



CSIR

annual report 1966

P.O. Box 395
PRETORIA
1st May, 1967

Sir,

I have pleasure in presenting to you the Twenty-second Annual Report of the Council for Scientific and Industrial Research. This Report covers the period 1st January, 1966 to 31st December, 1966.

Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1966 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

COVER PHOTO

A Schlieren photograph of a typical aerodynamic model in the CSIR Trisonic Wind Tunnel at a Mach number of 1.6.

A sensitive optical system using two concave mirrors of very high accuracy passes a uniform beam of light through the test section of the tunnel. Density changes produced by expansion and shock-waves are translated into alternate light and dark regions on a photographic film.

A great deal can be learned about supersonic flow by means of such studies of the flow patterns.

Published 1967 by the
South African Council
for Scientific and Industrial Research
P.O. Box 395
PRETORIA

Copies of this report (in English or Afrikaans) can be obtained from

**The Distributor of Publications
Information Division
CSIR
P.O. Box 395
PRETORIA
South Africa**

Printed 1967 in the
REPUBLIC OF SOUTH AFRICA
by Hayne and Gibson
Doornfontein
JOHANNESBURG

PHOTOGRAPHS

The photographs used in this publication were provided by the CSIR's Graphic Arts Division, Dotman Pretorius, Die Vaderland, the Department of Information, the South African Sugar Journal, the Bernard Price Institute, Rand Mines Ltd. and the various Laboratories and Institutes of the CSIR.

CSIR

TWENTY-SECOND ANNUAL REPORT 1966

Ook in Afrikaans verkrygbaar

Council for Scientific and Industrial Research

Annual Report S.Afr. CSIR, No. 22, UDC 5 + 61:061.6.055.5] (680) Pretoria, South Africa, 1966.

MEMBERS OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH 1966



S. M. NAUDE
M.Sc. (Stell.), Ph.D. (Berlin),
D.Sc.h.c. (Potchef.), D.Sc.h.c. (Rand),
LL.D.h.c. (Cape), D.Sc.h.c. (Stell.),
F.R.S. (S.A.).
President, CSIR



J. D. ROBERTS
B.Sc. (Eng.) (Rand), M.(S.A.)I.C.E.,
A.M.I.C.E.
**Chairman, Roberts Construction,
Co. Limited**



C. A. DU TOIT
M.Sc. (Stell.), Ph.D. (Cape), F.R.S.
(S.A.).
**Professor of Zoology, University
of Stellenbosch**



A. J. A. ROUX
B.Sc. (Mech. Eng.) (Rand), M.Sc.
(Mech. Eng.) (Rand), B.Sc., B.Sc.
(Hons.) (Rand), D.Sc. (Eng.) (Rand),
D.Sc.h.c. (Stell.).
**Director General, Atomic
Energy Board**



B. CAIGHER
D.Sc. (Pret.).
**Chairman, Fuel Research Council;
Chairman, Standards Council;
Member, Board of Trade and
Industries**



R. L. STRASZACKER
M.Sc. (Eng.) (Rand), Dipl. Ing. and
Dr. Ing. (Berlin-Charlottenburg),
M.I.Mech.E., M.S.A.I.Mech.E.
**Chairman and Consulting Engineer
Escom;
Member Atomic Energy Board**



G. C. V. GRAHAM
B.Sc. (S.A.).
**Managing Director, Fine Wool
Products of South Africa Limited**



H. J. VAN ECK
M.Sc. (Stell.), Dr. Ing. (Charlotten-
burg), LL.D.h.c. (Drexel Inst. of
Tech., Phil., U.S.A.), LL.D.h.c.
(Natal), LL.D.h.c. (Rhodes), LL.D.h.c.
(Rand), LL.D.h.c. (Cape), D.Com.h.c.
(Stell.).
**Chairman, Industrial Development
Corporation; Chairman, Iscor;
Chairman, Munitions Production
Board**



F. G. HILL
B.Sc. (Eng.) (Rand), M.A. (Iuris)
(Oxon.), M.I.M.E., M.I.M.M. (Lond.),
M.S.A.I.M.M.
**Manager, Technical Services, Rand
Mines Limited**



J. N. VAN NIEKERK
M.Sc. (Cape), Ph.D. (Cape).
**President, South African Institute
of Physics; Head, Basic Research
Department, Iscor**



S. F. OOSTHUIZEN
M.D. (Cape), D.Sc. (Pret.), D.Sc.h.c.
(Natal), F.R.C.P. (Edin.), F.A.C.R.
(U.S.A.), F.F.R. (Lond.).
**President, South African Medical and
Dental Council; Professor of
Radiology, University of Pretoria**



E. T. WOODBURN
B.Sc. (A.I.C.) (Cape), A.M.I.Chem.E.
**Head, Department of Chemical
Engineering and Dean of the Faculty
of Engineering, University of Natal**

Members of the Executive Committee of the Council for Scientific and Industrial Research as at 31st December, 1966: Dr. S. M. Naudé (Chairman), Mr. F. G. Hill (Vice-Chairman) and Dr. R. L. Straszacker (with Dr. B. Caigher, Prof. S. F. Oosthuizen and Dr. H. J. van Eck as alternates to Mr. Hill and Dr. Straszacker).



The Hon. B. J. Vorster, Prime Minister of South Africa, in conversation with Dr. S. M. Naudé, President of the CSIR (left), and Dr. A. D. Wassenaar, Managing Director, SANLAM (right), before the commencement of a banquet in celebration of the CSIR's 21st birthday.

21st ANNIVERSARY OF THE CSIR



Dr. S. Meiring Naude'
President
CSIR

EXECUTIVE OF THE CSIR

VICE-PRESIDENTS



Dr. F. J. Hewitt



Dr. W. H. Craib



Dr. N. Stutterheim

CONTENTS

Council members of the CSIR: 1966	iv		
Executive of the CSIR	vi		
General introduction	1		
Research for particular economic sectors	5		
Sector 1 Agriculture	7		
Fisheries	8		
Fishing industries research institute	8		
2 Gold mining	10		
National Mechanical Engineering			
Research Institute	11		
3 Coal mining	13		
4 Other mines and quarries	13		
Diamonds	13		
5 Processed foodstuffs	14		
Sugar	14		
Sugar Milling Research Institute ..	14		
Meat	15		
Food technology	15		
6 Liquor	16		
Bantu beer	16		
7 Textiles	17		
South African Wool Textile Research			
Institute	17		
9 Footwear	19		
10 Timber and timber products	19		
Timber Research Unit	19		
12 Paper and paper products	20		
14 Leather and leather products	20		
Leather Industries Research Institute	20		
16 Basic industrial chemicals	21		
17 Diverse chemical products	21		
South African Paint Research In-			
stitute	21		
18 Petroleum and coal products	21		
19 Non-metallic mineral products	22		
20 Iron and steel	23		
21 Non-ferrous metals	23		
23 Machinery	23		
24 Electrical equipment	24		
25 Transport equipment	25		
26 Motor vehicles	26		
27 Diverse manufacturing industries ..	26		
28 Electricity, gas and water	28		
29 Transport and communication	29		
National Institute for Telecommuni-			
cations Research	29		
		32 Building and construction	30
		National Building Research Institute	30
		Roads	36
		National Institute for Road Research	36
		Research in the public sector	39
		Earth and space sciences	40
		Electrical shark barrier	41
		Labour and management	42
		National Institute for Personnel Research	42
		Air pollution	43
		Medical research	44
		National Nutrition Research Institute ..	47
		Road safety	48
		Water	49
		National Institute for Water Research ..	49
		Corrosion	51
		Research for national defence	51
		Fundamental research	53
		Research at universities	53
		Scientific co-operation	54
		Chemistry	56
		National Chemical Research Laboratory ..	56
		Chemical physics	59
		Physics and geophysics	60
		National Physical Research Laboratory ..	61
		Astronomy	63
		Republic Observatory	62
		Mathematics	64
		National Research Institute for Mathematical	
		Sciences	64
		Psychology	65
		Bantu labour	65
		Scientific services	67
		Time service	68
		Space tracking	69
		Data processing	70
		Standards of physical measurement	71
		Radioactivity	71
		Vocational guidance	72
		Technical services	73
		Techno-economic and information services ..	75
		Development of industrial research	76
		Industrial economics	77
		Technical information for industry	78
		Publications	78
		Library services	79
		Public information	80
		Financial statements	ix
		CSIR periodical publications	xv



SCIENTIA—

headquarters of the CSIR

GENERAL INTRODUCTION

SOUTH AFRICA'S expenditure on research now amounts to approximately 0.5% of the national income. The stage has been reached where research is an integral and dynamic factor in the national economy. Research is no longer aimed merely at satisfying intellectual needs, but is making a positive contribution to the growth and development of the economy, promoting the efficacy of national defence and playing an important part in furthering national health and building up an effective infra-structure. Research has reached a stage in South Africa where it is important and essential to national prosperity.

The increasing economic impact of research has inevitably given rise to various problems. One of the most important is to ensure that the relative contribution of research to development continues to increase by the more effective utilization of research funds and staff which are perennially in short supply. To meet this situation the C.S.I.R. has adopted an approach aimed at identifying technical and economic bottle-necks to serve as a basis for allocating priorities for applied research.

On the other hand, it must be remembered that research is a long-term investment. It should continually add to the reservoir of knowledge required to exploit new raw materials, techniques, products and services. Basic research also has to be maintained on a sound basis.

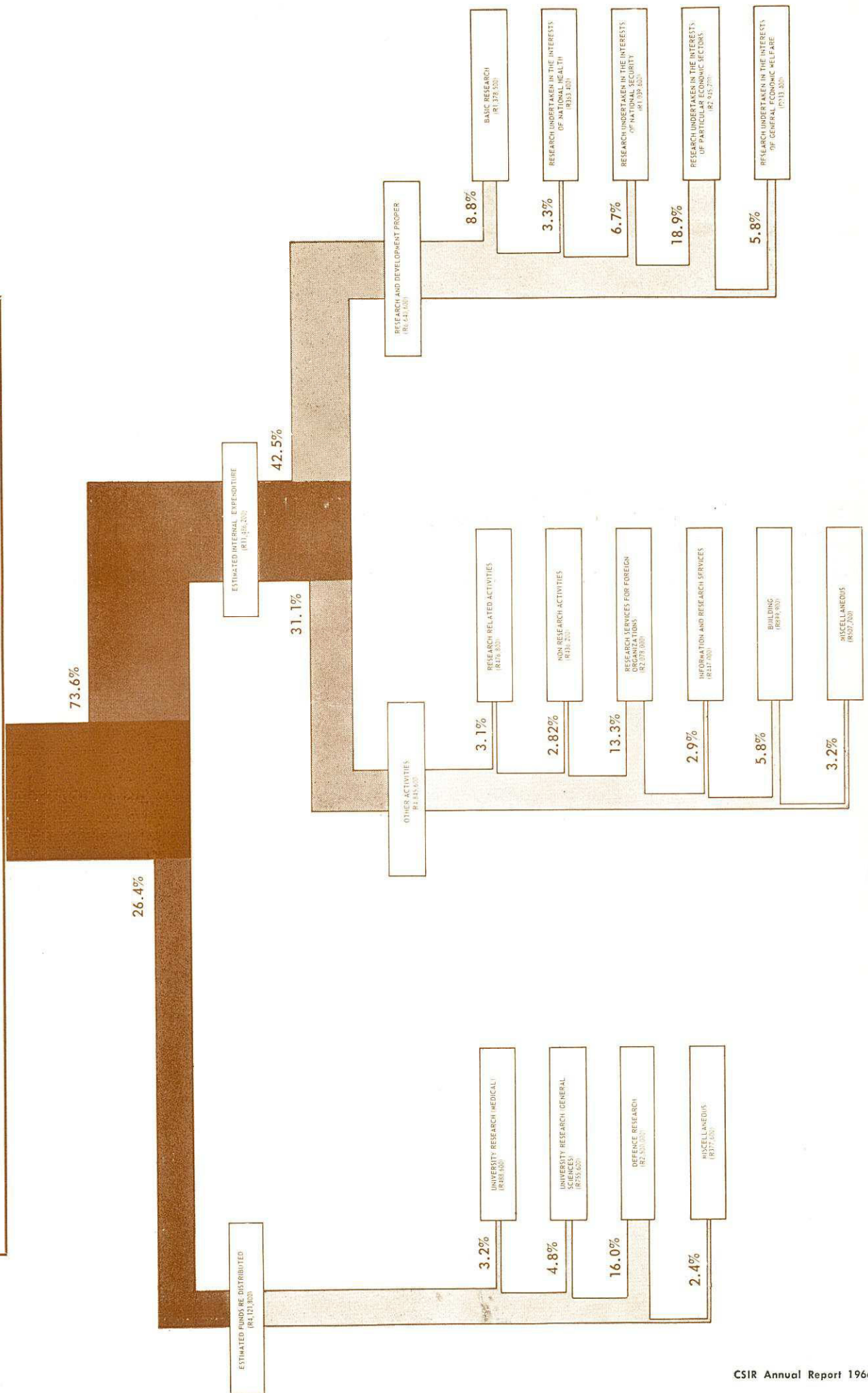
In this report, applied research and development in the C.S.I.R. are related as far as possible to appropriate fields of application and the economic sectors to which they are directed.

As a background to this discussion, the following diagram shows the allocation of the C.S.I.R.'s total budgeted income for 1965/66 (from all sources).

This diagram shows how the budgeted C.S.I.R. income (from all sources) is divided into expenditure within the C.S.I.R.'s organizational structure and funds redistributed.

The estimated internal expenditure is in its turn subdivided into seven categories, which may further be described as follows:—

**TOTAL BUDGETED CSIR EXPENDITURE FOR 1965/66 AND ESTIMATED ALLOCATION OF FUNDS
(TOTAL AMOUNT R15,608,000)**



navitics and Space Administration (N.A.S.A.). The funds for this emanate from N.A.S.A.

(vi) "Building".

(vii) "Miscellaneous".

External activities

Funds redistributed represent funds made available by the State through the C.S.I.R. for research at universities as well as research funds transferred by the C.S.I.R. to another body for certain projects.

The diagram shows that about R6.6 million of the C.S.I.R.'s gross budget of R15.6 m. was devoted to "research and development proper". The R6.6 million spent on this activity was canalized into the sub-activities and to the extent mentioned below.

Fundamental research	.....	.....	.....	.....	approx. 20.8%
Research for national health	.....	.....	.....	.....	approx. 5.5%
Research for national security	.....	.....	.....	.....	approx. 15.7%
Research for particular economic sectors	.....	.....	.....	.....	approx. 44.3%
Research for promoting general economic welfare	.....	.....	.....	.....	approx. 13.7%
					<hr/> 100.0%

Research undertaken in these categories is discussed more fully in the relevant parts of the annual report.

(i) "Research and development proper" is taken to mean systematic intensive study primarily aimed at the advancement of knowledge, whether to expose fundamental facts of nature, provide a factual background for the solution of practical problems, or to provide the insight required for finalizing the design of new products, processes or practices, or advancing the design of existing ones, to meet given functional or economic requirements.

(ii) "Research-related activities" excludes research and development, and includes activities such as training and instruction provided by scientific organizations, in addition to data gathering on a general basis, scientific information work, and testing and standardization.

(iii) "Non-research activities" includes routine testing and analysis, trouble-shooting and all scientific activities arising from patent applications and litigation.

(iv) "Information and research services" includes the activities of the C.S.I.R.'s library and information service and other professional services (e.g. economic analysis).

(v) "Research services for foreign organizations" consists mainly of the space observation services conducted on behalf of the United States of America's National Aero-



RESEARCH

FOR

PARTICULAR ECONOMIC SECTORS

IN this section research projects which are designed to advance the progress of particular economic sectors are reviewed. The projects are grouped according to the economic sector benefitting, and the economic sectors are in turn classified according to the system used by the Department of Planning in drawing up the Economic Development Programme.*

An overall picture of the amount of research undertaken in each sector can be obtained from the accompanying table which indicates the CSIR's research expenditure on behalf of each economic sector for the financial year 1965/66.

This table shows that the activities of the CSIR cover virtually the entire spectrum of economic activities. Precisely how this research relates to practice may be deduced from the review of the projects.

Before discussing individual projects, a brief explanation of the form of organization within

which the research services are rendered is appropriate.

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 National Institute for Water Research's work benefits the economic sector "Electricity, Gas and Water", while the National Institute for Telecommunications Research in collaboration with the National Institute for 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, non-ferrous metal industries, and machinery, etc. The National Chemical Research Laboratory's activities, again, can be traced to the sector "Miscellaneous chemicals."

* While this article was being prepared, the Economic Development Programme for the Republic for 1966-67 was not yet available, and the sectoral sub-division is the same as that which obtained for the period 1965-70.

Research expenditure for various economic sectors

	C.S.I.R.Ex- penditure R	% of Total
1. Agriculture, Forestry and Fisheries	100,600	3.4
2. Gold mining	49,500	1.7
3. Coal mining	215,200	7.3
4. Other mining and quarrying	28,500	1.0
5. Processed foodstuffs (excluding liquor)	64,900	2.2
6. Liquor (including Bantu beer) and Tobacco	246,200	8.4
7. Textiles	103,900	3.5
8. Clothing factories and knitting mills	0	0
9. Footwear	287,200	9.7
10. Wood and wood products (excluding furniture)	37,700	1.3
11. Furniture	32,400	1.1
12. Paper and paper products	7,100	0.2
13. Printing, publishing and allied industries	52,900	1.8
14. Leather and leather products (excluding footwear)	0	0
15. Rubber products	23,800	0.8
16. Basic industrial chemicals	400	<0.1
17. Miscellaneous chemicals	11,700	0.4
18. Petroleum and coal products	141,200	4.8
19. Non-metallic mineral products	26,400	0.9
20. Basic iron & steel products	67,200	2.3
21. Basic non-ferrous metals	82,900	2.8
22. Metal products (excluding machinery)	11,800	0.4
23. Machinery (excluding electrical machinery)	6,800	0.2
24. Electrical equipment and machinery	135,000	4.6
25. Transport equipment (excluding motor vehicles)	154,600	5.2
26. Motor vehicles and repair	0	0
27. Miscellaneous manufacturing industry	0	0
28. Electricity, gas and water	0	0
29. Transport and communications	191,600	6.5
30. Trade (wholesale and retail)	166,500	5.7
31. Miscellaneous services	2,900	0.1
32. Construction (civil engineering and buildings)	0	0
Total	696,800	23.7
Total	R2,945,700	100.0%

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 N.I.W.R. on contract basis. Industries where effluent problems have been investigated during the year, include textile factories, pulp and paper factories, a chemical industry, wine distilleries, yeast factories, a brewery and abattoirs. More detailed information of this work is given under "Industrial effluents", page 49.

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 (F.I.R.I.) which serves the economic sector "Agriculture, forestry and fisheries"; the Leather Industries Research Institute (L.I.R.I.), which covers both the economic sectors "Footwear" and "Leather and leather products"; and the Sugar Milling Research Institute (S.M.R.I.), which serves the sector "Processed foodstuffs". The work of the South African Paint Research Institute mainly benefits the economic sector "Miscellaneous chemicals". 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 (S.A.W.T.R.I.).

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 Wood and Cork sector is for example served by the Timber 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 (N.B.R.I.). The Department of Food Technology of the National Nutrition Research Institute (N.N.R.I.) serves the "Processed Foodstuffs" sector.

A further example of specialized facilities is the Electrical Engineering Research Department of the National Research Institute for Mathematical Sciences (N.R.I.M.S.), 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.

Research into the digestion of ruminants: A sample is being taken from a sheep's rumen.



AGRICULTURE

THE progress of farming in South Africa demands the constant adaptation of farming practice to new requirements and circumstances, and for this research is indispensable. The Department of Agricultural Technical Services bears the responsibility for this and has an extensive research organization with specialized branches covering the various areas of agriculture. Certain problems with which the Department has to deal, however, also demand research in other fields in which the C.S.I.R. is particularly well-equipped.

The following items give a picture of the research which the C.S.I.R. has undertaken during the past year in support of and in collaboration with the Department of Agricultural Technical Services.

Digestion in ruminants

A joint team of the National Chemical Research Laboratory (N.C.R.L.) and the Veterinary Research Institute at Onderstepoort, continued their research on the digestive process in ruminants. The development of apparatus for the continuous cultivation and study of anaerobic micro-organisms, which are found in the rumen of ruminants, is regarded as an important scientific achievement.*

The team also assisted in an investigation of **biuret** which is at present being test-marketed as a supplementary cattle feed.

Analysis of plant material

The National Physical Research Laboratory (N.P.R.L.) has initiated

research on the development of a supplementary method for the analysis of plant material with the aid of X-ray fluorescence. It is anticipated that this will make possible the determination of several elements which cannot readily be determined in the plants by conventional methods.†

Utilization of Maize Starch

The N.C.R.L. is investigating the industrial uses of maize starch. This project is financed by the Mealie Industry Control Board and managed by a research officer who was sent abroad by the Board to be trained for this purpose.

Poisonous irids

The N.C.R.L. furthermore participated in an investigation to determine the structure of the toxic component in poisonous irids which is responsible for the poisoning of cattle.‡

Grading of hides

The Leather Industries Research Institute (L.I.R.I.) assisted the Board

of Control of the Cattle and Meat Industry with the compilation of regulations for the processing and grading of hides and skins. To that end more than 5,000 skins were processed and studied during the tanning process and valuable information was obtained thereby.

Agricultural products

The C.S.I.R. also assists in research into the more efficient processing of agricultural products. More information about this may be found under the heading, **Processed Foodstuffs**.

* KISTNER, A. Possible factors influencing the balance of different species of cellulolytic bacteria in the rumen. *Physiology and Digestion of the Ruminant*, Washington, 1965, pp. 419-432.

† BUTLER, L.R.P. and MATHEWS, P. M. The determination of trace quantities of molybdenum by atomic absorption spectroscopy. *Anal. Chim. Acta*, vol. 36, 1966, pp. 319-327.

‡ ENSLIN, P. R. NAUDE, T. W. POTGIETER, D. I. J. & VAN WYK, A. J. 1 α , 2 α -epoxyscillirosidine, the main toxic principle of *Homeria glauca*. *Tetrahedron*, vol. 22, 1966, pp. 3212-3220.

It is C.S.I.R. policy to encourage groups of industries with common problems to establish industrial research associations. As soon as sufficient financial support is guaranteed by industry, an autonomous industrial research institute is established and the C.S.I.R. usually contributes half of the funds.

Such an institute is established at a university, the director enjoys professorial status, the staff share in the academic facilities and the university's post-graduate students have the opportunity of gaining valuable experience in the industry's technology while carrying out research for higher degrees at the institute.

Sector 1

THE South African fishing industry progressed so rapidly in the post-war period that the **Fishing Industry Research Institute (F.I.R.I.)** was established in Cape Town in 1946 under the auspices of and in col-

Fisheries

The Fishing Industries Research Institute building on the campus of the University of Cape Town.

laboration with the C.S.I.R. The C.S.I.R. together with the industrial firms concerned contribute on a rand-for-rand basis towards the upkeep of the Institute. The fact that the Republic now ranks ninth among the leading fishing countries is due in no small measure to the activities of the Institute during its 20 years of existence.



The following survey of the C.S.I.R.'s work during the past year gives an indication of the role this Institute plays in promoting the South African fishing industry.

Fish storage

The F.I.R.I., in collaboration with visiting scientists from the Torry Research Station in Aberdeen, Scotland, continued their investigations into the storage of frozen hake. The F.I.R.I.'s earlier findings—that the storage period could be extended from 9 to 15 days by storing the fish at 2-3° F. below freezing point—were confirmed.

Salted fish

Investigations by F.I.R.I. have resulted in the issue of a code of practice for the preparation, packaging and storage of salted snoek. This work covers, *inter alia*, the drawing up of specifications for acceptability of a product; the heat treatment of salt to eliminate halophilic bacteria; and the use of semi-permeable wrapping material.

Fish meal

Packing in plastic bags: In view of the increasing use of locally produced impermeable plastic bags for packing fish meal, investigations have been initiated into certain phenomena which are associated with this kind of packing. Particular attention was given to the determination of the conditions favouring and retarding mould growth in fish meal and to moisture migration in meal subject to thermal gradients. On the basis of laboratory tests and practical experience specifications have been prepared for hermetically sealed bags for fish meal.

F.I.R.I. contributed to the solution of several important problems connected with bulk storage of fish meal aboard a fish meal factory ship which started operations during the year, and directives were issued on the safety measures required. These measures include the creation and maintenance of an inert atmosphere in the



Dr. G. M. Dreosti, the Director of F.I.R.I. Dr. Dreosti is Chairman of the Walvis Bay Harbour Pollution Committee and one of the three members of the Commission of Inquiry into the Fishing Industry appointed by the Administrator of South West Africa.

ship's hold to inhibit spontaneous heating of the meal.

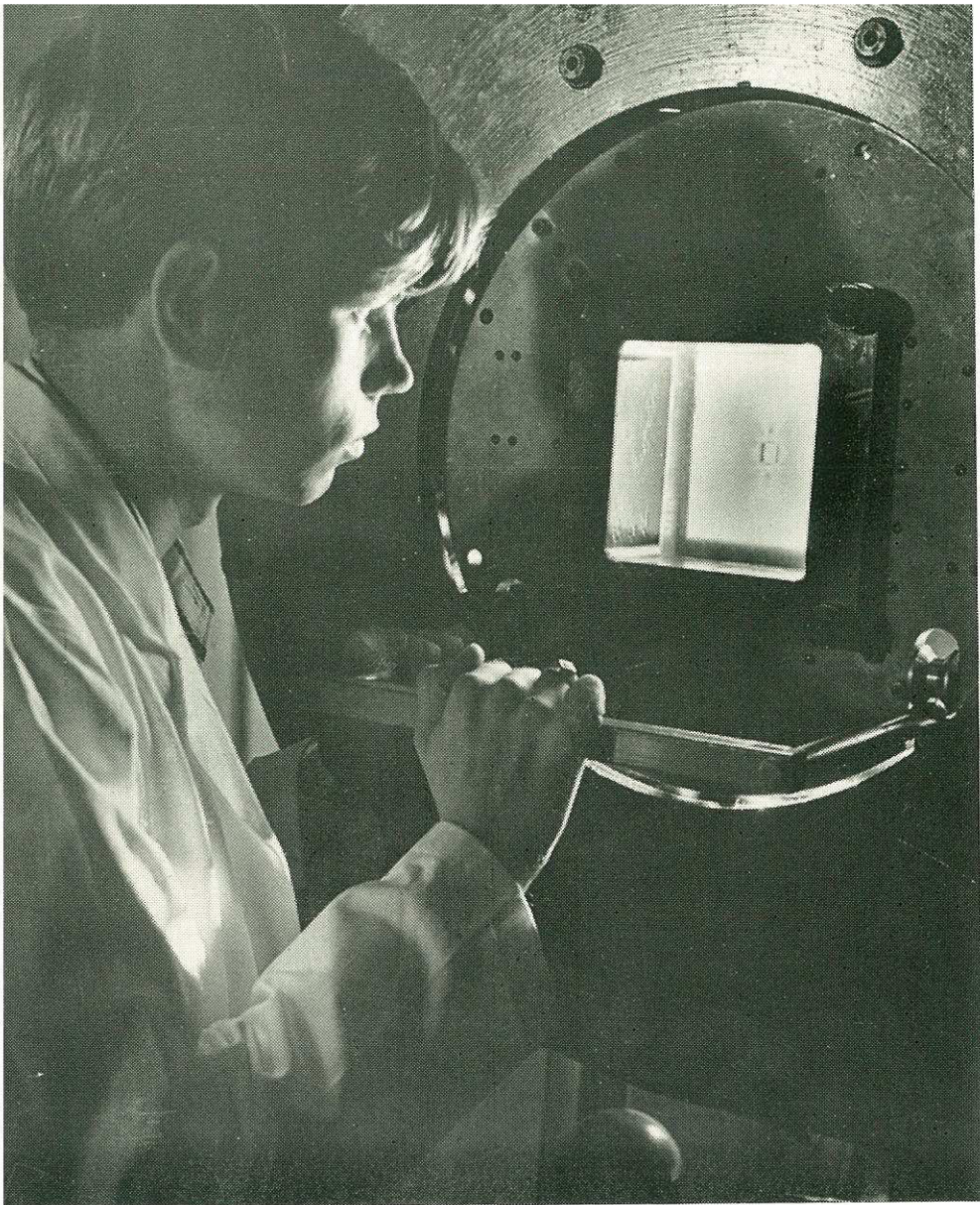
The implementation of these recommendations in practice has proved extremely effective in connection with the discharging of bulk containers. The flow properties of fish meal are at present being studied.

The nutritional value of fish products

F.I.R.I., in close co-operation with similar organizations in Europe and America, is at present working on the perfection of a rapid and inexpensive method of chemical assessment of the protein quality of fish products. F.I.R.I. plays a leading role in this sphere and the results to date are very promising.



Pilchards being sucked up from the hold of a fishing vessel. F.I.R.I. inter alia undertakes research into the storage of pilchards for export.



A plastic model of a mine shaft being subjected to biaxial loads. Polarized light indicates the stress patterns in the model.

THE mining industry has its own research laboratories where most of its problems are investigated. For the solution of problems requiring certain types of specialized research, however, the industry relies to a great extent on the laboratories and institutes of the C.S.I.R. which are specially equipped for research of this type. The concise report below gives an indication of the extent of the C.S.I.R.'s contribution to the development of the mining industry. At least five of the C.S.I.R.'s thirteen laboratories and institutes were involved in this work during the past year.

Gold in mine wastes

The N.P.R.L. has developed an automatic method for determining the concentration of gold in mine effluent. The method, based on chemical extraction followed by atomic absorption analysis, is a rapid one: up to ten samples can be analysed per hour. Any rise in the gold content of mine effluent can be traced within minutes. This method constitutes a great advance over the time-consuming assay system at present in use on the mines, and has been successfully tested in practice.

Its introduction into the mining industry should result in considerable savings.*

The N.P.R.L. also conducted radioactive tracer tests for a mining group in order to ascertain the conditions causing losses during chemical enrichment of gold before analysis by neutron activation. The source of the methodological errors occurring in the determination of the gold loss in residues was also investigated by means of tracer tests.

Mineralization studies were under-

taken in the Barberton-Nelspruit area by means of uranium-lead and rubidium-strontium-isotope ratios and significant facts were discovered concerning the nature and source of the gold occurring in the region. This investigation is at present being extended southwards through Swaziland to northern Natal.

* STRELOW, F. W. E., FEAST, E. C., MATHEWS, P. M. BOTHMA, C. J. C. & VAN ZYL, C. R. Determination of gold in cyanide waste solutions by solvent extraction and atomic absorption spectrometry. *Anal. Chem.*, vol. 38, 1966, pp. 115-117.

GOLD MINING

Ore mills

The National Mechanical Engineering Research Institute (N.M.E.R.I.) is carrying out research to determine which metals are the most suitable from the point of view of durability and cost of linings and grinding media in tube mills used in gold mines for grinding gold-bearing ore. Field observations have almost been completed, while laboratory determinations of the metallurgical characteristics of the metals tested are continuing and a start has been made with the statistical analysis of the results. This work is sponsored by the Transvaal and Orange Free State Chamber of Mines.

Rock mechanics

The N.M.E.R.I. has for many years been engaged in research into the causes and possible prevention of rockbursts in the gold mines. During the past year the emphasis of the research has been the determination of the strength properties of rock and the mechanism of fracture of rock under static loading conditions. This information should make it possible to ascertain the underground conditions in which rockbursts are likely to occur. In addition, research was undertaken into the mechanism of fracture under dynamic conditions, as a better understanding of this process is expected to throw more light on the mechanisms of drilling, crushing and grinding rock and result in economies in these aspects of mineral mining operations.

During the year a standardized procedure for determining the drillability of rock was developed, and progress was made in the development of facilities for studying the behaviour of rock surrounding underground excavations by means of models. As a result of enquiries from abroad, arrangements were made with a commercial firm to manufacture equipment developed in the

Institute for measuring the in situ stress in rock.*

Mine shafts and lift equipment

A unique testing apparatus for determining the fatigue strength of mine hoisting ropes under any ser-

vice conditions was constructed by N.M.E.R.I. The apparatus has already been manufactured and has been installed at the Mining Equipment Research Unit at Cottesloe, Johannesburg.

* HOEK, E. and BIENIAWSKI, Z. T. Brittle fracture propagation in rock under compression. *Int. J. of Fracture Mechanics*, vol. 1, 1965, pp. 137-155.

HOEK, E. and BIENIAWSKI, Z. T. Fracture propagation mechanism in hard rock. *1st Int. Congr. on Rock Mechanics*, Lisbon, vol. 1, 1966, pp. 243-249.

LEEMAN, E. R. and HAYES, D. J. A technique for determining the complete state of stress in

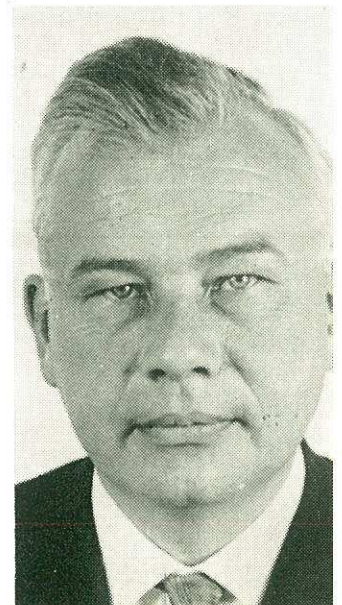
rock using a single borehole. *1st Int. Congr. on Rock Mechanics*, Lisbon, vol. 2, 1966, pp. 17-25.
COLBACK, P. S. B. An analysis of brittle fracture initiation and propagation in the Brazilian test. *1st Int. Congr. on Rock Mechanics*, Lisbon, vol. 1, 1966, pp. 385-391.
BIENIAWSKI, Z. T. and DANKHAUS, H. G. Der triaxiale Spannungszustand im Gebirge. *8 Länder-treffen Int. Bür. Gebirgsmech.*, Leipzig, 1966.

NMERI

RESEARCH in the National Mechanical Engineering Research Institute (N.M.E.R.I.) is devoted largely to the development of promising new engineering techniques; to the improvement of machinery and materials used in industry, and to research fields such as rock mechanics where the aim is to improve efficiency and safety in mining. The Institute is equipped with machinery, instruments and qualified personnel for research in the fields of metallurgy, strength of structures, rock mechanics, aeromechanics (including aeronautics), hydromechanics (including harbour and river engineering) and heat mechanics (including air-conditioning and refrigeration).

To meet the growing demand for its services, N.M.E.R.I. is, *inter alia*, installing two new wind tunnels for aerodynamic testing. The Mining Equipment Research Unit at Cottesloe, Johannesburg, is part of N.M.E.R.I. and deals with investigations related to mine ropes and winding equipment.

Dr. H. G. Denkhäus, Director of N M E R I. During the year under review Dr. Denkhäus attended the following conferences: the 19th Meeting of the International Organizing Committee for Mining Congresses in Stockholm, Sweden, from 15 to 20 August; the 6th Meeting of Group III (Rock Strength) of the International Bureau of Rock Mechanics in Clausthal, Germany, from 25 August to 1 September; the 1st International Congress on Rock Mechanics in Lisbon, Portugal, 25 September to 1 October. Dr. Denkhäus acted as reporter on one of the subjects and was elected Vice-President for Africa of the International Association for Rock Mechanics.





Headgear of a modern mine. N M E R I ' s Mining Equipment Research Unit investigates inter alia the performance of hoisting ropes and other hoisting equipment.

This Unit's laboratory is well-equipped for a wide variety of tests on ropes and mining equipment. The periodic inspection of mining equipment previously done by the Government Laboratory for Mechanical Engineering is now being undertaken by the Unit. A variety of other tests can also be done when necessary. During the year under review the Unit continued to carry out research on the design of steelwork installed in vertical mine shafts. Special equipment was developed for measuring the misalignment of the steel guides in which the skips and cages run. Further consideration was also given to the use of rope guides, a subject of detailed study by the N.M.E.R.I. some years ago.

A chapter on the streamlining of shaft steelwork to improve the flow of ventilating air in mine shafts was prepared for inclusion in a manual for the mining industry. This was

based on research by the Institute which showed that streamlining effected large savings in the consumption of electricity for operating ventilation fans.

Extraction

With monetary support from the Chamber of Mines, the **National Chemical Research Laboratory** has continued its work on the design of thickeners for gold-bearing pulps. This work has also aroused considerable interest abroad.*

An experiment concerning the use of neutron-activated silica in model studies of the sedimentation tanks of gold mines was performed by the N.C.R.L.'s Chemical Engineering Group and by the National Physical Research Laboratory.

The **National Building Research Institute** has investigated the possibility of leaching uranium from exist-

ing slimes dams on the gold mines on an economic basis. See also the item **Gold Chemistry** in the chapter **Fundamental Research**.

See also report under the heading **machinery** where further research of interest to the mining industry is described. Research concerning mine personnel problems is discussed in the section on **Labour and Management**.

* SCOTT, K. J. Effect of factors other than solids concentration on sedimentation. *Trans. Inst. Min. & Met.*, vol. 75, 1966, pp. C181-C182.

SCOTT, K. J. Mathematical models of mechanism of thickening. *I & E C Fundamentals*, vol. 5, 1966, pp. 109-113.

COAL MINING

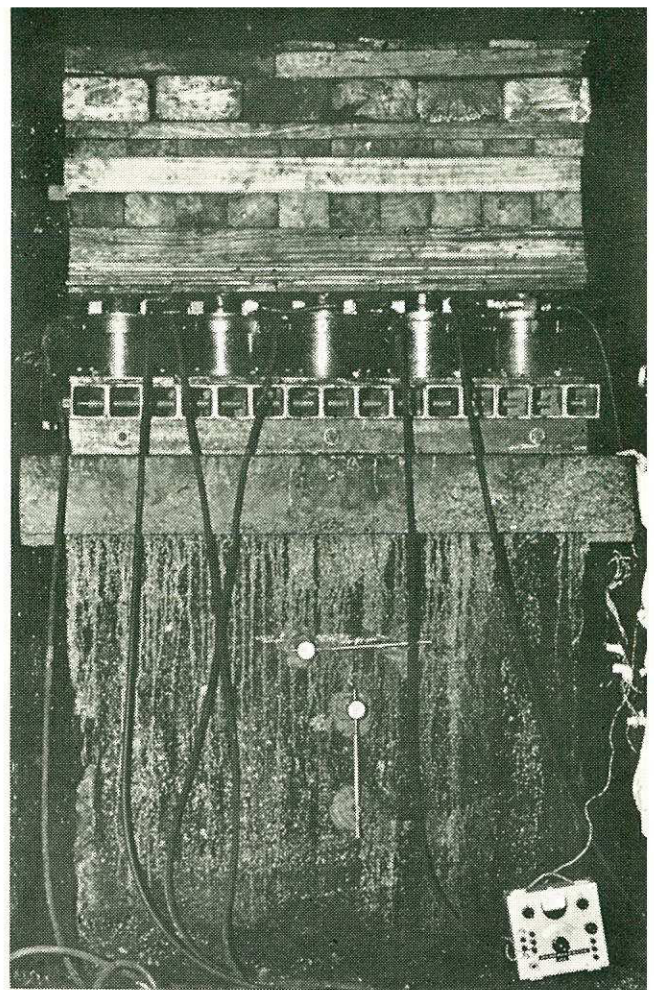
Sector 3

THE National Mechanical Engineering Research Institute has carried out intensive research into the stability of colliery workings. Most of this work has been undertaken in collaboration with the Coal Mining Research Controlling Council and as contract projects for that body.

During 1966, large-scale *in situ* testing of coal pillars was carried out. Large prisms were cut from underground coal pillars and loaded with the aid of hydraulic jacks specially designed and built by the C.S.I.R., in order to determine accurately the strength of the pillars.

Valuable information was obtained about the strength of the coal pillars which normally remain in the workings in accordance with the conventional coal-mining method used in this country. Further tests are envisaged for 1967.

A coal pillar in a mine being subjected to a pressure test.



Sector 4

Other mines and quarries

THE National Physical Research Laboratory has developed a successful X-ray fluorescence method of analysis of a wide variety of rock samples. Results obtained with this method compare favourably with those obtained by conventional chemical methods. The new procedure is far less time-consuming than the chemical method.

A start has also been made on the development of atomic absorption techniques for the determination of certain trace elements in rock samples. A satisfactory procedure for the determination of molybdenum has already been evolved.

Manganese dioxide for batteries

In the National Chemical Research Laboratory (N.C.R.L.) development tests to determine the suitability of manganese dioxide for use in dry cell batteries have continued. A senior scientist visited various establishments overseas to exchange information on the subject. The object of

this work is to assist local producers to market their product.

Purification of magnesite

In the industrial manufacture of magnesite problems arise in connection with the purification of magnesite containing a low percentage of foreign matter. A mathematical model devised by the National Research Institute for Mathematical Sciences enables the manufacturer to evaluate the efficiency of the purification process on a statistical basis without going to the expense of acquiring costly purification apparatus.

Diamonds

THE N.M.E.R.I. has assisted various diamond mines in the solution of problems by applying the principles of rock mechanics. Earlier this year an extensive investigation was launched to establish the extent to which surface ground will be affected as a result of diamond mining operations planned for the next few years. Survey pegs for measuring ground movement were installed and will be continually surveyed to ascertain the behaviour of the ground as mining proceeds.

PROCESSED FOODSTUFFS

SUGAR

LIKE the fisheries, leather and paint industries, the sugar milling industry in the Republic has its own research institute, which is supported partly by the C.S.I.R. and partly by the sugar industry. The **South African 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.



Dr. M. Matic, Director of the Sugar Milling Research Institute.

The quality of raw sugar

AS in previous years, a considerable proportion of the work carried out by the S.M.R.I. during the past year was connected with improving the quality of raw sugar. Regular analyses were carried out of export raws and various factories were visited by officials to determine whether the S.M.R.I.'s recommendations for sugar manufacture were being applied correctly.

The investigation into the performance of factory vacuum pans was continued. A number of instruments for accurately controlling vacuum and steam and syrup feed were installed and accurate temperature readings taken within the pan. The analysis and interpretation of the mass of data obtained is in progress.

The turbidity recording meter developed by the S.M.R.I. was successfully used in the determination of the capacity of the sugar juice clarifiers. In addition, a good correlation between the juice flow surges and mud entrainment was obtained.

The Institute's work on direct evaluation of cane quality has progressed to such an extent that the method will be applied next season to full-scale production. Continuous analysis of cane over prolonged periods was successfully completed in one factory.

A number of preliminary experiments in connection with the Rabe clarification process is planned for the next season.

Further work on the nature of gums formed during the deterioration of cane after harvesting gave research workers a better idea of the structure of the polysaccharide formed.



The Sugar Milling Research Institute building in Durban.

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 the 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.

This transformation in the nature of the S.M.R.I.'s activities has created a need for more accommodation and more staff. Development plans have been approved and the extension of the building for the Institute will be commenced shortly. The costs of the planned extensions will be covered on a 50-50 basis by the C.S.I.R. and the Industry.

Though the work is still in progress it has already been established that the amount of gums in mixed juice is the best available criterion for judging the freshness of sugar cane.*

Waste matter

The wastes of the sugar milling industry are also receiving the attention of C.S.I.R. research workers. This cane waste is used in the manufacture of bagasse board, and during the past year the C.S.I.R. **Timber Research Unit** (T.R.U.) studied its properties with a view to its use in the building and construction industry.

* BUCHANAN, E. J. Direct sampling and analysis of individual cane consignments: Part I: Rapid cane and bagasse analysis using the S.M.R.I. cold extractor. *S. African Sugar Journal*, vol. 50, 1966, p. 1049.

BUCHANAN, E. J. Direct sampling and analysis of individual cane consignments: Part II: Design and performance of the S.M.R.I. automatic cane sampler. *S. African Sugar Journal*, vol. 51, 1967, p. 151.

BRUIJN, J. Deterioration of sugar cane after harvesting: Part I: Changes in juice composition. *Int. Sugar Journal*, vol. 68, 1966, p. 331.

BRUIJN, J. Deterioration of sugar cane after harvesting: Part II: Investigation of the polysaccharide formed. *Int. Sugar Journal*, vol. 68, 1966, p. 356.

Meat

ON instructions from the Livestock and Meat Industries Control Board, the **National Mechanical Engineering Research Institute** (N.M.E.R.I.) has carried out valuable research on the refrigeration of foods and particularly the problems associated with abattoirs. The results of this research have shown that considerable savings in capital and running costs can be effected by proper design.

The Institute, as in previous years, played a significant rôle in the year under review in advising local authorities on the design of their abattoir facilities.†

† HODGSON, T. The design and testing of abattoirs refrigeration equipment. *J. East. Prov. Soc. Engrs.*, Aug. 1965, pp. 37-45.

HODGSON, T. The effect of environmental conditions on the chilling rates of meat. *Suppl. Bull. Int. Inst. Refrig. Annexe*, 1966, pp. 635-646.

FOOD TECHNOLOGY

DURING the year a Department of Food Science and Technology was created out of two divisions of the **National Nutrition Research Institute** (N.N.R.I.) with the following functions:

- to gain new knowledge about the composition of different foodstuffs and the performance of foodstuffs and food components during handling, transport, storage and processing;
- to investigate problems concerning handling, transport, storage, packing and processing of food in order to develop new methods and techniques or to improve existing ones, and especially to give attention to the problems of the South African food industry, with a view to its greater efficiency and expansion;
- to determine by means of close liaison with the industry the need for research into particular fields or on particular aspects and to make known to the food industry the facilities existing at the C.S.I.R.;
- to carry out, for payment or otherwise, short-term studies on behalf of individual members of the food industry;
- to assist the industry to make use of published information.

Butterfat powder

A method was developed at the **National Nutritional Research Institute** (N.N.R.I.) for producing a stable, free-flowing butterfat powder to be used in making cakes and other confectionery. The product is already being used in industry.

Mealies

With the financial support of the Mealie Industry Control Board, work was continued on the storage and other properties of mealies. New uses for mealies in various foodstuffs were also investigated and *inter alia* a method was developed for preparing soup powders with mealies as base.

Kaffircorn grits for Bantu beer

Support was obtained from the Kaffircorn Control Board for research into the preparation of kaffircorn grits with a low fat content which could be more suitable for use as adjunct in Bantu beer brewing than conventional grits. See also report on beer brewing under **Liquor**.

Groundnuts

With financial assistance from the Oil Seed Control Board, the N.N.R.I. conducted research on the storing of groundnuts under different climatic conditions, on the use of groundnuts in foodstuffs and on improving exist-

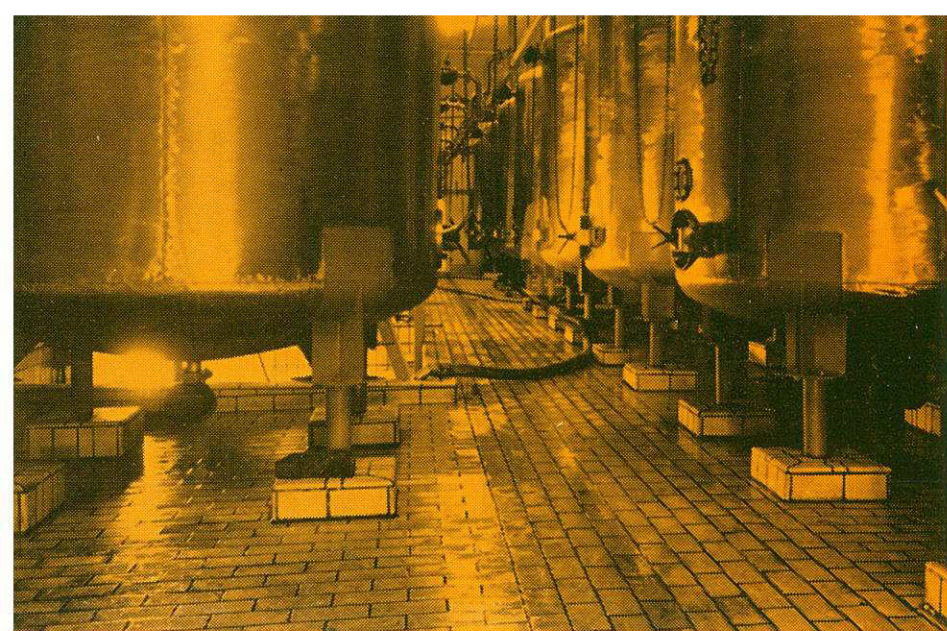
ing groundnut products. Research on the flavour substances in groundnuts was also started, particularly to determine what effect mechanization of the harvesting of groundnuts has on the flavour.

Protein

Lack of protein in the diet is a problem which occurs not only in South Africa but also in certain other countries where it assumes more serious proportions. In order to make more protein available, it is very important to find methods for determining the biological availability of different sources of protein. Research carried out by the N.N.R.I. has contributed not only to the improvement of protein evaluation by means of experimental animals, but also to a better understanding of the protein metabolism in the experimental animal.

Flavourings

The development of various modern techniques has made it possible to give more attention to the nature of flavours in foodstuffs. The N.N.R.I. has therefore initiated research in this field. Knowledge about the substances which impart flavour to foodstuffs can contribute greatly to improving the storage and processing techniques of different kinds of food.



Stainless steel vats in a large Bantu beer brewery outside Pretoria.

Sector 6

Liquor

THE work of the C.S.I.R. in this field during the past year was directed particularly to the brewing process itself, the utilization of certain by-products and the purification of waste water.

Beer brewing

WITH the generous support for research work made possible by the research levy imposed by the Department of Bantu Administration and Development on Bantu beer sales, the work of the Bantu Beer Unit of the **National Chemical Research Laboratory** is at present progressing on a wide front.* Recently particular attention was given to the development of methods for determining malt quality, to a survey of the micro-organisms present in kaffir-corn malt, to the equipment used for straining and packaging Bantu beer, and to the improvement of the bac-

terial souring process. Concerning the latter aspect, research was carried out also by the **National Nutrition Research Institute** (N.N.R.I.) into the dehydration of lactic acid bacteria cultures for use in the manufacturing process of brew mixes.

The **National Institute for Personnel Research** (N.I.P.R.) assisted the N.C.R.L. during an enquiry into retailer and consumer preferences for different types of Bantu beer containers, and made recommendations.

Drainage water

The problems connected with the effective purification of effluent from beer breweries in sewage systems are receiving attention at present.

Winery wastes

With a view to the possible use of wine lees, a by-product of the wine industry, as a source of tartaric acid, the N.C.R.L., in collaboration with the industry, completed a comprehensive survey over a whole season. The data collected show that the tartrate content of wine lees is reasonably high and that there is sufficient wine lees from the main wine-producing centres in the country to satisfy South Africa's total needs for tartaric acid.

The purification of effluent from wine-producing centres in the Western Cape gives rise to difficult problems. Owing to the high load of organic pollution of the effluent, it cannot simply be treated in conventional sewage treatment systems. Research by the **National Institute for Water Research** to break down the organic pollutants by means of anaerobic fermentation has led to the development of a practical and economic technique which has already given satisfactory results. The N.I.W.R. is at present engaged in refining this technique.

* NOVELLIE, L. Kaffircorn malting and brewing studies, XIV: Mashing with kaffircorn malt: Factors affecting sugar production. *J. Sci. Food Agric.*, vol. 17, 1966, pp. 354-361.

O'DONOVAN, M. B. & NOVELLIE, L. Kaffircorn malting and brewing studies, XV: The fusel oils of kaffir beer. *J. Sci. Food Agric.*, vol. 17, 1966, pp. 362-365.

DYER, K. & NOVELLIE, L. Kaffircorn malting and brewing studies, XVI: The distribution and activity of α - and β -amylases in germinating kaffircorn. *J. Sci. Food Agric.*, vol. 17, 1966, pp. 449-459.

NOVELLIE, L. Biological ennoblement and kaffir beer. *Food Tech.*, vol. 20, 1966, pp. 101-102.

NOVELLIE, L. Bantu beer — popular drink in South Africa. *Int. Brewer and Distiller*, vol. 1, no. 1, 1966, pp. 27-31.



THE South African Wool Textile Research Institute (S.A.W.T.R.I.) is concerned primarily with research into the processing properties of South African wool and mohair, with improving existing processing methods and with the development of new and more rapid methods. The Institute serves all branches of the industry which processes the Republic's most important agricultural product and which collaborates closely with the Technological Division of the South African Wool Board.

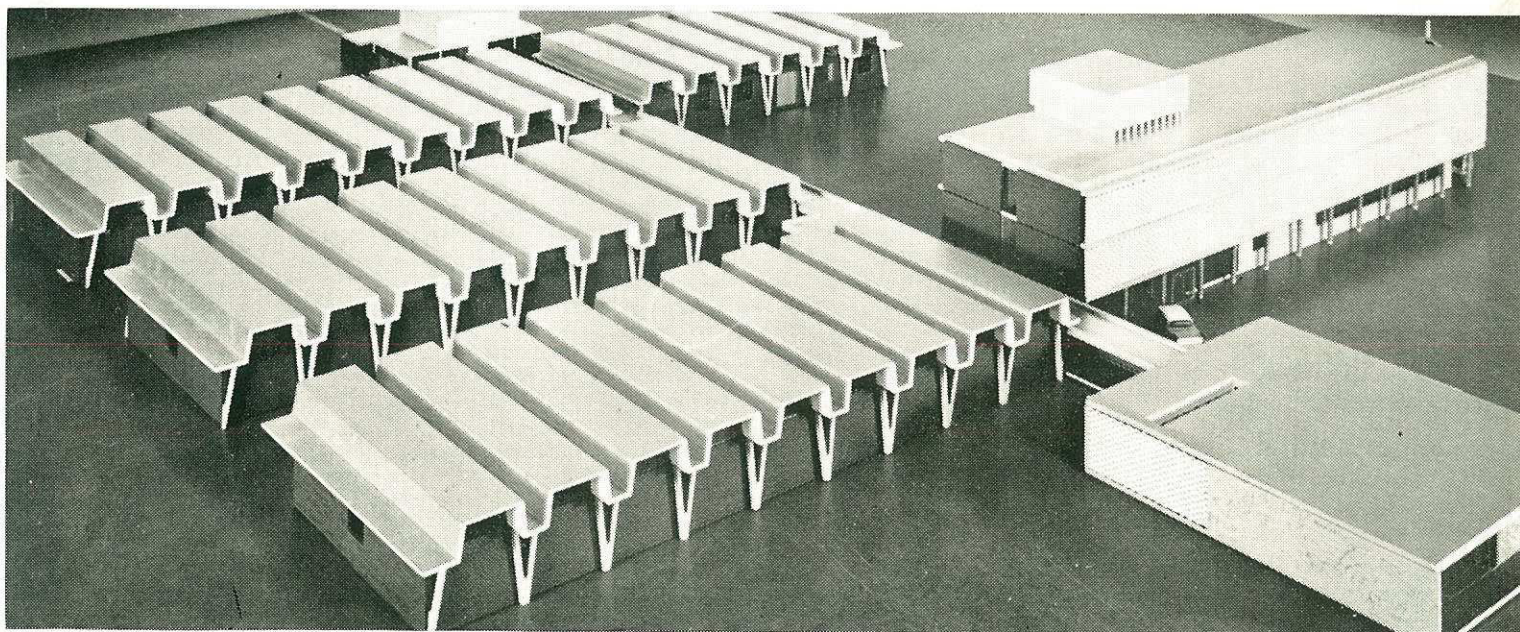
S.A.W.T.R.I.'s research programme covers the entire field of wool processing—from the fibre to the cloth—and encompasses both fundamental and applied research. The following items offer a picture of the contribution made by the Institute to the progress of the textile industry.

Wool chemistry

A research group of the South African Wool Textile Research Institute (S.A.W.T.R.I.) is maintained at the National Chemical Research Laboratory (N.C.R.L.). Under the guidance of and in collaboration with this Laboratory's divisions for physical, inorganic and analytical chemistry, the group carried out basic research on wool chemistry on behalf of the wool industry. The N.C.R.L.'s specialized equipment is available to this group.

Sector 7

TEXTILES



During the year under review a member of the group was sent to Australia for a year's study, as that country has made the most progress in this field.

Disulphides in wool

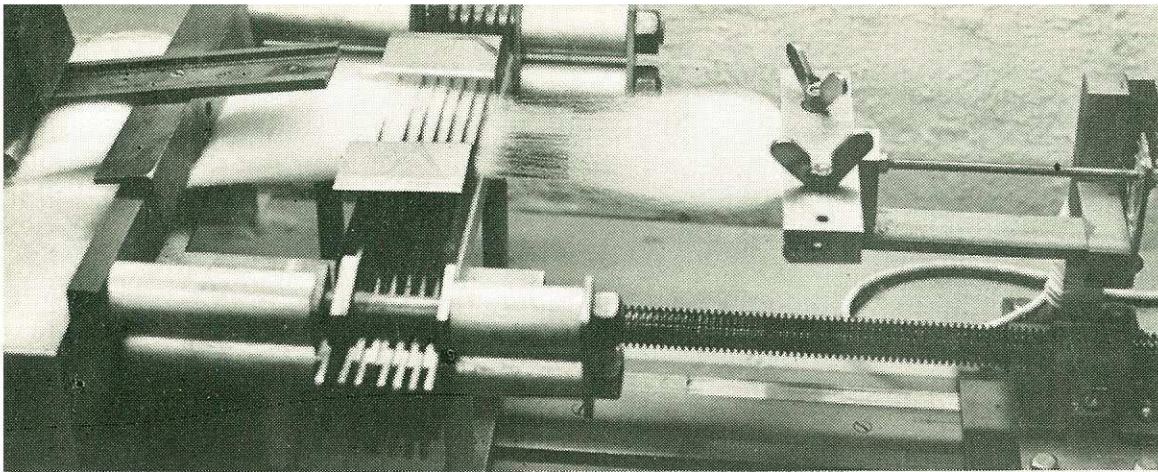
S.A.W.T.R.I. carried out a great deal of fundamental research on a number of chemical processes used industrially to modify the wool fibre so as to improve the properties of the

final product. Certain chemical reactions, for example, make wool more shrink-resistant and others improve the setting properties so that it is possible to make woollen clothes that are "non-iron" or permanently creased. All these reactions are associated with the disulphide bonds in wool, and research on the performance of these combinations constitutes a large part of S.A.W.T.R.I.'s fundamental research.

A model of the South African Wool Textile Research Institute's new building complex at Drijtsands, Port Elizabeth.

Washability of wool products

Extensive research by S.A.W.T.R.I. in close collaboration with the South African Wool Board, the International



Apparatus for measuring the withdrawal forces of fibres and for determining the mean fibre length.

Wool Secretariat and the local textile industry will result in wool products which can be machine-washed becoming available to consumers in the near future. S.A.W.T.R.I. drew up its own specifications for the machine-washability of woollen articles and at present wear-and-wash tests are being carried out to determine the behaviour of articles of clothing during long use.**

Spinnability of wool/mohair blends

Research into the spinnability of wool/mohair blends has also made a considerable amount of technical information available to the local textile industry. The most important results here were that during the spinning of wool and mohair, the thicker mohair fibres tend to migrate to the outside of the yarn; that the spinnability declines as the mohair proportion increases; that the yarn obtained is also more uneven and the breaking strength lower as the mohair content is increased.‡

Mohair combing

The South African Wool Textile Research Institute (S.A.W.T.R.I.) made an extensive study of the optimum conditions for processing mohair on the Noble comb, and the results of this investigation were made available to the textile industry.†

Withdrawal of slivers

In the course of an investigation into the withdrawal forces of slivers during the primary stages of wool processing (i.e. from the card sliver to the wool top), a special apparatus designed by S.A.W.T.R.I. was used. This device has an advantage over some conventional instruments in that it can also be used to determine the length of fibres in a sliver. A patent was taken out for the equipment with the assistance of the South African Inventions Development Cor-

poration, and a local firm has undertaken its manufacture. The price should compare favourably with that of instruments already on the market.*

Training of textile technologists

In order to alleviate the acute local shortage of textile technologists and technicians, S.A.W.T.R.I. initiated correspondence courses in various branches of textile processing. The courses have received good support from the local industry. From 1967 however, these courses will be re-

placed by full-time textile courses given at the University of Port Elizabeth: both a four-year B.Sc. degree course and a three-year Diploma course in textile technology will be offered.

Symposium on research for the textile industry

Following the appearance of a report on a techno-economic survey of the research and information requirements of the textile industry in South Africa, the C.S.I.R. undertook the organization of a national symposium (to be held during 1967) to review the existing facilities for research on behalf of the South African textile industry, and to try to determine the possible future requirements of the industry. It is felt that such a symposium will offer a suitable opportunity for exchanging views on the research needs of the industry, and that attention will at the same time be concentrated on the specialized technical and scientific services which organizations such as the Department of Agricultural Technical Services, the South African Bureau of Standards, and the C.S.I.R. can make available to the industry.

Dr. D. P. Veldsman, the Director of S A W T R I, attended two meetings (in April and November) of the Research and Development Committee of the International Wool Secretariat (I W S) in Melbourne, Australia. These meetings are the medium for proper co-ordination of the research programmes of the three countries in partnership (Australia, New Zealand and South Africa) and of the subsidized research work conducted under the supervision of the I W S.



* KRUGER, P. J. *Withdrawal forces in the processing of wool slivers. Part II: Influence of variations in gilling on withdrawal force.* SAWTRI Technical Report No. 66, January 1966.

† KRUGER, P. J. *Carding and combing of mohair. Part II: Noble combing.* SAWTRI Technical Report No. 71, March 1966.

SWART, L. S., JOUBERT, F. J., HAYLETT, T. & DE JAGER, P. J. *The physico-chemical study of the high-sulphur proteins from oxidized mohair. Proc. Third Int. Wool Textile Research Conf., Paris 1965, Section 1, pp. 493-505.*

‡ CILLIERS, W. C. *The spinning of wool/mohair yarns on the French system.* SAWTRI Technical Report No. 85, October 1966.

** LONG, Denise M. & DEN HEIJER, Z. M. M. *Test conditions for machine-washability of wool woven fabrics.* SAWTRI Technical Report No. 70, January 1966.

TIMEOUS research by the **Leather Industries Research Institute (L.I.R.I.)** on new footwear materials now available has prevented the manufacture of defective shoes, thus saving the shoemaking industry large sums of money. The material investigated included insole boards, threads, P.V.C. and resin soling materials, adhesives and patent leathers.*

A new type of thermoplastic-thermosetting board for heel stiffeners has been developed at L.I.R.I. and is undergoing large-scale trials in shoe factories.

On behalf of the Chamber of Mines L.I.R.I. also developed a satisfactory fitting board which is being manufactured in quantity for use in fitting miner's boots.

A regular foot-health and shoe-fitting inspection service has been established in a number of Cape schools as a pilot trial. As experience is gained from this, the service will be extended to all schools. (A report on the activities of the Institute is also given under the heading, **Leather and Leather Products**).

* WILLIAMS-WYNN, D. A. & SHUTTLEWORTH, S. G. The causes of perspiration damage to upper leather. *J. S. L. T. C.*, vol. 50, 1966, p. 397.

HILL, L. M. A preliminary evaluation of fourteen PVC soling compounds. L.I.R.I. Research Bulletin No. R. 425.

Footwear

Sector 10

THE C.S.I.R.'s **Timber Research Unit (T.R.U.)** is closely linked with the Department of Forestry and the Institute of Forestry and Timber Technology of the University of Stellenbosch and its research is concentrated mainly on the better utilization of South African structural timber. In addition to research to obtain basic knowledge of the characteristics of this product, the Unit is studying the seasoning of timber and the stress grading and finger jointing of structural timber. Structural timber is particularly important

since local production of timber has increased in the last five years by 140% to 20 million cubic feet per annum.

During the year the TRU became administratively independent of the **National Building Research Institute** to which it was formerly connected.†

Wood-base board products

Research was also carried out to determine the durability of wood and wood-base board products, particularly for use as exterior clad-

ding in houses. A waste substance of the sugar milling industry can for example, be used in the manufacture of bagasse board. The properties of this product are being studied by the T.R.U. to determine the extent to which it can be used in the building and construction industry.

An investigation was carried out for the Department of Forestry into the chemical and physical requirements of pulpwood.‡

(See also report under heading, **Paper and Paper Products**.)

TIMBER AND TIMBER PRODUCTS

† LOUW, F. The quality control of finger joints. *Timber Technology*, vol. 3, no. 6, October 1966.
BANKS, C. H. The shrinkage and distortion of wood. *Timber Technology*, vol. 3, no. 8, December 1966.
Houtim: information from the CSIR Timber Unit, nos. 9, 10 & 11. Reprinted from *Timber Technology*, March, June and September 1966.
BRYANT, P. A. V. The mechanical properties of S.A. timber for use in structures, with special reference to roof trusses. *Timber Technology*, vol. 2, no. 12, April 1966.
BANKS, C. H. Timber quality as related to seasoning practice. *Timber Technology*, vol. 3, no. 1, May 1966.
LOUW, F. Die vingerlas as 'n strukturele voeg. Part I. *Timber Technology*, vol. 3, no. 1, May 1966.
LOUW, F. Die vingerlas as 'n strukturele voeg. Part II. *Timber Technology*, vol. 3, no. 2, June 1966.
BANKS, C. H. Sawing and stacking timber to reduce warp. *Timber Technology*, vol. 3, no. 3, July 1966.
DU TOIT, A. J. The case for chemical preseasoning of S.A. pine, Part I. *Timber Technology*, vol. 3, no. 4, August 1966.

NAUDÉ, S. MEIRING. Research in the timber industry. *South African Forestry Journal*, no. 59, December 1966.
DU TOIT, A. J. The case for chemical preseasoning of S.A. pine, Part II. *Timber Technology*, vol. 3, no. 5, September 1966.
BOSMAN, D. L. Summary of Symposium on S.A. structural timber. *Timber Technology*, vol. 3, no. 4, August 1966.
BOSMAN, D. L. & BANKS, C. H. Research on the utilization of S.A. grown Eucalyptus timber. *Timber Technology*, vol. 3, no. 5, September 1966.
BANKS, C. H. The protection of building timbers in South Africa against natural destructive agencies: the case for an extension of control. *Municipal Affairs*, vol. XXXII, no. 274, October 1966.
VISSER, J. H. The research needs of the S.A. forest products industry. *Timber Technology*, vol. 3, no. 7, November 1966.
VISSER, J. H. *The research needs of the South African forest products industry — a technoeconomic survey*. CSIR Special Report Info. 20, Pretoria, CSIR, 1966.
‡ SCHARFETTER, H. Durability of wood-based board products. *Timber Technology*, vol. 3, no. 7, November 1966.

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



THE C.S.I.R.'s Timber Research Unit contributes to the development of the paper and paper products manufacturing industry by co-operating closely with the pulp and paper industry, the Department of Forestry and other government departments.

Sector 12

Paper and Paper products

RESearch workers of the Unit, for example, are determining on behalf of the Department of Forestry the chemical and physical requirements with which pulpwood must comply. The ageing of paper is being studied on behalf of the State Archives and special attention is being

given to the influence of storing conditions on paper quality, while the possibility of using "permanent paper" in government departments is being investigated. A careful study is also being made of the production of such paper.

Attention was again given to methods of counteracting the deterioration of stored pulpwood, with special emphasis on biological methods.

The quality of straw fibre for the production of corrugated paper was investigated.

Sector 14

Leather and leather products

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 achieving improved leather tanning methods.

It is mainly due to the **Leather Industries Research Institute (L.I.R.I.)**, one of the co-operative industrial research institutes, that the standard of leather products in the Republic is so high. In the development of this research institute, the leather industry has been assisted by the financial contributions from the C.S.I.R. equivalent in amount to annual contributions by interested industrial subscribers.

Dr. S. G. Shuttleworth, Director of the Leather Industry Research Institute.



Besides research into methods of tanning leather and into other processes used in the treatment of raw skins and hides, L.I.R.I. also conducts tests to evaluate the quality of finished leather and its suitability for the manufacture of various products.

Waste water of tanneries

During the year under review the disposal of tannery effluents has continued to be a major problem in the leather industry. Working in collaboration with the Department of Water Affairs and its advisers, L.I.R.I. has been able to find satisfactory solutions to this problem for most of the tanneries concerned.

Special attention has been given to methods of water and effluent economy and to the re-use of tan liquors.

Sector 16

basic industrial chemicals and diverse products

Sector 17

THE chemical and chemical products industry is highly dependent on scientific research. Virtually all the large manufacturers have their own research laboratories where specialized research is carried out uninterruptedly into a variety of problems.

New uses for products

The National Chemical Research Laboratory (N.C.R.L.) is carrying out research, for example, on the use of polypropylene in the weaving of bags for agricultural products.

*Prof. G. M. Hamilton, Director
of the South African Paint Research Institute.*

Paint research

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 the 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 report on these aspects appears under the heading "Building and Construction Industry."

Discoloration and staining of paint

A considerable amount of work has been carried out during the year under review in the laboratory of the South African Paint Research Institute on the question of the staining and discoloration of paints both in the tin and after application. Discoloration in the tin has been traced in one case to the use of pentachlorophenol with a reactive pigment, and in the second case to an impurity in the raw materials used for the preparation of the emulsion, the impurity being present in extremely small quantities.

Staining after application has in some cases been found to be due to attack by fungi, but much work remains to be carried out on this problem because there are cases of discoloration still unexplained.



The investigation of commercial fungicides has been continued, and it has been found that tributyl tin oxide is not very effective in acrylic emulsions, although perfectly satisfactory in polyvinyl acetate.

Sector 18

PETROLEUM AND COAL PRODUCTS

THE petrol and coal products industry has its own extensive research facilities at Sasol and at the Fuel Research Institute. The C.S.I.R.'s activities in this field are accordingly of a supplementary and auxiliary nature.

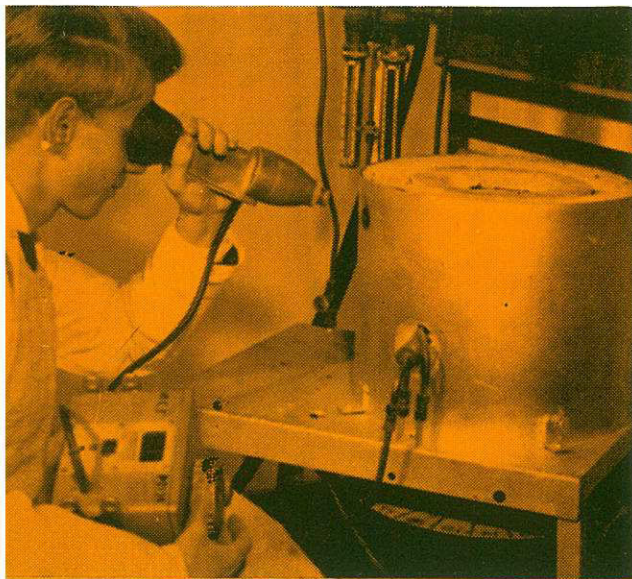
Apart from personnel selection work and operational surveys by the National Institute for Personnel Research (N.I.P.R.), the National Physical Research Laboratory (N.P.R.L.) served the industry by conducting research to im-

prove the mechanical properties of wax-containing polyethylene, a by-product of SASOL.

A low energy electron diffraction apparatus is being developed to study the arrangement of atoms in catalytic surfaces. Research on the interpretation of diffraction patterns is continuing. This work is being sponsored by SASOL. The N.P.R.L. is also preparing equipment for a geophysical investigation into oil-bearing structures in the Eastern Cape.

DURING the past year the activities of the C.S.I.R. Ceramic Research Unit were reviewed and it was decided to disband the Unit and to integrate its staff and facilities with the National Building Research Institute (N.B.R.I.). This group has the task of investigating raw materials and their properties on behalf of the ceramics industry and of serving this industry with technological know-how. Research on the use of ceramic products in the building and construction industries is also carried out in the N.B.R.I.

Non-metallic mineral products



With the aid of an optical pyrometer the behaviour of cones of South African clays placed in an oxy-acetylene furnace is compared with that of standard Seger cones whose properties are known.

Cement technology

A considerable amount of research work is being undertaken at the National Building Research Institute in the field of cement technology. Some of this work involves basic studies, with the object of collecting the information required for solving practical problems in the manufacture and use of hydraulic cements. In this connection a study of the heat of hydration of hydraulic cements was completed and investigations are continuing on the composition of blastfurnace slag of local steelworks and its effects on the properties of cements in which it is used.* Studies

of this type are important as considerable quantities of cement now being produced in South Africa contain blastfurnace slag.

Another investigation is being carried out to establish the feasibility of producing a satisfactory super-sulphated slag cement from local blastfurnace slags.

Lime

The N.B.R.I. is developing techniques for the analysis of limestone and dolomite with the aim of obtaining information which will lead to the manufacture of better building lime.

Bricks and burnt clay products

The South African Brick Association has undertaken to sponsor research in the N.B.R.I. on fired clay products by making available R10,000 per year for five years. Initially the investigation will cover the production and use of fired clay products in industrialized building, the development of techniques for the rapid firing of clay products, the problem of expanding brickwork and the preparation of reports concerning certain practical aspects of brick construction.

Raw materials

The National Building Research Institute (N.B.R.I.) has located several clay deposits in Ovamboland, South West Africa, that are suitable for brickmaking. The Institute is co-operating with the S.W.A. Administration and the Department of Bantu Administration and Development in initiating a brickmaking industry in this Bantu area. The industry should prove most valuable for the development of this large territory where a serious shortage of building materials is being experienced.

The Institute is conducting several investigations into the mineralogy of clays in order to gain a better understanding of the properties required for producing improved clay products.† Several contract investigations have also been carried out to determine the suitability of clay deposits for making bricks.

A report on refractory raw materials was compiled by the N.B.R.I. on behalf of the National Resources Development Council. The object was to provide information in order to promote the use of local raw materials.

* BASSON, G. R. Heat of hydration of Portland cement and of mixtures of Portland cement and milled granulated blast-furnace slag with special reference to the heat development in mortars under adiabatic conditions. *Trans. S. Afr. Instn.*

Civ. Engrs., vol. 8, no. 2, February 1966, pp. 63-67.
SEHLKE, K. H. L. A study of the thermal behaviour of blast-furnace slag by means of a heating microscope. CSIR Research Report 239 (NBRI Bulletin 42), Pretoria, CSIR, 1966, 40p.

† KAEMPFE, F. & VAN DER MEULEN, G. J. R. Investigations into South African raw materials for manufacturing expanded light-weight aggregates for concrete. CSIR Research Report 217 (NBRI Bulletin 36), Pretoria, CSIR, 1966, 23p.

IRON AND STEEL INDUSTRIES AND NON-FERROUS METALS

Foundries

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. Results showed that South African chromite sand has a marked superiority over other local sands.

This work was done under the auspices of the South African Foun-

dry Research Foundation which is sponsored by major firms in the South African foundry industry.*

Prestressed steel

A report on the properties of prestressed steel manufactured in South Africa and its use in prestressed concrete construction was prepared by the **National Building Research Institute** (N.B.R.I.) on behalf of the Prestressed Concrete Development Group.



Foundry sand being placed in a moulding box prior to casting.

* WISCHNACK, W. H. F. Some aspects of high temperature properties of moulding materials, Part I. *Founding, Welding, Production Engineer*, Jan. 1967, pp. 19-29.

WISCHNACK, W. H. F. Some aspects of high temperature properties of moulding materials, Part II. *Founding, Welding, Production Engineer*, Feb. 1967, pp. 3-21.

M A C H I N E R Y

Testing heavy machinery

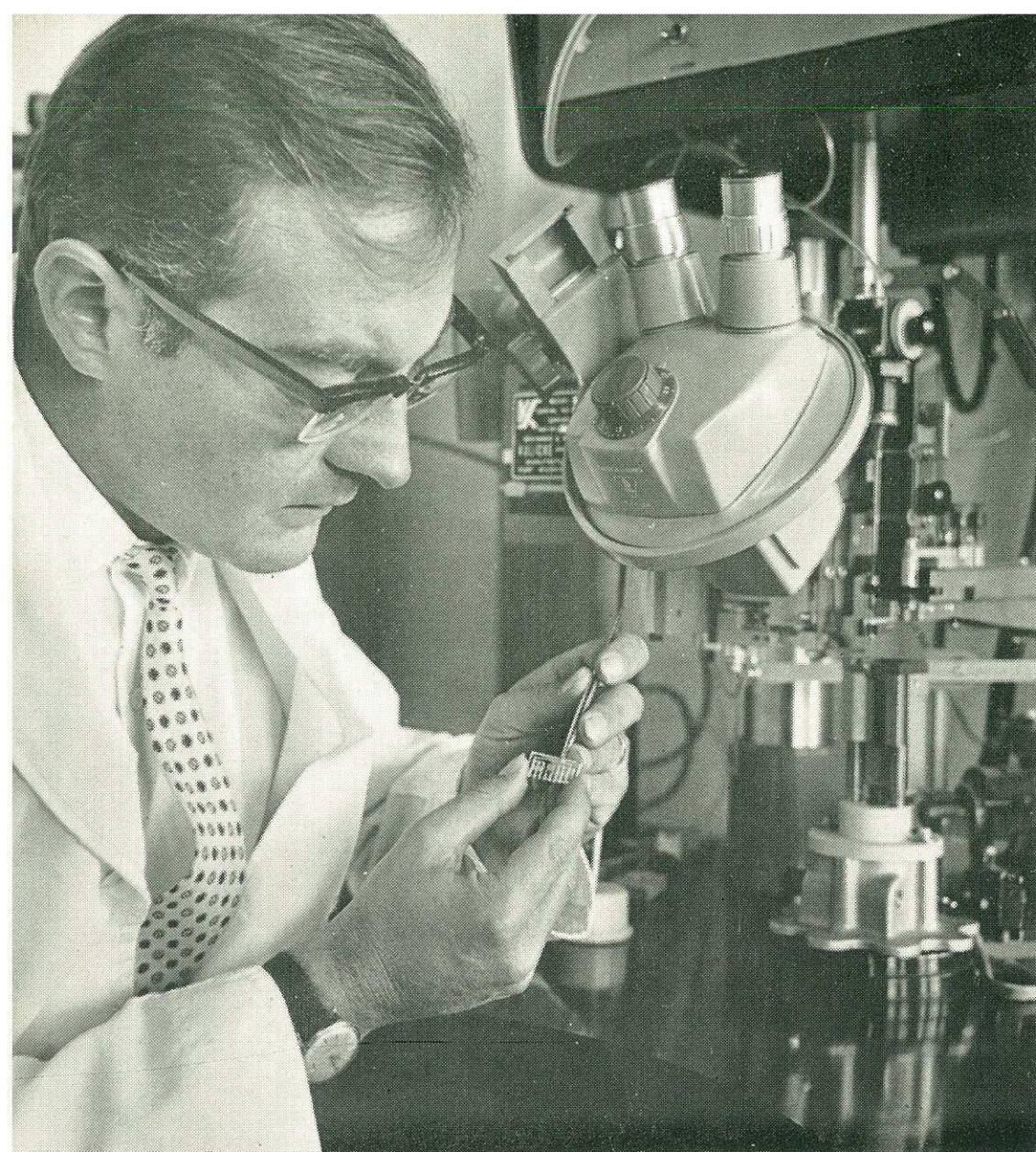
In collaboration with the South African Bureau of Standards, a detailed study was undertaken by the **National Mechanical Engineering Research Institute** (N.M.E.R.I.) of the facilities which would be required in the Republic for testing heavy rotary machinery and for carrying out research into testing methods. The most urgent demand apparently is for the testing of large pumps: facilities to cover the testing of fans, compressors and the like will have to be provided at a later stage.

This study resulted from the need of the industry for adequate proof testing of the large pumps and fan units being used at present in order

to establish whether they were meeting the requirements laid down in their design specifications.

Centralized testing facilities

A survey of the need for centralized facilities for testing large fans was made by the Industrial Economics Division to determine which facilities were necessary for promoting heavy industry in South Africa. The survey showed that there was a need for a central experimental station which could undertake both development tests and acceptability tests for fans. It also appeared that manufacturers will be making increasing use of such facilities as consumers demand higher standards.



Studying a thin-film circuit attached to a ceramic base before the transistors are fastened to it.

Sector 24

Electrical equipment

Microminiature circuitry

Microminiature circuitry has made it possible to achieve a reliability in electronic circuits which was previously unattainable and, owing to the strategic importance of applications of this approach, for both military and industrial purposes, it is of paramount importance that a thorough knowledge of this subject be attained locally.

The Electrical Engineering Research Department of the National Research Institute for Mathematical

Sciences (N.R.I.M.S.) has therefore installed facilities for manufacturing prototypes of thin-film circuits (a type of microminiature circuit) and for assembling and testing. Although the equipment is primarily intended for research purposes, it makes possible the manufacture of limited quantities of special circuits at the C.S.I.R.

Transistors

The N.R.I.M.S. also undertook a preliminary investigation to study the scope of application of M.O.S. transis-

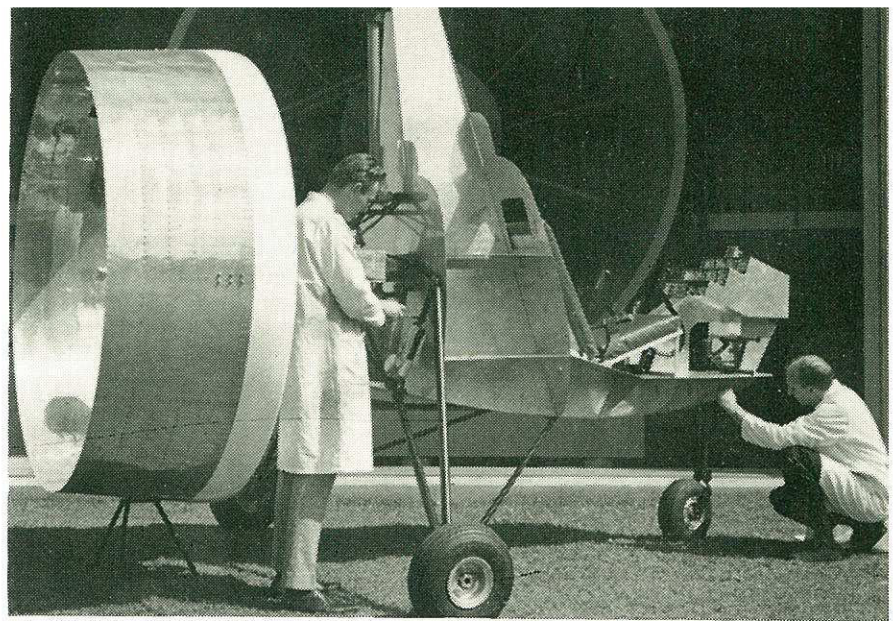
tors (insulated gate field effect transistors) and the technological processes necessary in their manufacture. These transistors involve a different type of microminiature circuit which cannot be produced by thin-film techniques.

See also report on professional and scientific instruments under the heading **Miscellaneous Manufacturing Industries.**

Aeronautics

At present more research is being undertaken to develop aircraft capable of taking off and landing vertically or at a very steep angle. The C.S.I.R. has also entered this field and significant progress in designing and constructing a two-seater autogyro has been made by the Aeromechanics

The prototype of the C S I R's two-seater autogyro under construction.



Division of the National Mechanical Engineering Research Institute in the design and construction of a two-seater autogyro.

The theoretical design characteristics of the craft's rotor have been confirmed by model tests in a wind tunnel and full-scale tests with a rig on a trailer towed by a motor lorry. Another rig for the static and dynamic testing of the structure under all conceivable flight conditions has been designed and will be used for testing the first of two autogyro prototypes which are to be built during 1967.

The team working on this project is gaining valuable experience as the nucleus of South Africa's first aircraft design and research group.*

New wind tunnels

Substantial progress has also been made with the installation of a subsonic wind tunnel with a 7 ft. by 5 ft. working section, while the erection and calibration of an 18-inch square tri-sonic wind tunnel has almost been completed.

The addition of these wind-tunnel facilities to others already existing in the Institute will broaden the scope of aeronautical research in the C.S.I.R. and in South Africa as a whole.

Aircraft noise

Research into problems of noise from aircraft in the take-off and landing configurations was continued as were studies of the effect of local gust loading on the fatigue life of aircraft structures.

* VAN NIEKERK, C. G. Aeronautical research in South Africa. *Wings over Africa*, June 1966.

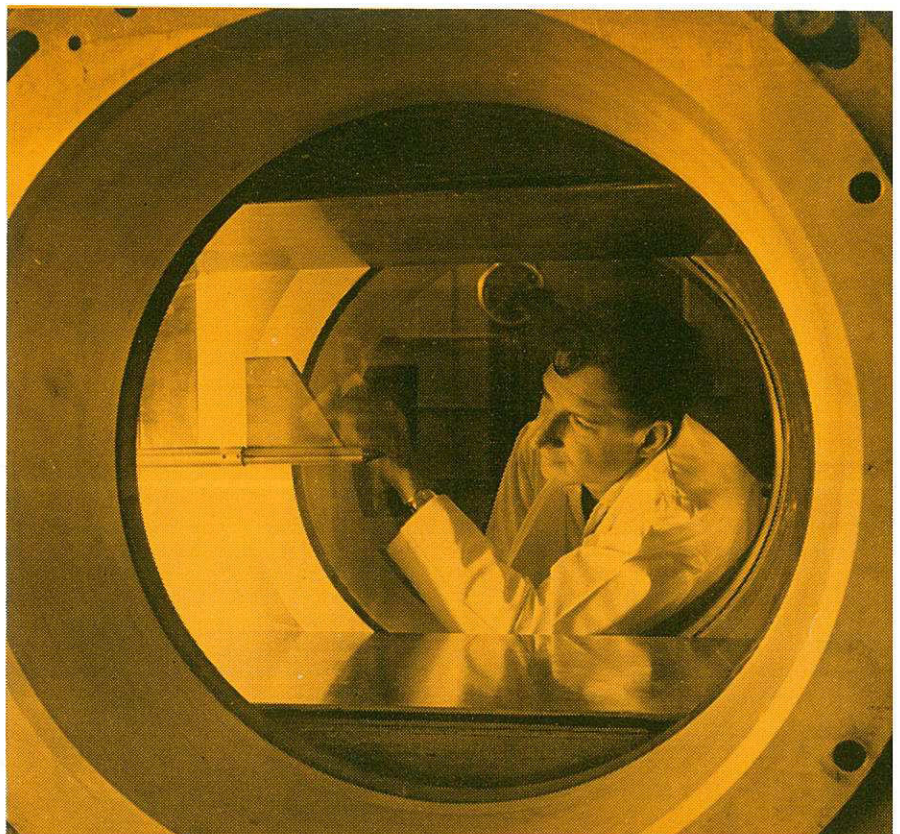
Sector 25

TRANSPORT EQUIPMENT

Airports

Visual approach slope-indicator units on the runways of certain South African airports did not have the required range of visibility and the National Physical Research Laboratory (N.P.R.L.) helped in the solution of these problems.

A view into the working section of the tri-sonic wind tunnel recently installed at the C S I R.



MOTOR VEHICLES

The motor components industry

In view of the rapid expansion and increasing complexity of the South African motor components industry, the C.S.I.R. carried out a survey of the problems and research needs of the motor industry in the Republic. The survey was primarily intended to determine the importance of the iron motor components industries in South Africa and to identify the research, development and information needs of the industries, to enable the C.S.I.R. to formulate a policy for co-ordinated research on behalf of these industries in the Republic.

The data gathered during the survey were published in a report. One of the most important findings was that the research facilities made available to the industry by the C.S.I.R. could cope with existing problems, but that these were neither widely known nor fully utilized. Attention was paid particularly to the wide range of vehicle models offered on the relatively limited local market

and to the technical and economic problems entailed.

To create closer liaison between the C.S.I.R. and the motor industry and between the C.S.I.R. and the metal engineering industry in general, a Technical Liaison Officer was appointed.

Fuel consumption meter

Research by the **National Research Institute for Mathematical Sciences (N.R.I.M.S.)** has resulted in the development of a fuel consumption meter for motorists. The device receives two signals — one proportional to the speed in miles an hour and the other proportional to the gallons of fuel consumed in an hour. These are taken from the speedometer and fuel pump respectively. The quotient of these two signals is obtained by means of a simple transistorized circuit and the results are indicated on a dial directly calibrated in "miles per gallon".

DIVERSE

Distance measuring apparatus

The **National Institute for Telecommunications Research (N.I.T.R.)** continued with the development of its "Tellurometer" distance-measuring apparatus, and this work contributed considerably to South Africa's retaining her position as a leading manufacturer of radio distance-measuring equipment. During the past year a new model of the "Tellurometer" instrument was developed which operates on an 8 mm wavelength and which is much more accurate than its predecessors.*

The N.I.T.R. was also engaged in developing a distance-measuring system by means of infra-red rays.† A prototype instrument which can accurately measure distances of up to 1 km. to within a few millimetres was constructed in the laboratory and operated satisfactorily. It is expected that this work will lead to the production of a highly accurate instrument which will be comparatively light and cheap.

The Institute continued to collaborate with a South African manufacturing industry in developing a VHF radio system for determining location at sea. Encouraging results were achieved and it is expected that the system will shortly be so developed that extensive tests could be conducted at sea.

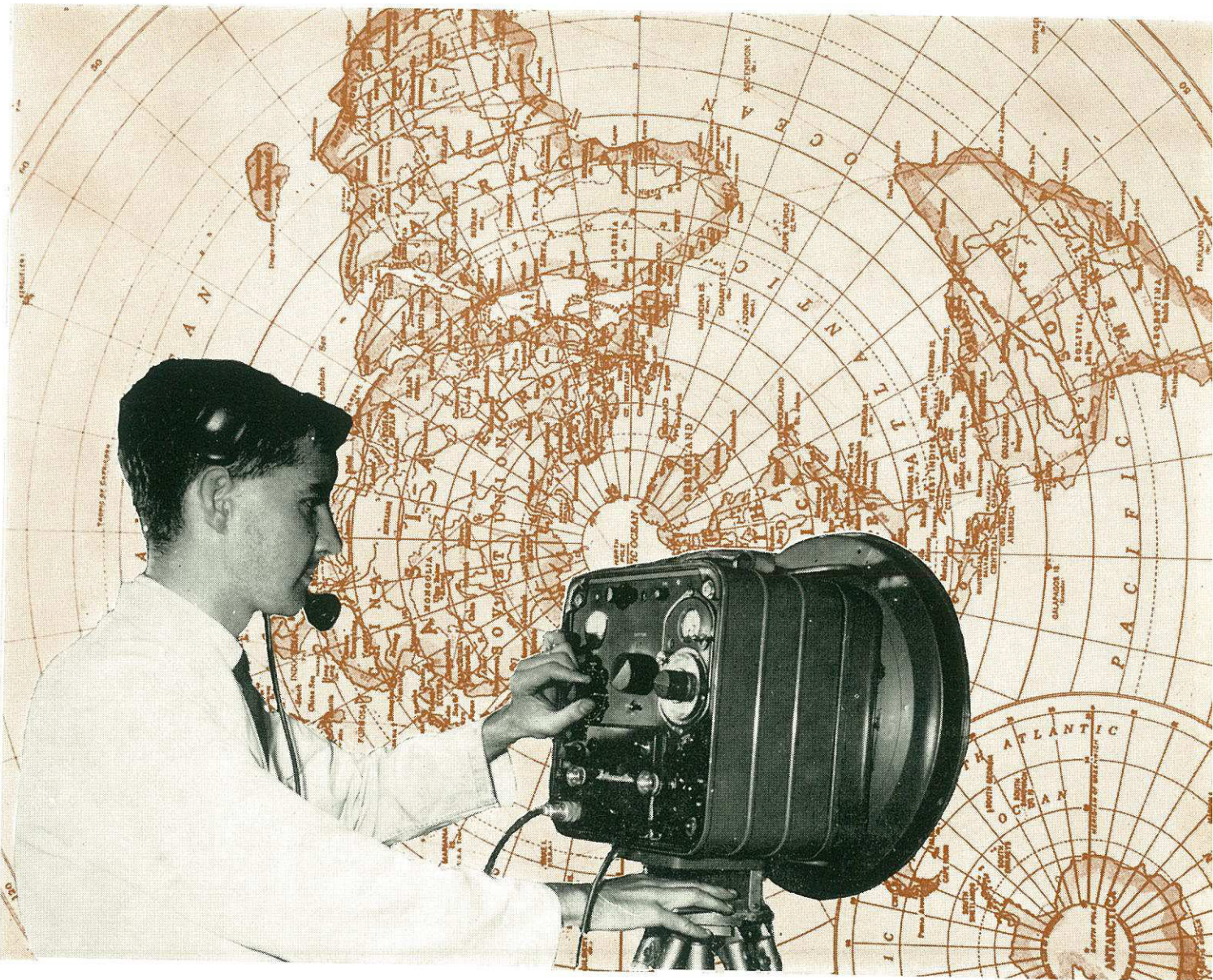
Medical electronics

Requests for assistance in medical electronics are received from time to time by the N.R.I.M.S. An electro-medical pulse generator used for electro-narcosis was designed for a psychiatrist. (See also report on equipment for road engineering under **Building and Construction Industry.**)

MANUFACTURING INDUSTRIES

*professional and
scientific instruments*

The "Tellurometer" distance-measuring instrument is at present in world-wide use. This apparatus was developed by the National Institute for Telecommunications Research.



* CABION, P. J. *Principles and performance of a high resolution 8 mm wavelength 'Tellurometer'*. Paper submitted to the Symposium on Electromagnetic Distance Measurement - International

Association of Geodesy, Oxford, 6-10 September, 1965.

† HOLSCHER, H. D. *The application of gallium arsenide light emitting diodes to electronic*

distance measuring equipment. Paper submitted to the Symposium on Electromagnetic Distance Measurement - International Association of Geodesy, Oxford, 6-10 September, 1965.

When designing protective devices for electrical power lines it is important to know how many lightning bolts strike the ground per square mile. The CSIR has commenced recording the number of lightning flashes within an area of 1,200 square miles.

Electricity, gas and water

Protection of power systems

The designing of effective protection systems in power electrical engineering requires knowledge of earth resistance. In South Africa this resistance is particularly high and overseas protective techniques cannot be applied here without modification. The N.R.I.M.S. has already made considerable progress with a programme for the gathering of data and there have been improvements in measuring techniques.

A reasonably good correlation between the moisture content and the resistivity of different types of soil is being established, and seasonal variations are being defined at present. As soon as sufficient data become available, certain design criteria will be specified for protection systems.

In the design of protection systems for electric power transmission systems, it is also important to know how many flashes of lightning strike the ground per square mile, and the N.R.I.M.S., in collaboration with the N.P.R.L. and the N.I.T.R., has commenced a project for counting individual lightning flashes within an area

approximately 1,200 square miles in extent. For this purpose three direction-finding stations will be established at Pretoria, at Johannesburg and at Hartbeeshoek near Krugersdorp. The equipment will distinguish between inter-cloud and ground lightning flashes.

The N.R.I.M.S. has also commenced investigations under contract with anti-lightning protective measures for a water pipeline of prestressed concrete to be laid over a distance of 28 miles between Johannesburg and Riversdale, about 10 miles from the Vaal Dam. The Institute's recommendations in this connection were accepted and are now being implemented by the contractor.

Water purification

An intensive research effort by the **National Institute for Water Research** (N.I.W.R.) is directed at the development of inexpensive and effective methods of water and effluent purification, sanitation and the re-use of water. At Bellville for example, investigations are proceeding into the re-use of sewage effluent for industrial purposes, and encouraging results

have already been achieved here.

The further purification of purified sewage effluent, with its complete re-use as the eventual goal, is also receiving much attention. In this connection investigations have been concentrated especially on the removal of certain chemical substances such as detergents and insecticides which, in small percentages, hamper the re-use of water and are also difficult to eliminate.

Limiting evaporation

The N.P.R.L. undertook research in one of the C.S.I.R.'s wind tunnels with a view to obtaining basic information which might be used in limiting or completely eliminating evaporation from smaller dams. To date the rate at which water evaporates has been correlated with the radiant energy falling on the water, the air temperature, the air humidity and the wind speed.

Water in desert areas

The N.P.R.L. made several important surveys in South West Africa with a view to detecting and utilizing subterranean water.

transport and communication

During the past year a seismic survey of the dune-covered Kuisieb River delta to the south of Walvis Bay was made and it was found that subterranean water of good quality occurred over a wide area of approximately 1,100 square kilometres.

The delta area of the Omaruru River was measured electrically to determine the size of the area in which subterranean water occurred.

A seismic survey was also carried out in the dune area to the north of Lüderitz to determine whether this town's water needs could possibly be supplemented by subterranean water.

Distillation of drinking water

Under contract to the Administration of South West Africa, the **National Institute for Water Research (N.I.W.R.)** undertook research into the water problems peculiar to the territory. The water resources of South West Africa are extremely limited, and often the water is brackish to such an extent that it is completely unfit for domestic use.

One of the research projects in this connection is the development of solar distillation units which can be used to supply water to industries and small communities. In addition to the use of solar energy, attention is also being given to the utilization of heat from hot springs and of the waste heat from diesel generators.

As evaporation and transpiration have a definite influence on the mineralization of water in sand-beds, experimental units have been erected to investigate the operation of these factors.

Water map

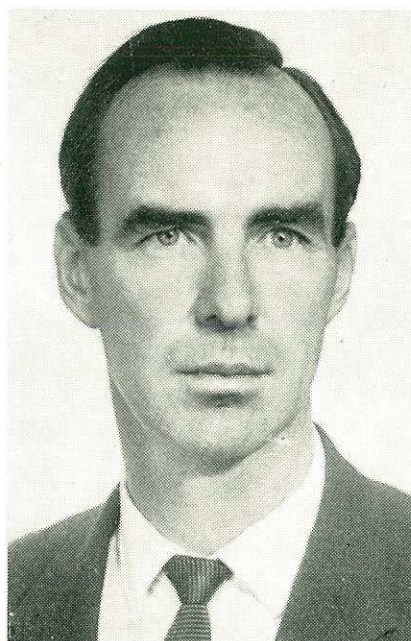
In addition much progress has been made with the drawing up of a water map for South West Africa. The map indicates the chemical quality of ground water at different places and may serve as a guide in establishing industries and residential areas, for which the quality of available water is an important consideration.

Survey of transport problems

Transport problems have become so complex and have reached such proportions that government bodies concerned have had to devote attention to methods of achieving an optimum transport system. The C.S.I.R. investigated and analysed the broad problem of providing and using roads and the country's future requirements in these respects, to provide the authorities with the necessary information

and guidance in formulating future transport policy.

A survey to determine the importance of roads in the national economy was carried out. The framework within which the responsibility lies for supplying and using roads over the next twenty years was studied and an attempt made to predict road needs in financial terms. In addition, problems concerning the allocation of funds and the financing of road building were reviewed.



Mr. R. W. Vice, Director of the National Institute for Telecommunications Research. The N.I.T.R.'s research programme concentrates on problems encountered by various bodies employing radio waves for civil or military purposes in South Africa. Important aspects of this research programme include a study of the propagation of radio waves in lower and higher atmospheres as well as research into the nature of atmospheric disturbances and their effect on receiving systems in radio communications and radio navigation aids.

Radio communication

In the year under review, the **National Institute for Telecommunications Research (N.I.T.R.)** continued to investigate ionospheric absorption and high frequency radio noise, in order to improve the reliable planning of high frequency communications systems.* Ionosonde stations are maintained in Cape Town and in Johannesburg. Ionospheric information from these stations is used to compile predictions of optimum traffic frequencies for HF radio communication in Southern Africa and between South Africa and other parts of the world. These predictions are published in monthly bulletins.

The N.I.T.R. has also investigated the application of semiconductors at high frequencies and the development of very low-noise receiving systems. These techniques are appropriate to specialized types of radio equipment such as the "Tellurometer" system of distance measurement invented by the N.I.T.R., and now applied throughout the world. (See report under the heading **Miscellaneous Manufacturing**.)

* GLEDHILL, J. A., TORR, D. G. & TORR, Marsha R. Ionospheric disturbance and electron precipitation from the outer radiation belt. *Journal of Geophysical Research*, vol. 72, no. 1, Jan. 1967, pp. 209-214. (TORR, D. G. of N.I.T.R. This joint publication was based on a project undertaken in collaboration with Rhodes University.)

THE building and construction industry is probably one of the most wide-ranging industries in South Africa, and the C.S.I.R. accordingly devotes particular attention to its expansion and development. Three of the C.S.I.R.'s research institutes are engaged in activities relating to this industry: the National Building Research Institute (N.B.R.I.), the National Institute for Road Research (N.I.R.R.) and the National Mechanical Engineering Research Institute (N.M.E.R.I.).

The N.B.R.I. concentrates particularly on applied research for the building industry and maintains close contact with its different branches and the allied professions. Its research is directed at improving building design and services and at the better construction, foundation, lighting, ventilation, heating and cooling of buildings. In addition it investigates the more efficient use of building materials such as concrete, stone, paint and plastic materials and it studies the effects of climate and weather on both building materials and intra-mural conditions in the interior of buildings. See also the report entitled **Housing** in the chapter **Research in the Public Sector**.

The value of this Institute's work to the South African building and construction industry is evident in the following report on some projects undertaken during the year under review.



Dr. T. L. Webb, Director of the CSIR's National Building Research Institute.

Sector 32

Building and construction

A NUMBER of contract investigations were undertaken by the N.B.R.I. for government departments, industry and allied interests. During the year ending 31st March, 1965, for instance, work on 125 such investigations was undertaken of which 73 were new contracts commissioned during the year.

Efficiency in the building industry

Since the building industry is essentially highly fragmented, there has always been a need for research to improve co-ordination and efficiency in its organization and management. In order to meet the problems of rising costs, manpower shortages and the increasing demands for more buildings it is essential that the industry improve organization and management at all levels in order to attain greater productivity at reasonable cost.*

For this reason a comprehensive survey was completed during the

year to examine the present overall situation in the building industry in order to define the more important problem areas and to recommend steps for immediate and long-term improvements. Some aspects of the investigation were carried out by the **National Institute for Personnel Research** (N.I.P.R.) working in collaboration with the N.B.R.I.

The first objective of this country-wide study was to determine research priorities, and a report will be submitted to the Building Research Advisory Committee.

Industrialized building

Important research in the field of industrialized or preconstructed building is also being carried out at the N.B.R.I. Various methods of industrialized building have been investigated to determine their suitability. In addition, studies are being made of the thermal performance and the resistance to rain penetration of such constructions, on the use of plastics in such buildings and of fire hazards and other problems resulting from the use of new and unconventional structures.†

* MINERS, T. W. Cost control in the building industry. *South African Builder*, vol. XLIV, no. 2, February 1966, 7p.

MINERS, T. W. The future role of cost planning in a changing industry. *S. Afr. archit. J.*, vol. 51, no. 12, December 1966, 6p.

WEBB, T. L. Some characteristics of industrialized building and its possible effects on professions associated with the building industry. *Property and Building*, vol. 14, nos. 1-3, July, August & September 1966, 3p.

† KRUGER, J. E. & LOUBSER, P. J. Water penetration of buildings. *South African Builder*, vol. XLIV, no. 8, August 1966, 6p.

WEBB, T. L. The evaluation and investigation of industrialized building methods. *Municipal Affairs*, vol. XXXII, no. 372, August 1966, 3p.

WEBB, T. L. The role of science in the making of buildings, with special reference to industrialized building in the next decade. *S. Afr. Archit. J.*, vol. 51, no. 11, November 1966, 4p.

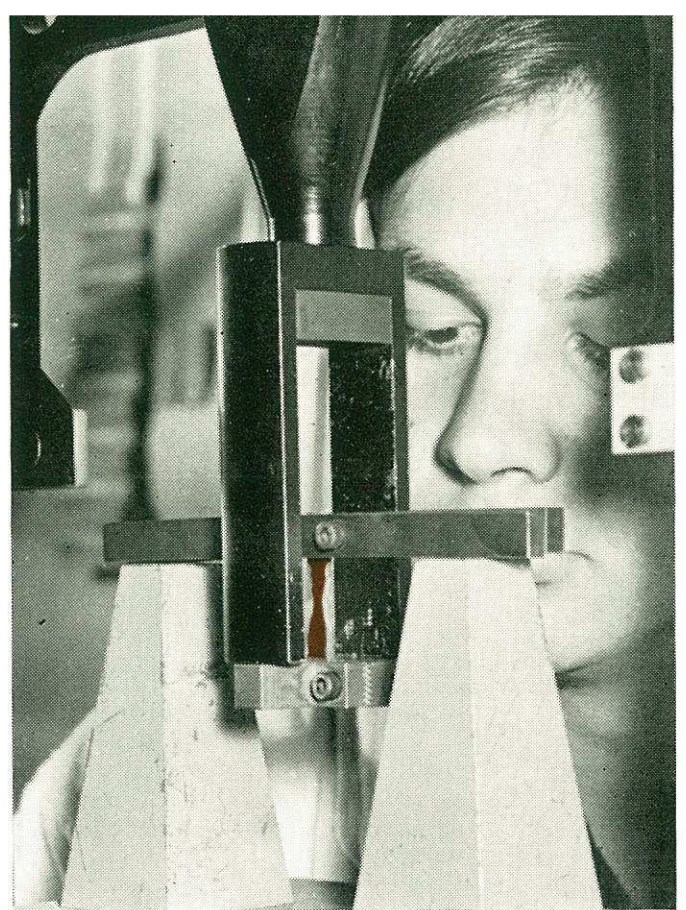
Raw materials for the building industry

The N.B.R.I. developed new techniques for mineralogical study of various raw materials used in producing building materials. This may lead to a better understanding of the basic reactions and changes occurring when raw materials are subjected to manufacturing processes. Information already obtained will contribute to solving certain problems experienced in producing Portland cement, blast furnace slag cement and builder's lime and to improving the quality of those products to suit various applications.

Foundation engineering

Intensive work on the founding of buildings and other structures on heaving clays has continued. Level observations are being made on a number of houses and industrial buildings in different heaving clay areas of the country in order to study the variations in foundation movements caused by wet and dry seasons, the progressive movement over periods of years, and the differences in movement of buildings founded on under-reamed piles compared with those founded directly on the soil. To date a great deal of useful information has been collected from these studies.*

At the same time, moisture changes in heaving soils under different cover-



A technician of the N B R I observing a plastic strip which is being subjected to tests in a tensile testing machine.

ings are being measured to obtain a better understanding of the factors influencing these changes and the effect of moisture changes on the swelling and shrinking of the soil.†

The mapping of the soils of a large area near Pretoria North which is being used for industrial and urban development was completed. This map indicates the engineering properties of the soils, and the most suitable construction methods for use on such soils.

* BASSON, G. R. Note on the crystallization of merwinite from glass of akermanite composition. *Mineralog. Mag.*, London, vol. 35, June 1966, pp. 873-875.

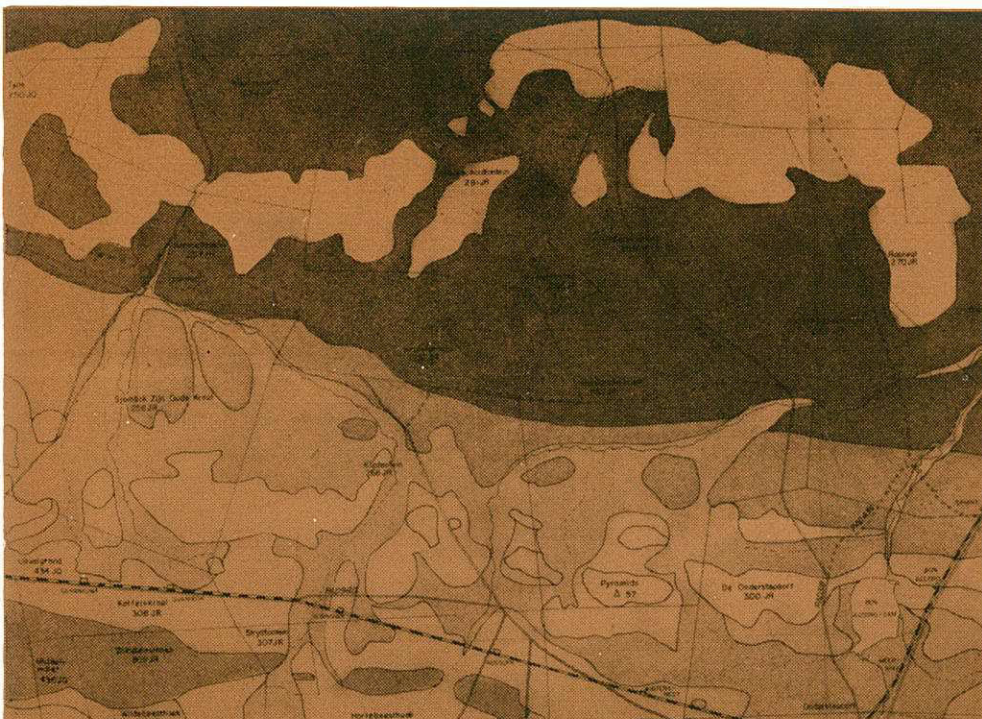
DE WET, J. A. (Assisted by GEYER, P.) The stress-strain behaviour of soils. CSIR Research Report 224 (NBRI Bulletin 38), Pretoria, CSIR, 1966, 66p.

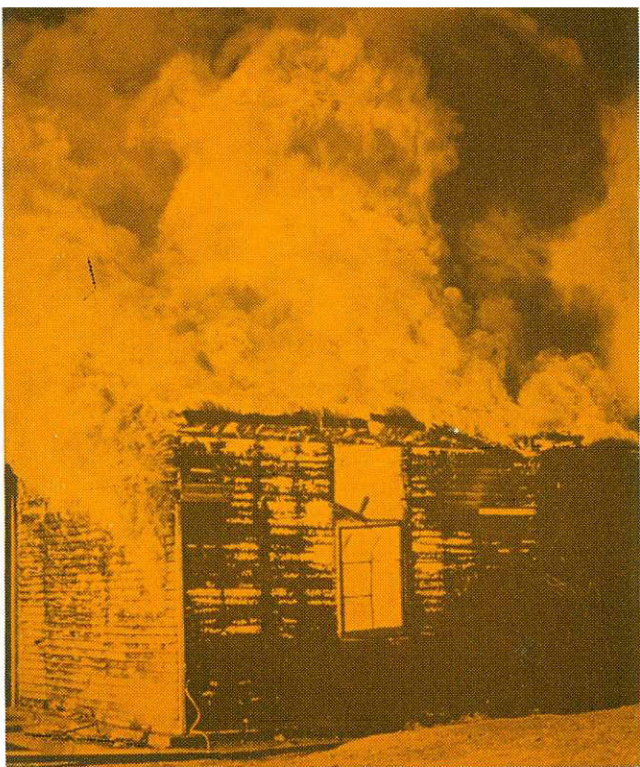
† DONALDSON, G. W. Engineering problems associated with soil moisture movement. *Proceedings of the Rhodesian Institution of Engineers*, vol. 4, no. 3, March 1966, 8p.

A section of the soil map of Pretoria North which was compiled by the N B R I for engineering purposes.

Concrete

A report on the properties of South African manufactured prestressing steel in relation to its use in prestressed concrete construction was completed on behalf of the Prestressed Concrete Development Group. Two important investigations on the concrete-making properties of South African materials are also in progress at the N.B.R.I. One investigation concerns the influence of various periods of wet and dry curing conditions on the strength development of concretes made with different cements. The knowledge thus gained should help building contractors to produce concrete of adequate strength in the most economical manner and in as short a time as possible. The second investigation is directed at overcoming the cracking of concrete during the setting stage.





The behaviour of building materials that have been set on fire is studied in full-scale fire tests of various wall and roof constructions.

The rate of production of precast concrete units used in building and construction can be considerably increased if a system of steam curing is used during manufacture. However, when prestressed reinforcing steel is used for producing units with greater strength, steam curing can have a detrimental effect on the strength of the bond between the steel and the concrete. The N.B.R.I. is at present engaged in research aimed at developing suitable steam curing procedures which will not have this detrimental effect.

Deterioration of building materials

The deterioration of cement and concrete products in "aggressive" environments where corrosive substances can have a deleterious effect — as in factories and in industrial areas, coastal regions and in sulphate-bearing soils — gives rise to many problems in South Africa. The N.B.R.I. is undertaking research to determine the influence of certain components used in the manufacture of cement and concrete as well as the influence of certain manufacturing techniques on the acid resistance of these products.

Deterioration of building materials, particularly those exposed to the weather, causes serious problems and entails costly repairs and maintenance throughout the country and many enquiries are received at the N.B.R.I. every year for information and advice on problems of deterioration.

Special research investigations are being made into the durability of wall coverings, the nature of paint failures,

deterioration of plastic building elements, adhesion failures of plastic floor tiles and the corrosion of steel in concrete.

Plastics

The use of plastics in the building industry is rapidly increasing. However, owing to a lack of information on the suitability of the various compositions for various purposes under South African conditions, types of plastic material are sometimes used for purposes for which they are not suited with the result that they have to be replaced after a relatively short time. The N.B.R.I. is therefore studying the properties and durability of various plastic building materials under local conditions so as to determine the applications for which they would be most suited. The materials being investigated include plastic floor and roof coverings, waterproofing agents and coatings, sealers for joints between building elements, pipes and pipe jointing systems.

Paints and corrosion

The N.B.R.I. is carrying out three important investigations into the suitability of various paints and paint techniques for the different climatic conditions in South Africa:—

- Research on paint systems for structural steel such as those used in bridges, factory and warehouse buildings, cranes, structures for carrying overhead power and lamp posts. The prevention of corrosion of the exposed steel presents a serious problem, particularly in the coastal areas.

- Research on the painting of asbestos cement, plastered surfaces and concrete.
- Research on the painting of timber and timber products.*

A considerable amount of money and labour is expended throughout the country on painting and the development of more durable paints and improved painting techniques will in the long term lead to substantial savings. The Institute is conducting an intensive study of the nature of paint failures to obtain a better understanding of this problem. This work is done in close collaboration with the Paint Research Institute in Durban.

(See also report under the heading, **Basic Industrial Chemicals and Miscellaneous Chemical Products**).

Fire research

Statistics of fires are of great importance in the planning and design of buildings and in the provision of fire-fighting equipment. For this reason all fire brigades in the country are providing the N.B.R.I. with information on all fires that occur in their areas so that these can be recorded and statistically analysed.

With the completion of the fire-testing facilities at the Institute it has become possible to embark on a much-needed programme of research to establish the behaviour of combustible or heat-sensitive materials used in orthodox and unorthodox light-weight forms of house construction, with particular reference to the control of construction presenting a fire-hazard.

The research involves tests of building elements in fire testing furnaces and full-scale fire testing of rooms and of houses with different wall and roof constructions.

Handbook on South African natural stone

A comprehensive handbook dealing with the classification, distribution and application in South Africa of natural stone suitable for masonry is being prepared by the N.B.R.I. in collaboration with the National Development Fund for the Building Industry and the Master Masons' and Quarry Owners' Association. The handbook will also include information on the selection of suitable types for a given application, on the processing of the stone and on the problems connected with the weathering, maintenance, restoration and preservation of stonework.

* FRANK, D. & LOW, C. The painting of timber. *Architect and Builder*, vol. 16, nos. 11 and 12, November and December, 1966.

Sewerage and plumbing

Research on sewer design and on methods of reducing or overcoming the corrosion of sewer pipes is yielding valuable information. Many municipalities, provincial administrations, government departments and some industries are contributing financially to this work and in some cases they are also participating in the studies on sewer systems. Useful data are being obtained on sewer flows for different categories of urban development in relation to pipe sizes, gradients and other aspects of design, and on design methods to reduce the infiltration of storm and ground water.*

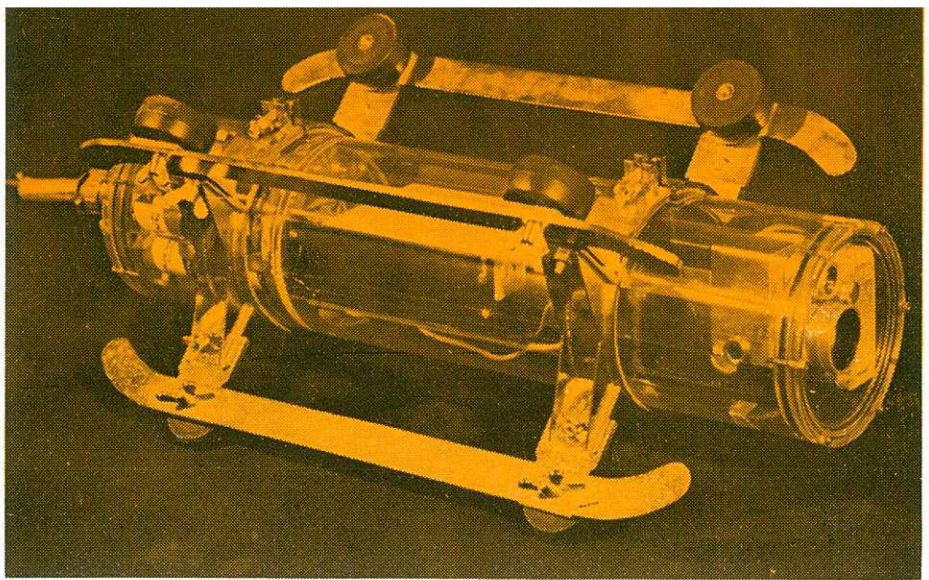
An investigation is also in progress into South African building bylaws in order to ascertain to what extent the application of progressive plumbing practices is being hampered by restrictive regulations. Overseas investigations seem to show for example, that the use of single-stack plumbing would result in considerable simplification of piping with consequent cost savings. Such plumbing is not permitted by regulations in most urban areas. An experimental scheme using this system of plumbing on a seven-storey block of flats is being studied by the N.B.R.I. in collaboration with the Department of Community Development.

Plumbing problems that are new to this country and arise from the construction of tall buildings in some South African cities are also being investigated.

Functional efficiency of buildings

The lighting, ventilation, thermal behaviour and control of noise in buildings as well as their acoustic properties have a very significant influence on the health, comfort and well-being of the people who have to work, live or relax in them. In the national interest therefore it is essential that more knowledge be gained to enable designers to plan buildings where the indoor environmental conditions are more in keeping with optimum working conditions.

The N.B.R.I. is making a detailed analysis of weather data, including solar radiation and daylight illumination, with a view to the design of buildings to suit the South African climate. Studies are also being made to improve the thermal performance of light-weight structures and to measure the efficiency of the various types of glass and shading devices used as insulation against solar heat.



Where corrosion of sewer pipes or other defects are suspected this special sewer camera can be used to provide photographic evidence of the interior. The camera was developed by the N B R I.

International monograph on construction

A comprehensive treatise on the thermal performance of buildings with special reference to warm climate was completed for publication in an international series of monographs on architectural science. The work was commissioned by an international publishing house which specializes in producing prestige scientific and technical books.†

School buildings

The N.B.R.I. completed a report on the planning of housecraft high schools for the education of girls whose aptitudes and talents are practical rather than academic.

Progress was also made on research into the planning of special schools for the physically and mentally handicapped as well as research into the best methods of utilizing the various forms of audio-visual teaching aids in education. The use of these aids is rapidly increasing abroad and their use is bound to spread in South Africa.‡

Hospital buildings

The N.B.R.I. is continuing its research work on the planning of hospitals on behalf of the health departments of the State and the four Provincial Administrations. During the past year, attention was concentrated on the planning of laundries, operating units, out-patients departments and central linen stores.

Liaison and information

An important function of the N.B.R.I. is to disseminate research results and to apply these in practice and generally to supply the building and construction industry with information and advice on practical problems. During the year about 20,000 enquiries from government departments, the private sector and the general public were dealt with. The Institute's two regional offices — in Cape Town and Windhoek — are an important link here.

* SHAW, V. A. Drain testing and gully inspection - two factors in the reduction of wet weather sewer flows. *Annual Proceedings Institute of Building and Drainage Inspectors (S.A.)*, 1966, 8p. Sewer camera. *TI - Technical Information for Industry*, vol. 4, no. 12, December 1966, Pretoria, CSIR, pp. 1-4.

† VAN DEVENTER, E. N., LOTZ, F. J. & BOER, P. The assessment of heating and cooling loads of buildings under South African climatic conditions. *Food Industries of South Africa*, vol. XVIII, nos. 10 and 11, February and March 1966, 7pp.

‡ VAN DEVENTER, E. N. & DOLD, T. B. Some initial studies on diffuse sky and ground reflected solar radiation on vertical surfaces. *Biometeorology*

II Proceedings of the Third International Biometeorological Congress, Pau, September 1963. Oxford, 1966, pp. 735-742.

VAN DEVENTER, E. N. & JOUBERT, G. R. An automatic sky scanning radiometer for measuring the distribution of radiation from the sky and interpretation of the measurements. *Biometeorology II Proceedings of the Third International Biometeorological Congress, Pau, September 1963*. Oxford, 1966, pp. 730-734.

VAN STRAATEN, J. F. *The thermal performance of buildings*. Barking, England, 1966, 250pp.

‡ NAPIER, K. P. J. Current developments in school planning in Europe and the U.S.A. *S. Afr. Archit. J.*, vol. 51, no. 5, May 1966, 4pp.

The N.B.R.I. is a member of ten international organizations concerned with technical aspects of the building and construction industry. Staff members served on 99 different local committees during the year and close liaison with various industrial sectors is maintained through several professional and industrial organizations and the Building Research Advisory Committee.

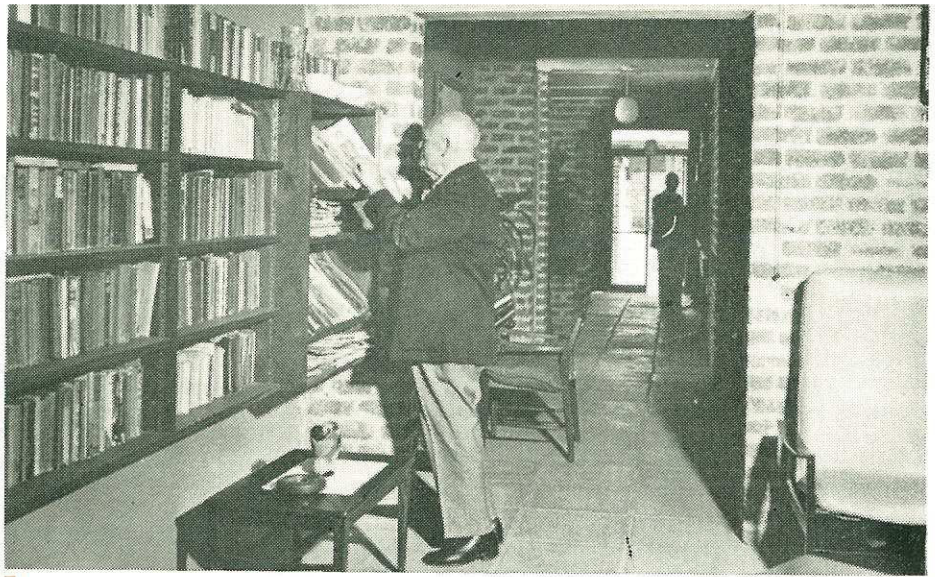
The Head of the N.B.R.I.'s Civil Engineering Division undertook a study tour to Australia, the U.S.A., Canada, Britain and Europe and attended three international conferences: the Conference on Industrialized Building and the Structural Engineer (London), the 5th International Congress of the Precast Concrete Industry (London), and the 5th Congress of the Federation Internationale de la Precontrainte (Paris). N.B.R.I. staff also attended various conferences in the Republic and read papers. Courses were provided by staff of the N.B.R.I. for civil engineers on soil profiling and shear strength of soils.

A colour film dealing with the effect of wind on buildings was made by the N.B.R.I. and is to be distributed shortly. The Director of the Institute also gave a radio talk on research and the building industry. At Gross Barmen near Windhoek, South West Africa, a display concerning building research was arranged for the Administrator and members of the Executive Committee of the South West Africa Administration, heads of government and municipal engineering departments and members of professional organizations.

National Advisory Council

As a result of requests made after the Building Research Conference through the C.S.I.R., the Minister of Planning acceded in principle to the nomination of a National Advisory Council for the Building and Construction Industry.

The Building Research Advisory Committee also suggested to the Government, via the C.S.I.R., that a formal organization for the technical evaluation of new construction methods be established.



A view of an old age home constructed to recommendations made by the C.S.I.R.

IN order to provide information to assist in planning on a national scale for the provision of more housing and of housing better suited to the needs and means of the population, the N.B.R.I. undertook the following tasks:

- An investigation of the socio-economic living patterns of urban communities in the lower income group with a view to modification of existing standards of accommodation.
- A survey of available data on the demand for housing throughout the country and the capacity of the building industry to meet the demand.
- A study of the planning of commercial centres suited to conditions and circumstances in the various urban communities in South Africa.

Research on the planning of housing for the aged in terms of present-day conditions resulted in recommendations being adopted by the National Housing Commission in their revised standards for state-sponsored old age housing schemes.

Acoustics

A number of services were rendered in regard to the acoustics of buildings. The Acoustics Division of the National Physical Research Laboratory (N.P.R.L.) were appointed accountants consultants for projected opera buildings in Johannesburg and Pretoria and for the drama theatre of Stellenbosch University. Guidance was also given on the acoustical treatment and/or planning of churches, halls, building complexes, airport buildings, veterinary hospitals and offices.

By measuring the sound transmission in light-weight and prefabricated buildings, data were obtained which could serve as a guide in the compilation of building codes by the South African Bureau of Standards.

The Acoustics Division's facilities for testing were also used for determining the accountants properties of different materials.

Noise

Noise was measured in factories and streets and guidance was pro-

vided on reducing noise in buildings, factories, schools and churches.

Air conditioning

The proper design of air conditioning equipment for a specific place depends upon an accurate knowledge of the climatic conditions prevailing there throughout the year. To assist designers of such equipment, the N.M.E.R.I. compiled a handbook, which is available to the public, containing climatological data for the entire Republic and South West Africa. A map of the Republic and South West Africa was drawn up showing the areas in which cheaper forms of cooling by means of water spray systems could be successfully utilized. In the past the use of these cooling methods in unsuitable areas resulted in the wasting of thousands of rand.*

* WENTZEL, J. D. and HODGSON, T. The analysis and application of climatic design data. *Proc. S. Afr. Inst. Refrigeration and Air Conditioning*, 1966.

Coastal engineering

In Port Elizabeth, a report was submitted by the N.M.E.R.I. to the City Council on a preliminary investigation into suspected siltation of the Swartkop River estuary. No particular evidence of progressive siltation was found, but erosion of the coast north of the Papenkuils River outlet was observed. This is of considerable importance because the new national road runs along the coast in this area.

In South West Africa, the Institute made a study of part of the coastline and advice was given to the appropriate authorities concerning the possibility of establishing harbour facilities at two sites for the purposes of the fishing industry and salt pan development.

In Natal, research into problems of beach erosion and harbour siltation were continued on behalf of the Durban City Council and the S.A. Railways and Harbours Administration. On the recommendation of the C.S.I.R., a large sand mound is being built about one mile offshore from Durban beach to provide protection for the beach against erosion. This recommendation resulted from exhaustive studies with various hydraulic models of the coastline.

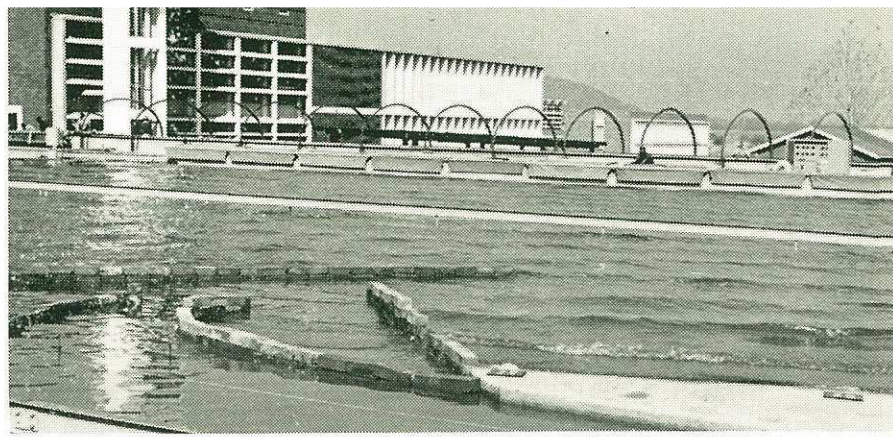
Information relating to the establishment of a harbour at Richards Bay was furnished to the authorities concerned.

The N.M.E.R.I. also completed an investigation into the merits of a breakwater armour unit invented by a harbour engineer in South Africa and dubbed a "dolos". In a report to the South African Railways and Harbours Administration it was stated that "dolosse" dumped at random were much more stable than any other known specially-designed breakwater block.*

Fishing harbours

An investigation was initiated 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 into possible ship-building facilities at Rietvlei in Table Bay. For this purpose a scale model of Table Bay, 200 feet long by 100 feet wide, was constructed at the Institute's laboratories in Pretoria and information will be obtained by simulating in the model, tidal, current and wave conditions found in Table Bay.

During the year an investigation into proposed extensions to the Gans-



baai fishing harbour, using a model of the coastline in the Gansbaai vicinity, was completed. Recommendations were made to the Fisheries Development Corporation that a proposed vertical wall breakwater be realigned and a wave absorber included to improve conditions in the entrance channel and the harbour.

Designing of flood water inlets

As a result of earlier research, the N.M.E.R.I. has prepared a design code for stormwater inlets and copies have been sent to municipal engineers throughout the country.

Designing of sand dams

In South West Africa research was initiated by N.M.E.R.I. into the use of sand dams for storing water with the ultimate object of drawing up a design code for their construction.†

In this scale model of Table Bay, constructed at the CSIR's site in Pretoria, investigations are carried out to determine the best location and design of a fishing harbour at Rietvlei.



Above: A "Dolos" breakwater block. As a result of research by the CSIR "Dolosse" were found to be far more stable than conventional breakwater blocks. These blocks are deposited at random in the sea (below).

* SAUERMAN, H. B. Hydraulic model study of St. Lucia estuary. *Trans. S. Afr. Instn. Civ. Engrs*, vol. 8, 1966, pp. 126-134.

MERRIFIELD, E. M. and ZWAMBORN, J. A. The economic value of a new breakwater armour unit "Dolos". *Proc. 10th Conf. on Coastal Engineering*, Tokyo 1966.

† SAUERMAN, H. B. Water storage in sand-filled dams. *The Friend*, Bloemfontein, 14 September 1966.



Roads



Dr. P. J. Rigden, Director of the CSIR's National Institute for Road Research (N.I.R.R.).

THE work of the 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.

The activities of this and several other institutes of the C.S.I.R. concerned with road building problems, are briefly outlined below.*



Road engineering equipment

The exacting standards of design and construction required for building and operating modern streets and highways have led to the need for the development of sophisticated test equipment. Because of the potential economic significance of this aspect, the C.S.I.R.'s N.I.R.R. devoted attention to the development of equipment for the purpose.

Following are some of the specialized instruments that have been developed: an instrument to determine the density of road foundations by means of nuclear radiation; a curvature meter to help assess the flexural properties of a road layer; a speed distribution meter, which is used to categorize traffic according to speed; a traffic weight analyser, which is used to make a similar classification according to weight.† The latter instrument is still in the

experimental stage and will prove of considerable benefit to road authorities who are faced with the problem of assessing existing traffic loads in order to arrive at a realistic rating for the design of future roads.

Flexure of road surfaces

Excessive flexure of the road surface weakens the structure and can cause cracking which is costly and difficult to repair. The amount of

flexure can be measured with the Benkelman beam or with the N.I.R.R. curvature meter referred to above. As a result of extensive work carried out by the Institute in collaboration with provincial road authorities and several municipalities test limits for local conditions using the above instruments have been established. These test limits have been incorporated into specifications of the Department of Transport and the City of Port Elizabeth.

* RIGDEN, P. J. Some external factors affecting pavement design. *National Congress on Concrete Roads*, Johannesburg, February 1966, Paper S4/P1.

RIGDEN, P. J. Some aspects of the science of road building and the role of research. *Certificated Engineer*, vol. 39, no. 1, January 1966, pp. 3-25.

RIGDEN, P. J. Some characteristic problems of road-building in South Africa. *International Road Federation*, 5th World Meeting, London, September 1966.

RIGDEN, P. J. *Planning and priorities in road research*. *International Road Federation*, 5th World Meeting, London, September, 1966.

† HEINZ, W. F. and ENGELBRECHT, C. A. Comparison of Monte Carlo calculations of the parameters governing the response of the nuclear soil density gauge with experimentally obtained values. *Radioisotope Instruments in Industry and Geophysics*, vol II. Vienna, International Atomic Energy Agency, 1966, pp. 351-368.

Recent work by the N.I.R.R. included a study of the effects of surface temperature and vehicle speeds on flexure of roads in South West Africa. Future work planned includes a study of methods for making rapid assessments of long lengths of road. This may entail the development of automatic, travelling instrumentation and is particularly important because of the manpower shortage.

New road-testing site

The N.I.R.R. is now making use of a large site for field experiments in order to bridge the gap between laboratory testing and full-scale testing on the road. At this test site new techniques are studied and a larger range of variables can be covered under closely simulated practical conditions than is possible in practice.

The road industry can also make use of the test site. For example the



The Portland Cement Institute is co-operating in the laying of a length of experimental concrete road in order to study the performance of local materials such as Portland cement and blast-furnace slag cement.

Provision has also been made for carrying out traffic studies which include intersection design and visibility investigations.

With the aid of this instrument the traffic load over a particular road can be assessed. The weight of every vehicle passing over the road is registered.

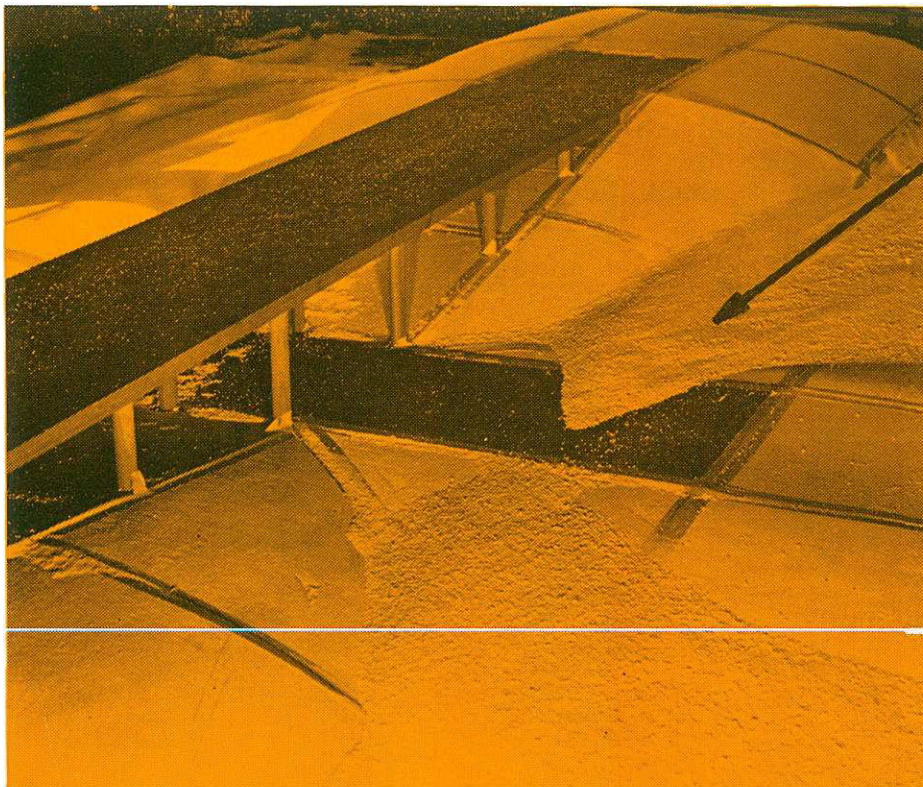
The N.I.R.R. road test site near Pretoria which is used to bridge the gap between laboratory testing and full-scale testing on the road.

Road construction in sandy areas

The National Mechanical Engineering Research Institute completed an investigation in a windtunnel of the movement of sand driven by wind across roads in desert dune terrain. As a result of the work, recommendations on the design and siting of roads was given to the South West Africa Administration, for whom the investigation was done.

Wind tunnel tests with this model of a road passing through desert terrain indicated the optimum design to ensure that the wind would not deposit sand on the road surface. Instead of sand expanded grains of polystyrene were used.

petroleum companies instituted a project to investigate the performance of bitumen-bound bases. A number of different mixes were manufactured with the Institute's premix plant and laid in the form of a continuous loop which can be trafficked by a heavily loaded truck. The performance of the mixtures after various periods of trafficking was evaluated by means of precise level observations and other methods in which electronic equipment developed by the Institute was used.*



* MARAIS, C. P. A new technique to control compaction of bitumen-sand mixes on the road using a vane shear apparatus. *S.A. Inst. Civ. Eng. Trans.* vol. 8, no. 3, March 1966, pp. 87-94.



RESEARCH

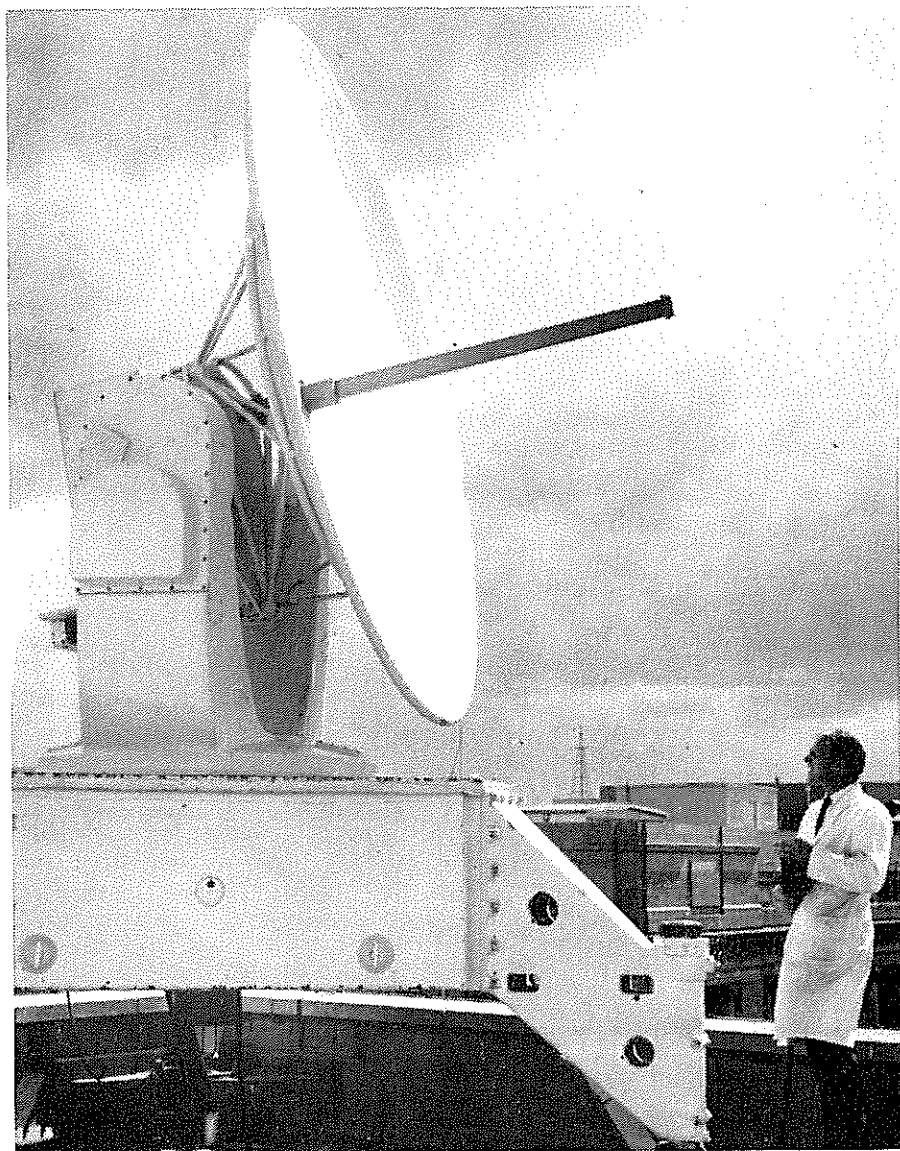
IN THE PUBLIC SECTOR

MUCH of the C.S.I.R.'s research is directed at solving community problems facing the State, the community and industry as a whole. Research work undertaken in this connection by the C.S.I.R. in its own laboratories and by other bodies supported by the C.S.I.R., embraces innumerable problems in fields such as national health, nutrition, housing, pollution of air and water, corrosion and road safety.

The work of some of the C.S.I.R.'s research laboratories and institutes is almost entirely devoted to these difficult fields. The **National Nutrition Research Institute** (N.N.R.I.) for example, devotes itself to problems concerning the nutritional status of the country's population; the **National Institute for Personnel Research** (N.I.P.R.) concentrates on studying man in his working environment with a view to greater work satisfaction and consequently greater productivity; the **National Institute for Road Research** (N.I.R.R.) and the **National Building Research Institute** (N.B.R.I.) respectively devote a considerable part of their resources to promoting road safety and better housing. Various other institutes and laboratories are also engaged in this broad sector.

This chapter presents a picture of the contribution made by the CSIR to solving these problems, as well as reports on the work of the medical research units, groups and projects which undertake research with CSIR aid for the benefit of the national health.

earth and space sciences

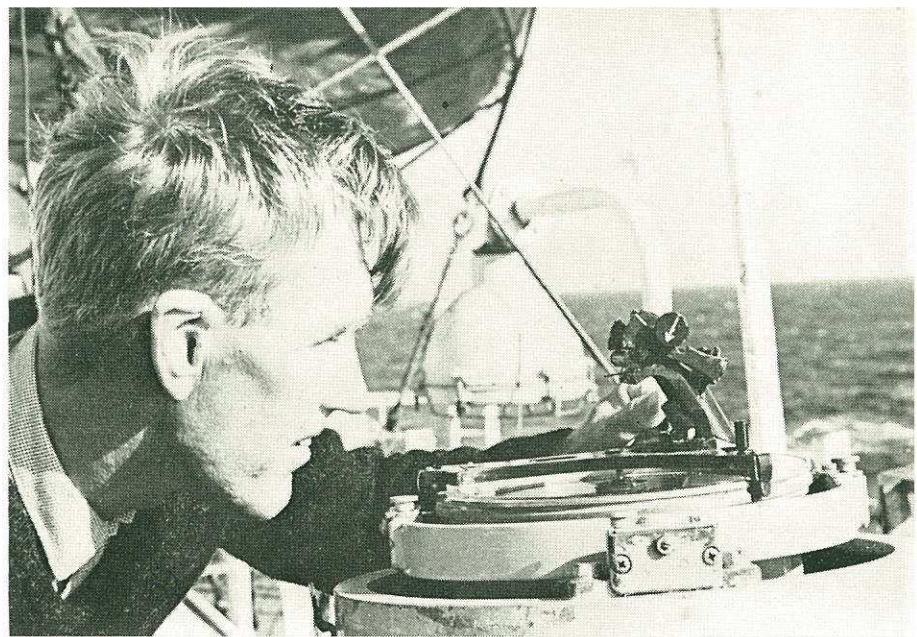


Radar echoes from precipitation

The study of radar echoes from precipitation was continued in the National Institute for Telecommunications Research (N.I.T.R.). The greater part of the effort has been devoted to the acquisition and installation of improved radar equipment. The possibility of increasing the correlation between rainfall and radar observations by measuring the polarization as well as the intensity of radar echoes is being investigated. It is thought that this may make more accurate measurements of rainfall by means of radar possible.

This new radar antenna recently installed at the National Institute for Telecommunications Research may make it possible to measure rainfall more accurately with the aid of radar.

A scientist on board a research ship determines the position of a float which is used for research into the sea currents along the Natal coast.



Movements of sea currents

Valuable information collected by the National Physical Research Laboratory (N.P.R.L.) during recent research cruises has brought nearer the possibility of forecasting sea conditions off the Natal coast. A unique technique has been developed for the direct measurement of sea currents. By means of a radiation thermometer flown across the area of study off Durban, it has been possible to gain information on the movement of the water masses. The Agulhas current shows daily variations in speed, breadth and position relative to the coast.*

The studies are relevant to shark research, effluent problems, sand transport along the coast, harbour siltation, weather forecasting and defence.

Cloud physics

Hailstorms often cause considerable damage over large areas of South Africa. The N.P.R.L. is carrying out research work to obtain a better understanding of hail formation and the occurrence of hailstorms.

Hailstorms were observed by a widespread network of voluntary workers and hailstones were collected and examined to obtain information about wind and temperature stratification of thunderclouds.

The internal pressures in hailstones were measured with an apparatus specially devised for the purpose.†

* ANDERSON, F. P. Fisiese oseanografie aan die Natalse kus. *Tegnikon*, 1966, pp. 177-183.

† CARTE, A. E. Hail studies in South Africa 1962-1966. *Newsl. Weath. Bur. Pretoria*, no. 209, August 1966, pp. 151-155.

CARTE, A. E. Features of Transvaal hailstorms. *Q. Jl R. Met. Soc.*, vol. 92, no. 392, 1966, pp. 290-296.

CARTE, A. E. and KIDDER, R. E. Transvaal hailstones. *Q. Jl R. Met. Soc.*, vol. 92, no. 393, 1966, pp. 382-391.

ROOS, D. v.d. SPUY. Two-dimensional grain growth in ice. *Jl Glaciology*, vol. 6, no. 45, 1966, pp. 411-420.

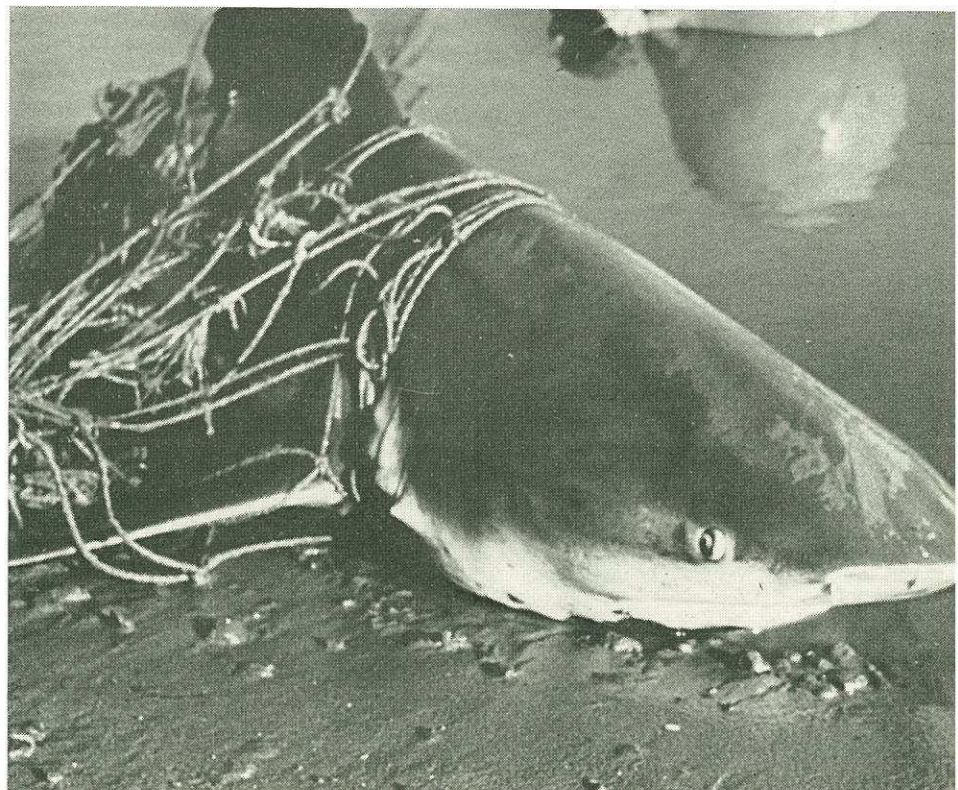
Electrical shark barrier

RESEARCH in connection with an electrical shark barrier is proceeding apace. A prototype was successfully tested at the St. Lucia estuary. Research is being concentrated on the development of a more economical electrode system which would be corrosion-resistant. The cost of electrodes was initially prohibitive but has already been reduced by two-thirds.‡

‡ BURGER, J. F. and SMITH, E. D. Die ontwikkeling van elektrodestelsels vir haaiwersperrings met behulp van 'n model. *Tydskr. vir Natuurwetenskappe*, June 1966, pp. 95-107.

SMITH, E. D. Elektrotaksieproefneming met betrekking op haaiwerende versperrings. *Tydskr. vir Natuurwetenskappe*, June 1966, pp. 108-117.

This shark was caught in the shark net erected at St. Lucia Bay. Experiments carried out with an electrical shark barrier have yielded promising results.



labour and management

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 C.S.I.R. devotes considerable attention to this problem, and there is scarcely a sector of industry which has not benefited to some extent from the C.S.I.R.'s work.



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

The work of the N.I.P.R. is of cardinal importance here, covering as it does the problems associated with the workers' productivity and work satisfaction. Because labour and management problems are basically community problems, the N.I.P.R.'s work in this respect over the past year, even when it was carried out at the request of particular sectors, is contained in this chapter on research on behalf of the public sector.

(See also report under the heading **Psychology** in the chapter **Fundamental Research**.)

A LARGE proportion of the research of the N.I.P.R. was devoted to management and personnel problems of the South African gold-mining industry. The implementation of recommendations here should promote not only the productivity of the mines but also the well-being of the mine-workers.

The following aspects in particular were considered:

- More effective communication between employer and Bantu employee, with particular reference to safety and productivity.
- Programmed lessons in mathematics to be used for training apprentices.
- Re-standardization of the existing general adaptability battery (G.A.B.) of tests for the placement of mining recruits into the categories of manual, operative and supervisory labour, as well as the development of a new parallel test. This work is essential as the educational level of recruits is higher nowadays than when the original test was designed.
- A neuropsychological investigation

of brain function in heatstroke cases with a view to preventative and therapeutic measures.

During the year under review, the N.I.P.R. conducted staff selection procedures and operational surveys in the following sectors: sugar production, liquor, tobacco, fertilizer, paper, rubber, petroleum, electrical equipment, motor vehicles, bricks and tiles.

The building and construction industry also made use of the Institute's services in the form of a survey of management efficiency. The primary object of this country-wide survey was to establish research priorities for the N.B.R.I., with whom there is close collaboration in this matter.

New tests

The N.I.P.R. continued to design new tests for general psychological-diagnostic and for specific selection purposes, e.g. tests for mechanical comprehension, conceptual reasoning, science interest, creativity and psychomotor abilities.

The development of a pencil-and-paper test involves the writing of "items", i.e. test problems of appropriate difficulty, their arrangement in

an optimal sequence, the determination of the reliability and validity of the test, and the establishment of norms. Only after a test has gone through these stages can it be made available in a final printed form to qualified test users. The N.I.P.R. maintains a register of qualified test users and ensures the proper administration as well as a continual quality control of the tests it produces and distributes.

The N.I.P.R. also undertook the construction of tests for specific research projects. In addition, personnel selection programmes for industrial organizations and government departments both in South Africa and abroad were carried out. About a thousand candidates were tested during the year under review, apart from nearly 800 applicants for posts at the C.S.I.R. itself.

In the field of operational analysis a start was made by the National Research Institute for Mathematical Sciences with the study of various mathematical models to serve as the basis for inventory control and production planning.

RESEARCH ON AIR POLLUTION

THE National Physical Research Laboratory (N.P.R.L.) and the N.C.R.L. gave attention during the past year to the problems of air pollution.*

The concentration of sulphur dioxide and of smoke in the air of a number of cities and towns was measured by the Air Pollution Research Group.† The potential of the air to dissipate pollutants was measured at a number of industrial sites to assist in efficient industrial planning and in the design of factory stacks. Similar work was also carried out on behalf of the provincial administrations.

It is difficult to make accurate measurements of fine dust particles in the gas stream of chimneys. Such measurements are required to determine current conditions against statutory pollution limits and to pave the way for designing control equipment. Accordingly, a great deal of trouble was taken in designing, constructing and testing an apparatus for drawing off dust samples at any point along the cross-sections of chimney stacks of up to 10 feet in diameter. During the year, at the request of several factories, such measurements were made at various places. A useful discussion was also arranged for representatives of various industries.

Extensive research is being carried out on the application of gas chromatography for the detection of malodorous constituents in the atmosphere to the lee of certain factories.‡

Vehicle exhaust control

Information obtained during the past year by the Air Pollution Research Group enabled the South African Road Safety Council's *ad hoc* committee for vehicle exhaust control to submit a recommendation that smoke be controlled by the use of the Hart-ridge smoke meter by the Transvaal traffic authorities. A maximum smoke density level was determined. It is expected that other provinces will presently follow suit.

Information on air pollution

After the Air Pollution Prevention Act was introduced and a National Air Pollution Advisory Committee was named to advise the Minister of Health, the C.S.I.R.'s Air Pollution Research Group experienced a greatly increased demand for scientific research and advisory services. Two of the C.S.I.R.'s senior officials were respectively appointed chairman and member of the above Committee.

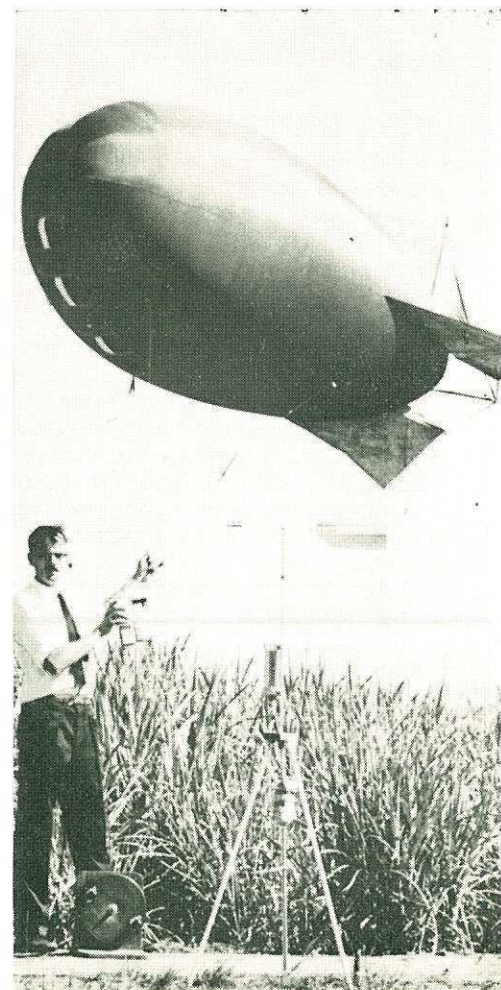
The leader of the Air Pollution Research Group, as a delegate for the Department of Health, read a paper in October, 1966, at the second International Congress on Air Pollution in London.

During the past year about 1,000 publications on air pollution were added to the pamphlet collection, including translations of several valuable Russian publications on air pollution. Several newsletters, reports, regulations, etc. relating to the prevention of air pollution are regularly received from abroad by the Information Office of the Air Pollution Research Group.**

During 1966 approximately 50 requests for advice and information were handled in writing. Many requests in connection with the Air Pollution Prevention Act were re-

ceived from local authorities. Seventeen documents containing general information and seven on specific technical aspects of air pollution were prepared and 100 enquirers were provided with literature on air pollution. A number of articles was published in journals and there was participation in an exhibition on health guidance and in another at the Museum for Science and Industry.

With the aid of this balloon to which a radio thermometer is attached, the ability of an atmosphere to disperse pollutants effectively can be determined.



* LOUW, C. W. The quantitative determination of benzo(a)pyrene in the air of South African cities. *Amer. Ind. Hyg. Assoc. J.*, vol. 26, 1965, pp. 520-526.

BRÜCKMANN, C. G. Air pollution control in the chemical industry. *S. Afr. Ind. Chem.*, July 1965.

† KEMENY, E. Introduction of a standard scale for smoke measurements. *S.A. Ind. Chem.*, vol. 20, no. 4, 1966, pp. 71-74.

‡ LOUW, C. W. Atmospheric pollutants and their analysis. *CSIR Special Report SMOG 2*, Pretoria, CSIR, 1966, 49p.

** LATSKY, C. E. Analytical activities connected with the enforcement of the Atmospheric Pollution Prevention Act. *Journal of the S.A. Institute of Assayers and Analysts*, June 1966, pp. 112-116.

LATSKY, C. E. Atmospheric pollution and health. *Public Health*, June 1966, pp. 269-271.

LATSKY, C. E. and HALLIDAY, E. C. Progress in air pollution control in South Africa. *Proceedings, Part 1, of the International Clean Air Congress*, London, 4-7 October 1966.

SINCE its inception the C.S.I.R. has supported medical research in the Republic, inter alia by establishing and maintaining research units and groups at universities, hospitals and other institutions. At present there are 23 research units and groups and a variety of projects under the guidance of leading research workers who, with the aid of the C.S.I.R., are doing research in fields of national importance. A complete list of these units, groups and projects appears on page 45.

medical research

DURING 1966 the Council granted some R533,300.00 to universities, university colleges, museums and other institutions for research in the medical sciences. These funds were allocated as follows:

C.S.I.R. Units and Groups	R415,000
Individual <i>ad hoc</i> grants	111,700
Post-graduate bursaries	6,600
	<hr/>
	R533,300

While the amount of money made available to the Council for supporting university and medical research has been increased steadily each year, the sum available falls substantially short of the requests received. For 1966 approximately half the funds requested could not be provided.

In the field of medical research, the need for more effective co-ordination of research, for liaison between scientists and between scientific disciplines and for a realistic appraisal of the scope, nature and direction of research effort were subjects for thorough consideration by the Council's Committee for Research in Medical Sciences (C.R.M.S.). Two committees were appointed, *viz*:

- (i) an Advisory Committee on Research and Co-ordination with the responsibility of advising

C.R.M.S. on the allocation of funds for medical research and how best to ensure the proper development of the various fields of the medical sciences;

- (ii) an *ad hoc* Committee on Medical Research Policy whose responsibilities include recommending priorities in the field of medical research in the light of the special needs and requirements of the country and stimulating research on important national health problems as well as in fields in which local circumstances would enable South Africa to make substantial contributions to knowledge.

The impact of other scientific disciplines on medical research and the broad interdependence of the various scientific fields have been a noteworthy feature of modern developments in science. The need for ensuring that South African medical research should be aware of and stimulated by developments in the fields of biophysics, biochemistry, biological engineering, biometrics and the behavioural sciences was recognized and a committee was appointed to investigate the question of holding a symposium on cross-disciplinary sciences in the bio-medical field. This committee is in the process of for-

mulating a programme for the symposium.

The work of the C.S.I.R.'s medical research units is reported annually in the **Annual Report on Medical Research**, which is obtainable from the Head, University and Medical Research, C.S.I.R., P.O. Box 395, Pretoria. The work described in this report represents but a fraction of the medical research potential of the Republic. Because of lack of funds this potential lies dormant.

Some aspects of medical research sponsored by the C.S.I.R. are discussed below and indicate a few of the fields investigated by research workers and the problems faced.

Pneumoconiosis research

At the instance of the Board of Sponsors, priority is now given by the **Pneumoconiosis Research Unit** to short-term research projects with reasonable promise of speedy results that might be applied to the immediate welfare of mine workers occupationally exposed to mine dust hazards.

Long-term projects of a basic or fundamental nature, and of greater interest to the academician than to the employer or employee, are being supported only when considered essential to elucidate relevant aspects

of applied researches of a short-term nature. It is generally found that research in the pneumoconiotic field requires a measure of fundamental work which cannot be avoided. But the allocation of available funds and effort to fundamental work, as compared with that given to short-term research, has to be realistically made.

The capital costs of the apparatus required for investigations on the living miner are increasing alarmingly year by year. There are two reasons for this. The first is that in order to obtain trustworthy results without unnecessary or excessive discomfort to the human subject, highly sophisticated techniques are essential. The second is that most of the problems capable of approach by simple or elementary methods have long since been solved. The problems that remain are complex in the extreme.

Sponsors of this Unit realize that this research has to be maintained at a high level for the important reason that material studied at the Miners' Medical Bureau is not only human but also unique in that it is composed of men of all ages working at a combination of depth levels, humidities and temperatures unknown elsewhere in mining history. Few if any overseas scientists are in a position to solve for us the physiological problems that arise from our particular mining environment, for nowhere else does man work day in and day out at a depth of 10,000 feet. In this matter we must help ourselves, cost what it may.

On the pathological side, dealing with the effects of human exposure to a variety of dust hazards, the skills of the P.R.U. are becoming widely known, and a steady increase in requests for help and advice from all quarters is becoming noticeable.

Industrial enterprises that give rise to chemical dusts in great variety, and thus expose man to occupational hazards not always fully understood, are approaching P.R.U. not only for

advice but also for actual investigation of their particular problems.

Steps are being taken to provide help when this can be done without reducing the tempo of the work on the main research programmes in hand.

Biochemical research by the N.C.R.L. is integrated with that of the whole **Pneumoconiosis Research Unit**. Through this work research workers aim to elucidate biochemical changes—and their causes—in the lungs of animals subjected to dusty atmospheres.*

Research grants from overseas

Two important developments in connection with overseas research grants are of interest. The first is that support from the U.S.A. is being reduced. The second is that where U.S.A. grants are being or may be used for research on human beings, the U.S.A. now requires assurances that the interests of the persons subjected to research are being properly safeguarded. A specially selected C.S.I.R. committee was convened in Durban on November, 1966, to ensure that the personal rights of patients subjected to research with the aid of C.S.I.R. and National Institutes of Health grants are fully protected by the establishment of all desirable safeguards, including the procedures necessary to obtain "informed consent".

There is at the moment no available evidence of irregularities in the management of South African citizens subjected to medical investigation and research. But it is agreed that steps taken to ensure that such is the case are all to the good.

* BREYER, MARIA G. & KILROE-SMITH, T. A. Changes in the activities of enzymes in the lungs of guinea pigs exposed to inhalation of quartz dust., IV: The effect of quartz dust on nicotinamide adenine dinucleotide-linked oxidase systems and on ATP-ase. *Enzymologia*, vol. 28, 1965, pp. 263-277.

KILROE-SMITH, T. A. A modified graphical method for determination of equilibrium constants. *Biochem. J.*, vol. 100, 1966, pp. 334-335.

MEDICAL

RESEARCH UNITS AND GROUPS

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).

Cardia-Pulmonary Research Unit, University of the Witwatersrand (Director: Prof. G. A. Elliot).

Cardia-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).



The heat exchange between a test person and his environment is measured in the Chamber of Mines' climatic chamber. The climatic chamber and the apparatus were designed by the CSIR.

Objectives of medical research supported by state funds

The C.S.I.R. Committee for Research in Medical Sciences is at present considering the wisdom of establishing disease prevalence profiles with a view to discovering noteworthy disease trends. The idea is to steer research funds into areas where such trends indicate special dangers to public wellbeing.

For example, the true impact of a disease such as bilharziasis on the general health of the infected population ($\pm 2,000,000$) is not yet known. It is intended to institute investigations to settle this vexed question once and for all. Some allege that bilharziasis does serious harm on a vast scale in the Republic; others maintain that the number of persons significantly disabled is too small for the disease to be classified as a serious public menace. There are a number of reasons why this obviously important information has not yet come to light and it may take several years for the necessary surveys to be completed.

Present economies in state grants for medical research

In general, State grants for medical research are allocated and spent with care by those whose responsibility it is to administer them. But since applications for grants are in-

creasing annually, the problem of drawing up acceptable criteria for establishing priorities in allocating grants is now a pressing one.

Existing ceilings to State grants for medical research based upon formulae rather than merit are creating problems for research advisory committees. Assessment of the priority claim on State support of research project "A" over that of "B" in an unrelated field, at present requires judgment based upon criteria which are subjective in the extreme. It is to be hoped that conditions will soon change for the better and that State grants will become available on a scale that will make it possible for research support to be granted purely on merit and on a non-competitive basis. Important research projects designed to supply information immediately applicable to the improvement of public health, do at present compete for funds with equally important projects which, though mainly of academic interest, are essential to scientific development and training at our universities.

South Africa today possesses sophisticated scientists and unique research opportunities for us to maintain a leading position in the resolution of problems in many important African fields, thereby contributing not only to our own salva-

tion but to that of all Africa as well. But supporting funds are relatively small.

Kwashiorkor

The protein deficiency disease, kwashiorkor, is the most prevalent deficiency disease among non-white children in the Republic. Research by the N.N.R.I. was concentrated on the development of relatively inexpensive foodstuffs which may be used to prevent this disease. A food mixture to supplement the typical Bantu diet which consists mainly of mealies was formulated and tested. The product is at present being tried out in field tests.

Other deficiency diseases

Apart from kwashiorkor the nutritional deficiency diseases, pellagra and marasmus, also occur in the Republic. Whereas marasmus is found chiefly among children, pellagra is found among both children and adults. Pellagra is definitely the most important deficiency disease among adult non-whites in South Africa.*

The N.N.R.I. also conducted research on the protein nutritional status of children suffering from pellagra.

The morphology of the small intestine of adult patients with acute, uncomplicated pellagra was studied by means of biopsies. The sugar-splitting enzymes in the small intestines of such patients are also being investigated.

Nutrition-status survey

To formulate an effective nutritional and food policy for the country, knowledge concerning the nutrition status of the different levels of the population is required. Research is therefore being carried out to ascertain the best method of determining the nutrition level of separate population groups and actual nutrition status surveys are also being carried out on a limited scale.*

* PRETORIUS, P. J. & WEHMEYER, A. S. Nutritional marasmus in Bantu infants in the Pretoria area. Part III. The effect of caloric intake on nitrogen and fat balance, certain serum constituents and the rate of recovery. *S. Afr. Med. J.*, vol. 40, no. 2, 19 March 1966, pp. 240-242.

POTGIETER, J. F., FELLINGHAM, S.A. & NESER, M. L. Incidence of nutritional deficiency diseases among the Bantu and Coloured populations in South Africa as reflected by the results of a questionnaire survey. *S. Afr. Med. J.*, vol. 40, no. 22, 18 June 1966, pp. 504-509.

National Nutrition Research Institute

THE National Nutrition Research Institute (NNRI) 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.



Dr. J. J. Theron, Director of the C.S.I.R.'s National Nutrition Research Institute.

Food analysis

In evaluating a diet the nutrient content of the foods being consumed must be known. Thus research is being done to determine the nutrient composition of the different food-stuffs—particularly the many edible wild fruits and other plants used by the Bantu especially in the rural areas and which constitute an important part of their diet.†

The metabolism of carbohydrates and fats

There are already indications that patients suffering from degenerative cardiovascular disease display certain deviations with regard to the metabolic utilization and digestion of carbohydrates and fats. However, the precise rôle that these abnormalities play in the origin and development of the disease states is still unknown. The rôle of certain hormones in carbohydrate metabolism is the main object of intensive biochemical studies by the N.N.R.I. Financial assistance for this project was obtained from a local insurance company.

Fungal toxins

The discovery some years ago of a certain type of fungus, *Aspergillus*

flavus, which, when growing on groundnuts, can produce substances which are not only extremely poisonous, but also possess powerful cancer-producing properties, drew attention to the dangers which fungal toxins contained for man and beast. When aflatoxin was subsequently found on many samples of South African groundnuts, it led to an extensive search for toxin-forming fungi on foodstuffs and to the study of the toxins produced. A joint committee of the Department of Health and the Department of Agricultural Technical Services is at present co-ordinating this research work.

The C.S.I.R.'s Microbiology Group has already found several toxin-bearing fungal strains in various grains. In addition this Group and

the N.C.R.L. are engaged in isolating and identifying the toxic components and working out analytic techniques. The N.N.R.I.'s Toxicology Division is determining the toxicity of these substances and is studying their rôle in the development of cancer.‡

Though the toxins produced by fungi are very potent, they occur in minute amounts so that highly specialized chemical techniques are required for their isolation and study. Some of these toxins were previously unknown to science. The structure and synthesis of one of these, ochratoxin, was recently completed and it can thus now be prepared in adequate amounts for toxicological and biochemical studies.

to health services in developing areas. *S. Afr. J. Sci.*, vol. 62, no. 9, September 1966, pp. 299-304.
NESER, M. L. A new approach to the definition and evaluation of nutrition status and its application to adult male labourers. *S. Afr. Med. J.*, vol. 40, no. 45, 17 December 1966, pp. 1082-1089.
DU PLESSIS, J. P., DE LANGE, D. J. & NESER, M. L. Biochemical evaluation of the nutrition status of urban primary school children: Vitamin-A Status. *S. Afr. Med. J.*, vol. 40, no. 45, 17 December 1966, pp. 1093-1097.
† WEHMEYER, A. S. The nutrient composition of some edible wild fruits found in the Transvaal. *S. Afr. Med. J.*, vol. 40, no. 45, 17 December 1966, pp. 1102-1104.
‡ HOLZAPFEL, C. W., STEYN, P. S. & PURCHASE, I. F. H. Isolation and structure of aflatoxins M₁ and M₂. *Tetrahedron Letters*, no. 25, 1966, pp. 2799-2803.
DE WIT, J. P., PURCHASE, I. F. H., VAN DER WALT, J. P. & VORSTER, L. J. Mycotoxins in food — recent advances in research in South

Africa. *S. Afr. Med. J.*, vol. 40, no. 45, 17 December 1966, pp. 1097-1100.
HOLZAPFEL, C. W., PURCHASE, I. F. H., STEYN, P. S. & GOUWS, L. The toxicity and chemical assay of sterigmatocystin, and its isolation from two new fungal sources. *S. Afr. Med. J.*, vol. 40, no. 45, 17 December 1966, pp. 1100-1101.
VORSTER, L. J. Studies on the detoxification of aflatoxin-contaminated groundnuts intended for oil crushing. *Revue Fr. Cps. Gras.*, vol. 13, no. 1, January 1966, pp. 7-12.
THERON, J. J., VAN DER MERWE, K. J., LIEBENBERG, N., JOUBERT, H. J. B. & NEL, W. Acute liver injury in ducklings and rats as a result of ochratoxin poisoning. *J. Path. Bact.*, vol. 91, no. 2, 1966, pp. 521-529.
PURCHASE, I. F. H. Aflatoxin in milk. *S. Afr. Med. J.*, vol. 40, no. 32, August 1966, p. 774.
VAN DER MERWE, K. J., STEYN, P. S. & FOURIE, L. Mycotoxins. Part II: The constitution of ochratoxins A, B and C, metabolites of *Aspergillus ochraceus* Wilh. *J. Chem. Soc.*, no. 1304, 1965, pp. 7083-7088.

* DU PLESSIS, J. P., DE LANGE, D. J. & FELLINGHAM, S. A. Biochemical investigation of the nutrition status of urban school children aged 12-15 years: Protein Status. *S. Afr. Med. J.*, vol. 40, no. 22, 18 June 1966, pp. 509-514.
DU PLESSIS, J. P., DE LANGE, D. J. & FELLINGHAM, S. A. Biochemical evaluation of the nutrition status of urban school children of 12-15 years: Riboflavin Status. *S. Afr. Med. J.*, vol. 40, no. 22, 18 June 1966, pp. 518-520.
NESER, M. L. Nutrition services as complementary

ROAD SAFETY

THE high accident rate on South African roads is a matter of great concern to every road user. Adequate and reliable facts about road accidents are essential in the planning of action programmes to reduce accidents. Although valuable research results obtained in other countries can be applied here to a certain extent, it is essential to carry out research under local conditions as well.

The N.I.R.R. is using accident reports completed by the S.A. Police to identify points in selected areas with high accident frequencies, so that detailed studies can be made at these places. Recommendations on improvements of various rural roads are being made.

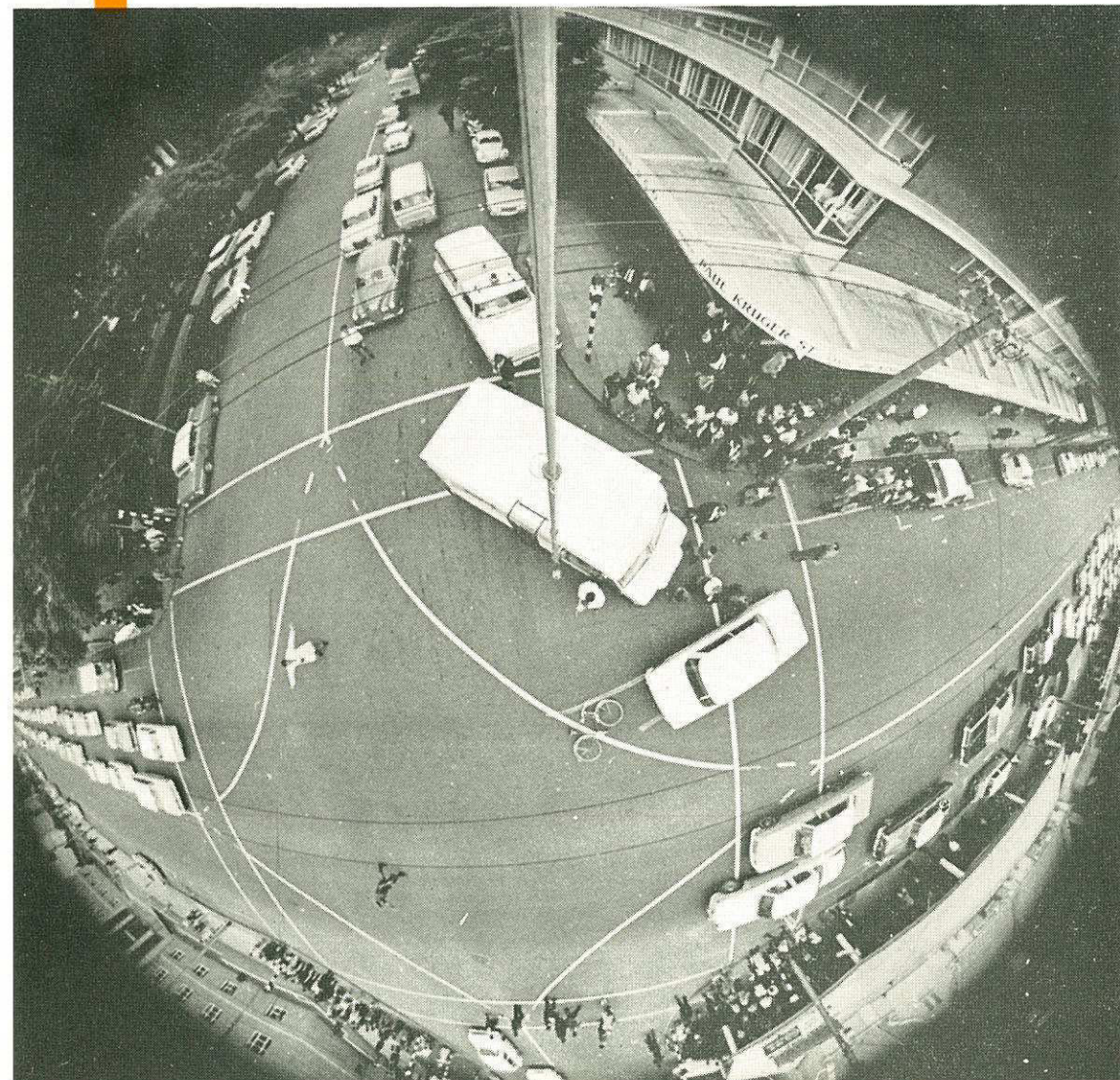
For research purposes, however, more data are required than those available from police reports and, for this purpose, a team comprising a civil engineer, a sociologist and a vehicle technician has been constituted by the N.I.R.R. to make "on the spot" investigations of particular accidents. The main objective of this project is to identify the main factors contributing to road accidents.

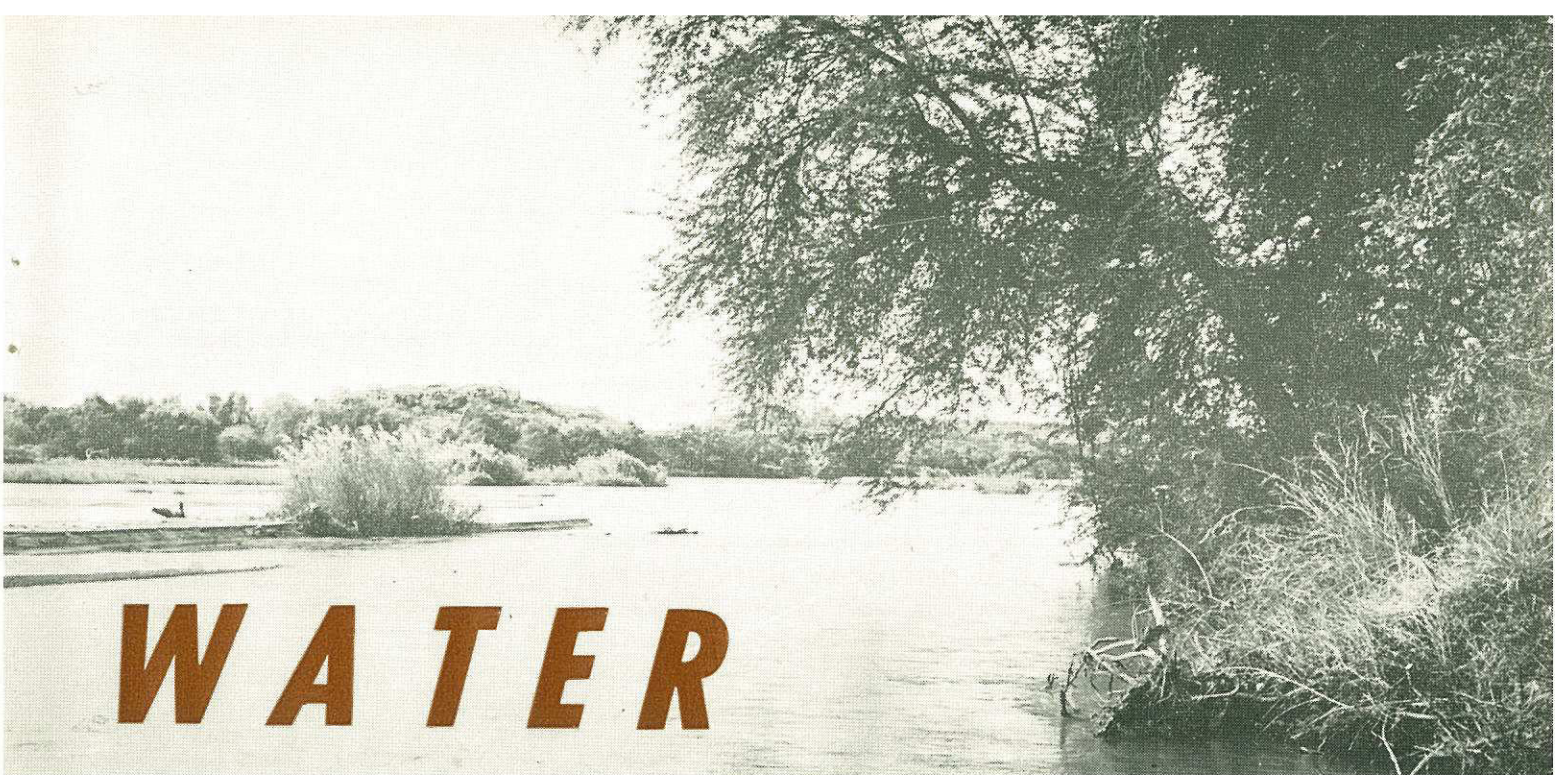
With the co-operation of the S.A. Police, the team proceeds to the scene of an accident as soon as possible after it has been reported. At the scene the engineer records various details required to reconstruct the events leading to the accident; the sociologist interviews the road users involved in the accident, and the technician inspects the vehicles. The use of a "fish-eye" camera at a suitable height has been found to be most valuable for expeditious recording of the scene.

Analysis of the accidents has confirmed the extremely complex nature of the numerous factors contributing to each accident, and it has been necessary to develop a systematic procedure of analysis. This method of collecting data is necessarily a slow process, but absolutely essential to a better understanding of the road accident problem.*

* WIUM, D. J. The road accident problem in South Africa. *National Congress on Concrete Roads*, Johannesburg, February, 1966. Paper S2/P3.
N.I.R.R. Annual Report 1965 (CSIR Special Report PAD 13). National Institute for Road Research, CSIR, Pretoria.
RIDGEN, P. J. *The road accident problem in South Africa and the role of research*. International Road Federation, 5th World Meeting, London, September, 1966.

This photograph of the scene of an accident at a street intersection was taken by a "fish-eye" camera mounted on a telescopic mast. The National Institute for Road Research's Accident Research Team endeavours to reconstruct the scene with the aid of such photographs.





WATER

National Institute for Water Research

THE increasing demands made by the Republic's growing population, and rapid industrial development on the country's limited water resources, make intensive water research and careful planning of industrial areas imperative. The serious drought which has afflicted South Africa over the past few years focused attention once again on the necessity for continuous research into the prevention and combating of water

pollution and on the re-use of water. This is mainly the task of the National Institute for Water Research (N.I.W.R.).

The Institute is also undertaking a comprehensive study of aquatic life in South Africa's streams. The fauna and flora of the country's rivers and dams play an important rôle in the self-purification of water and their study provides valuable information about the

extent to which water is polluted.

Apart from the activities described here and under the heading "Electricity, Gas and Water", the N.I.W.R. has undertaken major investigations for factories in various industrial sectors, such as Goldmining, Paper and Paper Products, Textiles, Processed Foodstuffs, Basic Industrial Chemicals and Miscellaneous Chemical Products.

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



Industrial effluents

Effluents from food processing factories are often heavily polluted with organic matter which is difficult to remove in conventional sewage purification works. Abattoirs, yeast factories, wineries and breweries are among the food processors whose effluent disposal problems are being investigated by the NIWR. Pilot plants for the treatment of these effluents with the aid of anaerobic fermentation are already operating successfully. The Institute is carrying out further research to improve the efficiency and the economy of these plants. At the same time it is investigating the disposal of solid waste products from abattoirs by composting.

The NIWR will shortly compile a code of practice for the disposal of effluent from textile mills and pulp and paper mills under South African conditions. Effluents, and particularly

mineralized effluents, from these industries are posing serious problems. The data required to compile such a code of practice is being acquired in the course of several contract investigations being carried out by the NIWR for individual manufacturers.

Aerobic processes for breaking down solid waste materials from pulp and paper mills and converting these into compost are also being investigated.

In conjunction with a large producer of industrial chemicals, the NIWR is carrying out a contract investigation into effluent purification problems at a chemical factory. Encouraging results have been obtained thus far.

These investigations are aimed not only at effluent disposal but also at more efficient water management in factories with the object of conserving water and facilitating the treatment of effluents. In this connection

particular attention is given to the recirculation of water and the reclamation of waste materials. As in many cases factory effluent is discharged into the sea, the whole problem of marine disposal is also being investigated. Such a study involves thorough preliminary investigations into marine conditions in the area concerned as well as follow-up studies.

Effluents of gold mines and drainage water from mine dumps are subjected to serious pollution by minerals and acids. This type of pollution not only affects the quality of the water but also inhibits the fauna and flora and the self-purification properties of the rivers, streams and dams into which the water is discharged. The quality of underground water can also be affected and the N.I.W.R. is investigating the problem and methods for eliminating it.

Water quality

In order to extend background knowledge of the quality of South Africa's water resources, the N.I.W.R. is undertaking a programme of chemical, hydrobiological and bacteriological surveys of the most important rivers in the country. The data thus obtained may serve as a basic reference for future estimation of the extent to which progressive

pollution of water resources has taken place.

During the past year a chemical and hydrological survey of the Swakop River in South West Africa was concluded, as well as surveys of a number of the most important rivers in Natal and the Orange Free State. As a direct result of the river surveys, a system for the classification of rivers in Natal was developed. The classification system, which is based on water quality, provides a useful guide in the planning of industrial development and the establishment of residential areas.

Since a definite correlation exists between the species of insects and diatoms found in water and the chemical quality of the water, a detailed knowledge of these organisms would be very valuable in providing indications of gradual pollution. For this reason fundamental research on the taxonomy and physiology of water organisms has been undertaken by the N.I.W.R. The ultimate aim is to establish biological criteria for water quality on the basis of the information collected.

Marine disposal of effluent

The discharge of effluent into the sea provides an inexpensive method of disposal but can cause serious pollution of the sea and beaches. This

is especially true of densely populated areas where pollution may not only harm the tourist industry by its unaesthetic effects on the sea and beaches, but may also constitute a serious threat to public health. For this reason surveys have for some time been made of sea currents, and of wave and wind action along the Natal coast. On the basis of this data, the dispersal of effluents in the sea when discharged at particular points can be predicted on a rational basis. Observations are also continued after the laying of pipelines in order to evaluate the actual situation.

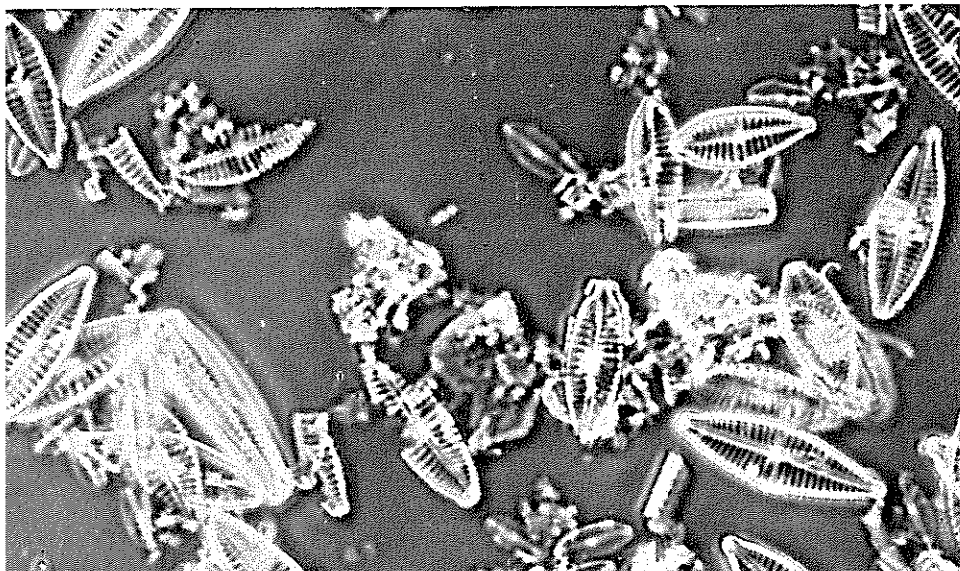
Associated with this work is the collection of background data on the chemical, bacteriological and biological conditions of beaches along the Natal coast, in order to be able eventually to determine the effect that the discharge of waste and effluents into the sea has on the beaches. In the past year the N.I.W.R. also developed pollution criteria for beaches along the Natal coast and for near-shore sediments along the beaches. The research on sea pollution is being carried out under contract with the Natal Provincial Administration, the Durban Corporation and various industries.

Research was continued in the laboratories of the **National Mechanical Engineering Research Institute (N.M.E.R.I.)** on the discharge of effluents into the sea with the aid of underwater jet outlets. The reliability of the simulation of actual conditions in the sea on a small scale in laboratory experiments, especially in regard to the degree of dilution and the layer thickness of the effluent on the sea surface, was investigated and design standards were established for the jet outlets.

The resistance of freshwater fish to poisons

The N.I.W.R. is engaged in the study of the resistance which different species of freshwater fish offer to environmental factors and especially to certain chemicals such as insecticides which arrive in dams and rivers. It has already been ascertained that certain insecticides, even in extremely low concentrations, can be fatal for fish.

Diatoms. These microscopic water organisms can give an indication of the quality of the water in which they occur.



Advice

The N.I.W.R. renders advisory services to government departments, provincial administrations and local authorities on problems of sanitation, water supply and effluent disposal which cannot be dealt with by consultants.

Further details of the N.I.W.R.'s work appear under *Water* in the section, "Research in the public sector".

The work of the C.S.I.R. on behalf of the water supply industry is reported under the heading, *Electricity, Gas and Water* in the chapter, "Research on behalf of particular economic sectors".

Liaison and information

A paper on the reclamation of waste water for domestic use was read by a staff member of the N.I.W.R. at the 3rd International Conference on Water Pollution Research in Munich in September, 1966. The paper attracted one of the largest audiences at the Conference and was most favourably received. At the Conference the Director of the N.I.W.R. was re-elected as Vice-President of the International Association on Water Pollution Research. The N.I.W.R. Director was also invited by the American Institute for Chemical Engineers to read a paper at the Institute's annual general meeting in Detroit on the re-use of water in South Africa. Two senior staff members of the N.I.W.R. undertook study tours abroad in order to visit important research organizations and industries and to exchange information with their colleagues. During the year the N.I.W.R. began the publication of a weekly bulletin, "Current Literature on Water". The bulletin covers a list of selected journals, which are of interest to the Institute's research workers. For this purpose 250 journals are regularly checked and a six-monthly index is drawn up with the aid of a computer. This service is also made available to interested parties outside the C.S.I.R.*

* CILLIE, G. G., VAN VUUREN, L. R. J., STANDER, G. J. & KOLBE, F. F. *The reclamation of sewage effluents for domestic use*. Paper presented to the Third International Conference on Water Pollution Research, Munich, September 1966. (See footnotes under 'Liaison and Information').
STANDER, G. J. & FUNKE, J. W. *Conservation of water in South Africa by re-use*. Paper presented to the American Society of Chemical Engineers at the International Symposium on Conservation of Water by Re-use, Detroit, December 1966. (See footnotes under 'Liaison and Information').

Research on corrosion

THE Corrosion Group† of the National Chemical Research Laboratory (N.C.R.L.) continued to spend much time in providing advice and assistance in a diversity of practical problems for industry, government departments and municipalities. As part of a long-term study of the corrosion of reinforcing steel in concrete, a scheme for cathode protection of a railway bridge on the Natal coast has been tested and has proved effective.

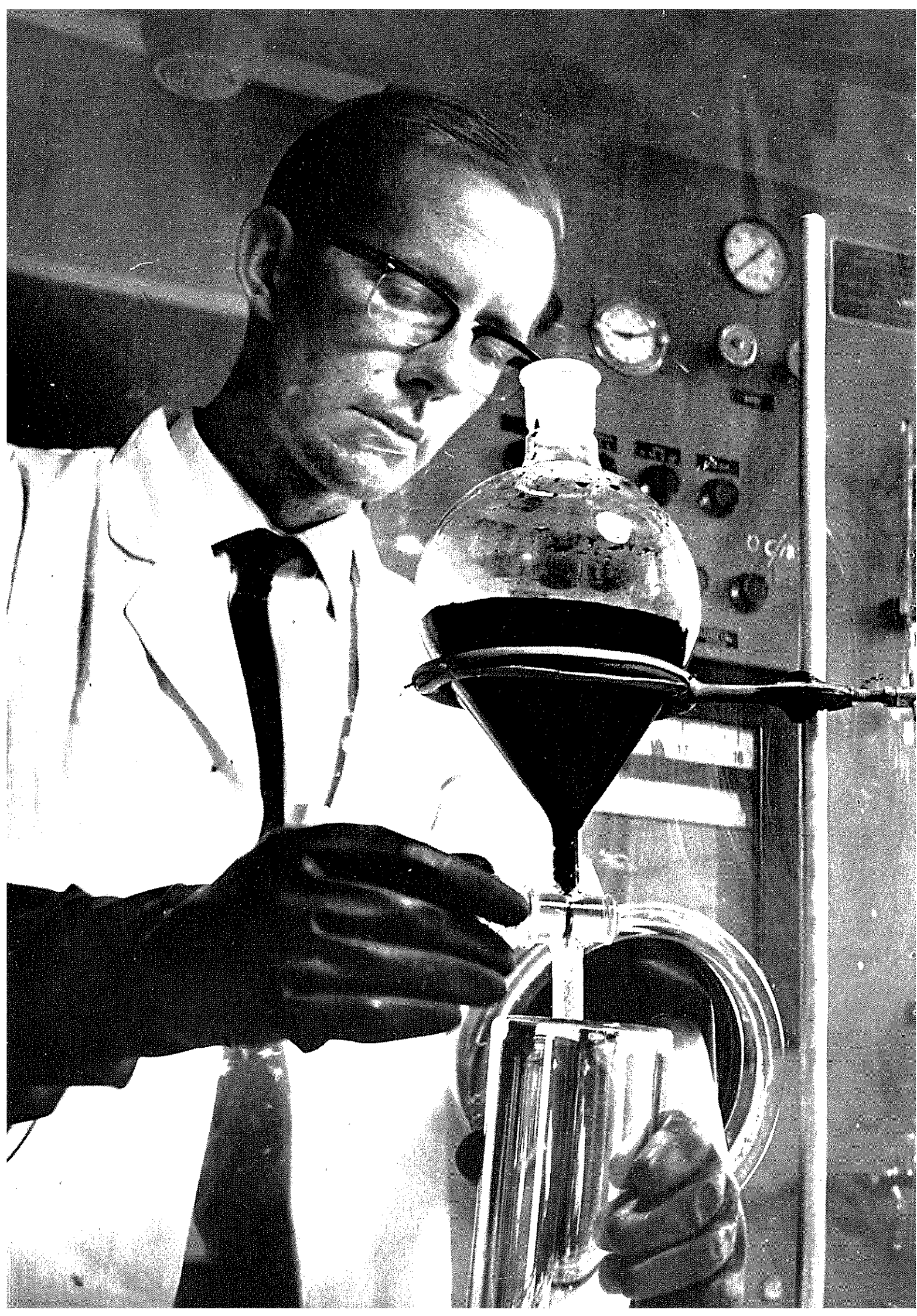
† BIRD, C. E. Corrosion research at the CSIR. *S.A. Corrosion Journal*, vol. 1, no. 3, 1965.
COPENHAGEN, W. J. Corrosion in the marine environment. *S.A. Shipping News and Fishing Industry Review*, December 1965.
ROSS, T. K. & CALLAGHAN, B. G. Role of ammonia in the atmospheric corrosion of mild steel. *Nature*, vol. 211, July 1966.
STANKO, J. S. The CSIR exposure testing programme. *S.A. Corrosion Journal*, October 1965.

RESEARCH FOR NATIONAL DEFENCE

A COMPLETE report covering all aspects of defence research is submitted annually to the Minister of Defence at the annual meeting of the Defence Advisory Council.



Dr. T. J. Hugo, Director of the CSIR's National Institute for Defence Research.



FUNDAMENTAL RESEARCH

CONTINUOUS applied research necessarily demands a fund of new knowledge of scientific fields which can only be obtained by direct basic research. Fundamental research, i.e. the search for new knowledge for its own sake, is of great importance in maintaining scientific interest and in expanding man's reserves of knowledge.

Through fundamental research, scientists obtain the opportunity of receiving training and experience in the use of highly specialized research equipment (such as the C.S.I.R.'s cyclotron). This type of equipment is of course too costly to be purchased by every university for research purposes. Research organizations like the C.S.I.R. and others that already possess such equipment accordingly offer research workers an opportunity to acquire specialized training and experience locally. Both directed and fundamental research are essential and the C.S.I.R. regards it as one of its most important functions to promote and expand basic research.

RESEARCH AT UNIVERSITIES

ONE of the ways in which the C.S.I.R. promotes and develops research is by supporting fundamental research in the natural sciences at universities in a way similar to its support for medical research (see report on medical research in the chapter on research in the Public Sector). *Ad hoc* grants are allocated to individuals while continuity in research is guaranteed by establishing units and groups under the leadership of research workers who have dis-

This so-called "glove box" is used whenever an experiment has to be carried out in a special atmosphere. Special gloves are worn and the relevant apparatus can be handled from outside the box.

tinguished themselves in their own fields. These units are established at institutions which have the required experts, research leaders and facilities.

In accordance with this policy the following units have been established by the C.S.I.R. in collaboration with universities and other research organizations:

Chromatography Research Unit, University of Pretoria (Director: Prof. V. Pretorius);

Cosmic Rays Research Unit, Potchefstroom University (Director: Prof. 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);

Namib Research Station, Transvaal Museum, Pretoria (Director: Dr. C. Koch).

The allocation of funds for the above purposes for the year under review was:

C.S.I.R. units and groups	R157,000
Individual <i>ad hoc</i> grants	242,800
Post-graduate bursaries	208,200
	<hr/>
	R608,000
	<hr/>

The increasing number of requests received to establish C.S.I.R. research units and groups in university departments shows the extent to which support by the C.S.I.R. has stimulated research at universities over the years. Each request is considered by a special committee of experts which reports to the Council on the merits of the proposed programmes and the research achievements of the applicants. Research units and groups provide the firm foundation and continuity necessary for ablishing good post-graduate training facilities at universities.

SCIENTIFIC

IN terms of its statutory functions of promoting science in general, the C.S.I.R. must constantly pay attention to current conditions in South Africa and to the Republic's relations with international scientific organizations, particularly non-governmental bodies. By participating in international scientific programmes arranged by these bodies, the Republic's scientists are kept informed and share in the latest developments in particular fields such as space research and oceanography.

At the same time South African scientists are in a favourable position, owing to the Republic's geographical location and the unique opportunities offered by local conditions, to make valuable contributions to particular projects and to the promotion of knowledge in general. Experience has shown that participation in international research programmes serves as a powerful stimulus to the expansion of research in South Africa.

The Upper Mantle Project

The second year of South Africa's participation in the three-year international Upper Mantle Project, a broad study of the outer layer, comprising 1,000 kilometres, of the earth's crust commenced in April, 1966. The South African Government made R136,000.00 available for the first year and R47,000.00 for the second year for participation in this programme, and the amounts were allocated by the National Committee for the Upper Mantle Project to the various projects carried out as part of the South African programme. The Republic's programme has to date progressed satisfactorily and the National Committee is confident that the final results obtainable will have far-reaching importance on both national and international levels.

Oceanographic research

The Government made R100,000.00 available for the second consecutive year for carrying out the National Programme for Oceanographic Research, as drawn up by the South African National Committee for Oceanographic Research. This programme, in which all oceanographic research stations in the Republic are participating, is directed at obtaining basic knowledge of the sea along the South African coast — knowledge which is a prerequisite for the proper development of the fishing industry and the exploitation of the mineral potential of the Republic's waters. Such knowledge is also essential for the effective defence of our coastal areas.

Funds allocated to this programme are administered by the C.S.I.R. on behalf of the Government and on the advice of the National Committee.

The Anglo American Corporation makes an annual contribution of R10,000.00 towards oceanographic research and is represented on the National Committee for Oceanographic Research.

CO-OPERATION

Geomagnetism, aeronomy and space sciences

A South African National Committee for Geomagnetism, Aeronomy and Space sciences was appointed in January, 1966, to organize and coordinate South Africa's participation in international activities in these fields.

Stratigraphical nomenclature

The use of various systems of stratigraphical nomenclature in the Republic has caused considerable confusion. South Africa is represented in the International Union of Geological Sciences (I.U.G.S.) by the C.S.I.R., which for this purpose created a South African National Committee. The Committee has since formed a Subcommittee for Stratigraphy to investigate the matter with a view to standardizing the nomenclature.

Relevant information has been obtained by means of questionnaires from interested local geologists and is at present being evaluated. The results of this investigation will be made known shortly so that recommendations can be put forward.

The International Biological Programme

At the beginning of 1966 a South African National Committee for the International Biological Programme (I.B.P.), on which the C.S.I.R., government departments, nature conservation organizations and the universities were represented, was appointed to submit recommendations regarding South Africa's participation in the I.B.P. which was being organized by the International Council of Scientific Unions (I.C.S.U.). This Committee has met twice and has drawn up a South African programme for participation in this new project which involves a world-wide study of organic production on land, in fresh water and the oceans; of the potential and uses of both new and existing biological resources; and of man's adaptability in a changing environment.

The South African programme, which is directed particularly at obtaining basic knowledge of the optimum use and control of the country's natural biological resources, is being supported enthusiastically by all interested organizations. The programme was submitted to the Government for consideration and financial support.

Owing to the exceptional opportunities for research within its borders, the Republic is capable of making an important contribution to this programme. It is already apparent that South Africa's participation in the I.B.P. is welcomed in international scientific circles. This emerges from the unanimous election of Prof. C. A. du Toit in April, 1966, as member of the international Special Committee for the organization and planning of the I.B.P. Prof. Du Toit is Chairman of the South African National Committee.

Antarctic research

Special attention was given during the year to the problem of continuing the South African Antarctic Research Programme, whose current five-year period will be completed in March, 1968. A revised research programme has been drawn up by the C.S.I.R.'s Scientific Committee for Antarctic Research and will shortly be submitted to the Government through the Department of Transport.

A scene inside an ice cave in Antarctica. The Republic sends a research expedition to Antarctica annually.



THE National Chemical Research Laboratory (NCRL) serves as a centre where the latest developments in chemical science are brought to bear on problems of national significance.

The NCRL 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 NCRL also supervises a che-

chemistry

Analytical methods in chemistry

Modern geochemical work depends to a large extent on accurate analysis of small traces of elements.† Systematic studies for the past few years on the use of ion-exchange columns have led to quicker and more accurate methods. In the past year, improved methods of determining and analysing calcium, strontium,

uranium and tantalum were worked out. Work was also continued, in collaboration with the Institute of Radiochemistry of the Technical University of Munich, on a general scheme for separation of radioelements after neutron activation. Other developments comprise a new titration method for thallium, and a solvent extraction method for concentrating small traces of gold.

* VERPOORTE, J. A., JOUBERT, F. J. & JANSEN, B. C. Studies on the soluble antigen and haemolysin of *Clostridium chauvoei* strain 64. *S. Afr. J. Agric. Sci.*, vol. 9, 1966, pp. 153-172.
 † PARRISH, J. R. Superficial ion-exchange chromatography. *Nature*, vol. 207, no. 4995, 1965, pp. 402-403.
 PARRISH, J. R. Chromatography of polyamines. *J. Chromatog.*, vol. 18, 1965, pp. 535-541.
 SMIT, J. van R. Radiometric determination of silver. *Analyst*, vol. 90, no. 1071, 1965, pp. 366-367.
 SMIT, J. van R. & JACOBS, J. J. Separation of cesium from fission product wastes by ion-exchange on ammonium molybdophosphate. *I & E C Process Design and Development*, vol. 5, 1966, pp. 117-122.

STRELOW, F. W. E. Separation of trivalent rare earths plus Sc(III) from Al, Ga, In, Tl, Fe, Ti, U and other elements by cation-exchange chromatography. *Anal. Chim. Acta*, vol. 34, 1966, pp. 387-393.

STRELOW, F. W. E. An accurate determination of rare earths and scandium in South African carbonatites using separation by ion-exchange chromatography. *Anal. Chem.*, vol. 38, 1966, pp. 127-128.

STRELOW, F. W. E. & TOERIEN, F. von S. Separation of lead(II) from bismuth(III), thallium(III), cadmium(II), mercury(II), gold(III), platinum(IV), palladium(II), and other elements by anion exchange chromatography. *Anal. Chem.*, vol. 38, 1966, pp. 545-548.

The model on the right is a physical representation of the molecular and crystal structure of a specific substance. This structure is determined by means of X-ray diffraction surveys — a researcher can be seen above studying one — which are in turn used in mathematical calculations.

Proteins and enzymes

These complex substances lie at the heart of life processes; and a complete range of specialized facilities for their study has been built up by the C.S.I.R. The work on wool chemistry under the heading **Textiles**, cited in the chapter, **Research on behalf of Scientific Economic Sectors**, is one of the projects for which these facilities are being used.

Another active field of study is that of the biosynthesis of proteins in living cells. It has been shown that the complex mechanism involved is readily disturbed if a test animal is injected with a cancer-producing chemical.*

CHEMICAL RESEARCH LABORATORY

mical 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 NCRL must limit its choice of fundamental study projects to those

which may benefit applied research.

It is the NCRL'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 CSIR's National Chemical Research Laboratory.

Gold chemistry

Current extraction procedures in the gold industry depend upon the formation of a complex cyanide, and any alternative method would depend upon one or other complex. A study of several such gold complexes and of their reactions is under way in the National Chemical Research Laboratory (N.C.R.L.).*

Some of the rates of reaction are so fast that it has been necessary to build apparatus to measure reactions that are complete in less than a hundredth of a second. This apparatus

was constructed at the C.S.I.R.'s Technical Services Department.

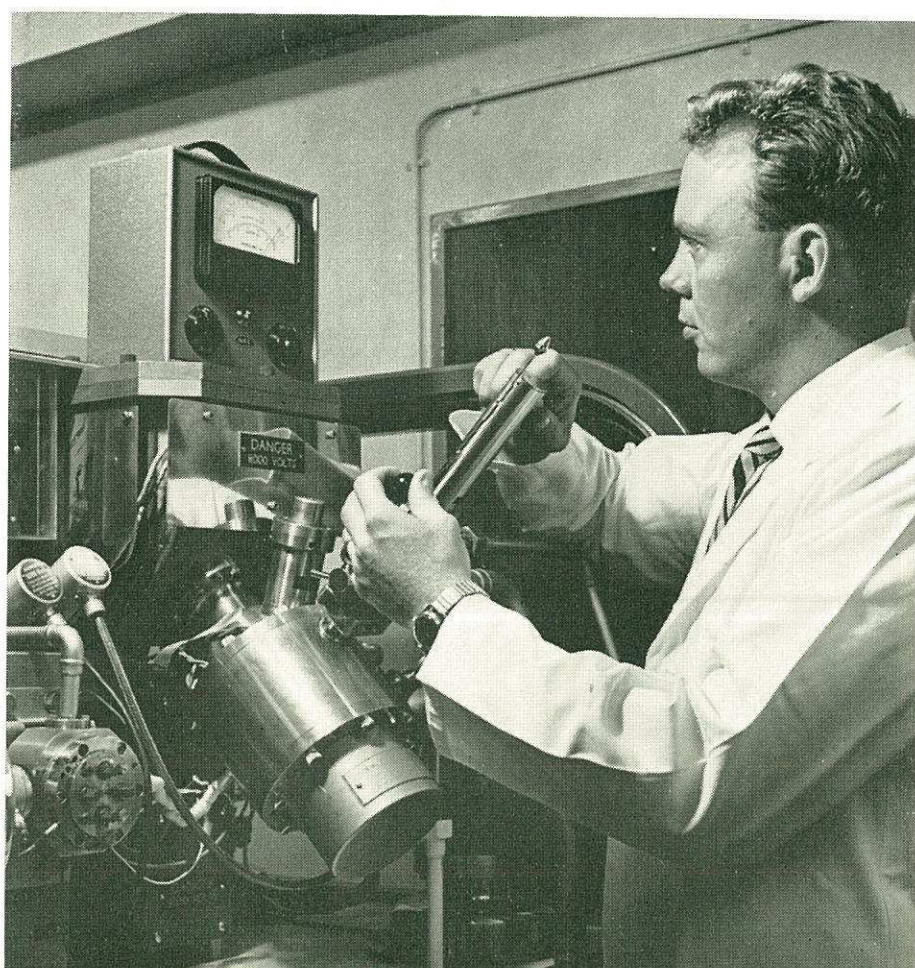
Structures of organic compounds

An important part of organic chemistry involves the determination of the structures of new compounds and

their synthesis; but an essential requirement for this nowadays is a group of techniques which require very expensive instruments, e.g., mass spectrometry, nuclear magnetic resonance, etc. Facilities at the C.S.I.R. are available to all research chemists

ROBB, W. Kinetics and mechanism of reactions of gold(III) complexes. Part I: Equilibrium hydrolysis of tetrachlorogold(III) in acid medium. *J. Inorg. Chem.*, vol. 6, 1967, p. 382.

This mass spectrometer in the National Chemical Research Laboratory facilitates inter alia the search for alkaloids and steroids with medical properties.



in the Republic and, during the past year, vital assistance has been given to organic chemists in most universities and also in certain other research institutes.

Drugs from plants

The South African pharmaceutical industry has commenced manufacturing drugs in addition to the preparation of imported drugs. In view of this, the N.C.R.L. is undertaking research in two directions into new types of drugs.

First, alkaloids from South African plants are being surveyed and those of interest synthesized and modified.* Second, certain naturally occurring chemical compounds closely related to steroidal hormones are being modified by research workers from this

laboratory. Pharmacological tests of the compounds produced have indicated several which deserve further study.

Before these products can be synthesized the crystal structure of the substances must be determined. The N.P.R.L. has determined several of these crystal structures, one of which may display particularly powerful pharmaceutical properties.

Agar

Agar, produced from certain seaweeds, forms a strong gel which is widely used for the culture of microorganisms. A method of obtaining a very high grade product from ordinary agar has been studied and is being applied by a South African firm.

Molluscicides

The N.C.R.L. is studying the manner in which molluscicides kill snails which are hosts to bilharzia parasites. It is hoped that this research will lead to the development of a molluscicide that will be relatively unharmed to fish and other forms of water life. The studies thus far have identified a group of substances with considerable promise. One of the greatest difficulties experienced by research workers is the building and maintenance of a snail colony large enough for the tests.†

Cancer biochemistry

The action of certain dyes which produce cancer in rats was investigated. While tumours usually take some months to appear, it has been found that the dyes are taken up by certain blood and liver cells and that vital biochemical changes take place in liver cells within hours of administration of a single dose. The most recent finding is that dye can be found even within the nucleus of a cell, where it is bound to proteins similar to dye-binding proteins in the blood.‡

* ARNDT, R. R., JORDAAN, A. & JOYNT, V. P. Alkaloids of *Macrorungia longirostris* C.B.Cl. *J. Chem. Soc.*, Supplement 2, 1964, pp. 5969-5975.

BAARSCHERS, W. H. & ARNDT, R. R. The syntheses of 1, 2, 9-trimethoxy-10-hydroxyaporphine and 2-methoxy-N-acetyl noraporphine. *Tetrahedron*, vol. 21, 1965, pp. 2155-2158.

PACHLER, K. G. R., ARNDT, R. R. & BAARSCHERS, W. H. Nuclear magnetic resonance study of aporphine alkaloids - II. The structure of rogersine. *Tetrahedron*, vol. 21, 1965, pp. 2159-2167.

† DE VILLIERS, J. P. The development of molluscicides. *S.A. Ind. Chem.*, 1965.


‡ HAWTREY, A. O. The effect of diisopropylfluorophosphate on [¹⁴C]-leucine incorporation by rat-liver ribosomes. *S. Afr. J. Med. Sci.*, vol. 30, 1965, pp. 100-104.

HAWTREY, A. O. & BIEDRON, S. I. Release of peptide chains from rat-liver polysomes by the N, N-dimethyl-p-methoxy-L-phenylalanyl analogue of puromycin. *Nature*, vol. 211, no. 5045, 1966, pp. 187-189.

HAWTREY, A. O. & NOURSE, L. D. The effect of 4-dimethylamino-3'-methylazobenzene on ¹⁴C-labelled amino acid incorporation by rat-liver polysome preparations. *Biochem. J.*, vol. 98, no. 682, 1966, pp. 682-688.

HAWTREY, A. O., NOURSE, L. D. & KING, H. W. Binding of s-RNA to rat-liver polysomes during protein synthesis. *Biochimica et Biophysica Acta*, vol. 114, 1966, pp. 409-412.

HAWTREY, A. O. & NOURSE, L. D. Succinylation of rat-liver polysomes. *Biochimica et Biophysica Acta*, vol. 114, 1966, pp. 413-415.



A white rat being dosed with a dye to induce cancer of the liver so that researchers can study the biochemical changes occurring in certain blood and liver cells.

THE research described here has been carried out by the Chemical Physics Group which consists of subdivisions sited in and sponsored by both the National Physical Research Laboratory (N.P.R.L.) and the N.C.R.L. The work is mainly of a fundamental nature.

CHEMICAL PHYSICS

Silver permanganate

During research undertaken in the N.P.R.L. into the arrangement of material in non-crystalline solids, the results for decomposed silver permanganate were found to be inexplicable in terms of the published structure of this compound in the undecomposed state. Its three-dimensional structure was therefore re-determined by X-ray methods and found to be completely different from the published structure. The new structure can be reconciled with the findings on the decomposed material.

Metal divinylpyridine dichlorides

In order to provide information on the spatial arrangement of metal divinylpyridine dichloride molecules, which is needed in a study undertaken by the N.C.R.L., of the solid-state polymerization of these compounds, structural studies have been undertaken in the N.P.R.L. A three-dimensional structure analysis of cobalt (4-vinylpyridine) 2-dichloride has been completed and two further analyses on analogous zinc compounds are nearing completion. Contrary to general experience regarding compounds which readily polymerize in the solid-state, no close inter-molecular vinyl carbon—vinyl carbon approaches are found here.

Electron spin resonance of manganese in ammonium and caesium chlorides

A combined N.C.R.L./N.P.R.L. project in which the electron spin resonance (esr) of manganese in various chlorides has been studied, has given structural information on how the manganese is incorporated in the host crystal. The esr line shapes have been used to follow one of the phase transitions in ammonium chloride. Possible mechanisms for the line shape changes were investigated with a view to determining whether this method of following this type of transition is generally applicable.

Infra-red studies of single crystals

In work undertaken in the N.P.R.L., thin single crystals are being grown in order to study these using polarised infra-red radiation. This work provides a new method of structure determination and most of the serious problems encountered in growing large platelets of extremely small thickness in special orientation between sodium chloride windows have now been overcome.

Nuclear magnetic resonance investigations

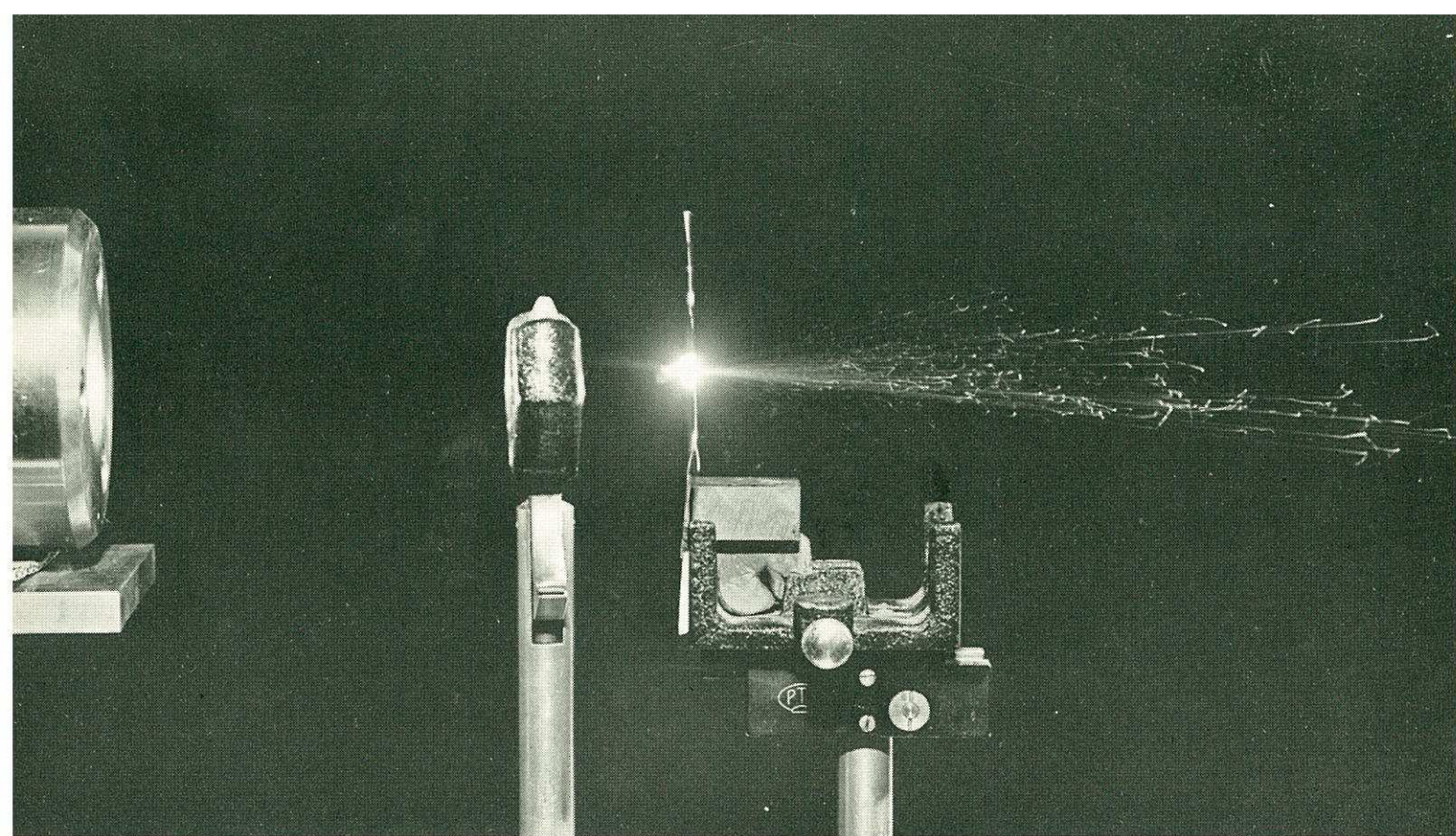
A new, versatile nuclear magnetic resonance (nmr) spectrometer has been in operation since the beginning of 1966 and has greatly widened the scope of nmr research. A nmr spectrum service is rendered free of charge and most universities and research institutes in the Republic and Rhodesia make use of it. Nmr spectroscopy has become indispensable for all structure determinations in organic chemistry and the constitu-

tions of neofolin, ficinin, kitol, leucodrine, and pencinin have been derived using nmr evidence.

Basic research is performed on a variety of subjects. The complete analysis of the nmr spectra of some pterocarpan derivatives and 1 α , 2 α -O-isopropylidene-3 β -O-acetyl-4 β -cyano-tetrahydro furan-1 α , 2 α , 3 β -triol led to the conformation of these molecules and gave valuable information on the relationship between nmr coupling constants and stereochemistry. A detailed study of the pH-dependence of the nmr spectra of malic and aspartic acids has been performed and the results are interpreted in terms of intra-molecular interactions. Inter-molecular solvent-solute interactions have been studied theoretically and experimentally with the nmr technique. Excellent agreement between theory and experiment can be achieved for 1,2-disubstituted ethanes if existing reaction field theories are extended to include quadrupolar interactions.

A researcher places a sample in a nuclear-magnetic resonance spectrometer.





A laser beam pierces a hole through a metal foil and projects a jet of molten metal sparks, while a luminous plume indicates the point of impact.

PHYSICS AND GEOPHYSICS

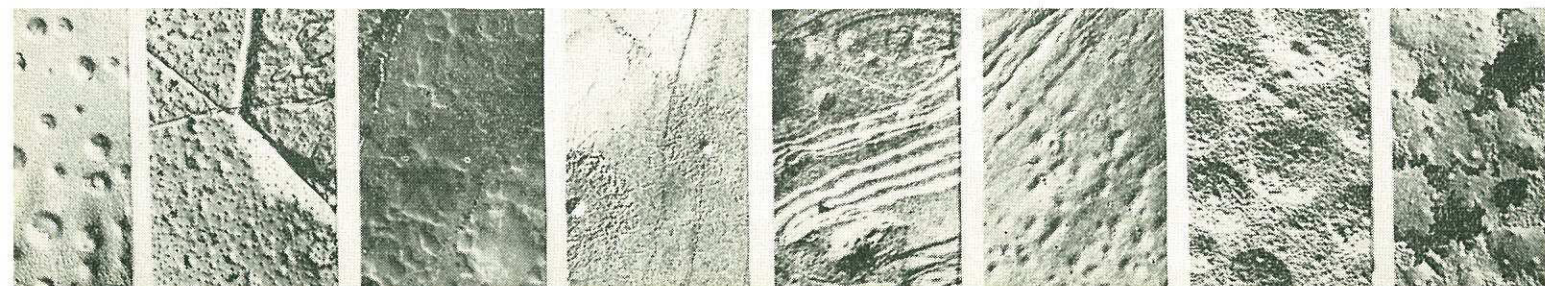
The laser

One of the most significant — and spectacular — scientific breakthroughs of the past decade was the successful demonstration of light amplification and generation by stimulated emission of radiation. Thus a new type of light source with unique properties — the Laser — was produced. In view of its potential for science and technology, and this applies to South Africa as well, a Laser Research Group was formed in 1964 by the N.P.R.L. to build up a reserve of scientific and technological knowledge on the subject.

Typical etching effects obtained by a Laser beam directed on (left to right) aluminium, gallium arsenide, calcite, brass, copper, iron, soda glass and a diamond.

An interesting outcome of the research hitherto undertaken by this Group in collaboration with the N.P.R.L.'s Electron Microscopy Group has been the discovery that focussed Laser radiation produces an etching effect on solid surfaces. Another important discovery is that materials can be significantly hardened by subjecting them to high-energy Laser light pulses.*

* MURPHY, R. J. and RITTER, G. J. Laser-induced thermal etching of metal and semi-conductor surfaces. *Nature*, vol. 210, no. 5032, 1966, pp. 191-192. MURPHY, R. J. and RITTER, G. J. Laser-induced damage in copper crystals. *Appl. Phys. Letters*, vol. 9, no. 7, 1966, pp. 272-273.



Indications are that once all the mechanisms are understood, the Laser-induced etching technique could develop into a powerful new method in metallurgical and solid investigations. It has several advantages over conventional etching methods: not only is the preparation of sample surfaces unnecessary, with resulting economies in time, but a very wide variety of materials can be studied.

Research into these effects is continuing.

Spark sources

The accurate analysis of metals by spectrochemical analytical methods is determined *inter alia* by the properties of a spark source. A voltage controlled spark source was developed by the National Research Institute for Mathematical Sciences in collaboration with the N.P.R.L. and German, American and British patents were applied for. The wear of the electrodes of the trigger system was investigated with the object of extending the period of continuous use before resetting becomes necessary. It was found that the controlled spark source excited more intensive spectra than conventional spark sources, but the reason for this is not yet clear.

Fundamental studies of sparks used as light sources for spectrochemical analysis have been continued. Further results on the temperature decay in spark plasmas in air, argon, and helium have also been obtained.*

Research is being carried out on the behaviour of melting curves and polymorphic transitions of simple inorganic substances under pressures of up to 45,000 atmospheres and at temperatures of up to 1500°C. These measurements rank among the most accurate of this kind obtained anywhere in the world.

The anomalous work-hardening properties of some copper alloys are being investigated with a view to understanding the basic processes which determine the strength of face-centred cubic metals.

Cyclotron research

By scattering the alpha particles accelerated by the cyclotron from iron, cobalt, nickel and copper, the

THE main function of the National Physical Research Laboratory (NPRL) 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 NPRL has statutory responsibilities for maintaining national standards of physical measurement for mass, length, electricity, radiation, etc.



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

NATIONAL PHYSICAL RESEARCH LABORATORY

Within the NPRL, 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.

N.P.R.L. showed that nickel nuclei are probably smaller than those of neighbouring elements. This finding indicated the special stability that the closed shell of 28 protons gives to the nickel nucleus. It was also shown that groups of excited states of cobalt-59 probably arose from the coupling of collective states of nickel-60, with 28 protons, and the hole of the missing proton in cobalt-59.†

Betaspectrometer

A new betaspectrometer built by the C.S.I.R. of which only a few exist in the world was put into operation. Its high transmission with good resolution properties makes the instrument most suitable for studying con-

version electrons following nuclear reactions. This apparatus was installed in one of the cyclotron's external beam lines.

Atomic absorption analysis

In the atomic absorption analytical field, the use of a time-resolved spark as primary light source has been investigated by the N.P.R.L. and has brought to light some very interesting applied possibilities. Further work on flames used in atomic absorption analysis has led to the design of a burner which gives a low temperature broad flame. With the aid of this flame, a large number of elements can be identified with much greater precision.

Geochronology

Basic knowledge of the earth's structure and the age and position of different rock layers is a prerequisite in searching for minerals and precious stones. The primary function

* STRASHEIM, A., MARITZ, F. R. and KOVACS, I. K. A. The characteristics and performance of the accurately timed spark when used as a spectrochemical light source. *Proceedings of the XII Colloquium Spectroscopicum Internationale*, Exeter, 1965, pp. 299-310.

† COWLEY, A. A., HEYMANN, G., KEIZER, R. L. and SCOTT, M. J. Elastic and inelastic scattering

of 15.8 MeV deuterons. *Nucl. Phys.*, vol. 86, 1966, pp. 363-377.

HEYMANN, G., BURDZIK, G. F., COWLEY, A. A., KEIZER, R. L. and V. D. MERWE, J. J. The elastic scattering of 31.7 MeV alpha particles from Fe, Co, Ni, Cu and Zn. *Proceedings of the International Conference on Nuclear Physics*, Gatlinburg, Tennessee, September 1966.

of the Geological Survey Office of the Department of Mining is to chart the Republic's geological structure. The structure of an area of approximately one-quarter of the country's 472,000 square miles is already known and structure of an additional area of 4,500 square miles is studied annually.

One way of tracing the relative positions of different rock layers and the geological developments of millennia is to determine a rock layer's age and then correlate the ages of different rock formations. In this task the Geological Survey Office is assisted by the Geochronology Division of the N.P.R.L.

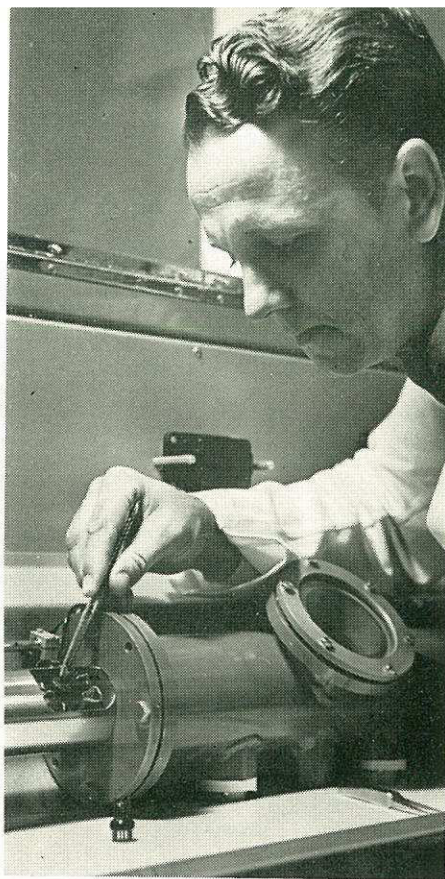
In determining rock age existing knowledge of the rates of decay of various radioactive elements is employed and this work often requires the use of special apparatus. The Geochronological Division has the necessary equipment to deal with this aspect of geological charting, and its work during the past year is reviewed below.

By solving various technical problems in connection with crushing, mineral separation and chemical processing, the Geochronology Division paved the way for determining the age of extrusive rocks. Several systems, including Karas, Ventersdorp and Onverwacht, were successfully dated.

Geochronological studies of uranium, thorium and rubidium-bearing rocks in the Springbok-Kakamas-Prieska area of the North-West Cape, showed that this 1,000 million year old pegmatite is much younger than its present correlates, the 2,500 million year old granite in the Northern Transvaal. This is a striking example of the value of geochronology in correlating widespread rock formations.

To supplement the International Upper Mantle Project, work has started on the preparation of a chronological sequence of granites in the Barberton-Nelspruit area.

In co-operation with the African Geology Unit of the University of



A filament with a sample being placed in the source of a mass spectrometer to determine the isotope ratios of an element in the sample.

Leeds, various geological problems in South West Africa were successfully investigated.*

In collaboration with various mining authorities copper deposits in the Messina area are being chronologically investigated with the aid of lead isotopes.

In co-operation with the N.C.R.L., ion exchange techniques were adapted for the preparation of samples for mass spectrometric analysis of micro-grain quantities of uranium, thorium and lead.

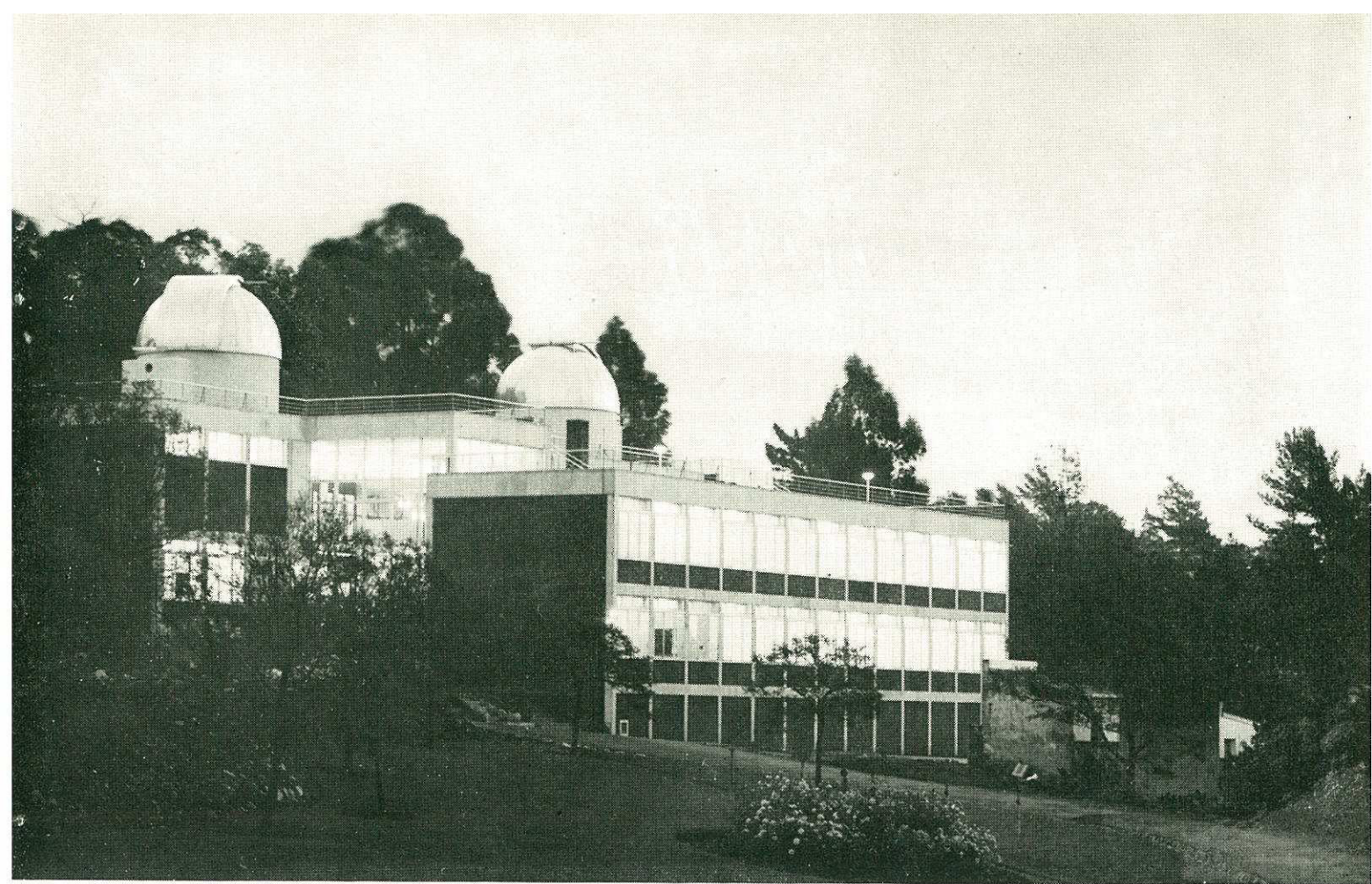
With the help of rubidium-strontium isotope ratios it was demonstrated that it is probable that the Vredefort ring structure is of terrestrial rather than extra-terrestrial origin. This work was done in co-operation with the Barnard Price Institute.

* BURGER, A. J. and CLIFFORD, T. N. Mineralogical radiometric studies of monazite and sphene occurrences in the Namib Desert, S.W.A. *Min. Mag.*, vol. 35, 1965, pp. 519-528.

A section of the building complex of the Republic Observatory in Johannesburg.

REPUBLIC OBSERVATORY

ASTRONOMICAL research is the main function of the Republic Observatory. During the year the 26½ inch refractor was used for micro-meter observations of double stars and the programme of interferometer observations of double stars was continued. The Franklin Adams telescope at the Hartbeespoort observation post was used for the photographic observation of minor planets and comets. The 9 inch refractor was used for the photoelectric observation of eclipsing variable stars.



ASTRONOMY

In recent years the optimum siting of expensive astronomical instruments has become a question of increasing importance, and it is clear that the possible erection of a large refracting telescope should be preceded by thorough study of this subject. With increasing industrial development in the Southern Transvaal, conditions for astronomical observation have deteriorated to such an extent that today it seems unlikely that a suitable site would be found within a fifty-mile radius of Johannesburg. It has, therefore, become necessary to find the most suitable spot in the Republic, irrespective of its distance from Johannesburg, and a start has been made with the study

of meteorological data relevant to astronomical observation. Preliminary results indicate that it should be possible to find a site in an area where the number of clear winter nights are at least 10 per cent greater and the number of clear summer nights more than 200 per cent greater than in Johannesburg.*

Radio astronomy

A limited programme of radio astronomy has been carried out with the aid of the large steerable antenna at the Radio Space Research Station at Hartbeeshoek. This work is of special international significance because of the scarcity of radio astro-

nomy stations in the southern hemisphere. A survey of galactic radiation at a wavelength of 13 cm has been carried out, and a new discrete radio source has been discovered.†

* KNIPE, G. F. G. and NEWBURG, J. L. Seeing conditions in Johannesburg. *Mon. Notes Astr. Soc. Sth Afr.*, vol. 25, March 1966, pp. 18-20.

† NICOLSON, G. D. A survey of southern galactic radiation at 960 Mc/s. *Publications of Astronomical Society of the Pacific*, vol. 77, no. 457, August 1965, pp. 260-268.

NICOLSON, G. D. A search for variations in the flux of the quasi-stellar source CTA 102. *Nature*, vol. 210, no. 5036, 7 May 1966, p. 611.

mathematics

THE National Research Institute for Mathematical Sciences (NRIMS) 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.

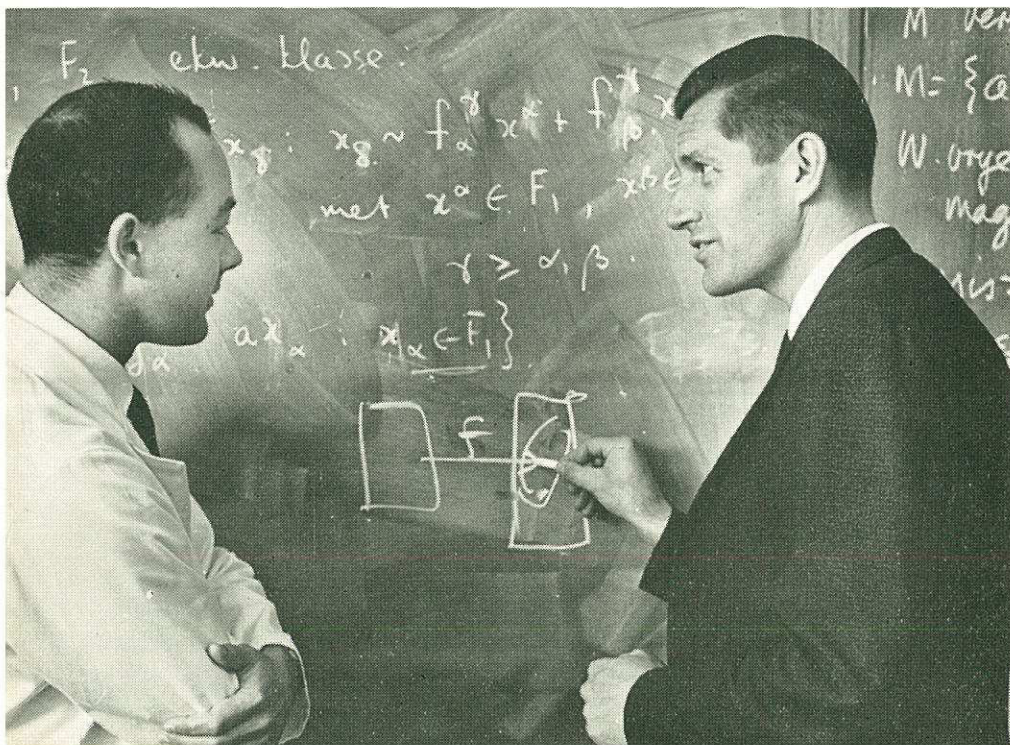
A STUDY was made by the National Research Institute for Mathematical Sciences (N.R.I.M.S.) of the close similarity between the nervous system of living organisms and computer circuitry. This has helped to advance understanding in both fields.

Studies of the relevant literature have been made to determine the scope and present state of development of this subject, called **bionics**. A discussion group, consisting of scientists from various disciplines who have an interest in this field, has met regularly during the past year. As a first project it has been decided to study the logical and organizational aspects of biological structures by making use of simulation on a digital computer. The general techniques that will be developed for the handling of information regarding a "teaching machine" in a modifiable environment, will be useful in other fields as well.

Dr. A. P. Burger, Director of the CSIR's National Research Institute for Mathematical Sciences discusses a mathematical model with one of his colleagues.

Geophysical fluid dynamics

In the field of the mathematical theory of **geophysical fluid dynamics** a study was undertaken to clarify aspects of the applicability of various types of boundary conditions, to ensure that in the mathematical formulation of atmospheric phenomena the problems are properly posed. The results were presented at an international symposium on the Dynamics of Rotating Fluid Systems held at the University of California.



A test subject about to be examined with the electro-encephalograph.

Psychology

Bantu labour

AN increasing number of enquiries and requests for research assistance received by the National Institute for Personnel Research (N.I.P.R.) in recent years concerns problems of Bantu labour, especially problems of assessing Bantu workers' abilities for and attitudes towards certain types of work. A relatively large number of basic research projects, therefore, deal with Bantu workers' attitudes towards work and with the development of test methods suitable for cross-cultural research.

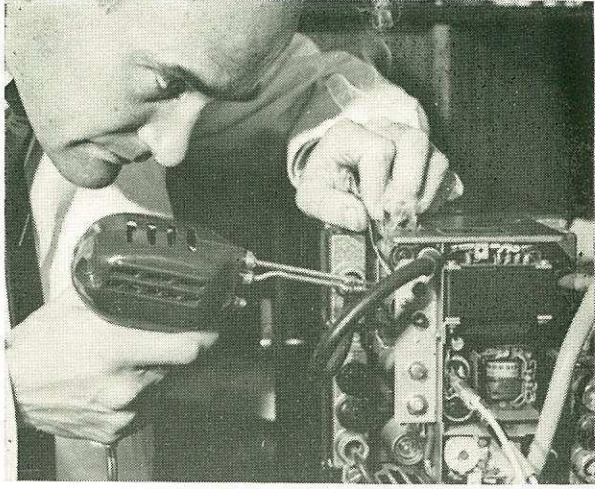
APART from the direct contribution to the improvement of manpower utilization that can be expected from such research work, it is also of importance for the development of theoretical psychological concepts. Psychological hypotheses about human behaviour have been formulated mainly within the sphere of Western culture and are not necessarily valid for people who have a different culture. By studying different peoples of different cultures and in different environments it should be possible to assess the extent to which psychological theories and methods are universally applicable. Southern Africa provides a unique laboratory for cross-cultural psychological and

sociological research — a more fruitful field of research than any being studied on a larger scale overseas.

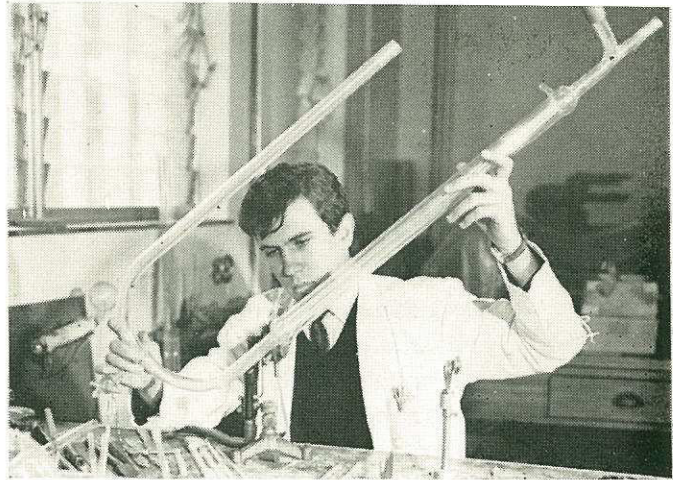
Refinement of research methods

Other basic research is undertaken almost exclusively in support of current applied work. It aims at the refinement of existing methods and the development of new methods that are needed for the solution of practical problems. Experimental work on neuropsychological, perceptual and psychomotor functions for the determination and measurement of temperament and personality factors may serve as an example.

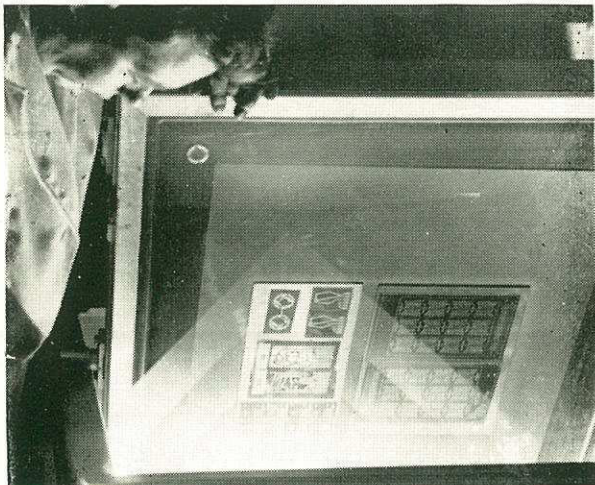
Further research topics, that are specifically relevant to South Africa are investigated to the extent that the staff situation allows. Two examples of these projects are: Studies of human relations in industry such as the supervisor/worker relationship, often superimposed on and complicated by the interaction of Whites and Blacks, and studies of the human element in the causation of accidents in factories or on South African roads. The importance of such investigations, for which only too little time and money are available, need not be stressed.



electrical equipment



glass-blowing



printed circuits



SCIENTIFIC SERVICES

THE building up of a national research organization like the C.S.I.R. entails more than the establishing of research laboratories — there are wider implications in regard to the scientific and industrial development of the country as a whole. Since its establishment the C.S.I.R. has endeavoured to gauge these implications and to determine the country's needs and ways and means to meet them.

These endeavours have given rise to specialized national scientific services, each having an important function in the economic and technical development of the Republic. These are briefly reported below.

THE Republic Observatory's responsibility for time in South Africa dates back to 1908, when regular hourly signals were first sent by landline to the Rissik Street Post Office in Johannesburg. For the first forty years pendulum clocks were used and the resulting time signals could therefore only be relied upon to within one or two tenths of a second. However, in 1947 a programme of modernization was started, and the pendulum clocks were gradually replaced by eight quartz crystal oscillators with associated electronic equipment.

The Observatory's radio station (call sign ZUO) was established in 1950 for the continuous broadcasting of standard frequencies and time signals, and today this is still the only station of its kind in Africa. Partly as a result of the requirements of the world-wide network of satellite tracking stations — several of which are operated in the Republic — it

became necessary to co-ordinate the local signals with those from other stations in Europe and the U.S.A.

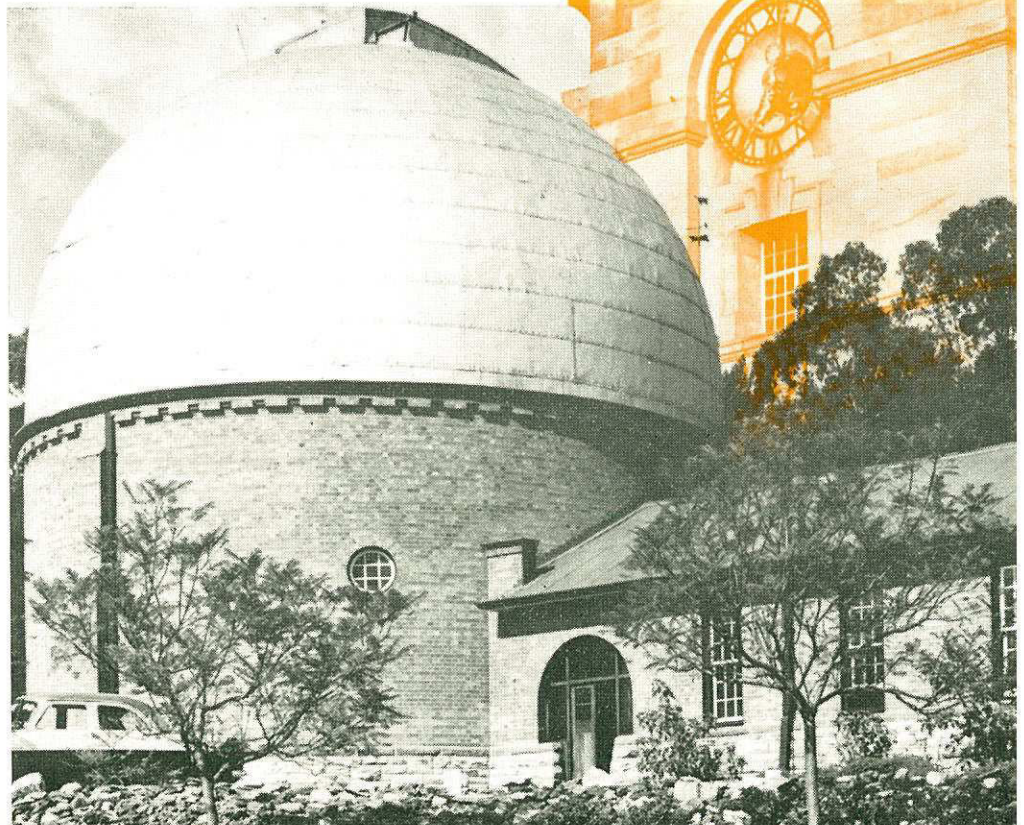
In practice this meant that differences in time of emission between the various signals were to be kept to within 1 millisecond, while frequency differences were to be kept to within 1 part in 10^{10} . Quartz crystal oscillators cannot be expected to perform much better than this, and they have therefore now been supplemented by a caesium beam frequency standard.

As frequency, and therefore time interval, is at present defined in terms of the caesium frequency, it is possible to maintain the local standard frequency without the aid of radio transmissions from overseas, to within about 1 part in 10^{11} . This means an error of only 1 millionth of a second per day.

The Republic Observatory circular No. 125 and 12 Time Service Bulletins were issued during the year.

time service

A composite photograph of the Republic Observatory which maintains the Republic's time standard and the clock tower of the Union Buildings whence emanate the chimes heard by radio listeners at specific times.



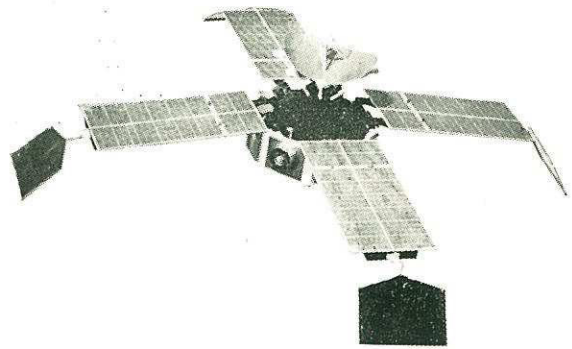
Space tracking

THE National Institute for Telecommunications Research (N.I.T.R.) has continued to operate the space tracking stations at Hartbeeshoek on behalf of the National Aeronautics and Space Administration (N.A.S.A.) of the U.S.A. in terms of an agreement between that organization and the C.S.I.R.

The deep space tracking station played a vital rôle in the tracking of a number of spacecraft, including the *Mariner* on its mission to the planet Mars, and *Surveyor*, which recently achieved a soft landing on the moon. The satellite tracking station has been heavily engaged in tracking earth satellites, and forms an important link in the worldwide chain of such stations.

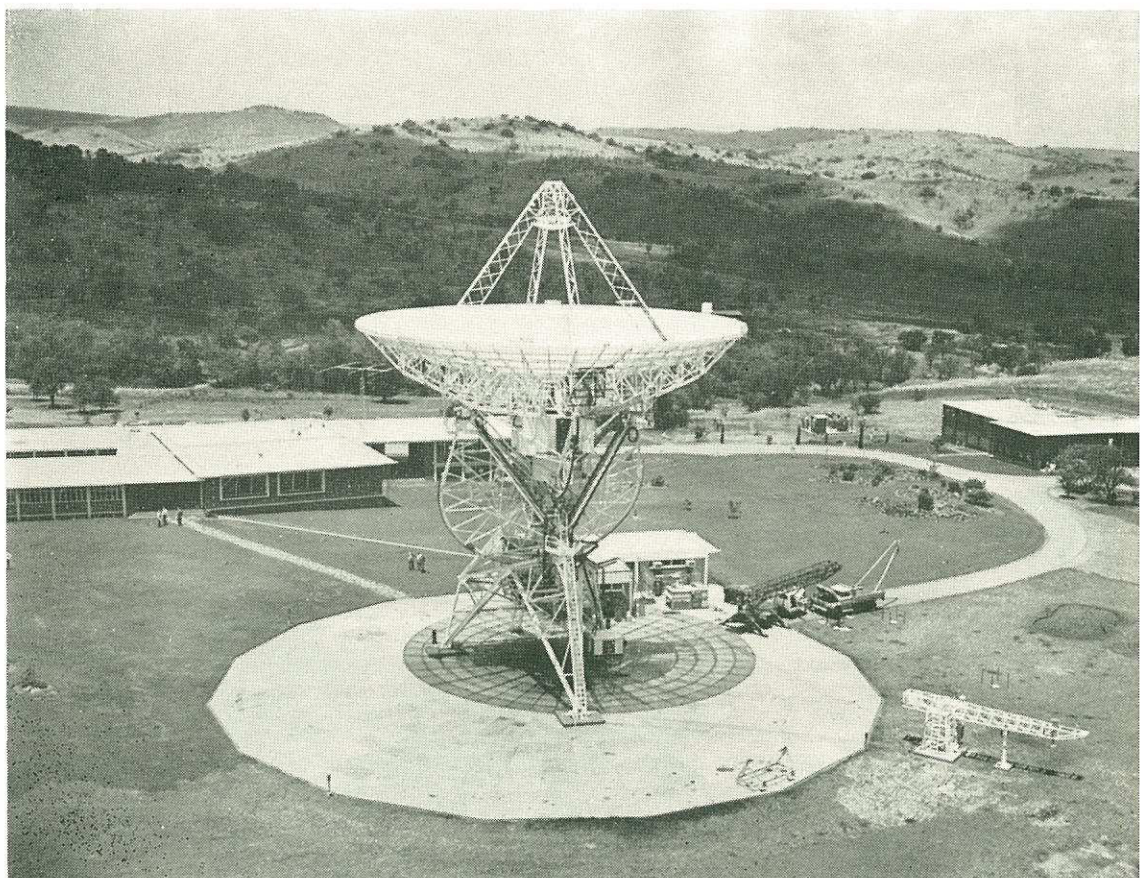
Personnel

The **Radio Space Research Station** employs a large staff of engineers and technicians to maintain and operate the specialized equipment used for tracking and data acquisition. This staff has been built up by local and overseas recruitment, supplemented by a technicians' training scheme for youths educated to a matriculated standard. In this way the R.S.R.S. has done much to build up a fund of engineering skill in the Republic of South Africa.



Model of the deep space craft, Mariner I.

The radio antenna at Hartbeeshoek which is operated by the C S I R on behalf of the National Aeronautics and Space Administration, U S A, for the tracking of deep space probes.



THE divisions for mathematical analysis, statistics and numerical analysis of the National Research Institute for Mathematical Sciences (N.R.I.M.S.) undertake, inter alia, statistical services and numerical and non-numerical computations on digital computers. These services significantly increase the scope of the whole C.S.I.R.'s research potential, and in particular the computing facility makes possible the tackling of many problems which would otherwise be entirely intractable.

DATA PROCESSING

ON behalf of the Timber Research Unit a mathematical statistical analysis was undertaken to evaluate the differences between three types of wood from which paper samples were made, these woods being tested on the basis of bursting, tearing and tensile strength.

A mathematical model of the atmosphere was used to compile a computer programme for atmospheric forecasting over the major part of the southern hemisphere. This work was done in collaboration with the Weather Bureau.

Emphasis on the southern subtropical region makes rigorous demands in regard to the handling of long waves, and the need exists for a better approximation than those

which have been used in the northern hemisphere. For this purpose a novel approach to the mathematical model is being explored.

During April an I.B.M. 1050 data transmission system was installed to connect the National Institute for Personnel Research (N.I.P.R.) in Johannesburg with the Computing Centre at the N.R.I.M.S. in Pretoria, the two terminals being linked by a private Post Office telephone line. Prolonged transmission tests are being carried out on the system. The installation was introduced partly to obtain experience with a view to future developments in on- and off-line computer data processing and partly to obtain a faster turnover of computing work submitted by the

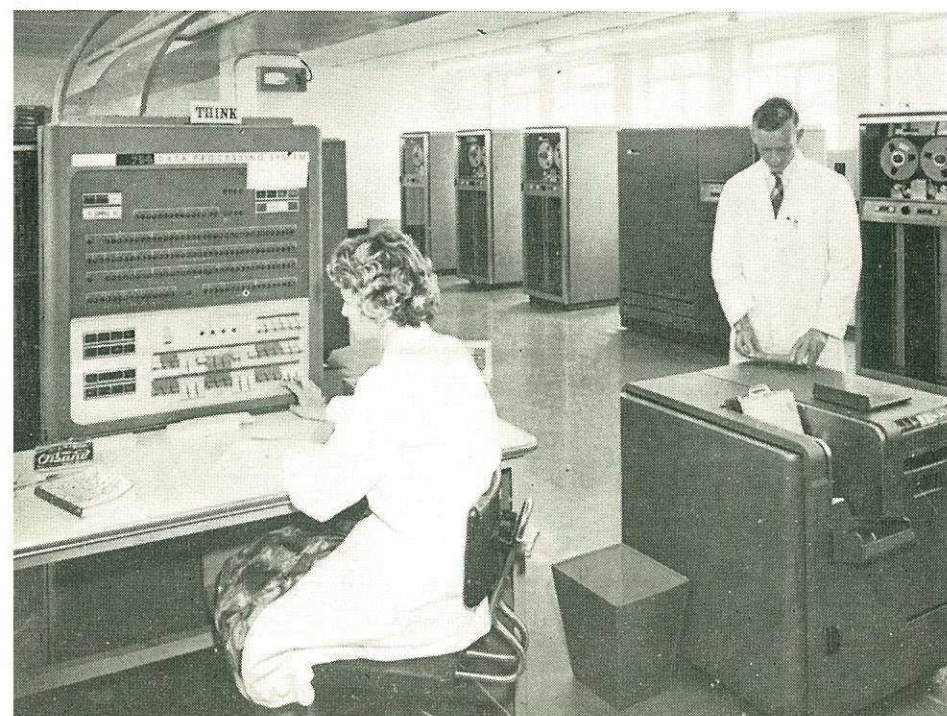
N.I.P.R. As a result of this project valuable experience has been gained in advanced machine-language programming and in error-handling techniques.

A set of computer programmes has been developed which will cover all phases of ground survey computations. The programmes accept data recorded in free form, that is, with any arbitrary sequence of observations, in a special field book, and give as output the final adjusted coordinates and an annotated diagram.

An iterative method of adjusting these computations, known as "figural adjustment", has been developed. This method is applicable to all traditional survey computations and replaces conventional methods.*

A section of the IBM 704 computer in the CSIR's National Research Institute for Mathematical Sciences.

* GREGOR, K. N. A figural distortion method for computing mixed triangulation, trilateration and traverse surveys using an electronic computer. CSIR Special Report WISK 22, CSIR, Pretoria, 1966, 24p.



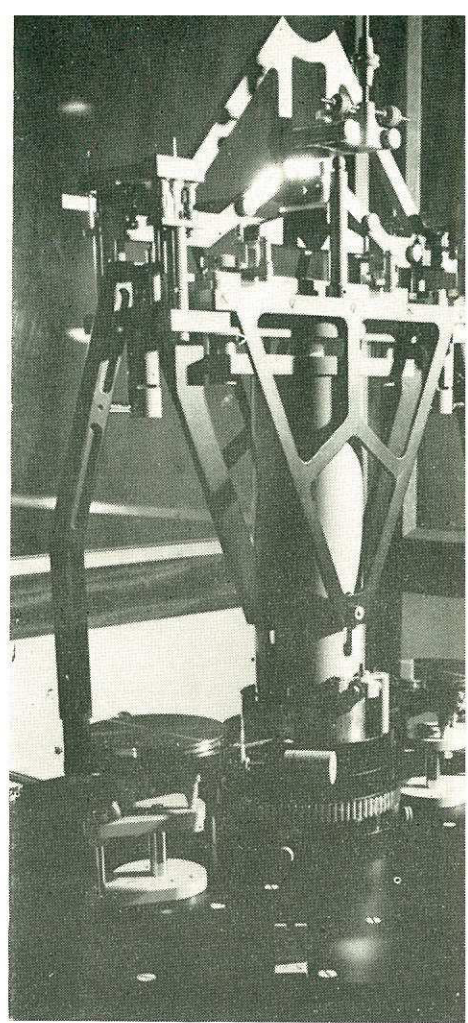
standards of physical measurement

THE C.S.I.R.'s statutory task of maintaining primary national standards of physical measurement is undertaken by the National Physical Research Laboratory (N.P.R.L.).

The main standards to be maintained are those concerning length, mass, temperature, electricity, pressure and light intensity. The N.P.R.L. undertakes the assizing of the operational standards of the **South African Bureau of Standards**, and of the **Weights and Measures Division of the Department of Commerce and Industries**, who in this turn assize the country's measuring instruments.

Maintenance of these standards of measurement also covers research aimed at ascertaining the best methods and the most accurate results. The new international definition of length in terms of light waves — previously a metal metre length was preserved in Paris and served as the international measuring standard — resulted in considerable research into interferometer techniques.

A primary kilogramme balance which can be used to weigh a Kilogramme correctly to within a few microgrammes was put into operation at the end of the year.



The standard Kilogramme balance recently acquired by the C S I R.

Radioactive fallout

The routine measurement of radioactive fall-out by the N.P.R.L. has continued during the year under review and, as in past years, the major emphasis has been placed on the total accumulated fall-out over representative areas of the Republic. According to these observations, the 1966 French and Chinese nuclear tests caused no significant increase in total fall-out and the total accumulated fall-out remains at a low level of between 100 and 200 millicurie per square mile.*

* STANDER, L. O. Radioaktiewe neerslag en waarneming daarvan in Suid-Afrika. *Tydskr. vir Natuurwetenskappe*, June 1966, pp. 118-135.

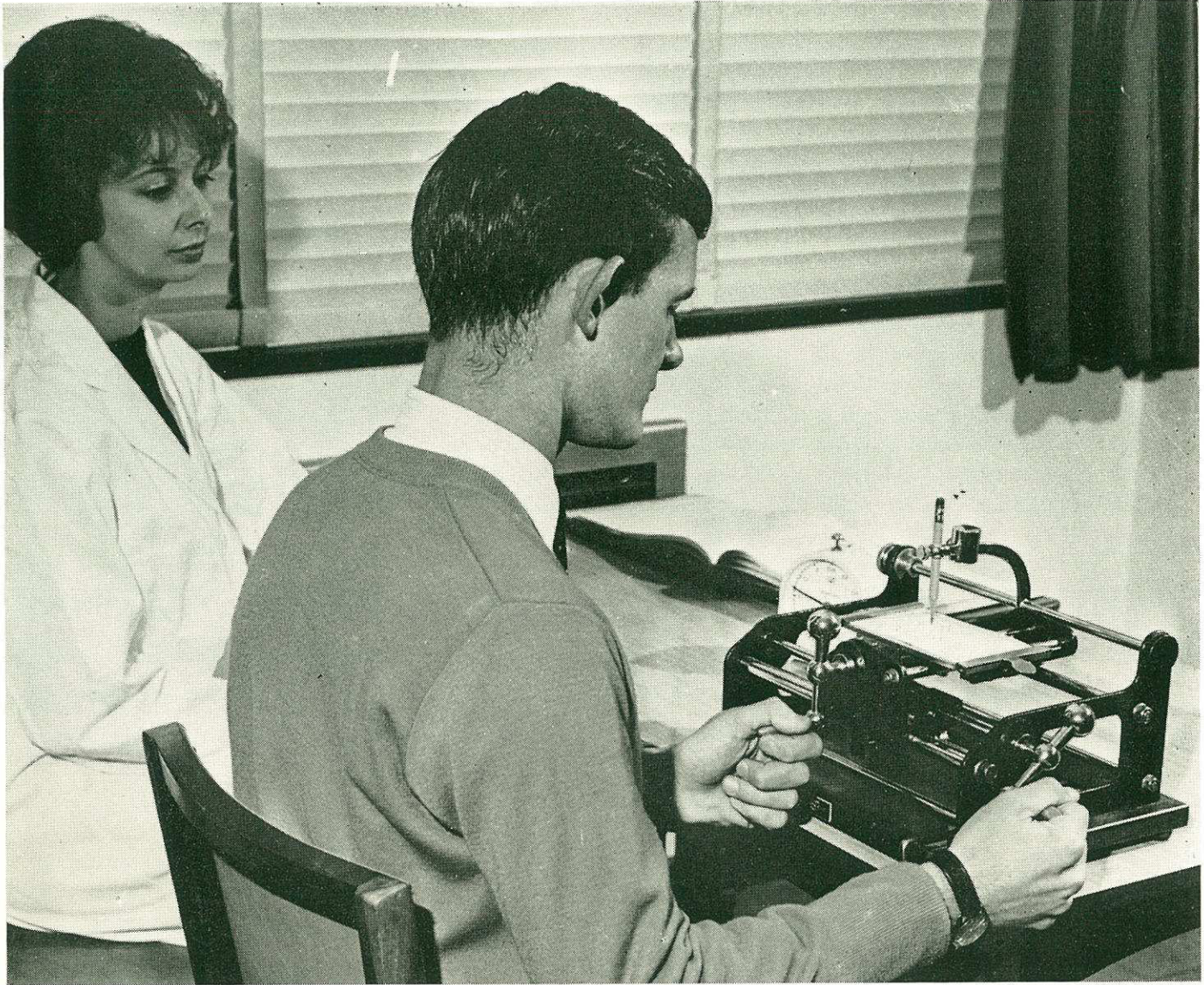
Radiation surveys

Radiation surveys were carried out for various medical organizations and private practitioners in order to ascertain the danger to patients and operators of various methods of exposure to X-rays. Recommendations were made with a view to minimizing this risk.

Standardization of radioactive isotopes

The N.P.R.L. is now able to standardize certain radioactive isotopes that are of considerable importance in diagnostic medicine. These are: the important isotope iron-55, as well as chromium-51, manganese-54, cobalt-57 and zinc-65.

RADIOACTIVITY



A test subject carrying out a two-handed co-ordination test at the National Institute for Personnel Research.

VOCATIONAL GUIDANCE

THE vocational guidance service of the N.I.P.R., which is limited owing to staffing problems, continued to be so much in demand in Pretoria and Johannesburg that a large number of applicants had to be referred to other organizations offering such services. During the year 748 candidates were tested, interviewed and provided with reports.

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.

The T.S.D. is equipped with specialised machinery and works in close co-operation with the laboratories and institutes of the C.S.I.R. Two valuable items of equipment, an electron beam welder and spark erosion machine have recently been added to the facilities, while a third, a numerically controlled milling machine is on order. These facilities enable the T.S.D. to design and manufacture specialized equipment which is not available elsewhere, but not on a mass-production basis.

Recent examples of such specialized equipment include instruments for the sorting of asbestos fibres manufactured on behalf of industry and a unique wood torsion testing machine manufactured for the C.S.I.R.'s Timber Research Unit.

Two instruments designed by the National Mechanical Engineering Research Institute for the Transvaal and Orange Free State Chamber of Mines were constructed by the T.S.D. With these instruments it is possible to measure the heat output of the human body through radiation and convection to a degree of accuracy of five per cent.

The T.S.D. also operates an apprentice training scheme for scientific instrument makers combined with theoretical training of technicians. During the year under review the centre was moved to a new building where at present 36 technicians and apprentices are undergoing training. Since its inception, the C.S.I.R. has trained 33 scientific instrument makers of which 16 are employed throughout the Republic.

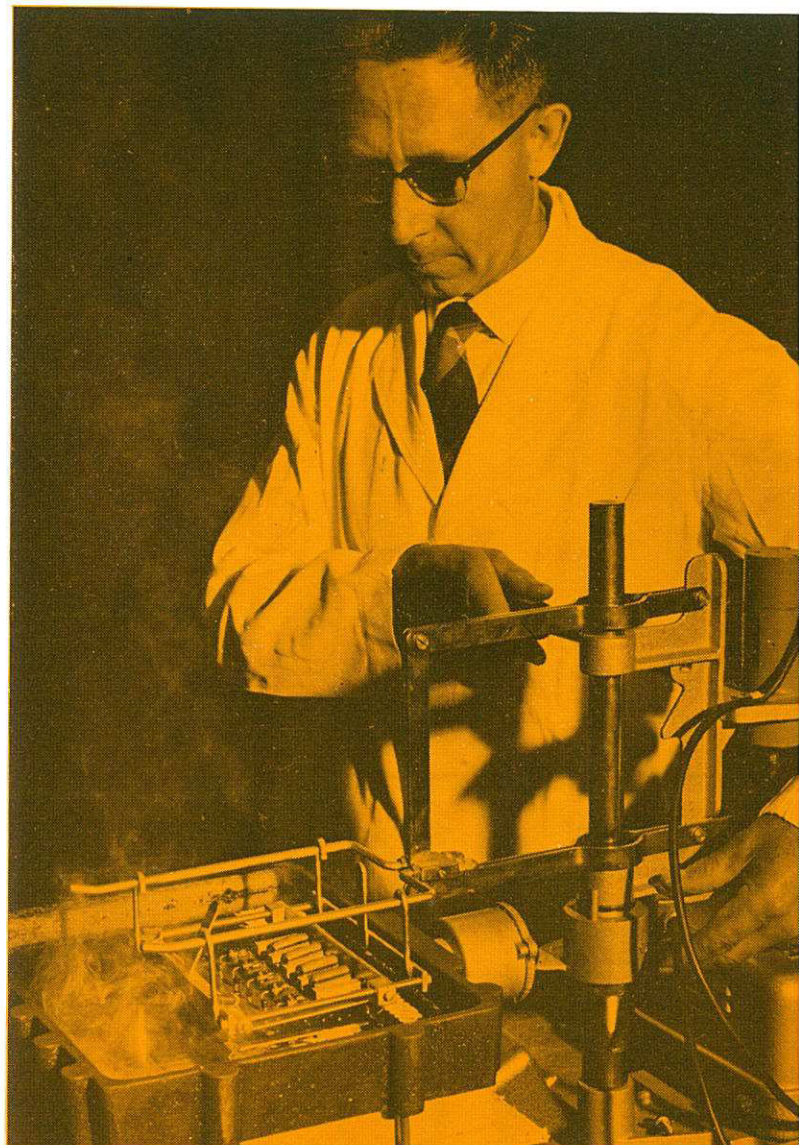
The T.S.D. also provides photographic, printing, stores and transport services to the C.S.I.R. and recently expanded its activities to include the manufacture of printed circuits.

Mr. J. J. van der Staaij, Director of the CSIR's Technical Services Department.



technical services

A printed circuit with transistors and other components mounted in position, being dipped into a bath of solder.





Mr. D. G. Kingwill, Director of the CSIR's Information and Research Services.

TECHNO-

ECONOMIC AND INFORMATION SERVICES

THE C.S.I.R. has specific statutory responsibilities to foster the development of science in the Republic, to facilitate the flow of scientific information between scientists and to promote the more effective application of the results of research. Although these aims permeate all the activities of the C.S.I.R., certain aspects are concentrated in specialist divisions grouped together in the Information and Research Services. These divisions' functions cover library services, industrial economics, the development of industrial research, information (including publications and language services), advertising and science journalism, public relations, university and medical research and science co-operation. The latter three aspects of the C.S.I.R.'s information and liaison functions, are mentioned in the chapters, **Research for the Public Sector** and **Fundamental Research**.

THE C.S.I.R.'s Advisory Committee for the Development of Research for Industry was provided with professional services in connection with the quinquennial reviews of two of the co-operative industrial research institutes which receive annual grants from the C.S.I.R. that match contributions by industrial subscribers — the Sugar Milling Research Institute and the South African Paint Research Institute, both in Durban.

DEVELOPMENT OF INDUSTRIAL RESEARCH

The new Amatikulu sugar mill in Zululand.

INCREASED contributions for the ensuing five-year periods were recommended. The substantial increase in the contributions of the industry to the Sugar Milling Research Institute will be matched by the C.S.I.R. over the five-year guarantee period. In order to place the South African Paint Research Institute on a sounder financial footing, increased contributions from the C.S.I.R. are conditional on a considerably increased contribution from industry.

These reviews have established very clearly that the services of these institutes are greatly appreciated by the industries concerned. The implementation of research results in practice is obviously favoured by the intimate contact between research institute and industry which this kind of research association engenders.



Industrial economics

TECHNO-ECONOMIC surveys of the research and information needs of the motor component manufacturing industry and the timber industry were completed and widely distributed.

The textile industry

Following the release of a report on a techno-economic survey of the research and information needs of the textile industry completed in 1965, a meeting of leading representatives of various branches of the industry and senior Government officials recommended that the C.S.I.R. should organize a symposium on textile research to take place in Port Elizabeth in July 1967.

Techno-economic survey

In collaboration with the **Industrial Economics Division** of the C.S.I.R. the T.R.U. conducted a techno-economic survey of the major sectors of the forest products industry to determine how scientific research can help solve technological problems confronting the industry. With the information collected, the Unit can now better adapt its research work to the needs of the industry.

The packaging industry

The **Industrial Economics Division** is at present conducting a survey of the research and information needs of the packaging industry in South Africa. The survey includes visits by officials of the Division to about twenty of the biggest consumers of packaging material, about twenty producers of such material and ten producers and suppliers of packaging machinery.

Expenditure on research and development

The Research Economics Group continued with its surveys of expenditure on research and development activities. By the end of 1966 a survey covering the activities of public bodies and universities for the period 1964/65 was virtually complete except for data pertaining to one government agency. As soon as these become available the report will be released and will present for the first time a

complete picture of the research activities of government departments, public bodies and universities.

This survey will be extended in 1967 to include private industry.

Xhosa homelands

During the past year the Xhosa Development Corporation (XDC) requested the C.S.I.R. to carry out on a contractual basis a techno-economic survey of the Transkei and Ciskei Bantu homelands and to gather and make available information to be used together with existing data by the X.D.C. in the compilation of an industrial development programme for these territories. At the same time the intention is to locate techno-economic problem areas and to gain clarity about those areas in which the C.S.I.R.'s research reserves could be fully employed in promoting industrial development in the Transkei and Ciskei.

Two progress reports have already been submitted to the X.D.C.

TECHNICAL INFORMATION FOR INDUSTRY

THE provision of technical information to industry is an integral part of the activities of the C.S.I.R.'s research institutes and units that serve particular branches of industry or fields of technology. However, there are many branches of industry for which such services are not available.

A survey of the flow of information to industry in South Africa, with particular reference to the factors affecting technical innovation, was completed. For practical purposes, the survey was limited to electronic instrumentation. It was found that small and medium sized firms are in need of assistance, particularly in locating sources of information on practical problems peripheral to their main line of business. Means of providing this type of service are being

investigated.

One-day industrial symposia have proved to be a useful means of promoting the exchange of information between research workers and industrial technologists. During 1966 such a symposium was held on aerodynamics research, and two symposia took place concerning the problems of the gold mining industry, the first on the design and use of thickeners and the second on dust sampling.

Equipment and services of particular interest are described in a monthly four-page publication **T.I. technical information for industry**. This publication has resulted in numerous enquiries for more detailed information, particularly from abroad. The circulation of the English version is now 5,110 and of the Afrikaans version 893.

In accordance with the publishing policy of the C.S.I.R., results of research are normally published in scientific and technical journals of standing.

PUBLICATIONS

However, these media are not always suitable and results of applied research and reviews are also published in two series. **Research Reports** and **Special Reports**. Standards of documentation are maintained through the central editorial office of the Information Division. A list of the C.S.I.R.'s regular publications appears on page xv of this report. All publications by C.S.I.R. staff or arising from research supported by C.S.I.R. are listed together with author ab-

stracts, in a six-monthly publication, **C.S.I.R. Research Review**. Many requests for reprints listed in this publication are received from all over the world.

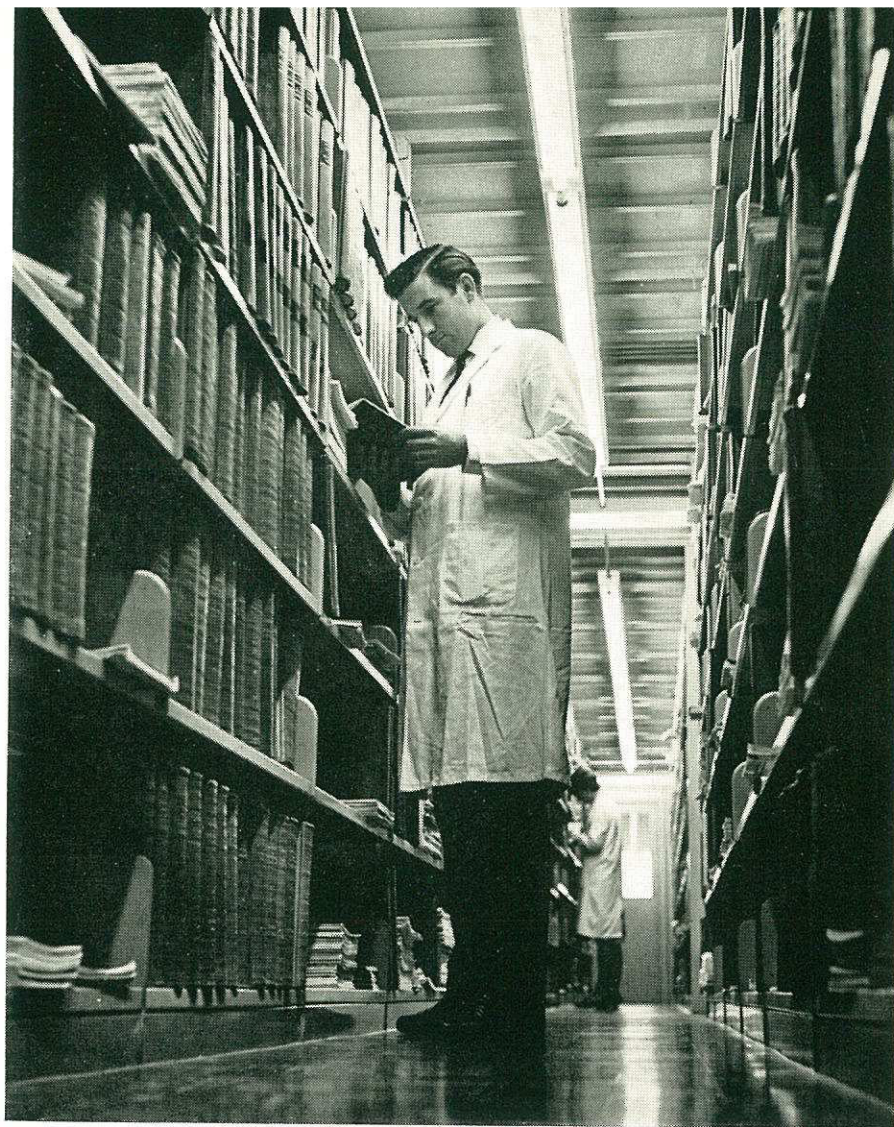
Guides to sources of scientific and technical information in South Africa are provided in the **Directory of Scientific and Technical Information in South Africa** and the **Register of current research at South African Universities** published by this office.

The C.S.I.R. also publishes **Periodicals in South African Libraries**, which is compiled jointly by the C.S.I.R. Library and the University of South Africa (the latter being responsible for entries on journals in the humanities, under a special grant from the National Council for Social Research). This is an alphabetic list which is being issued letter by letter. By the end of 1966 this publication had been issued as far as the letter "M".

LIBRARY SERVICES

THE central C.S.I.R. Library is increasingly called upon to serve as a national library of science and technology. As a central library serving the nine national research institutes and laboratories centred at Scientia, Pretoria, it is well equipped for this purpose.

Attention has been directed to mechanized procedures and a punched card charging system has been successfully introduced for normal loans and photocopies. Good progress has been made towards the computerization of serial records.



In the C S I R Library's stack room for bound periodicals. The C S I R receives about 3,500 different scientific and technical periodicals and in addition possesses approximately 65,000 books.

ASSOCIATION with a co-ordinate indexing project, initiated in the Chemical Engineering Group for the purpose of storage and retrieval of information on air pollution control engineering, is providing valuable experience in the development and application of this technique of deep indexing for retrospective search.

Similarly, association with the National Institute for Water Research in the production of a weekly listing of titles, Current literature on water, selected from 250 journals, coupled with a six-monthly K.W.I.C. (Key-word-in-context) index, is providing invaluable experience in providing a mechanized current awareness service.

Information processing

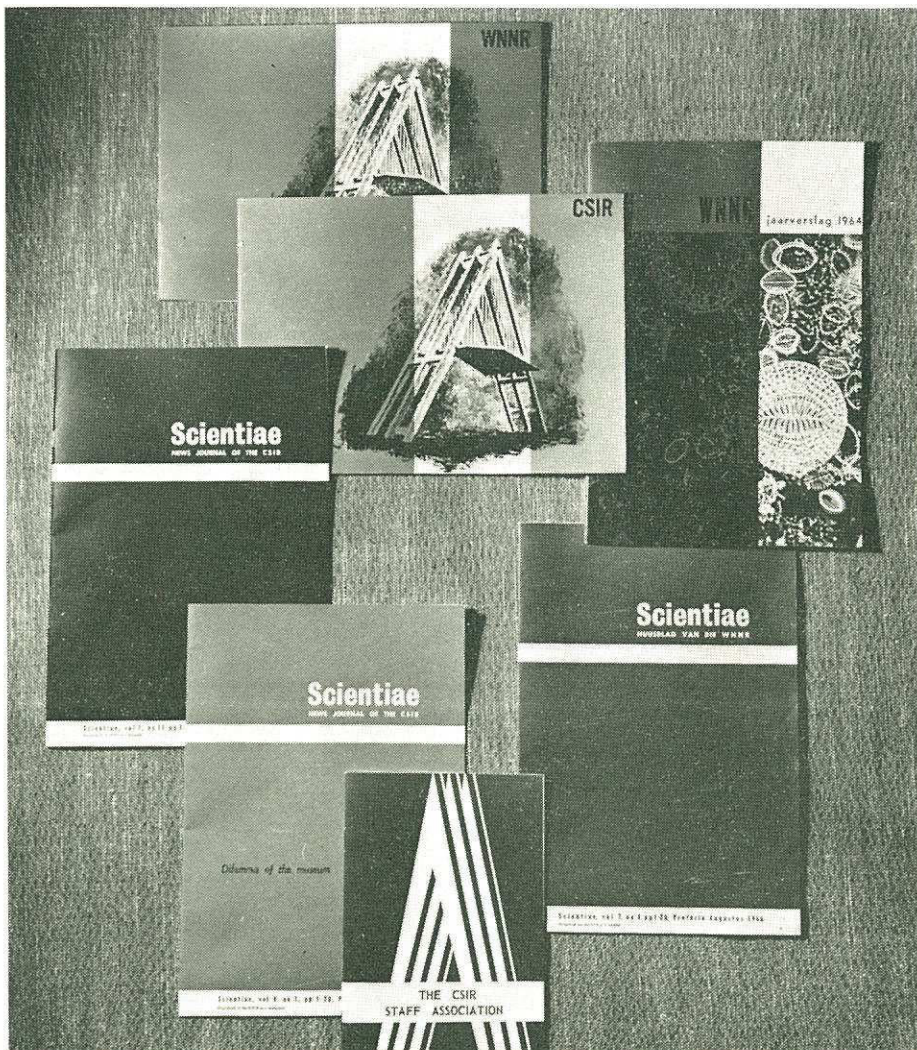
Public

Information

IN addition to the Annual Report, C.S.I.R. activities are reported regularly in a monthly journal *Scientiae*, which now has a circulation of 6,000. During 1966 a general 36 page, illustrated brochure describing the organization and services of the C.S.I.R. was published while an illustrated brochure on career opportunities in oceanography was produced on behalf of the South African National Committee on Oceanographic Research.

In collaboration with the Pretoria Publicity Association, arrangements are made for the general public to visit the C.S.I.R. laboratories on the first Wednesday of each month. In addition, in collaboration with the School Tours Service of the Transvaal Provincial Administration, arrangements were made for over 1,000 high school science scholars to visit the laboratories during the year.

During the year many distinguished visitors from abroad were received at the C.S.I.R.



Some publications issued by the Information and Research Services of the C S I R.



FINANCIAL STATEMENTS

South African Council for Scientific and Industrial Research
Balance Sheet as at 31st March 1966

STATEMENT No. 1

	1965		1966		1965		1966		1965		1966		
	R		R		R		R		R		R		
	General fund	Building fund					University Institutions	CSIR	Written off				
ACCUMULATED FUND.....													
Balance as at 31.3.1965.....	9,284,574.77	7,927,171.75	20,399,534.71		17,221,746		—	432,436.40	—	7,755,153.76	—	7,755,153.76	7,322,717
Inter-fund transfers.....	(—)85,902.00	85,902.00					—	432,436.40	—	7,755,153.76	—	7,755,153.76	7,322,717
SUB-TOTAL.....	9,198,672.77	8,013,073.75					—	432,436.40	—	7,755,153.76	—	7,755,153.76	7,322,717
Capital receipts 1965/66.....							152,666.96	1,790,285.83	41,543.49	7,982,278.81	—	7,982,278.81	6,080,869
Parliamentary grants:							2,556.31	78,357.87	8,307.06	603,350.94	—	603,350.94	530,744
CSIR.....	1,032,200.00	300,000.00					—	30,338.41	27,181.48	199,665.28	—	199,665.28	196,508
University institutions.....	141,569.00	144,303.00					1,097.79	68,056.05	—	548,216.48	—	548,216.48	479,063
Donations.....	68,135.20	155,770.25					—	—	—	10,517.83	—	10,517.83	10,518
Interest.....	—	—					—	—	—	100,000.00	—	100,000.00	100,000
Sale of assets written off:							—	—	—	—	—	—	—
CSIR.....	7,579.72	—					—	—	—	—	—	—	—
University institutions.....	212.05	—					—	—	—	—	—	—	—
Investigations and services:							156,321.06	1,967,038.16	77,032.03	9,444,029.34	—	9,444,029.34	7,397,702
CSIR.....	642,577.60	114,441.82					—	—	—	—	—	—	—
University institutions.....	5,853.61	—					—	—	—	—	—	—	—
Add: Excess income 1965/66.....	1,896,127.18	714,515.07	2,580,894.92		714,515.07		—	—	—	—	—	—	—
	684,767.74	—					—	—	—	—	—	—	—
Less: Costs of assets written off 1965/66:							—	—	—	—	—	—	—
CSIR.....	68,853.14	—					—	—	—	—	—	—	—
University institutions.....	8,178.89	—					—	—	—	—	—	—	—
Adjustment in respect of previous years.....	30,589.77	—					—	—	—	—	—	—	—
SUB-TOTAL.....	2,473,273.12	714,515.07	3,187,788.19		3,187,788.19		—	—	—	—	—	—	—
TOTAL.....	R 11,671,945.89*	8,727,588.82*	20,399,534.71		17,221,746		R 156,321.06	2,399,474.56	77,032.03	17,199,183.10	R 156,321.06	17,199,183.10	14,720,419

STATEMENT No. 1 CONTINUED

	1966	1965	1966	1965
	R	R	R	R
CURRENT LIABILITIES				
Advances for investigations and services.....	867,051.23	763,310		
Sundry creditors and credit balances.....	1,963,085.12	1,563,063		
			239,765.21	223,751
			294.60	1,635,686
				135,294
				632,244
			390,569.49	2,296,603
			1,243,972.74	
				632,244
			42,724.89	2,296,603
			5,731.45	
			9,523.82	(-)105,878
			57,980.16	R4,817,700
TOTAL.....	R2,830,136.35	R2,326,373	R6,030,487.96	R4,817,700
GRAND TOTAL.....	R23,229,671.06	R19,538,119	R23,229,671.06	R19,538,119
CURRENT ASSETS				
Stores stock.....				
Wool stock.....				
Sundry debtors and debit balances.....				
Investigations and tests in progress.....				
Advances and deposits.....				
Research grants.....				
Other.....				
Investments.....				
Cash:				
At S.A. Reserve Bank.....				
At Standard Bank, Grahamstown.....				
Petty cash imprests.....				
TOTAL.....			57,980.16	(-)105,878
GRAND TOTAL.....			R6,030,487.96	R4,817,700
			R23,229,671.06	R19,538,119

NOTE: *Contractual obligations against the General and Building Funds as at 31st March, 1966, was R773,703 and R372,534 respectively.
 PRETORIA: 8th December 1966

S. M. NAUDÉ
President

J. H. VISAGIE
Secretary/Treasurer

The above Balance Sheet has been audited in accordance with the provisions of Section K56 of the Exchequer and Audit Act, No. 23 of 1956, 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.

CAPE TOWN, 5th January, 1967.

I. T. MEYER
Controller and Auditor-General

**South African Council for Scientific and Industrial Research
Operating Account for the year ended 31st March 1966**

STATEMENT No. 2

EXPENDITURE	1965/66			1964/65		
	University Institutions	CSIR	Total	University Institutions	CSIR	Total
	R	R	R	R	R	R
Salaries, wages and allowances.....	204,289.73	5,934,576.20	6,138,865.93	5,080,530	5,934,576.20	6,071,031.00
Consumable stores and services.....	22,543.84	5,235,755.84	5,258,299.68	2,387,591	5,235,755.84	6,649,116.25
Subsistence and transport.....	15,436.34	378,325.26	393,761.60	388,910	378,325.26	268,272.37
General Expenses.....	23,864.43	1,058,281.08	1,082,145.51	1,043,008	1,058,281.08	1,167,741.67
Subsidies: Research by industry.....	601,121.72	168,085.74	168,085.74	228,432	168,085.74	21,581.38
Grants.....	—	—	601,121.72	581,714	—	2,949.51
SUB-TOTAL.....	867,256.06	12,775,024.12	13,642,280.18	9,710,185	12,775,024.12	21,581.38
Less: Income for internal services.....	76.00	1,306,854.20	1,306,930.20	1,111,437	1,306,854.20	2,949.51*
SUB-TOTAL.....	867,180.06	11,468,169.92	12,335,349.98	8,598,748	11,468,169.92	—
Balance transferred to Accumulated fund.....	94,591.38	590,176.36	684,767.74	537,895	590,176.36	—
TOTAL.....	R961,771.44	12,058,346.28	13,020,117.72	R961,771.44	12,058,346.28	13,020,117.72
						9,135,843

INCOME

Parliamentary grant.....	—	5,137,600.00	5,137,600.00	—	5,137,600.00	5,137,600.00
Investigations and services.....	—	6,622,809.31	6,622,809.31	—	6,622,809.31	6,649,116.25
Contributions to C.S.I.R. projects.....	—	268,272.37	268,272.37	—	268,272.37	268,272.37
Publications.....	—	5,133.51	5,133.51	—	5,133.51	6,146
Sundry.....	—	21,581.38	21,581.38	—	21,581.38	30,199
Reimbursement of cost of capital facilities.....	—	2,949.51	2,949.51	—	2,949.51	84,344
TOTAL.....						9,135,843

NOTE: *Cost of capital facilities (i.e. buildings, roads, etc. provided on repayment for the National Aeronautics and Space Administration, U.S.A.

PRETORIA: 8th December, 1966.

S. M. NAUDÉ
President

J. H. VISAGIE
Secretary/Treasurer

CSIR Budget 1966/67

STATEMENT No. 3

A. Operation 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
CSIR laboratories and departments	R 7,230,321	R 9,976,013	R 429,259	R 506,421	R 212,140	R 956,546	R 1,422,918	R 17,887,782	R 5,244,390	R 12,643,392
Grants and subsidies	596,751	82,722	25,915	24,420	898,632	127,855	2,190	1,754,105	1,595,610	158,495
TOTALS	R 7,827,072	10,058,735	455,174	530,841	1,110,772	1,084,401	1,425,108	19,641,887	6,840,000	12,801,887

B. Capital Expenditure

ACTIVITIES	EXPENDITURE						Total
	Books/Journals	Technical equipment	Furniture/Office equipment	Vehicles	Stores stock	Buildings	
CSIR laboratories and departments	44,730	1,917,653	58,249	5,680	18,316	699,543	2,744,171
Grants to universities, etc.	100	168,900	500	—	—	—	169,500
TOTALS	R 44,830	2,086,553	58,749	5,680	18,316	699,543	2,913,671
GRAND TOTALS							R 22,555,558

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 organisations 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 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.

Gratis.

Monthly bulletin of ionospheric characteristics observed at Johannesburg and Cape Town

Issued by the National Institute for Telecommunications Research.

Gratis.

Enquiries

The Distributor of Publications, CSIR,

P O Box 395, Pretoria

Telephone: 74-6011 Extension 435.

