department of Agriculture. The main recommendations of the symposium were that the government and the C.S.I.R. should take steps to establish facilities for textile research (other than wool) and that further symposia should be organized by the C.S.I.R. to provide a forum for discussion on technical matters of common interest to the various sections of the textile industry.

SYMPOSIA

The Symposium on Textile Research referred to in the section on Industrial Research Development was but one of a series of technical symposia organized by the C.S.I.R. and dealing with specialized topics for industry. These symposia are intended to make particular industries aware of the facilities available at the C.S.I.R. and other research institutions, and are arranged whenever a need for research is identified.

The other symposia in the series were: (i) *Foundry Research* in Pretoria on 22nd March 1967 in collaboration with the National Mechanical Engineering Research Institute, (ii) *Accurate Measurement for Industry* in Pretoria on 21st September 1967 in collaboration with the National Physical Research Laboratory and the South African Bureau of Standards, (iii) *Hydraulics Research* in Pretoria on 12th October 1967, in collaboration with the National Mechanical Engineering Research Institute, (iv) *Cathodic Protection of Metals* in Johannesburg on 7th - 8th November 1967, in collaboration with the Corrosion Group of the National Chemical Research Laboratory and the South African Corrosion Council.

INDUSTRIAL ECONOMICS

In addition to the activities referred to in the previous section, the Industrial Economics Division has continued to be responsible for the professional direction of two economics units attached to research groups. These two units are the Road Economics Section of the National Institute for Road Research and the Industrial Economics Section of the Timber Research Unit. Co-ordination of these activities by a central economics division has proved to be most effective.

Contract investigation

The final stage of an investigation by the Industrial Economics Division in connection with the industrial development programme for the Transkei and Ciskei which has been in progress for some years under contract to the Xhosa Development Corporation, was sub-contracted to Prof. H. J. J. Reynders and Prof. J. A. Lombaard of the University of Pretoria.

Research economics

During the year under review, the Industrial Economics Division continued its study of science in the overall context of the national economy. The purpose of this study is twofold: to obtain information about the total research and development expenditure in the Republic, and to contribute towards better understanding of the impact of science upon economic development.

As far as the surveys of expenditure on R and D are concerned the following data have been obtained and analysed: (a) expenditure on research and development by Government Departments for the financial year 1965/1966, (b) expenditure on research and development within the C.S.I.R. for the financial year 1966/1967, (c) expenditure on research and development undertaken within the Industrial Research Institutes supported by the C.S.I.R. for the financial year 1966/67. (d) expenditure on research and development at universities and university colleges for the academic year 1966.

In addition, a start has been made with surveys of (e) expenditure on research and development in industry for the financial year 1966 and (f) expenditure on research and development by private persons and non-profit organizations, museums, etc. for the financial year 1965/66.

The results of these surveys are reported directly to a sub-committee of the Scientific Advisory Council. This sub-committee which was appointed during the year, and which is known as the Committee on Research Expenditure (C.O.R.E.) advises the Industrial Economics Division of the C.S.I.R. on the data needs of the Scientific Advisory Council and studies the reports prepared by the Industrial Economics Division to ensure that they are effectively dealt with at the meetings of the Scientific Advisory Council. The Division was asked by the Department of Planning to provide the secretariate for C.O.R.E.

During the year under review these survey activities occupied virtually all the time of the Research Economics Section, with the result that hardly any effort could be devoted to a study of the economic impact of science. It is hoped, however, that the Scientific Advisory Council will provide financial support to the Industrial Economics Division for appointing persons specifically for these surveys so that their professional economists could concentrate on the study of the economic impact of science.

TECHNICAL INFORMATION SERVICE

Following a survey of industry's needs for technical information services, the investigating officer was sent overseas to study the organization of national technical information services in Western Europe, the United Kingdom, North America and Japan. The first steps have now been taken to initiate a technical information service for industry.

In the initial stages, this service will be able to do little more than provide a 'question-and-answer' service, and will serve mainly as a clearinghouse for channeling enquiries to sources of information. As a first step, a guide to sources of technical

Part of the CSIR library.

information has been compiled and distributed. Particular attention is being directed to small and medium sized firms in industries which are not served by their own research institutes or by national research institutes.

LIBRARY

The central C.S.I.R. library fulfils an important national function as the main scientific and technical library in the country. Development of its full potential is to some extent hampered by the shortage of trained personnel and by the need for additional accommodation. The accommodation problem will be alleviated when planned extensions to the library building are completed, but the shortage of suitably qualified and experienced staff is a nation-wide problem for which no solution appears to be in sight.

Mechanization

Efficiency in the provision of services has been improved by the introduction of semi-mechanized procedures, using punched-cards for charging photocopies and loans. A computerized procedure for handling records of some 4,000 serial titles (periodicals) to which the library subscribes, has been developed with the assistance of the National Research Institute for Mathematical Sciences, and is at present being introduced. Attention is now being directed to the computerization of acquisition procedures for monographic works.

The group responsible for these projects in library mechanization has, at the same time, been giving attention to techniques of information processing. On behalf of the National Institute for Water Research, titles from 250 journals relevant to the interests of the research staff are selected and listed in a fortnightly bulletin *Current literature on water*. With the aid of a computer, keyword-in-context (KWIC) indexes are produced periodically. The computer programme developed for this purpose has been adapted to produce a KWIC index for current awareness service in the National Institute for Road Research, and an annual index to C.S.I.R. research projects. At the same time, the group has collaborated closely with the Chemical Engineering Group in the application of concept co-ordinate indexing to the literature on special-

ized fields. This has provided valuable experience concerning the problems of thesaurus generation and control.

These projects, which are providing valuable experience in the more sophisticated techniques of documentation, are proceeding in parallel with systematic studies of the needs of the users of information. In addition to the study of the information needs of industry (see p. 104), a comprehensive study of the generation and use of information by research workers in South Africa has been initiated. The response to a postal questionaire, designed after a thorough survey of the literature on similar studies elsewhere, has been reasonably good and the data obtained are at present being analysed. It is hoped that this study will provide a better understanding of the real needs of the country's research workers and of the extent to which these are being met by existing information services. This in turn should provide a basis for planning the development of improved information services.

Union Catalogue

The C.S.I.R. library has accepted responsibility for maintaining a union catalogue of scientific and technical periodicals held in South African libraries. The alphabetic listing of these titles is being published, together with the titles in the corresponding catalogue for the humanities (which is maintained by the University of South Africa) under the title, *Periodicals in South African Libraries*. This is being issued in loose-leaf form, letter by letter, and has been completed up to the letter N. Progress is unavoidably slow.

PUBLISHING AND LANGUAGE SERVICES

Publishing

As part of its function to maintain standards of documentation for C.S.I.R. publications, the Information Division, as the central editorial office, is compiling a manual for the use of authors and editors in the C.S.I.R. The first few chapters of this manual were published during the year.

Another aspect of this Division's activities is the compilation and publication of guides to sources of scientific and technical information in South Africa. During 1967 revisions of the *Directory of scientific research organisations in South Africa*, the *Directory of scientific and technical societies in South Africa*, and the *Directory of scientific and technical periodicals published in South Africa* were completed. These directories, which previously formed part of the *Directory of scientific resources in South Africa*, are now issued as separate publications and will be revised annually. The 1967 issue of the *Register of current scientific research at South African universities* was also completed during the year.

Coupled with the compilation of the *Directory of scientific and technical periodicals* a select list of South African journals containing technical information for industry was prepared for the Committee on Information for Industry of the International Federation for Documentation (FID - II) as part of a collaborative venture in which several countries participated. Interesting data were obtained in the course of this preliminary evaluation and it is hoped to follow up the work and to publish the findings in due course.

The Information Division's three periodical publications dealing with C.S.I.R. research also appeared regularly. *C.S.I.R. Research Review*, a six-monthly bibliography of articles and reports arising out of the work undertaken or supported by the C.S.I.R., mostly with abstracts by the respective authors, has been published for several years and continues to provide a useful reference aid for scientists both locally and overseas. *TI - technical information for industry*, the monthly information bulletin on aspects of the C.S.I.R.'s work with industrial application is aimed mainly at the practioner in industry. The circulation of this publication increased steadily and material from it was often reproduced in technical and trade journals in this country and overseas. There has also been an increasing demand for *Scientiae*, the monthly journal which contains feature articles on scientific topics and caters mainly for the interested layman.

In addition to these regular publications, two brochures on wool textile research and several other *ad hoc* publications were produced in association with specialized research institutes and groups of the C.S.I.R.

Translations

Apart from its language editing and translation services in the official languages which are concerned mainly with C.S.I.R. publications, the Information Division undertakes the translation of scientific and technical articles from foreign language publications. There is a considerable demand for this type of service on a national basis, but because of the smallness of its staff the Division has hardly been able to cope with the work requested by the C.S.I.R.'s institutes and laboratories. In certain cases, though, translations have been undertaken for outside bodies where it was deemed to be in the interests of scientific communication generally.

The following table gives some indication of the scope and volume of this work.

No. of translations requested during 1967

German	21
French	28
Russian	27
Italian	4
Polish	4
Swedish	3
Czech.	2
Spanish	3
Rumanian	1
Serbo-Croatian	2
Danish	2
Portuguese	2
Total	99

Where a complete translation has been undertaken (as opposed to oral translations and excerpts) such translation is listed in the bulletin *C.S.I.R. Library Information and Accessions*, and copies are supplied on request at a nominal charge. During the year under review a total of 56 copies of translations were dispatched to en-

quirers both in South Africa and overseas. Similarly, lists of translations completed by overseas services are maintained and these are consulted before undertaking any translation as the article in question may already have been translated elsewhere.

SCIENCE FEATURES

With a view to improving public understanding of science, a science feature service was initiated. Articles on scientific topics of current interest to South Africa (not necessarily confined to the C.S.I.R. organization) were featured in the daily weekend press, magazines and other media and a science film commentary service is provided. A series of 35 radio talks on scientific topics of world interest were contributed under contract to the S.A.B.C. A start has been made with the compilation of a series of books on the general theme of "Science in South Africa". Good progress has been made with the first of these which will deal with "Life of the past in Southern Africa".

PUBLIC RELATIONS

Information on current activities of the C.S.I.R. is also provided by the Public Relations Division which is responsible for liaison with the daily Press and Radio and for arrangements for the increasing stream of visitors to the C.S.I.R. (many of them distinguished visitors from abroad) either as individuals or in groups. In addition, monthly visits are arranged for the general public, university and high school students.

The organizing of special functions and national conferences formed a major activity of this office. This year these included the opening of the new laboratories of the South African Wool Textile Research Institute in Port Elizabeth on June 20th, and the Pneumoconiosis Research Unit in Johannesburg on the 29th August, a visit by the Administrators and heads of provincial departments, a two-day visit by Members of Parliament and Senators on October 17th and 18th, and a two-day conference on air pollution in Cape Town on October 25th and 26th (organized on behalf of the Department of Health).

The Public Relations Office is also responsible for arrangements in connection with the production of films. The Council has decided to make one film per year, each dealing with a particular aspect of C.S.I.R. research activities at a popular level suitable for showing on the South African cinema circuits on the general theme of "Science in your Service". A film on road research, "Your Highway Tomorrow", was released during the year and work has started on a film on wool textile research.

SCIENCE CO-OPERATION

Science has come increasingly to the fore in international relations, and the Science Co-operation Division has been developed to provide the services required by the Council in this connection.

The main function of the Division is that of dealing with matters arising out of the Council's responsibilities as National Member of the International Council of Scientific Unions (I.C.S.U.) and its affiliated Unions. In addition it undertakes the administration and organization of South African participation in international scientific projects developed under the auspices of I.C.S.U. To meet the responsibilities outlined above, the Science Co-operation Division administers a national fund created by the Council. In 1967, this fund stood at approximately R189,000.

Secretarial and administrative facilities are provided for the functioning of the South African National Programme for Oceanographic Research as well as for participation in the International Biological Programme (I.B.P.) and the Upper Mantle Project (U.M.P.). South African participation in the I.B.P. and U.M.P. follows directly from the Council's membership of I.C.S.U. I.C.S.U. membership has further resulted in two international meetings which will take place in South Africa during 1969 and 1970. The International Union of Pure and Applied Chemistry (I.U.P.A.C.) has accepted an invitation to hold a Symposium on "Chemical Control of the Human Environment" in Johannesburg during July 1969. Arrangements for this Symposium which is being organized jointly with the S.A. Chemical Institute, are well in hand. In addition to the above meeting, the sub-Commission on Gondwana Stratigraphy of the International Union of Geological Sciences (I.U.G.S.) has accepted an invitation to hold its next three-yearly meeting in South Africa during 1970.

A second five-year programme for Antarctic Research has been approved by the Government and will commence in 1968. The amount approved for the scientific programme (excluding logistic support and meteorology) is approximately R540,000, to be spent over five years. These funds are administered by the Department of Transport on the advice of the C.S.I.R.'s Scientific Committee for Antarctic Research, and the secretarial facilities required by the Scientific Committee are provided by the Science Co-operation Division.

REGIONAL OFFICES

In addition to regional offices in Durban and Bellville, Cape, which are housed in the same premises as the regional laboratories, the C.S.I.R. has regional research committees for South West Africa, Natal and the Cape Midlands.

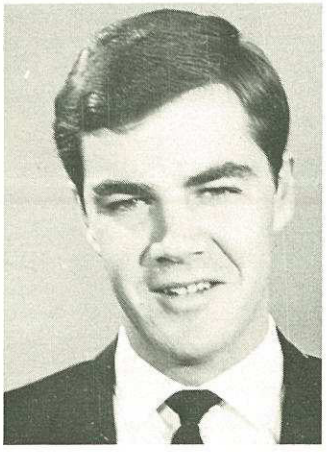
The regional research liaison committees for South-West Africa and Natal meet once a year under the chairmanship of the President of the C.S.I.R. with Directors of the national research institutes and laboratories.

On the occasion of the meeting of the Natal Regional Research Liaison Committee on May 19th, 1967, three seminars on the application of computers to industrial management; industrialized building with particular reference to Natal; and some recent developments in biochemical research in Natal, were organized in association with the University of Natal, Durban. A public lecture on the search for oil in Southern Africa was also organized.

In Windhoek, on the evening preceding the

Dr. P. le R. Malherbe, Scientific Attaché, Cologne.

Dr. R. G. Shuttleworth, Scientific Counsellor, Washington.



Mr. O. A. van der Westhuyzen, Scientific Attaché, Paris.

Mr. C. G. Hide, Scientific Attaché, London.

meeting of the S.W.A. Regional Committee on August 23rd a public film show was held, with short lectures by Dr. S. Meiring Naudé, President of the C.S.I.R., Dr. J. J. Theron, Director of the National Nutrition Research Institute, Dr. S. G. Shuttleworth, Director of the Leather Industries Research Institute, Grahamstown and Mr. S. Kühn of the National Institute for Road Research.

In Port Elizabeth the C.S.I.R.'s Midland Regional Research Committee under the chairmanship of Mr. H. Schauder, continued to provide a valuable point of contact with public bodies and manufacturing industry in the Eastern Cape and border areas.

OVERSEAS SCIENTIFIC OFFICES

In addition to the offices which have been maintained by the C.S.I.R. in collaboration with the Department of Foreign Affairs in London, Washington and Cologne, it has been decided to establish a fourth office in Paris. The office will come into operation in January, 1968.

These offices provide scientific services to the South African diplomatic missions and in addition, represent South African science abroad and provide valuable services to the C.S.I.R., other South African research organizations and technical agencies, such as the Atomic Energy Board and the South African Bureau of Standards, and the universities in arranging interviews and study tours for visiting scientists. They also obtain information and help in the recruitment of staff.

UNIVERSITY AND MEDICAL RESEARCH

The division responsible for the administration of *ad hoc* university research grants and grants

to units at universities and other institutions in the natural, engineering and medical sciences, reports directly to the Executive on all professional matters.

A brief report on the administration of funds for medical research and research in the natural sciences at universities appears below.

The budget of the University and Medical Research Division for the year under review was as follows:

General Sciences	R667,800
Medical Research	609,200
	R1,277,000

In addition funds for the following research were administered.

Pneumoconiosis Research Unit R277,000
Asbestosis Research Project R 45,000

The Pneumoconiosis Research Unit is sponsored jointly by the State and the Chamber of Mines of South Africa and the Asbestosis Research Project by the State and the asbestos mining industry.

Owing to limited funds no substantial expansion of support for university research activities was possible during the year. Most existing university research units have attained some measure of stability and their research productivity in relation to the funds at their disposal can be regarded as very satisfactory.

The Desert Ecological Research Unit has now attained the stage where it has excited world-wide interest and during the year received a considerable flow of local and overseas visitors working there on problems of arid zone research.

In addition to 170 *ad hoc* grants to university and museum personnel and independent research workers, the Council awarded the following numbers of bursaries for post-graduate research and training at the universities in the general sciences:

Post-B.Sc.	167
Post-B.Sc. (Hons.)	145
Post-M.Sc.	38
Senior and Overseas	51

Twelve scientists from universities were given grants to enable them to attend overseas international scientific conferences.

SELECTED PUBLICATIONS

A brief guide to sources of technical information in the Republic of South Africa, Pretoria, 1968.

VAN DER WALT, D. G., ZULCH, B. J. and MINNAAR, A. C. *The research needs of the motor component manufacturing industry in South Africa (with special reference to ferrous metals) — a techno-economic survey,* Pretoria, 1966.

VAN DER WALT, D. G. *The research needs of the South African textile industry — a techno-economic survey.* Pretoria, May 1965.

VAN HOUTEN, ROBERT. *Technische Informatie voor de Industrie met spesiale verwijzing naar voorlichting op elektronisch gebied, Potchefstroom,* July 1966.

ZULCH, B. J., MINNAAR, A. C. and EATON, W. L. *The research needs of the metals engineering industry in South Africa — a techno-economic survey,* Pretoria, October, 1967.

MEDICAL RESEARCH GROUPS AND UNITS

The medical research units and groups supported by the C.S.I.R. are as follows:

Amoebiasis Research Unit, Institute of Parasitology, Durban (Director: Dr. R. Elsdon-Dew).

Arthropod-borne Virus Diseases Research Unit, Poliomyelitis Research Foundation, Johannesburg (Director: Dr. J. H. S. Gear).

Bacterial Genetics Research Unit, Institute of Pathology, University of Pretoria (Director: Prof. J. N. Coetzee).

Bilharzia Research Group, sub-divisions at Nelspruit (Head: Dr. R. J. Pitchford), University of Potchefstroom (Head: Prof. J. A. van Eeden) and South African Institute for Medical Research, Johannesburg (Head: Dr. J. H. S. Gear).

Cardio-Pulmonary Research Unit, University of the Witwatersrand (Director: Prof. G. A. Elliot).

Cardio-Vascular Pulmonary Research Group, University of Cape Town (Director: Prof. V. Schrire).

Clinical Nutrition Research Unit, University of Cape Town (Director: Prof. J. F. Brock).

Degenerative Diseases Research Group, University of Stellenbosch (Director: Prof. A. J. Brink).

Dental Research Unit, University of the Witwatersrand (Director: Prof. C. J. Dreyer).

Endocrine Research Group, University of Cape Town (Director: Dr. W. P. U. Jackson).

Heart Research Group, University of Pretoria (Director: Prof. H. W. Snyman).

Human Biochemistry Research Unit, S.A. Institute for Medical Research, Johannesburg (Director: Dr. A. R. P. Walker).

Iodine Metabolism Research Unit, University of Stellenbosch (Director: Dr. A. van Zyl).

Iron and Red Cell Metabolism Research Unit, University of the Witwatersrand (Director: Dr. T. H. Bothwell).

Nutritional and Dental Health Research Group, University of Pretoria (Director: Prof. C. L. de Jager).

Nutritional Anaemia Research Group, University of Natal, Durban (Director: Prof. E. B. Adams).

Orthopaedic Development Unit, University of Cape Town (Director: Prof. C. Lewer-Allen).

Photobiology Research Group, University of Pretoria (Director: Dr. G. H. Findlay).

Pneumoconiosis Research Unit, Johannesburg.

Protein Research Unit, University of Cape Town (Director: Prof. J. E. Kench).

Renal Metabolic Research Group, University of Cape Town (Director: Prof. L. Eales).

Tissue Damage and Cell Metabolism Research Unit, University of Stellenbosch (Director: Dr. F. M. Engelbrecht).

Tuberculosis Research Project, Veterinary Research Institute, Onderstepoort (Director: Prof. B. C. Jansen).

Virus Research Unit, University of Cape Town (Director: Prof. A. Kipps).

GROUPS AND UNITS FOR RESEARCH INTO THE NATURAL SCIENCES

Chromatography Research Unit, University of Pretoria (Director: Prof. V. Pretorius).

Cosmic Rays Research Unit, Potchefstroom University (Director: P. H. Stoker).

Geochemistry Research Unit, University of Cape Town (Director: Prof. L. H. Ahrens).

Marine Research Unit, Oceanographic Research Institute, Durban Director: Prof. J. F. C. Morgans).

Natural Products Research Unit, University of Cape Town (Director: Prof. F. L. Warren).

Oceanographic Research Unit, University of Cape Town (Director: Prof. J. K. Mallory).

Palynology Research Unit, University of the Orange Free State (Director: Prof. E. M. van Zinderen Bakker).

Solid State Physics Research Unit, University of the Witwatersrand (Director: Prof. F. R. N. Nabarro).

Desert Ecological Research Unit, Transvaal Museum, Pretoria (Director: Dr. C. Koch).

A schedule of the research grants administered by the CSIR appears in the annex ure at the end of this report.

THE TECHNICAL SERVICES DEPARTMENT

Mr J. J. van der Staaij, Director of the Technical Services Department.

The Technical Services Department (T.S.D.) provides essential services for the national laboratories and institutes of the C.S.I.R. and designs and produces equipment for scientific and industrial research. It also undertakes contract work for allied organizations and industry if the work cannot be done elsewhere in the Republic.

Technical training centre

An ultra-modern training centre, where 48 apprentices can be fully trained to manufacture delicate instruments and fine mechanical equipment, was recently inaugurated. The Republic's rapid industrial development has brought about a great need for people with such training who could fill key positions as development technicians. The interest shown throughout the country in the training centre is further proof of the urgent need for facilities where technicians of this kind can be taught.

Special services and facilities

Apart from designing and manufacturing special equipment, instruments and apparatus for C.S.I.R. institutes and state departments, the T.S.D. has been working increasingly on behalf of private organizations. Such work cannot be undertaken by private industries — a fact that shows how unique facilities and skilled workmanship enable the C.S.I.R. to provide exceptional services.

Equipment acquired

Additional equipment was bought to satisfy the ever-increasing demand for specialized services, usually with stringent requirements.

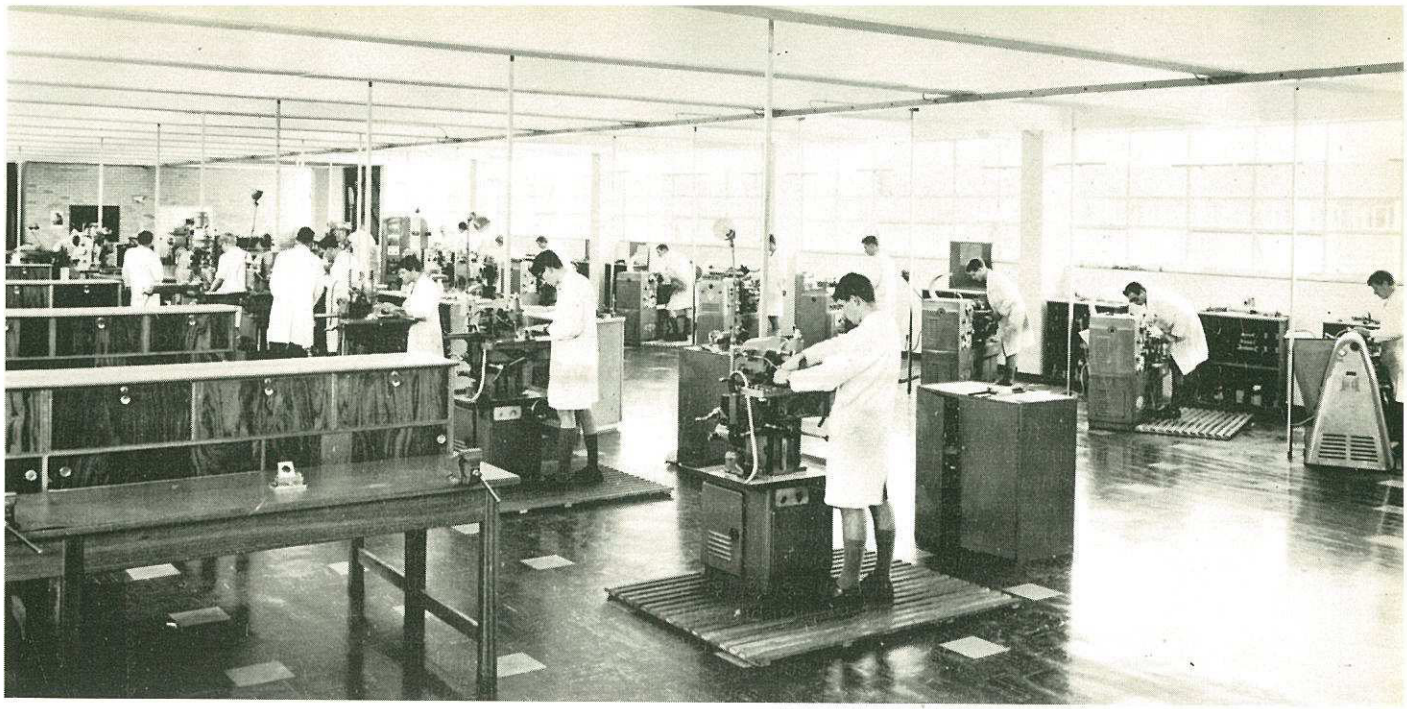
Numerically controlled milling machine

This machine will make possible the serial production of highly complicated components at high speed.

It has already been agreed in principle with the Atlas Aircraft Corporation that complicated components can be manufactured advantageously on this machine.

Thread-grinding machine

A thread-grinding machine was bought to manu-



The ultra-modern training centre of the C.S.I.R.'s Technical Services Department where 48 young men receive comprehensive training in manufacturing delicate instruments and apparatus.

facture taps, and also extremely accurate thread-measuring instruments for quality control.

Printed circuits

The modern trend toward developing electronic equipment with ever smaller physical dimensions is being followed by the C.S.I.R. Thus the demand for printed circuits is increasing — as are the problems related to various electronic projects. A Unit has been established in the Graphic Arts Division to manufacture printed circuits and it is already clear that this facility will have to be extended to meet the demand.

Services to related organizations and industries

Among others, the following services were provided:

Modernization of telescope

The control mechanism of the 60-inch telescope at the Boyden Observatory, which is operated by an international astronomical association, was redesigned and modernized.

Test equipment for the asbestos industry in Rhodesia

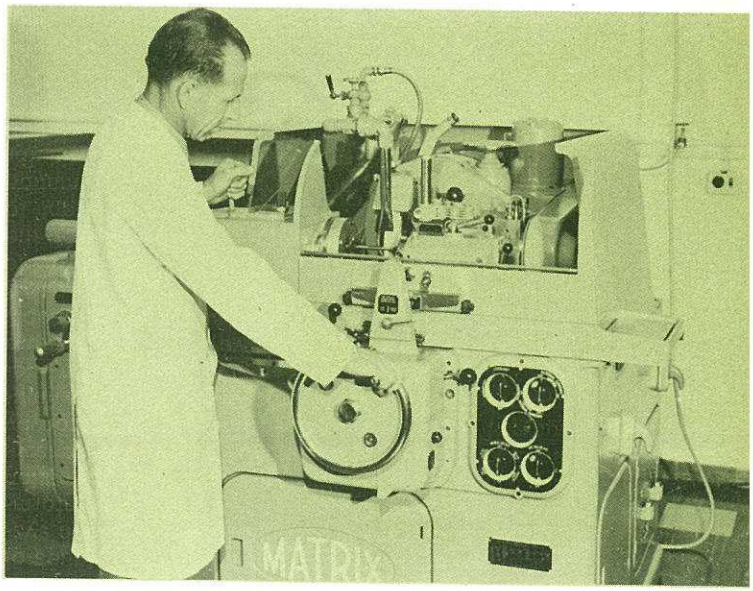
Equipment which could not be supplied to the asbestos industry by industries in Rhodesia or South Africa was designed and manufactured here.

Medical equipment

A biopsy instrument was manufactured, and also a film-cutting appartus for a camera which is used internally for photographing the stomach wall of a patient.

Artificial heart valves

Development work related to the manufacture of artificial heart valves is progressing well and fatigue tests, which already represent ten years of normal work, are continuing.



The thread-grinding machine recently installed in the Technical Services Department.

THE FISHING INDUSTRY RESEARCH INSTITUTE

Dr. G. M. Dreosti, Director of the Fishing Industry Research Institute.

The Fishing Industry Research Institute (F.I.R.I.) is affiliated to the University of Cape Town and has its main laboratory on the University campus; a second laboratory is situated at Walvis Bay.

For its annual income F.I.R.I. depends on voluntary contributions from the fishing industry. Firms directly engaged in fishing or fish processing in South Africa or South West Africa may become members of F.I.R.I. by guaranteeing annual subscriptions. Firms with an indirect interest in the fishing industry may contribute to F.I.R.I.'s income as associate members. All subscriptions guaranteed for five years are matched on a rand for rand basis by the C.S.I.R. and this money is used exclusively to finance F.I.R.I.'s research projects. The total annual income of the Institute has increased from about R19,000 at the time of its establishment to over R220,000.

The fishing industry was the first to take advantage of the opportunity offered by the research association scheme of the C.S.I.R. to establish industrial research organizations when this scheme came into operation in 1945/46.

The primary function of the Fishing Industry Research Institute is to conduct fundamental and applied research for the fishing industry.

South Africa was, e.g., the first country to produce fish flour or fish protein concentrate (F.P.C.), based on a process developed in 1937, for human consumption. This highly nutritious product can be used for enriching bread and other cereal products, as well as in stews and soups. Since the use of whole fish for the production of F.P.C. was approved recently by the U.S.A. Food and Drug Administration, it is anticipated that F.P.C.

Research into the impermeability of plastic bags for storing fish meal.

is going to play an increasing role in human nutrition.

Other subjects that are being or have been investigated include: the canning, chilling, freezing, salting and smoking of fish; effluent clarification and the recovery of solids therefrom. (See reports under the heading *Fisheries* in the chapter *Research for specific economic sectors* on page 15).

F.I.R.I. is also collaborating in a fish-tagging programme in order to study the impact commercial fishing has on the fish population.

The fishing industry provides much scope for fruitful research in such diverse disciplines as physics, engineering, chemistry, microbiology and nutrition.

Although applied and fundamental research for the fishing industry is the primary object, the Institute also performs the following functions:

(a) it provides scientific or technical advice on specific problems and conducts tests for individual members at their cost;

(b) it performs analyses of finished products as well as of raw materials at the cost of industry; it also conducts routine analyses of fish products such as fish meal, salt, tomato paste, fish oils, water, and fresh, frozen, salted, smoked, dried and canned fish;

(c) it keeps members of the Institute informed of modern scientific and technical advances considered to be of interest or of use to the fishing industry

The value of the analytical department to the industry is illustrated by the fact that during 1967 over 2,100 samples were analysed.

All South African and South West African fish meal is purchased and paid for on the basis of the F.I.R.I. analyses. These examinations also serve to keep the Institute in touch with the problems of the industry. Moreover, the results provide a good basis for the formulation of regulations, specifications and standards for raw materials and for finished products.

A permanent Technical Committee gives technical guidance to both the industry and the Research Institute and also assists the industry in applying research findings in practice. There is closer co-operation between the Research Institute and the fishing industry it serves than in any other country, and at international conferences F.I.R.I. is often quoted as a model in this respect.

Dr. M. Matic, Director of the Sugar Milling Research Institute.

THE SUGAR MILLING RESEARCH INSTITUTE

Like the fisheries, leather and paint industries, the sugar milling industry in the Republic has its own research institute, which is financed partly by the C.S.I.R. and partly by the sugar industry. The *Sugar Milling Research Institute* (S.M.R.I.) is located in Durban and serves the entire sugar milling industry in the Republic, as well as affiliated factories in Swaziland, Portuguese East Africa and Rhodesia.

All South African sugar factories support the S.M.R.I. through a levy paid to the South African Sugar Millers' Association. The sugar cane producers have their own experimental station at Mount Edgecombe in Natal, where the cultivation of sugar cane is studied.

Since the S.M.R.I. was established in 1948, the sugar industry has benefited considerably from its work, which has been devoted chiefly to the solution of practical problems in the manufacturing and refining of sugar, and to the improvement of manufacturing processes. The Institute's function, however, has undergone a gradual change: sponsored work on performance testing of factory equipment and the tracing of errors and difficulties has diminished and at present an increasing number of long-term research projects are being undertaken on behalf of the industry.

Possibly the most interesting work carried out at the S.M.R.I. during the year was in connection with a new clarification process based on a well-known principle of air flotation.

Preliminary trials have been very successful and a small pilot plant has been constructed at a sugar factory in order to carry out further tests.

Investigations are continuing into direct sampling and analysis of cane, and members of the staff, working with a Committee appointed by the Sugar Industry Control Board, are testing a sampler at the Mount Edgecombe factory.

Cane starch, after it had been separated from the juice and subjected to a purification process, was obtained in the form of a dry white powder. Hydrolysis of this product, followed by a determination of its glucose content indicated a purity of 97 per cent.

However, by conventional colorimetric analysis a purity of only 66 per cent was obtained, indicating that a considerable part of the amylose fraction of cane starch was lost during the isolation.

Work continues on all aspects of raw sugar quality including clarification, formation of gums in deteriorating sugar cane and circulation in vacuum pans.

Members of staff, throughout the year, visited factories in an advisory capacity. Analytical work on behalf of the industry continues to increase. One hundred and fifteen instruments were repaired for factories by the workshop staff, apart from work carried out in respect of S.M.R.I. equipment.

THE LEATHER INDUSTRIES RESEARCH INSTITUTE

The South African tanning industry has made considerable progress in recent years and is now generally acknowledged as leading the world in tanning techniques for shoe-sole leather. This reputation can be maintained only by continuous research aimed at finding improved leather tanning methods.

It is partly due to the *Leather Industries Research Institute* (L.I.R.I.), one of the co-operative industrial research institutes, that the standard of of leather products in the Republic is so high. The C.S.I.R. has assisted the leather industry in developing this Research Institute by granting financial aid equivalent in amount to annual contributions by interested industrial subscribers.

The Institute has pursued a well-balanced programme of fundamental research, applied research and general development work.

In the hides, skins and protein research section of L.I.R.I. a feature of research during the past year has been large-scale experiments carried out at the main slaughtering abattoirs. These experiments have enabled the Livestock and Meat Industries Control Board to improve the grading and curing regulations, which should do much to raise the quality of hides and skins supplied to both local and overseas tanners. Fundamental protein research results have been published overseas and have attracted wide interest.

The wattle industry, with its valuable agricultural export market, has faced declining demands and a quota system has been introduced in recent years. The main hope for reversing this downward trend lies in L.I.R.I.'s work on the use of modified wattle extract as an adhesive for the world's vast chipboard industry, and as a mud thinner in oil-well drilling. Products developed by L.I.R.I. are undergoing large-scale trials in both these fields, yielding promising results. L.I.R.I. is the recognized leader in the research field of polymeric flavonol structures of the type forming the basis of the tannin structures.

The L.I.R.I. has greatly assisted the tanning industry in solving its effluent disposal problems. The manganese aeration process for eliminating evil-smelling sulphide decomposition products has saved a number of tanneries from closure. This process is being adopted overseas. The "no-effluent" sole leather tanning process developed by L.I.R.I. and used locally for some years, is now in use in Holland, Australia and the U.S.A.

In the field of footwear research, L.I.R.I. has designed and built more than 100 special foot-fitting devices for the Chamber of Mines of South Africa, in order to reduce the incidence of "foot rub" in miner boots. Most South African footwear factories are availing themselves of a system of worn shoe examination by L.I.R.I. This has the threefold advantage of im-

Dr. S. G. Shuttleworth, Director of the Leather Industries Research Institute.

A foot-measuring device, developed by the L.I.R.I., in use.

proving customer service, drawing attention to faulty construction and materials and providing a basis for further investigation into methods of manufacture and into the quality of components.

Of special interest, in view of the shortage of trained manpower in industry, is the wide scope of training programmes sponsored by industrial subscribers to L.I.R.I. and carried out as follows:

(a) Approximately 300 students from the footwear and tanning industries are taking a correspondence course organized by staff members of L.I.R.I. and supplemented by regular tutorials and factory sponsored lectures. Subjects include both managerial skills (cost accounting, production and personnel management) and technical subjects (footwear technology, footwear materials and tanning technology), the latter subject being illustrated by visual aid slides produced by L.I.R.I. staff.

(b) Intensive short courses are held at the Institute, covering hides and skins, tanning and footwear technology. These are conducted by both L.I.R.I. staff and overseas specialists.

(c) Operative training schools have been set up within the factories and teachers are regularly trained for these schools.

(d) Training courses for trade union officials and shop stewards are being held in the various industrial centres.

Over a period of 26 years, the L.I.R.I. has accumulated a valuable store of information and technical knowledge which, through these training courses, is being made available to the younger generation of industrialists and factory workers.

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ROUX, D. G., SAAYMAN, H. M. and DREWES, S. E. Some chemical aspects of heartwood formation in *Acacia Mearnsii* and related *Acacia* spp. In: *Proceedings of the International Union of Forest Research Organizations*. Munich, Sept. 1967, Section 41.

RUSSELL, A. E., SHUTTLEWORTH, S. G. and WILLIAMS-WYNN, D. A. Further studies on the mechanism of vegetable tannage. Part 2. Effect of urea extraction on hydrothermal stability of leathers tanned with a range of organic tanning materials. *J. Soc. Leath. Trades Chem.*, vol. 51, 1967, p. 222.

RUSSELL, A. E., SHUTTLEWORTH, S. G. and WILLIAMS-WYNN, D. A. Further studies in vegetable tannage. Part 3. Solvent reversibility of wattle tannage. *J. Soc. Leath. Trades Chem.*, vol. 51. 1967, p. 349.

SHUTTLEWORTH, S. G. Further studies on the mechanism of vegetable tannage. Part 1. Experiments on wattle-tanned leather. *J. Soc. Leath. Trades Chem.*, vol 51, 1967, p. 134.

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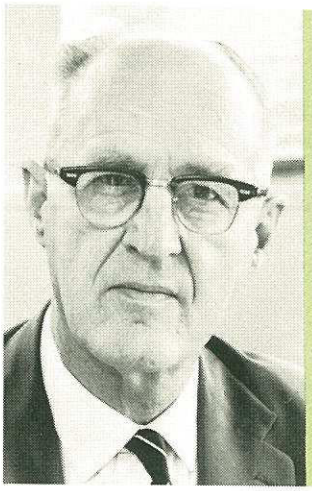
THE SOUTH AFRICAN PAINT RESEARCH INSTITUTE



Prof. G. M. Hamilton, Director of the South African Paint Research Institute.

In accordance with its policy of encouraging groups of industries with common interests to establish co-operative research institutes, the C.S.I.R. assisted in the establishment of the *South African Paint Research Institute* (S.A.P.R.I.) in Durban. The S.A.P.R.I. serves the producers and consumers of paint as well as suppliers of the raw materials which are used in producing paint. Its work largely involves research into the problems experienced by member-industries in using existing materials and in improving paint surfaces. These problems arise as a result of climatic conditions in this country which often vary from extreme to extreme.

A film of modern protective paint lasts two to three times longer than a film of similar thickness of the paint of 20 years ago, and it is forecast that the quality of paints will be such that, during the next 10 years, their life span will be three times as long again. These products will be expensive, but because of the rising cost of labour their use will still be economic.

Longer life naturally puts a greater strain on current methods of evaluating surface coatings, as no large utility awarding a contract could contemplate waiting several years for assessment of products by natural exposure. It has thus become necessary to re-examine methods of accelerating the process of deterioration as a means of evaluation.

A number of methods of speeding up the ageing process are already in use, but none can be applied with any degree of confidence. One theory which has been investigated at the S.A.P.R.I. for some years, is that much can be gained by increasing the sensitivity of measurement.

In addition, therefore, to the exposure of paints at the outdoor site at Louis Botha Airport, and the established methods of acceleration by means of arc light and salt fog exposure, the Institute has been measuring the loss of paint film by the weight loss of panels exposed to normal outdoor weather conditioning. It is also engaged in measuring the electrical conductivity of paint films on metal. The first of these methods enables scientists to forecast the probable life of the film; the second to assess the ability of the paint film to protect underlying metal from corrosion.

In addition to other characteristics, the adhesion of the paint film to the article to be protected, and of subsequent films to each other, is of the greatest importance. Work is proceding along these lines, starting with the S.A.B.S. series of primers on steel, with attention to the time which elapses between coats and its effect on the strength of the bond.

A very large number of clear finishes (varnishes) on wood have been evaluated. The general finding is that, if fully exposed, the life of the finishing layer is short, and that in the present state of knowledge, it is not advisable to adopt such a system of finishing for exposed timber, however attractive it may look. There are indications that improved products may be available shortly.

One problem facing the industry is to produce a coating to prevent marine encrustations forming on ships' hulls. Severe encrustation takes place rapidly in some waters and can both reduce the ship's speed and increase fuel consumption until the costly process of dry-docking, cleaning and repainting becomes necessary. By kind permission of the South African Railways and Harbours Administration, the Institute has been allowed to moor a raft in Durban harbour for testing and evaluating anti-fouling paints.

Also of interest is the evaluation of South African-produced raw materials that are intended to replace imports. It is pleasing to record that local soya-bean oil, for example, is equivalent to that imported from overseas.

In spite of care in application and rigid material specifications, faults do occur, and on behalf of its members, the Institute examines many cases of failure and unsatisfactory performance. In the large majority of cases the cause is found and a remedy suggested.

FINANCIAL STATEMENTS

South African Council for Scientific and Industrial Research
Balance Sheet as at 31st March 1967

STATEMENT No. 1

	General Fund R	Building Fund R	1967 R	1966 R
ACCUMULATED FUND			24,367,732.91	20,399,535
Balance as at 31.3.1966	11,671,945.89	8,727,588.82		
Inter-fund transfers	(—)76,100.00	76,100.00		
SUB-TOTAL	11,595,845.89	8,803,688.82		
Capital Receipts 1966/67				
Parliamentary grants:				
CSIR	1,070,000.00	585,000.00		
University institutions	151,000.00	—		
Donations:				
CSIR	249,377.44	202,343.00		
University institutions	4,087.10	—		
Interest	—	215,089.37		
Sale of assets written off	16,127.85	110,000.00		
Investigations and services:				
CSIR	840,669.91	—		
University institutions	3,352.58	—		
	2,334,614.88	1,112,432.37		
Add:				
Excess income 1966/67	701,031.84	—		
Adjustment in respect of previous years				
CSIR	57,519.97	—		
University institutions	21,310.20	—		
	3,114,476.89	1,112,432.37		
Less:				
Costs of assets written of 1966/67:				
CSIR	127,511.98	123,772.42		
University institutions	7,426.66	—		
SUB-TOTAL	2,979,538.25	988,659.95		
TOTAL	R14,575,384.14*	9,792,348.77*	24,367,732.91	20,399,535

	1966/1967 Additions: University Institutions R	1966/1967 Additions: CSIR R	1966/1967 Written off R	1967 R	1966 R
FIXED ASSETS (AT COST)					
Land and buildings	—	1,038,386.50	123,772.42	8,669,767.84	7,755,154
SUB-TOTAL	—	1,038,386.50	123,772.42	8,669,767.84	7,755,154
Laboratory and workshop equipment	156,504.53	1,780,616.16	85,085.14	9,834,314.36	7,982,279
Furniture, fittings & office equipment	1,328.99	101,316.08	15,408.73	690,587.28	603,351
Vehicles and cycles	—	68,559.83	33,487.47	234,737.64	199,665
Books and journals	1,292.87	76,149.28	957.30	624,701.33	548,216
Prefabricated structures	—	1,381.63	—	11,899.46	10,518
Shares in S.A. Inventions Development Corporation	—	—	—	100,000.00	100,000
SUB-TOTAL	159,126.39	2,028,022.98	134,938.64	11,496,240.07	9,444,029
TOTAL	R159,126.39	3,066,409.48	258,711.06	20,166,007.91	17,199,183

STATEMENT No. 1 Continued

CURRENT LIABILITIES	1967 R	1966 R	CURRENT ASSETS		1967 R	1966 R
Advances for investigations and services	928,766.04	867,051	Stores stock	260,960.73		
Sundry creditors and credit balances	3,140,553.25	1,963,085	Wool stock	658.41	261,619.14	240,060
			Sundry debtors and debit balances		978,238.95	601,105
			Investigations and tests in progress		566,423.69	358,576
			Advances and deposits			
			Research grants	477,994.13		
			Other	2,759,080.86	3,237,074.99	1,634,542
			Investments			
			Cash		2,963,646.14	3,138,225
			At S.A. Reserve Bank	251,318.81		
			Petty cash imprests	12,722.57	264,041.38	57,980
TOTAL	R4,069,319.29	R2,830,136	TOTAL		R8,271,044.29	R6,030,488
GRAND TOTAL	R28,437,052.20	R23,229,671	GRAND TOTAL		R28,437,052.20	R23,229,671

NOTES:

* Contractual obligations against the General and Building Funds as at 31st March, 1967, was R886,457 and R206,343 respectively.

PRETORIA: 13th October, 1967.

S. M. NAUDÉ
President

J. H. VISAGIE
Secretary/Treasurer

The above Balance sheet has been audited in accordance with the provisions of Section 56 of the Exchequer and Audit Act, No. 23 of 1956, as read with Section 14(1) of the Scientific Council Act No. 32 of 1962, and I certify that it is a true and fair view of the accounts of the Council for Scientific and Industrial Research.

PRETORIA: 23rd November, 1967.

I. T. MEYER
Controller and Auditor General

South African Council for Scientific and Industrial Research
Operating Account for the year ended 31st March, 1967

STATEMENT No. 2

EXPENDITURE	1966/67 University Institutions	1966/67 CSIR	1966/67 Total	1965/66
Salaries, wages and allowances	236,112.37	6,961,120.39	7,197,232.76	6,138,866
Consumable stores and services	24,346.61	10,414,027.60	10,438,374.21	5,258,300
Subsistence and transport	21,109.95	388,506.55	409,616.50	393,751
General expenses	54,157.78	1,261,354.84	1,315,512.62	1,082,146
Subsidies: Research by industry	—	221,615.50	221,615.50	168,085
Grants	617,321.72	16,389.59	633,711.31	601,122
SUB-TOTAL	953,048.43	19,263,014.47	20,216,062.90	13,642,280
Less: Income for internal services	706.90	1,464,417.86	1,465,124.76	1,306,930
SUB-TOTAL	952,341.53	17,798,596.61	18,750,938.14	12,335,350
Balance transferred to accumulated fund	113,530.33	587,501.51	701,031.84	684,768
TOTAL	1,065,871.86	18,386,098.12	19,451,969.98	13,020,118

INCOME	1966/67 University Institutions	1966/67 CSIR	1966/67 Total	1965/66
Parliamentary grant	1,037,000.00	5,803,000.00	6,840,000.00	6,071,031
Investigations and services	23,383.42	12,215,347.52	12,238,730.94	6,649,116
Contributions to C.S.I.R. projects	4,000.00	276,421.20	280,421.20	268,273
Publications	1,488.44	5,382.75	6,871.19	7,167
Sundry	—	85,946.65	85,946.65	21,581
Reimbursement of cost of capital facilities	—	—	—	2,950*
TOTAL	1,065,871.86	18,386,098.12	19,451,969.98	13,020,118

NOTE:
* Cost of capital facilities (i.e. buildings, roads, etc) provided on repayment for the National Aeronautical and Space Administration, U.S.A.

PRETORIA: 13th October, 1967

S. M. NAUDE
President

J. H. VISAGIE
Secretary/Treasurer

A. Operating Cost

ACTIVITIES	EXPENDITURE								FUNDS	
	Salaries	Supplies and services	Subsistence and transport	Scientific services	Grants and subsidies	General expenses	Amount internally recovered	Total	Parliamentary grant	Recoverable expenses
	R	R	R	R	R	R	R	R	R	R
CSIR laboratories and departments	7,649,093	10,354,296	396,484	380,397	215,385	870,094	1,561,949	18,303,800	5,458,830	12,844,970
Grants and subsidies	657,506	80,970	36,345	50,608	1,182,083	87,688	134,370	1,960,830	1,788,170	172,660
TOTALS R	8,306,599	10,435,266	432,829	431,005	1,397,468	957,782	1,696,319	20,264,630	7,247,000	13,017,630

B. Capital Expenditure

ACTIVITIES	EXPENDITURE								FUNDS	
	Books/ Journals	Technical equipment	Furniture/ Office equipment	Vehicles	Stores stock		Buildings	Total	Parliamentary grant	Recoverable expenses
CSIR laboratories and departments	65,877	2,131,579	71,832	9,418	3,000		842,961	3,124,667	1,969,595	1,155,072
Grants to universities, etc.	100	182,805	500	—	—		—	183,405	183,405	—
TOTALS R	65,977	2,314,384	72,332	9,418	3,000		842,961	3,308,072	2,153,000	1,155,072
GRAND TOTALS R								23,602,702	9,430,000	14,172,702

CSIR PERIODICAL PUBLICATIONS

Scientiae

Monthly.
Recent events at the CSIR; feature articles on scientific topics; comment on topics of current scientific interest.
Gratis.

Research Review

Six-monthly list of articles and reports published under the auspices of the CSIR, with author summaries where available.
Gratis.

TI (technical information for industry)

Monthly.
Notes and short articles on aspects of CSIR research with industrial application.
Gratis.

CSIR Library Information and Accessions

Monthly.
News and views on information and documentation; recent translations by the CSIR Information Division; latest accessions to the CSIR Library.
Gratis.

Scientific research organizations in South Africa

Annual.
A guide to government organizations, statutory bodies and industrial concerns which maintain research laboratories.
R1.00 per issue.

Scientific and technical societies in South Africa

Annual.
A guide to societies, giving particulars of their aims and objects, membership, publications etc.
R1.00 per issue.

Scientific and technical journals published in South Africa

Annual.
A list of current journals, arranged alphabetically and by issuing body, giving particulars of fields covered, subscription price, date of foundation etc.
R1.00 per issue.

Register of current scientific research at South African universities

Annual.
Gratis.

Annual Report of the CSIR

Gratis.

Psychologia Africana

Journal of the National Institute for Personnel Research, CSIR.
R3.00 for three issues.

NBRI Information Sheets

Every two months.
Brief questions and answers on technical and practical problems related to building.
Gratis.

Houtim

Quarterly.
Technical news for the timber industry, compiled by the CSIR Timber Research Unit.
Gratis.

Via

March and September.
Summarized reports (mostly of an interim nature) by the National Institute for Road Research, CSIR.
Gratis.

Radio-propagation predictions for Southern Africa

Monthly.
Issued by the National Institute for Telecommunications Research, CSIR.
Gratis.

Monthly bulletin of ionospheric characteristics observed at Johannesburg and Cape Town

Issued by the National Institute for Telecommunications Research, CSIR.
Gratis.

ENQUIRIES

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Annexure

RESEARCH GRANTS ADMINISTERED BY THE CSIR

This schedule, produced with the aid of a computer, is in three parts:

(a) A list of the grant-supported projects, arranged according to university or other institution and numbered consecutively.

(b) A keyword-in-context (KWIC) index based on keywords selected from the titles of the projects. Each of these keywords, which appear in alphabetic sequence towards the middle of the line, is used as a subject entry. As much as possible of the project title in which the keyword appears is printed on either side of each keyword - a slash sign '/' is printed in the line to indicate from which point one should start reading the title, while a hash sign '≠' indicates the end of a title. Each KWIC entry is followed by the number of the project to which it refers.

(c) A name index.

UNIVERSITY OF CAPE TOWN

1 THE ELECTROPHYSIOLOGY OF THE ISOLATED PERFUSED COLLECTING TUBULE OF THE RABBIT KIDNEY
ISAACSON LL

2 AN INVESTIGATION INTO THE DETECTION AND SIGNIFICANCE OF FO ETAL ANOXIA
BAILLIE P

3 ULTRASTRUCTURE AND FLUORESCENCE IN PORPHYRIA
CAMPBELL JAH

4 FLUORESCENT ANTIBODIES (AND ULTRASTRUCTURE) IN EGG-YOLK CI RRHOSIS
CAMPBELL JAH

5 KINETIC AND THERMODYNAMIC STUDIES OF THE MECHANISM OF ENZY ME ACTION
DAVISON AJ

6 AN INVESTIGATION INTO THE MANAGEMENT, PATHOGENESIS AND PRE VENTION OF RHESUS ISO-IMMUNIZATION
FARRELL AGW

7 STUDIES OF LABELLED PLASMA PROTEIN METABOLISM
HOFFENBERG R

8 CHARACTERIZATION OF LONG-ACTING THYROID STIMULATOR
HOFFENBERG R

9 ELECTRON MICROSCOPY OF HUMAN DECIDUAL SPIRAL ARTERIOLES
MARAIS WD

10 STUDIES IN ALCOHOLIC PANCREATITIS IN THE SOUTH WESTERN CAP E
MARKS IN

11 ACID SECRETION FOLLOWING GASTRIC SURGERY
MARKS IN

12 STUDIES IN SMALL BOWEL DISEASE IN THE SOUTH WESTERN CAPE
MARKS IN

13 FACTORS INFLUENCING THE CONTACT PHASE OF BLOOD CLOTTING IN RELATION TO THE COAGULATION MECHANISM, HAEMORRHAGE AND TH ROMBOSIS
MIBASHAN RS

14 PLATELET ADHESIVENESS IN DIFFERENT POPULATION GROUPS, IN R ELATION TO CORONARY DISEASE, AND TO AGENTS LIKELY TO IMPAI R OR ENHANCE PLATELET FUNCTION
MIBASHAN RS

15 THE RADIOIMMUNOASSAY OF PROTEIN HORMONES IN DISEASE STATES , WITH PARTICULAR REFERENCE TO GROWTH HORMONE SECRETION IN CLINICAL AND EXPERIMENTAL PROTEIN DEPLETION AND PRE- DIAB ETES
PIMSTONE BL

16 THE ASSAY OF ANTI- DIURETIC HORMONE IN BLOOD AND URINE OF PATIENTS WITH VARIEGATE PORPHYRIA IN THE ACUTE ATTACK
SWEENY GD

17 IMIDAZOLES AND UNIDAZOLE METABOLISM. AN INVESTIGATION INTO THE CHEMICAL STRUCTURE/ BIOLOGICAL ACTIVITY RELATION OF C ERTAIN ANALOGUES OF HISTIDINE AND HISTAMINE
TROUT GE

18 THE NATURE, PATHOGENESIS AND CLINICAL SIGNIFICANCE OF PROT EINURIA IN PREGNANCY WITH PARTICULAR REFERENCE TO THE NATU RE OF CHRONIC RENAL DISEASE PRESENT IN PREGNANCY
VAN COEVERDEN DE GROOT HA

19 A STUDY OF ATTITUDE DYNAMICS WITH SPECIAL REFERENCE TO ETH NOCENTRISM
COLMAN AM

20 THE BEHAVIOUR, BIOLOGY AND FEEDING OF THE CAPE GANNETT MOR US CAPENSIS
BROEKHUIZEN GJ

21 NUCLEAR REACTIONS PRODUCED BY NEUTRONS AND CHARGED PARTICL ES
BROOKS FD

22 LOW-LEVEL ALPHA AND GAMMA-RAY ACTIVITY IN NATURALLY OCCURR ING SAMPLES
CHERRY RD

23 OPTICAL STUDY OF A PLASMA BY MEANS OF A MACH-ZENDER INTERF EROMETER
CILLIERS WA

24 THEORETICAL INVESTIGATION OF DIRECT NUCLEAR INTERACTIONS A T INTERMEDIATE AND HIGH ENERGIES
FRAHN WE

25 PREPARATION OF VARIOUS MONONITRONES AND A STUDY OF THEIR R EACTIONS
LAMCHEN M

26 PREPARATION OF VARIOUS MONOCYCLIC DINITRONES AND A STUDY O F THEIR R EACTIONS
LAMCHEN M

27 STUDIES OF E LACTONES
LAMCHEN M

28 INFRA-RED SPECTROSCOPY
LEISEGANG EG

29 METABOLISM AND PIGMENT FORMATION BY TRICHODERMA GLAUCUM (B ON.) AND OTHER FUNGI
LUTJEHARMS WJ

30 THE CRYSTAL STRUCTURE OF COMPOUNDS DERIVED FROM THE REACTI ON OF METAL CARBONYLS AND DIPHOSPHINES
NASSIMBENI LR

31 X-RAY DIFFRACTION STUDIES OF IRRADIATED SOLIDS
PROUT EG

32 THE THERMAL DECOMPOSITION OF IRRADIATED SOLIDS
PROUT EG

33 ELECTRON DIFFRACTION FROM CRYSTALS WITH SPECIAL REFERENCE TO DIAMOND-TYPE STRUCTURES
SCHAFFER W

34 STUDIES IN THE CHEMISTRY OF SOUTH AFRICAN PLANT POLYSACCHA RIDES, WITH EMPHASIS UPON GAS-LIQUID CHROMATOGRAPHIC METHO DS OF ANALYSIS
STEPHEN AM

35 NMR SPECTROSCOPY AS AN ESSENTIAL-ANALYTICAL AID IN ORGANIC CHEMICAL RESEARCH
STEPHEN AM

36 GAS-LIQUID CHROMATOGRAPHIC SEPARATION IN THE FIELD OF ORGA NIC CHEMISTRY, WITH PARTICULAR REFERENCE TO THE STUDY OF C ARBOHYDRATES
STEPHEN AM

37 OPTICAL ASTRONOMY
WARREN PR

38 STUDY OF (PROTON GAMMA), (PROTON, PROTON' GAMMA), (ALPH A, ALPHA) AND (ALPHA, GAMMA) REACTIONS
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