Journal of
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Research

V. 9, No. 10, OCTOBER 1950

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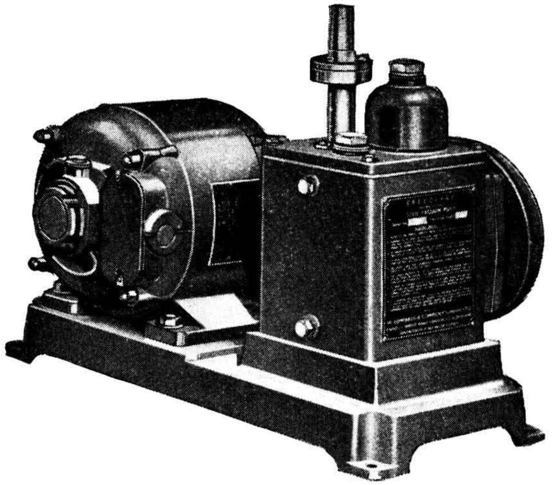

Journal of
Scientific & Industrial Research

V. 9A, No. 10, OCTOBER 1950

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COVER PICTURE

The picture on the cover shows the Central Glass & Ceramic Research Institute, Calcutta, which was declared open by Dr. B. C. Roy, Chief Minister of West Bengal, on August 26, 1950. This Institute is the fourth among the National Laboratories, sponsored by the Council of Scientific & Industrial Research, to be declared open this year.

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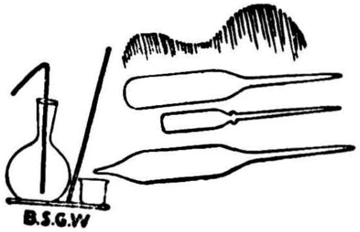
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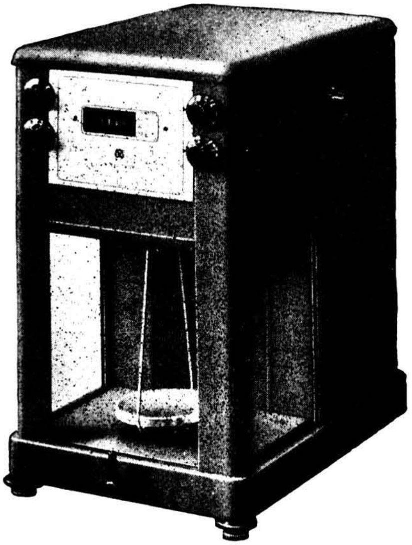

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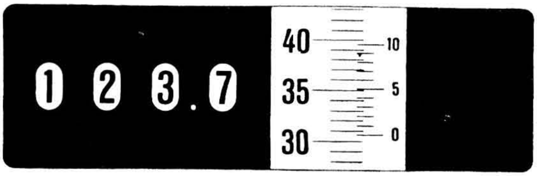

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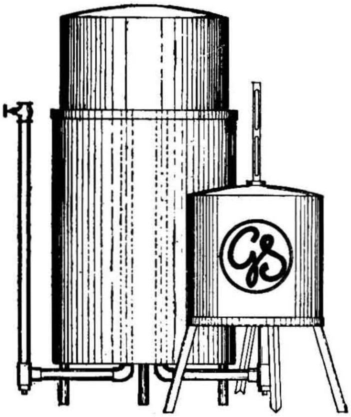
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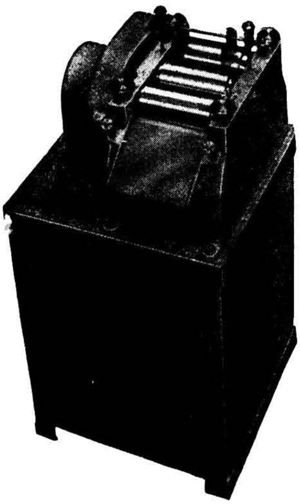

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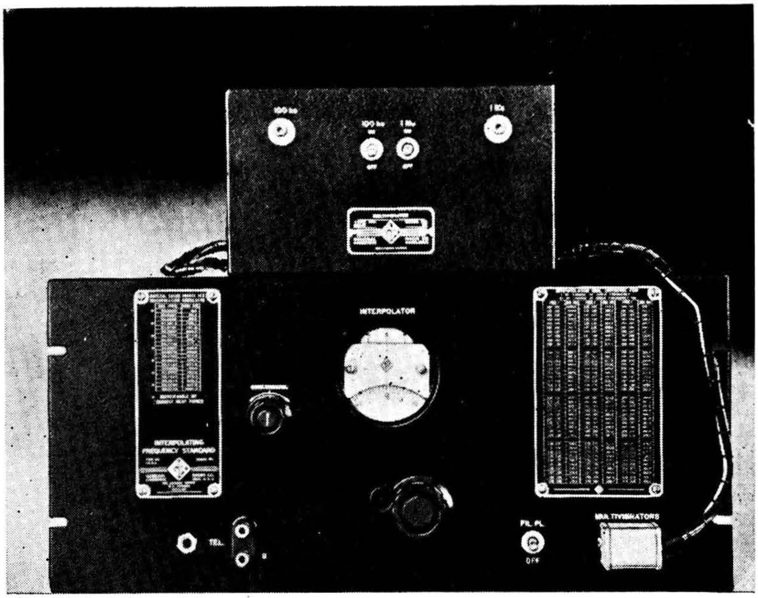

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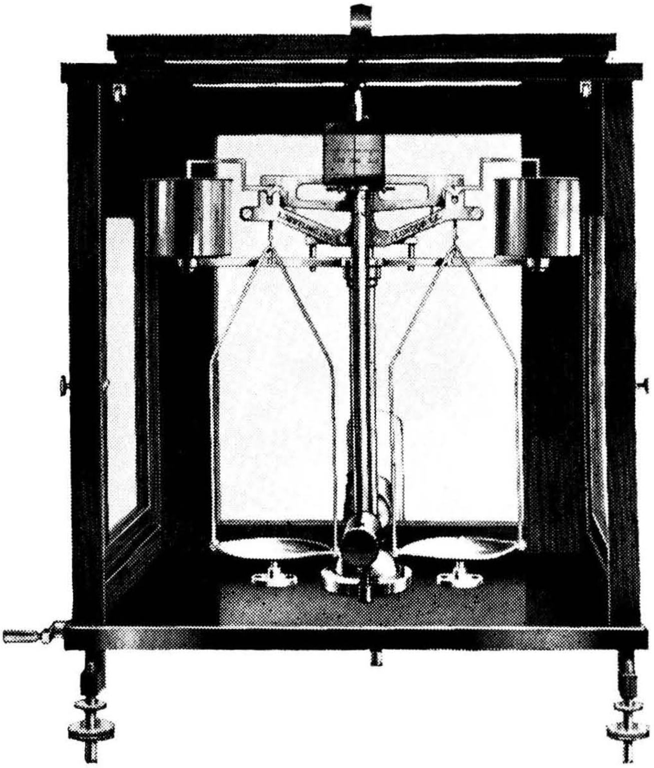

The Central Road Research Institute

THE laying of the foundation-stone of the Central Road Research Institute on September 6,1950, at Delhi, by the Hon'ble Shri N. Gopalaswami Ayyangar, Minister for Transport, Government of India, is yet another landmark in the great constructive work of " bringing into existence large-scale laboratories and institutes for the promotion of scientific research and its application to industry and to the betterment of human life ", initiated and pursued by Dr. Shanti Swarup Bhatnagar with such conspicuous success. The need for a central organization for the study of soils in relation to road construction was first mooted by the Indian Roads Congress in 1943, but the proposal to establish a Central Road Research Institute, covering all aspects of road construction and maintenance, emerged in 1944 as a recommendation of the Industrial Research Planning Committee of the *Council of Scientific & Industrial Research.* The Governing Body of the *Council* accepted the recommendation in 1945 and appointed a Committee to work out the details.

The importance of good road communications to a country, both for economic progress and defence, is now widely recognized, but the vital rôle of scientific research in the making and maintenance of roads and the magnitude and the economic significance of road research do not appear to have been so widely appreciated. The Hon'ble Shri N. Gopalaswami Ayyangar observed in this context : " Like all things connected with all forms of communications, there has been a revolution in ideas, technique, policy and action. The study of soil conditions is now recognized to be a necessary preliminary to the designing of foundations and embankments on which roads could be built. The requirements of effective drainage call for careful investigation. The materials for surfacing roads and the methods of soiling, binding, rolling and carpeting require knowledge, experience and intelligence. There have been very rapid developments in the kind, weight and speed of fast-moving road traffic ; and the relating of the strength and durability of the road surface to such traffic is among the major problems of road construction and maintenance. Above all, due to these and other reasons, the public have come to demand a progressively higher standard of road maintenance. We have, therefore, reached a stage when we can no longer avoid or delay an organized scientific approach to the satisfactory solution of what is an intensely practical human problem."

The total length of roads of all kinds in India is 3·5 lakh miles. According to the Indian Roads Congress, India should have an additional 4 lakh miles of roads including approximately 25,000 miles of national highways and trails, 65,000 miles of provincial highways, 60,000 miles of major district roads, 1 lakh miles of other district roads and 1·5 lakh miles of village roads. The cost of constructing tarred roads is about Rs. 30,000 per 10-ft. wide mile, Rs. 50,000 per mile of cement-concrete road, Rs. 5,000 or more per mile of *kucha* road. According to the estimates of the Planning Commission, 1,159 crores of rupees are to be spent on transport development schemes in India. The implementation of this plan of road construction calls for the expenditure of huge amounts of money and material, and if, as a result of research, it is possible to reduce the cost of construction and maintenance by even 1 per cent, the saving effected would amount to a few crores of rupees.

It is obvious that a good road must be solid, and that it should withstand the effects of traffic as well as those of climate. The construction of such solid roads in the most economical way is one of the aims of road research. Yet economy does not only depend on the cost of construction, but also on the durability of the road. Both good construction and efficient maintenance postpone the need for repairs or expensive reconstruction. If one considers the enormous sums of public funds that yearly go into roads, it would be in the interests of national economy to ascertain, even from the beginning, the optimum conditions for constructing " the solidest and safest roads using the natural and most economical methods ".

Road-making and road maintenance are intensely practical problems, and research of a purely scientific character, which is both necessary and important, has to be carried out in the closest collaboration with engineers in the field. The raw material resources have to be investigated collectively and on a regional basis ; the requirements of various tracts and regions have to be determined and assessed, and the results of research carried out in the laboratory and in the field, both at the Institute and at other stations, have to be co-ordinated. It was emphasized by the Hon'ble Shri N. Gopalaswami Ayyangar that " research, before it can be held to be complete, will have to pass at least three stages. There is, first, purely scientific work in the laboratory. The results of this work have, in most cases, to be tried out first in working models. There has then to be the field test. It is only when all the stages have been successfully passed through that large-scale construction work on the roads embodying the results of the research could be put in hand. There has to be very close liaison between engineers and scientists at all the three stages ; in the laboratory when the engineer states the problem for which he requires a solution ; at trials on the working models and, during the field tests, the assistance of the engineer will be necessary in ensuring that the natural conditions are reproduced there as fully as possible."

The special requirements of road research have been fully examined and taken into account in planning the work of the Institute in its various divisions. The Central Institute will work in close co-operation with regional stations like those at Madras, Patna, Karnal, Lucknow, Calcutta and Poona. A Division of Economics and Statistics has been organized and results of research will be proved and tested before they are recommended for adoption in the field. The Institute will undertake investigations on the properties of materials of construction, their testing and standardization ; the characteristics of roads under different traffic conditions ; incidence of accidents, road safety, and road statistics. Recently work on road building and surfacing materials has been made in the temporary laboratories erected at the site, and significant results have already emerged.

The Institute is fortunate in securing the services of Dr. Ernst Zipkes, distinguished for his many original contributions to the scientific and engineering aspects of road construction and maintenance. Dr. R. K. N. Iyengar, Assistant Director (Planning), has been largely responsible for drawing up detailed plans for the Institute. Dr. Zipkes, Dr. Iyengar and their colleagues have before them vast opportunities for constructive work. All men of goodwill will join the Hon'ble Shri N. Gopalaswamy Ayyangar in wishing the Central Road Research Institute " an unbroken career of increasing usefulness to the country of which we are proud to be citizens ".

North-east Assam Earthquake of 15th August 1950

D. N. WADIA

NORTH India, more precisely extra-peninsular India, has been visited by a succession of disastrous earthquakes within historic times. It is a well-authenticated generalization that the majority of the Indian earthquakes have originated from the great plains of India or from their peripheral tracts, mostly the northern border, which has been a region of great seismic sensitivity. This area is a zone of weakness and strain implied by the severe crumpling of the rock-beds in the uplift of the great pile of the Himalayas within recent geological times, and which have not yet attained stability or quiescence. In the Assam region, the geological instability is largely due to the occurrence of two great fault lines, one along the foot of the Himalayas and the other passing from south of Shillong plateau to beyond the Patkoi range. Minor slippings or dislocations along these faults are believed to have occasioned the great Assam earthquake of 1897 as well as the present quake. Compared with the disaster of 1897, the present quake seems to be of lesser violence and intensity. Then, Shillong and the surrounding country of 1,50,000 square miles with many populous cities were laid waste in a minute, all the communications destroyed, the plains riddled with rents and flooded and the hillside scarred by gigantic landslides. The total disturbed area bounded by the isoseismal of V was not less than 16,00,000 square miles[1]. In the present earthquake the area severely shaken is comparatively much less, being largely restricted to Lakhimpur district and area further north-east.

Up to now no accurate data are available from seismographic records to enable us to fix the epicentre, or epicentres, in case there are two foci, as in the case of the Bihar earthquake of 1934. From such data as are available, the area surrounding the Lakhimpur district, about a thousand to 1,200 square miles, may be an epifocal tract. Possibly the main epicentre lies without the borders of the Assam Valley, in barren uninhabited mountainous tracts from which the Brahmaputra, the Dihang and tributaries of the Salween have cut out deep canon-like valleys. This inference is supported by the havoc wrought by floods which have swept successively the rivers of upper Assam, caused by landslides interrupting normal drainage and creating temporary lakes bursting their dams one after the other. Changes in topography, ground movements and relative level of the land, usual accompaniments of great tectonic quakes, will only be apparent when proper ground surveys have been made. But such relative rise or subsidence of tracts is generally of a minor nature, the differential movements being rarely as much as 30-40 feet. Fissures and rents in the ground erupting water and sand, with occasional gases (sometimes inflammable), are common features of such earthquakes, though their significance is often exaggerated. The more gaping fissures in the 1934 Bihar earthquake were usually not more than 20 feet in width, the majority being about a foot in width and rarely more than 40 or 50 feet in depth[2]. Their length may vary from a hundred yards to about half a mile at most. Much of the devastation caused by the earthquake of 15th August is really to be ascribed to subsidiary effects, felt long after the passage of the seismic wave, and not to the actual violence of the earth tremors. It is possible that a few permanent changes may be noticed in the tributaries of the Brahmaputra, e.g. in the shifting of their courses, creation of new lakes, etc. Sounds accompanying great earthquakes are usual features. These have been variously described as booming of guns, passage of express trains or heavy motor vehicles, heard by many people during or immediately after the passage of earthquake. These are caused by sound-waves generated by the undulatory motion of seismic wave as it sweeps along the earth's surface.

It is certain that the present earthquake is of the "tectonic" type, connected with the structural weakness in the underground rock framework and not at all connected with any volcanic eruption. There are no living or dormant volcanoes within hundreds of miles of Assam, the nearest volcanoes being the Popa and Narkondam cones of Burma and the "Barren Island" Volcano of the Bay of Bengal. Reports and tales of mythical volcanoes in Tibet having been observed in actual eruption by travellers are not substantiated. The emission of sulphurous vapours and inflammable hydrocarbon gases from some of the ground fissures has evidently led to stories of volcanic outbursts. Such gaseous emissions are entirely superficial and have not even a distant connection with volcanic phenomena. Earthquakes of valcanic origin are, moreover, local in their effect and do not shake an area of thousands of square miles.

The most usual feature of violent tectonic quakes is aftershocks, which may number hundreds, or even thousands, felt in the epifocal tract and may last for months if not a year. These aftershocks are of gradually decreasing intensity and may show shifting foci. Though these aftershocks cause panic and may further intensify the damage caused by the initial shocks, their occurrence is to be welcomed, as they indicate gradual relief of strain and the settling down of rocks before held under tension.

Science has yet no means of forecasting or fore-warning of impending earthquakes and the only protection man has against this natural calamity is building of earthquake-proof structures which minimize the damage to life and property.

Further data for study of this earthquake are to be awaited till the usual *Memoir* on the subject is published by the Geological Survey of India — the distribution, duration and severity of the shocks; their direction and focus of origin; the effects on topography, hydrography, agriculture and other works of man; seismometric records from Indian and extra-Indian stations; isoseismals of different intensities and carefully compiled lists of aftershocks.

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1. "The Great Earthquake of 12th June 1897", R. D. OLDHAM: *Memoir*, Vol. XXIX, *Goel. Surv. India*, 1900.
2. "The Bihar-Nepal Earthquake of 1934 with Seismometric Study", *Memoir*, Vol. LXXIII, *Geol. Surv. India*, 1939.

Characteristics of the Ionosphere over Calcutta (July 1950)

S. S. BARAL, R. K. MITRA, D. C. CHOUDHURY, A. P. MITRA & R. B. BANERJEE

Ionosphere Laboratory, Institute of Radio Physics & Electronics, Calcutta

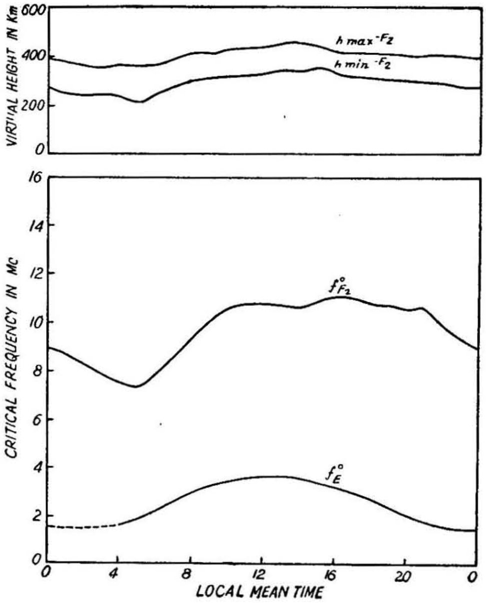
THE following are the ionospheric data observed at Calcutta for the month of July 1950.

The mean hourly values of the penetration frequency of region E and the penetration frequencies and virtual heights of region F_2 are represented in Fig. 1 in graphical form. The figures are obtained from average values of the data taken for each hour of the day for 5 days a week. Fig. 2 gives the prediction of the maximum usable frequencies which can be used for different distances of transmission by reflection at the F region over Calcutta for the month of October 1950. Table I records the various occasions during routine observations when sporadic E ionization was observed and the corresponding values of penetration frequencies and heights.

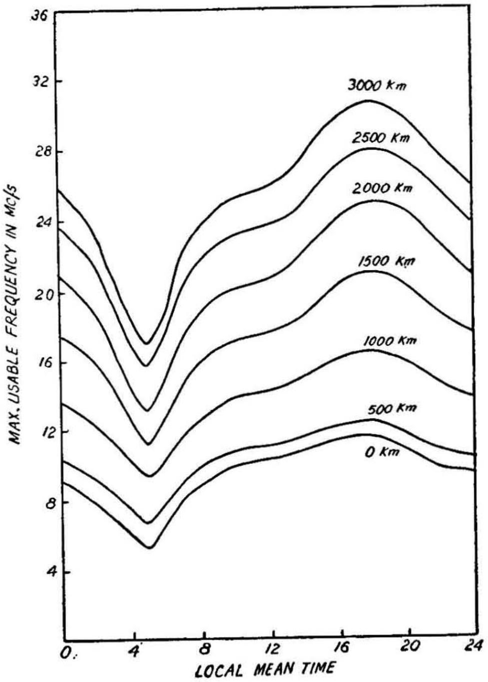
Sporadic E ionization was found to occur frequently during evening and at night and sometimes during the afternoon. Sporadic E ionization occurred more frequently during night than during day in the present month. Region F_2 ionization was found to remain steady up to late afternoon.

TABLE I

MONTH & YEAR	DATE	HOURS L.M.T.	$f^{\circ}E_s$ Mc.	h_{E_s} Km.
July 1950	6	14.00	7·80	150
		16.00	6·65	135
	7	13.00	8·00	150
		14.00	8·00	150
		15.00	7·20	135
	8	09.00	6·15	120
		10.00	6·70	120
		11.00	7·00	135
	10	13.00	8·00	150
		14.00	8·00	150
	11	13.00	7·10	135
		18.00	5·50	135
		19.00	5·50	120
		20.00	4·00	105
	12	20.00	6·10	105
		22.00	5·40	105
	13	18.00	3·50	90
		19.00	3·50	90
		20.00	3·20	90
	18	16.00	3·40	120
		17.00	3·00	105
		19.00	2·75	105
	19	20.00	2·50	90
	20	10.00	7·00	120
	21	16.00	7·80	135
		17.00	7·00	120
		18.00	6·75	120
		19.00	5·00	120
		21.00	3·00	105
		22.00	4·00	105
	24	16.00	6·50	120
		17.00	6·00	120
		19.00	5·00	105
		20.00	3·50	105
	26	17.00	4·00	105
		18.00	3·50	105
		19.00	4·00	105
		20.00	3·20	90
		21.00	3·00	90
	27	15.00	4·40	120
		16.00	4·00	120
		18.00	5·00	105
		19.00	4·80	105
		20.00	3·40	105
	28	17.00	3·50	105
		18.00	5·00	105
		19.00	4·30	105
	31	18.00	6·50	135
		19.00	5·80	120
		20.00	5·00	120
		21.00	3·30	105



(5 HR. 54 MIN. AHEAD OF G.M.T.)
FIG. 1 — JULY 1950.



AT POINT OF REFLECTION.
FIG. 2 — PREDICTED M.U.F. VIA F_2 LAYER DURING THE MONTH OF OCTOBER 1950.

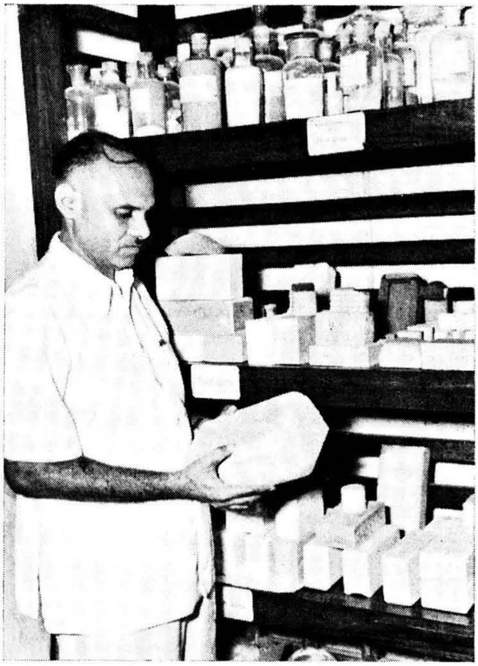
The Central Glass & Ceramic Research Institute, Calcutta, Opening Ceremony, August 26, 1950

THE Central Glass & Ceramic Research Institute, Calcutta, was declared open by the Hon'ble Dr. B. C. Roy, Chief Minister, West Bengal, on August 26, in the presence of a distinguished gathering of scientists, representatives of the glass and ceramic industry, officials of the Central and State Governments and prominent citizens of Calcutta. His Excellency Dr. Kailas Nath Katju, Governor of West Bengal, presided over the ceremony.

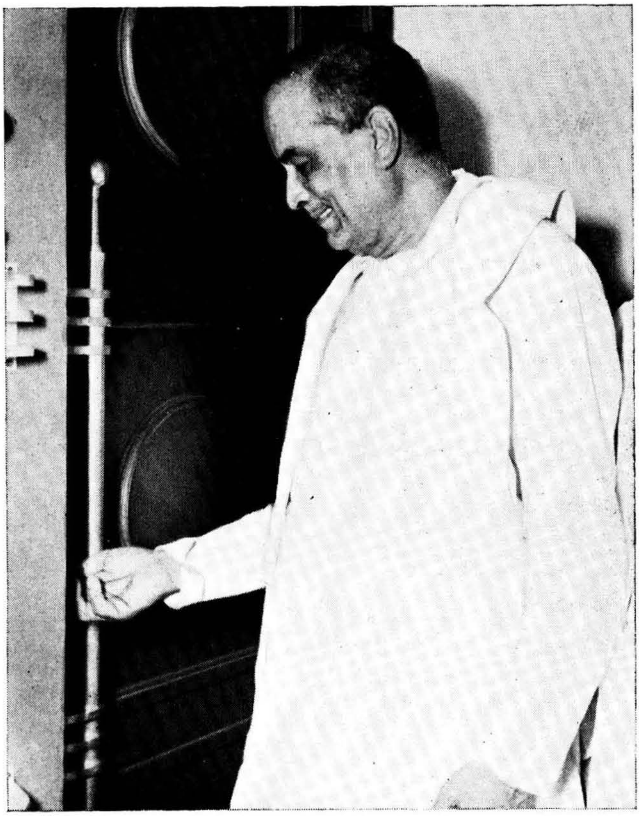
Fourth in the chain of National Laboratories to be declared open this year, the Central Glass & Ceramic Research Institute satisfies a long-felt need. Since the time of the Industrial Commission, 1918, the need for setting up a research institute was stressed by a succession of Tariff Boards, leaders of science and industry and scientific organizations. For the development of the Indian glass industry, two primary requirements were considered essential: trained workers, and scientific knowledge relating to materials, processes and techniques. Thanks to the efforts of the *Paisa Fund Glass Works* at Talegaon near Poona, a large number of skilled workers were trained and made available to the industry. This was of considerable assistance to the industry in the early stages of its development. Facilities for research and investigation and for training glass technologists, vital to the progress of the industry, were not so far available, and these have now been provided in an adequate measure by the new Institute, which owes its establishment to the zeal, foresight and energetic leadership of Dr. Shanti Swarup Bhatnagar, who initiated this project in 1942 and took measures necessary for its completion.

Dr. Shanti Swarup Bhatnagar, in his address, referred briefly to the developments which led to the establishment of the Institute. He had received considerable encouragement in the work connected with this project from Dr. B. C. Roy, Chief Minister of West Bengal, the late Mr. K. C. Roy, Secretary, College of Engineering and Technology, Jadavpore, and Dr. Meghnad Saha. He paid a warm tribute to the work of Dr. Atma Ram who, as Planning Officer and subsequently as Joint Director, contributed that zeal, industry and vision to the project which provided Calcutta " with a modern palace of glass — a real thing of beauty, which will instil inspiration in industry taking to scientific techniques of manufacture, and which will inspire our young men to contribute their mite to the success and progress of Indian industry ".

Situated on a spacious site on the Gariahat Road, close to the Jadavpore Technical College, the Central Glass & Ceramic



DR. ATMA RAM, JOINT DIRECTOR, CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE.



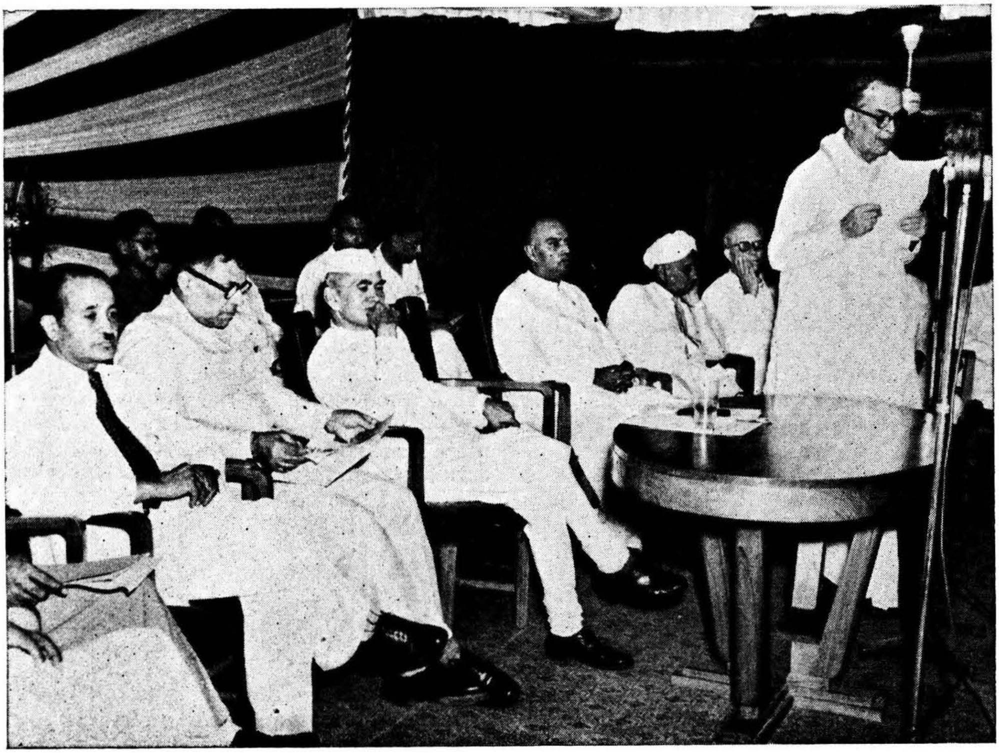
DR. B. C. ROY, CHIEF MINISTER OF WEST BENGAL, OPENING THE CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE.

Research Institute, with its imposing tower, is a carefully designed and well-equipped laboratory providing facilities for team work and for specialized research in glass and ceramics. It consists of two blocks, the Main Block comprising laboratories for precision work, the library and the museum, and the Technological Block comprising units for processing raw materials, furnaces and workshops. This imposing structure has many notable features. Special mention may be made of the glass doors made of bullet-proof armoured plates. The vestibule is decorated with a mural in cut glass depicting the glass blower's craft and an enamelled panel bearing the Council's insignia and the inspiring words of Pandit Jawaharlal Nehru: "Do it now! I am not interested in excuses for delays. I am interested only in things done". The museum, the entrances of which are curtained by artistic glass fabrics, houses, besides the raw materials and the finished products of the glass and ceramic industries, many rare exhibits of historic interest. Excavated pieces of ancient Indian art from Mohenjodaro and Harappa, glass articles of the Moghul, Napoleonic, pre-Victorian and Victorian periods, specimens of the historic articles from Westminster Abbey, Switzerland, France and Sweden provide an array of exhibits spanning the long stretch of man's evolutionary history. Of special interest to the man of science are a double-ended discharge tube belonging to de la Rive, a Woulfe's bottle used by Davy and Faraday, an original heavy glass prism made by Faraday, porcelain prisms, glass and semi-cylinders employed by Sir J. C. Bose in his investigations and a desiccator, a stone bottle and measuring cylinder belonging to Sir P. C. Ray. A specimen of glass produced by the first atomic bomb explosion at New Mexico has been presented to the museum by Chancellor Arthur Compton of U.S.A.

The subjects of study at the Institute include glass, pottery, porcelain, enamels, glazes, abrasives and refractories. Its functions will be to conduct fundamental research having a bearing on different aspects of glass and ceramics, testing and standardization of raw materials and finished products and dissemination of technical information. Special provision has been made for rendering technical assistance to industry for improving the quality of glass and ceramic products and to induce industry to adopt improved techniques of manufacture. Even during the incubation period, the Institute has carried out a large number of investigations for improving the quality of raw materials by such treatments as washing and magnetic separation. Researches on coloured glass, sintered glass and foam glass, are in progress. The work on foam glass is of particular significance as the product possesses thermal isolation and buoyancy and is expected to find use as a building material. It is proposed to put up a pilot plant to study the commercial aspects of foam glass production. With the limited facilities of staff and equipment so far available, the Institute has been rendering technical assistance to industry with regard to raw materials, processes and techniques and giving advice on plant lay-out, furnaces, etc. The work of analyses of raw materials and the testing of articles for serviceability is well organized and samples for examination and report are being regularly received. The Institute is equipped with a modern workshop and several items of equipment now in use have been designed and fabricated by the staff in the workshop. A sand washing plant of about $\frac{1}{2}$ ton per hour capacity and a percolator for treating casting slips have been presented to the Institute by *Messrs Hardy & Padmore* and *Messrs Rapid Magnetting Machine Co.* A section for making refractory parts has been organized and it is proposed to conduct trials on slip casting of pots required in the manufacture of optical glass. The Institute has been assisting the Indian Standards Institution in preparing standards for glass and ceramic products.

Declaring the Institute open, the Hon'ble Dr. B. C. Roy stressed the rôle of research in the development of the Indian glass and ceramic industry and the rôle of the Institute in improving the range and quality of products manufactured in India. He said: " It is not only necessary that the Institute should be well established in properly cons-

DR. S. S. BHATNAGAR, DIRECTOR, COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, ADDRESSING THE GATHERING.



DR. B. C. ROY DELIVERING HIS ADDRESS AT THE OPENING CEREMONY OF THE CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE.

tructed building and equipped with all the necessary paraphernalia, but it is also essential that it should be manned by the type of persons who would create enthusiasm amongst the trainees and confidence in those who would be benefited by the results of research. Dr. Atma Ram and his associates have established a reputation and I hope and trust that this Institute will have a succession of achievements to its credit."

In his message, which was read on the occasion by the Hon'ble Sri Hare Krushna Mahtab, Pandit Nehru referred to the scientific developments in the country during the past two or three years and pointed out: "it may be said with truth that we have laid, during this period, the foundations of scientific research on a firm basis. If these foundations are built upon properly and in the right spirit, I have no doubt that they will bear rich fruit in India." He hoped that the Institute will play an important rôle in developing not only the glass industry in India, but many of its ramifications, and nurture and spread the spirit of science.

There are at present 80 glass factories and 40 pottery works distributed all over the Indian sub-continent. A large majority of these are small concerns and the total value of their production is 3 to 4 crores of rupees. These industries provide employment to about 1,00,000 workers. Abundant raw materials required by the industry are available in the country, but the quality of the indigenous products is not uniformly satisfactory. India imports annually nearly Rs. 2 crores worth of glassware and Rs. 70 lakhs worth of chinaware and porcelain. The demand for imported goods is on the increase, and when in 1948 the Open General Licence was in force, the imports of glass and ceramic articles rose to Rs. 3·67 crores.

This serves as a pointer to the need for improving the standard of indigenous production. No improvement is possible without a clear understanding of the science and technology of glass manufacture and the activities of the new Institute would provide that understanding which would enable the industry not only to hold its own against foreign competition but also to make substantial new advances.

Outbreak of a Fresh Cycle of the Desert Locust

HEM SINGH PRUTHI

Director, Locust Control & Plant Protection Adviser to the Government of India, New Delhi

BEFORE describing the initiation of a fresh locust cycle in 1949, a brief account of the history of the previous locust outbreaks and main features in locust biology should be of interest. There are about half a dozen species of locusts found in the world of which three occur in India; of these, the Desert locust,* *Schistocerca gregaria* Forskal, is the most important. India, like some other countries, has been, from times immemorial, subject to periodical visitations of locust swarms. Comparatively authentic records of locust swarms are available only since the beginning of the nineteenth century. Outbreaks occurred in 1812, 1821, 1834, 1843, 1863, 1869, 1878, 1889 and 1896-97. In the present century, the locust was active during 1901-3, 1906-7, 1912-15, 1926-31 and 1940-46. Thus there is a certain amount of periodicity in locust outbreaks when swarms appear and cause incalculable damage and destruction to crops, resulting sometimes in severe famines. Due to lack of fodder and pasture, there is also heavy mortality among cattle, goats and sheep and sometimes people have to leave their homes in search of livelihood elsewhere. During the 1926-31 cycle, which was of moderate intensity, direct losses to crops alone amounted to about 10 crores of rupees in spite of some expensive control measures undertaken. In view of India's food position, the locust epidemic at this juncture is full of evil potentialities.

Generally locust invasions are confined to north-western India, but in some years the swarms spread as far as Bengal and Assam in the east and Madras in the south. The Desert locust is, however, an international pest. The areas where this locust remains and breeds permanently lie in a vast desert tract, extending from Hissar district of the Punjab and Rajasthan in India, through Pakistan, the Middle East countries, eastern Africa, Sudan and up to the west coast of Africa. Investigations carried out in India for about eight years (1931-39) under the *Indian Council of Agricultural Research* have shown that permanent breeding grounds of this locust on the Indian continent are mostly in the sandy regions of Hissar, Rajasthan, Cutch, etc., in India proper, Thar district of Sind, Khairpur Mirs and Bhawalpur States and the coastal areas of Lasbela and Baluchistan in Pakistan. These otherwise dry and desert tracts become green with wild vegetation after rainfall and afford food to young locusts. Generally the locust population is low and the general public and even the cultivators are hardly aware of it. When thus scattered about and rather inactive in movement, the locusts are said to be in the solitary phase. However, if the rainfall is abundant in the permanent breeding grounds and other meteorological conditions are favourable, the

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*The other two locusts are the Bombay locust and the Migratory locust.

locusts multiply very rapidly, giving rise to immense swarms which fly actively, leave their desert homes and invade not only the neighbouring parts of the country, but go into adjoining countries as well. Locust swarms have been visiting all countries of southern Europe and U.S.S.R., the major part of the African continent, all the Middle East countries, Afghanistan, etc. The active phase of locusts in which they have the tendency to move in mass flights is the swarming or gregarious phase.

General Biology of the Locust : Phase Characteristics

The locust, like the common grasshopper, has three distinct stages in its life history : (1) egg ; (2) hopper — the young wingless individual, which hops about ; and (3) adult or flier, when wings are fully developed.

The freshly emerged fliers in the swarming phase are pinkish in colour. After a fortnight or 3 weeks (during late spring and summer), they become sexually mature, when they assume a distinct yellow colour. The adult locusts of the solitary phase are grey and become only slightly yellow when mature.

The adult locusts, though active during the day, do not usually fly during the night and on cloudy days. After sunset they settle down on crops and trees and feed on them. Most of the damage is thus caused between dusk and morning.

The female lays eggs in moist, sandy or sandy loam after drilling a 3″ to 6″ deep hole with its abdomen. Hot and moist conditions are necessary for egg-laying. Eggs are not laid during winter and the adult locust over-winter and lay eggs in spring. During her lifetime, a female can lay as many as eleven clusters, each containing 60 to 120 eggs, at an interval of about one week, so that the total number of eggs laid by a female may be about 800. The rate of mortality at the egg and hopper stage is low. In fact there are very few natural enemies or diseases which effectively keep down the locust population.

The eggs resemble rice grains in size and shape. They hatch in about 10 to 14 days in summer and in 3 to 4 weeks in spring and autumn, depending on soil temperature and moisture content. The hopper or wingless stage lasts from 6 to 8 weeks in spring and about 5 weeks during summer depending on the prevailing temperature and humidity conditions.

The characteristics of the two phases of the locust may be briefly described. In general, the colour of the hoppers in the gregarious phase is black in early stages but later on it turns yellow or pinkish with distinct black markings. The solitary hoppers are generally green but vary in colour depending on the colour of the surrounding vegetation. For example, on "booh" (*Arena javanica*) the solitary hoppers assume an ashy hue and those found on "bajri" (*Pennisetum typhoideum*) or "wekra" (*Indigofera cardifolia*) are green. The colour of the freshly developed adults or fliers in the gregarious phase is pink, gradually turning to grey and finally yellow when sexually mature, unless they get scattered. The adults of the solitary phase remain grey even when sexually mature, but when they get crowded the colour turns yellowish.

There are three important anatomical features which distinguish the two phases. In the gregarious phase the ratio between the length of elytra and that of hind femur is over 2·15 ; in the solitary phase this ratio is about 2·05. In the intermediate specimens, the ratio varies between the two limits. There are invariably 6 eye-stripes in the gregarious phase, whereas they are generally 7, sometimes 6 and rarely 8 in the solitary phase. Similarly, whereas in the gregarious phase the number of antennal segments is 26, in the solitary phase it is 27 to 30.

Breeding Seasons & Swarm Migration

Locust breeding depends very much on rainfall as the eggs are laid in sandy soils which have sufficient amount of moisture for proper incubation and hatching of eggs. There are generally two breeding seasons during the year, namely the spring and monsoon. In some countries in the locust belt the rainfall is received mostly during winter and early spring, e.g. in south-eastern Arabia, Red Sea coastal areas, southern Iran, Baluchistan, etc. In such areas the locust breeds in the spring season and there may be one or two broods and generations. For example, in Baluchistan breeding starts in January and again in April. In India, Anglo-Egyptian Sudan, etc., where the rainfall is received mostly in the summer and monsoon seasons, locusts breed during these seasons. However, when there is spring rainfall and the soil conditions are suitable for breeding, as is often the case in the Punjabs (P. and I.), breeding takes place during spring also, if swarms are present.

The swarms produced during spring and early summer in the Middle East and Baluchistan (winter-rainfall countries) usually fly eastwards into Sind, Punjab, Rajasthan, Uttar Pradesh, etc., during May, June and July. They are, however, mostly concentrated in Sind, Khairpur, Bhawalpur and Rajasthan. In the wake of the monsoon rainfall these swarms of locusts lay eggs and breed up to about the middle of September and even October and November if the rainfall continues to be favourable and the temperature is fairly high as was the case in 1949. Thus, as in the spring and early summer period, there can be two generations during the monsoon and autumn. Many of the new swarms, produced as a result of monsoon breeding, fly westward into Baluchistan, Persia, eastern Arabia, etc., where they breed again in the spring of the year following. However, a number of swarms developed in Rajasthan, Sind, etc., also fly in the northern, eastern and southern directions and thus invade all parts of India and damage *kharif* crops over vast areas. The swarms are yet not known to States beyond U.P. and Madhya Bharat and those going there eventually die off. Some swarms may over-winter in northern India and when conditions are favourable in the next spring, they breed and damage *rabi* crops. In the summer they are joined by migrants from Baluchistan and other spring breeding areas. Thus the multiplication of swarms continues from season to season and year to year, the breeding becoming progressively more intense and extensive and thus the cycle gets into full swing. When conditions either in the spring or monsoon breeding areas become unfavourable for active breeding, or there is heavy destruction of locusts in any zone, there is a decrease in the number and size of swarms and general decrease in the locust population. Ultimately, when conditions become unfavourable for rapid breeding throughout a year, or control measures are successful both in spring and monsoon breeding areas, locusts get scattered and revert to the solitary phase. However, even in the solitary phase, locusts keep on breeding on a negligible scale and undergo seasonal migrations as scattered locusts. When general ecological conditions for mass multiplication of locusts become again suitable in any part of the belt, the locust changes into the gregarious or swarming phase, and there is an outbreak of a fresh cycle.

Swarming Phase in 1949

After the last cycle ended in India in 1946, no locusts of gregarious phase were noticed in this country and the population of solitary individuals also remained low for about two years. However, there were fluctuations in their population because of seasonal migration of locusts from western countries, viz. Baluchistan, Persia, east Arabia, etc., into India from May onwards and their emigration in the opposite directions in the autumn.

After a lull in locust activity during 1947 and 1948, gregarious breeding took place in some parts of east Arabia in March 1949, giving rise to swarms. Similarly, in April of the same year, gregarious breeding was noted in Baluchistan. Gregarious breeding was observed also in some parts of northwest Africa.

A sudden rise in locust population in India was observed towards the end of May, the population rising to about 800 locusts per sq. mile in some localities. Some locusts of the gregarious phase were met with, and these had obviously come from western countries. This infiltration continued during June and July, and the maximum population of 19,200 locusts per sq. mile was observed on 13th July at Kaki (Bikaner).

The monsoon broke out in the second half of June. Rainfall was heavy and extensive in some parts of Rajasthan, Jodhpur having recorded 739 cents, Barmer, 1313, Phalodi, 1363, Jaisalmer, 477, Bikaner, 1113 and Sikar, 1220. During June, the rainfall was mostly concentrated in Jodhpur (Phalodi area) and Bikaner districts (Kaku-Bhadla area). In August-September, the western districts also received heavy rainfall.

After the first shower of rain, locusts became sexually mature and started laying eggs by the end of June. Hoppers were fairly grown up in the last week of July in Kaku-Bhadla-Hansasar area of Bikaner and Ajasar-Rohena area of Phalodi. Control operations were organized against a huge population. The survivors which escaped destruction in these areas moved about and got scattered, raising the population in the neighbourhood. A maximum of about 9,000 per sq. mile was reached during August at a few localities. Late migrants (end of July) also laid eggs, and the second brood was located in Amla area (Phalodi) and Loia-Hadda-Bholasar area of Kolayatji (Bikaner) during September-October. By the end of September, a yellow swarm entered Jaisalmer from the north-west (Pakistan) and apparently laid eggs in the western parts of Jaisalmer and moved into Khairpur Mirs. Large bands of hoppers were discovered in north-west Jaisalmer extending from Kishengarh to Shahgarh over a gross area of about 400 sq. miles near the Indo-Pakistan border. Some breeding was also observed at one locality in eastern Jaisalmer in the middle of October. There was breeding during October in west Bikaner also (Bikaner and Anupgarh tehsils) covering an area of about 250 sq. miles near Bahawalpur State. Control operations were soon organized and the situation brought under control ; only a couple of small swarmlets could develop in Jaisalmer and Bikaner areas. The operations were concluded in the first week of December.

Simultaneously, breeding occurred during October in the desert area of Bahawalpur and Khairpur Mirs States and Thar district of Sind, where the locust breeds at the same time as in Rajasthan. This was detected by Pakistan's Locust Organization early in September (in the Chachhro area) after which control operations were organized. As it was widespread and had extended into the remote corners of the desert area, such as south-east Bhawalpur and east Khairpur Mirs, many concentrations appear to have escaped destruction and hoppers fledged into adults. The tendency of hoppers, which bred along the Indo-Pakistan border, was to migrate towards east and south and thus big concentrations were found coming into Kishengarh, Tanot and Shahgarh tehsils of Jaisalmer district during October-November, requiring large-scale operations and, therefore, involving the aid from Defence Forces of the Government of India.

Locust Situation in 1950

India was free from swarms during the winter. However, one swarm came into Jaisalmer from Pakistan towards the end of January but it went back after a couple of days. In Pakistan several swarms were present throughout the winter and spring. Some swarms were observed in southern Iran also. Breeding took place on a fairly extensive scale in D.I. Khan district of N.W.F.P. and several districts of Western Punjab, viz. Mianwali, Khushab, Muzaffargarh, etc. Hoppers were noted from the beginning of March onwards. During April-June, breeding took place on a fairly extensive scale in northern Baluchistan also. Control measures were undertaken by the Pakistan Organization, but apparently several hopper bands escaped destruction, particularly in western Punjab. It is reported by the Director of Plant Protection, Pakistan, that during spring breeding was in progress in parts of Afghanistan bordering on N.W.F.P. and that many swarms developed in that area. The breeding areas are shown in Fig. 1.

In the second week of May, a number of swarms entered India from the Pakistan side. The invasion was in full swing up to about the middle of July and some locusts came in later also. The swarms visited almost all districts of East Punjab, PEPSU, Rajasthan, Saurashtra, U.P., Madhya Bharat, etc., the easternmost limit being Patna and Ranchi in Bihar. In the southern direction, they reached some northern districts of Madhya Bharat. With the onset of the monsoon, the swarms which had gone into Bihar returned to U.P. (Fig. 1). Similarly, there was a check to their further movement in the southern direction. The swarms got concentrated in Rajasthan and from the second week of July the activity of swarms started declining. This was mainly due to the fact that in the wake of good rainfall swarms were settling down to breed. Egg laying was reported from several parts of Rajasthan since the middle of July and hoppers started hatching out at several localities from the 23rd or 24th of that month. It is feared that extremely heavy breeding will take place during this season in Rajasthan. Unless the pest is destroyed in hopper stage, India will be overrun by swarms which would develop during September.

Anti-locust Campaign

Anti-locust Organizations — The success of a locust campaign depends on two factors, viz. (i) anti-locust organization ; and (ii) efficacy of methods of locust destruction. The former is administrative and the latter technical. Both are equally important. Technical work includes, besides measures for destruction, locust intelligence, such as

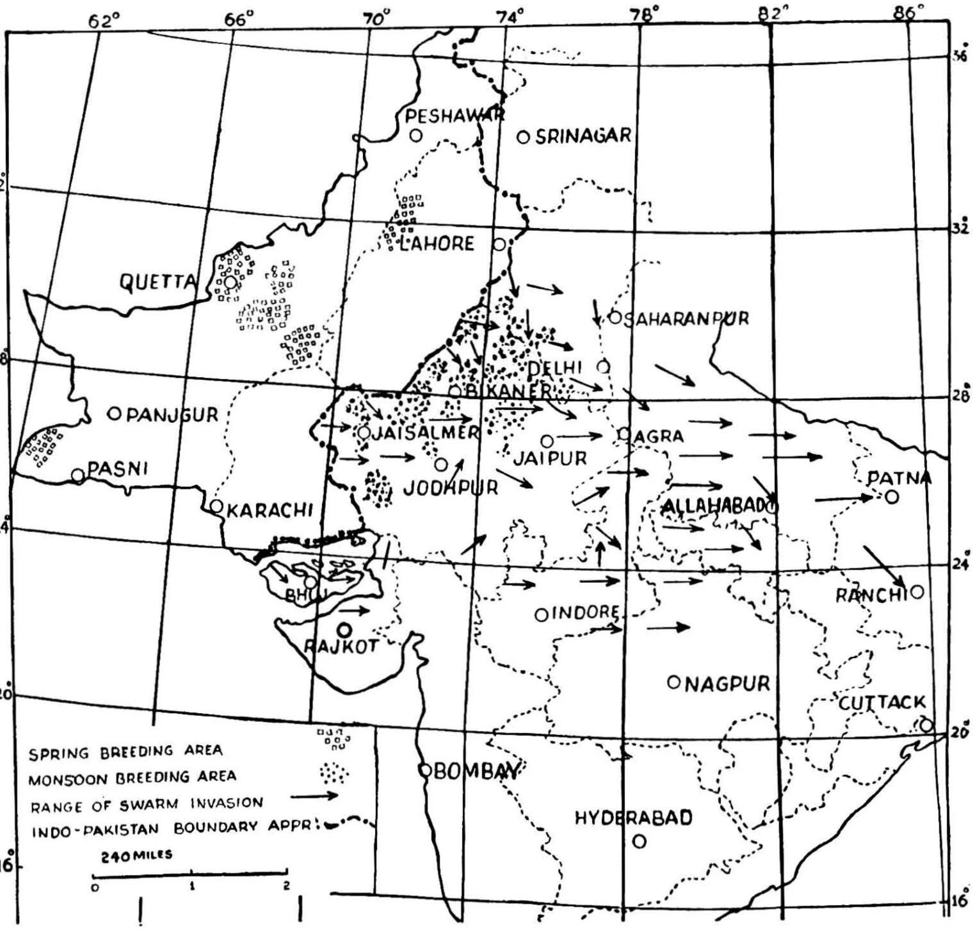

FIG. 1 — LOCUST SITUATION IN 1950.

collection of information regarding the time of swarm migration, their sites of resting, breeding and development. On the basis of such information control equipment is moved and labour arranged to carry out control operations in time.

Since locusts breed often far away from inhabited tracts, the work of collecting information on their occurrence, movements and actual breeding has to be carried out mostly by rural authorities and villagers under the guidance of trained technical staff. Officers of the revenue, police, forests, excise, railways, etc., work in rural areas, and since for locust control operations timely recruitment and movement of labour and transport of equipment have to be ensured, the primary responsibility for such work falls on the Revenue Department and its village officers, viz. *Patwaris*. Other departments, however, are also important because the normal duties of the officers lie in rural areas and they can render valuable assistance in the collection of locust information and in educating villagers in anti-locust measures. It is, therefore, essential that every State should enlist the assistance of all officers belonging to various departments as an integral part of its anti-locust organization and arouse the interest of all inhabitants.

For purposes of technical work, the Indian States can be divided into two parts. The permanent breeding grounds of the locust are the desert areas of Rajasthan and the neighbouring parts of Punjab (Hissar district), PEPSU, Saurashtra, Bombay, etc. In such permanent desert breeding areas in which foreign swarms generally breed initially, multiply and thence spread to other States, the responsibility for technical work is that of the Central Government. The Government of India are maintaining a permanent Locust Warning Organization, the staff of which is posted at strategic points in the main permanent breeding areas, with a substation at Jodhpur. This Organization works under the control of the Director, Locust Control, and Plant Protection Adviser to the Government of India, Ministry of Agriculture, keeps close watch on fluctuations in locust populations in the permanent breeding grounds even when the locust is not active and studies the changes in locust phase from solitary to gregarious and vice versa. In order that control measures may be organized by all States as soon as there are signs of increase in locust activity, the Director, Locust Control, at New Delhi, issues weekly or fortnightly reports which describe locust situation and contain timely warnings. He also keeps a close watch on the locust situation in other countries in the belt which, as already explained, extends up to west Africa. This is essential in order that India as a whole may be in a position to anticipate the approximate time of outbreak of a locust cycle in any area in the belt. When a cycle breaks out, similar studies on a more intensive scale have to be undertaken in order to determine the time and direction of swarm invasions from foreign countries. Within India also the Central Locust Warning Organization has to intensify its surveys. This organization is considerably expanded to cope with the increase in intelligence work. Villagers and rural officers also assist in this work.

As regards the actual destruction of the pest in desert breeding areas, a Control Wing is added to the Central Organization for conducting and supervising control operations which are carried out in close co-operation with the officers of Revenue and other departments of the States concerned.

In the States in which permanent desert breeding areas do not exist, such as the U.P., Madhya Bharat, etc., anti-locust work starts when a locust cycle actually breaks out. The technical authorities in these States are kept informed by the Director, Locust Control, Government of India, of the changes in locust population in permanent breeding areas in India and abroad even when the locust is in the solitary phase. During a cycle, the anti-locust work in a State has to be carried out by the rural departments and the technical department of the State concerned on the same lines as in the permanent breeding areas. Similar arrangements have to be made in the cultivated areas of Rajasthan and other States which contain permanent desert breeding areas. Since the locust situation is inter-dependent in various States of India, in the same way as the locust situation in the country as a whole is dependent on the situation in other countries in the locust belt, the anti-locust work in India has to be co-ordinated by a single all-India authority. The Director, Locust Control, and Plant Protection Adviser to the Government of India, Ministry of Agriculture, is entrusted with this work.

The Government of India have expanded considerably their Anti-locust Organization during 1950. The budget for locust work during 1950-51 is about 10 lakhs of rupees as against 1½ lakhs of rupees budgeted during 1949-50 before the outbreak of the cycle. This figure, however, includes cost of 18 new light trucks, 6 land rovers fitted with power-operated dusting machines, about 700 hand-dusting machines, etc. About 30 outposts have been established in Rajasthan and in adjoining States. Additional staff has been appointed and the Locust Warning Organization has the same strength now as during the previous cycle of 1940-46. It will be recalled that during the previous cycle a part of the expenditure incurred (cost of labour, pesticides, etc.) in desert breeding areas was distributed among the beneficiary states. This time, however, Government of India have agreed to finance the entire scheme for at least one year. Such expenditure during the current year is estimated to be about Rs. 4 lakhs.

All non-desert States, particularly those adjoining Rajasthan, Punjab, Madhya Bharat, U.P., PEPSU, etc., have also established Anti-locust Organizations and have equipped them with pesticides and appliances. Locust breeding in these States is not likely to be extensive or menacing because the majority of swarms have got concentrated in desert areas as described above.

Nodular Cast Iron—Literature Report No. 10

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IT is well known that graphite in cast iron has a very marked effect on its properties. In the basic metal structure of grey cast iron graphitic carbon is distributed in the form of flakes the size and shape of which vary according to composition, cooling rate, method of melting, etc. It is this flaky graphite structure which breaks the continuity of the matrix and is responsible for the poor mechanical strength of grey cast iron. When cast iron is under stress, intense local stresses develop at the edges of the flakes which may exceed the elastic limit, resulting in local distortion or strain. This effect has marked influence on the physical properties of the iron. The low tensile strength as well as the high fatigue ratio and good damping capacity are also attributed to it. In malleable cast iron these drawbacks have been overcome by annealing white cast iron. The metal, after it is cast, is annealed so that roughly spheroidal aggregates or nodules of graphitic carbon are formed.

Thus, the mechanical properties of grey cast iron could be considerably improved if the graphite in the metal could be had in the nodular form instead of being flaky. Recent investigations at the laboratories of the *British Cast Iron Research Association* have led to the development of a new process for producing cast iron containing nodular graphite in the as-cast state. No annealing treatment is necessary to obtain this structure. The nodular graphitic structure in the iron is achieved by the addition of suitable quantities of cerium to the molten metal of suitable composition. More recently certain American investigators[1,2] have been able to obtain this structure by the addition of magnesium. Morrogh[3-6] claims that under appropriate conditions both processes will produce grey iron castings with all the graphite in the nodular form, giving the finished casting superior mechanical properties.

The new product resembles malleable iron in having a nodular graphitic structure, but has not the same properties as malleable iron which can be subjected to considerable deformation and distortion prior to fracture. According to Pearce[3-7], this nodular iron is a new product between ordinary grey iron and malleable iron and may be regarded as a high-duty cast iron with special qualities rather than as a new form of malleable iron. The material, however, possesses the properties of the present high-duty cast irons in use and is readily castable and machinable.

Nodular Iron by Cerium Additions

Irons having under-cooled graphitic structure are found to be suitable for this purpose, since they solidify and graphitize immediately after solidification.

Morrogh and Williams[4,8] have studied the nickel-carbon and cobalt-carbon systems and showed that it should be possible to obtain nodular structures in cast irons by the addition of a carbide-stabilizing element to retard carbide decomposition. The element added should be a desulphurizer also. Low sulphur content very likely assists in achieving the desired structure.

It was found by Morrogh and Williams[4] that addition of cerium to cast iron of appropriate composition would produce spherulitic nodular graphitic structure.

Cerium metal could be added as such to the molten metal. It can also be added in the forms in which it is commercially available. Misch metal, containing between 43 and 50 per cent cerium together with other rare earths and a little iron and manganese, has also been employed. Misch metal dissolves readily in cast iron at all temperatures above 1,200°C. Its solution in cast iron is not violent or explosive. Misch metal is produced from monazite sands. The composition of a standard alloy of this type is cerium, 50-55 per cent; lanthanum, 22-25 per cent; neodymium, 15-17 per cent; iron 0·5-3 per cent; and the rest 8-10 per cent consisting of other rare elements.

The cast iron employed should have the following characteristics and composition: (1) the iron must solidify grey even without cerium addition ; (2) the carbon content should exceed the value $4{\cdot}3-1/3(\%Si+\%P)$; (3) silicon preferably about 2·3-7 per cent ; (4) sulphur content should be as low as possible and after treatment should be below about 0·015 per cent ; (5) phosphorus content should not exceed 0·6 per cent and preferably below 0·1 per cent ; and (6) manganese, copper and nickel, chromium and molybdenum may be present in small amounts singly or in combination, provided condition (1) is observed.

Cerium, when added to molten cast iron, first combines with the sulphur present and acts as a desulphurizing agent. As long as the sulphur content of the metal is above about 0·015 per cent, this desulphurizing action will take place. When the sulphur content is reduced to about 0·015 per cent, metallic cerium goes into solution in the molten cast iron. The cerium content at this stage should exceed 0·02 per cent of the metal to induce the formation of nodular graphitic structure.

The structure and cooling curve data of cerium-treated nodular irons, in which special care was taken to ensure that sufficient cerium remained in the cooling ingot, have been examined by Morrogh and Williams[5]. They observed that on slow cooling to room temperature the samples showed well-developed hypereutectic spherulites with quasi-flake graphite. The sample was found to be completely graphitized when it is quenched from 1,087°C. and has the same graphitic structure as the slowly cooled specimen. The samples quenched just after complete solidification (i.e. about 1,140°-45°C.) were found to be substantially white with some small and some large graphite spherulites.

Nodular Graphite by Magnesium Addition

Donoho[1] has described the results of the investigations conducted at the *American Cast Iron Pipe Co.* on the use of magnesium. Suitable precautionary measures have to be taken while carrying out the addition of magnesium since magnesium in any form may be violently explosive. Nodular cast iron can be produced by adding pure stick magnesium on to the surface of iron in the ladle, but 95 per cent of magnesium may be lost. In spite of this, with an addition of 1 per cent of magnesium, sufficient metal may be retained to produce the nodular graphite structure. One practical method of adding magnesium in the ladle is to use an alloy in which the magnesium is diluted to make the mixture non-explosive. It has been observed that the 80 per cent copper and 20 per cent magnesium alloy is not explosive but burns quietly on the surface of the metal. This alloy appears to be suitable for use in a commercial foundry. More efficient methods of adding magnesium have still to be developed. The results can be summarized as follows : (1) high-strength cast irons with the graphite in the nodular form are produced by incorporating 0·03-0·10 per cent of magnesium ; (2) pure magnesium and several magnesium alloys are effective in producing nodular graphite irons ; (3) magnesium recovery and convenience of addition were found to be better with copper or nickel alloys of low magnesium content ; (4) advantages of magnesium treatment over cerium treatment are that magnesium is effective in low carbon, high phosphorus and relatively high sulphur irons ; (5) ladle addition of a graphitizing inoculant (such as ferro-silicon) after the magnesium addition is useful for controlling the structure and machinability of nodular irons. A granular graphite inoculant, however, causes reversion to flake graphite ; (6) there is an optimum magnesium content for a given iron ; too little magnesium results in a mixed structure and too much of magnesium causes increased hardness and brittleness ; (7) excessive holding time after magnesium treatment may result in loss of magnesium and reversion to flake graphite ; and (8) tests on keel block test bars of magnesium-treated cast irons gave strength-ductility properties superior to most malleable irons and approaching those of cast steels.

Properties

Table I gives the mechanical properties of nodular cast iron (obtained by treating with cerium) with those of untreated iron.

TABLE I

MATERIAL	TENSILE STRENGTH RANGE (tons/sq. in.)	SHOCK RESISTANCE (ft. lb.)	BRINELL-HARDNESS NUMBER
Untreated cast iron	24-28	25-50	250-400
Nodular cast iron	17-60	25-120	130-500

The endurance or fatigue strength is markedly improved in nodular cast iron. This superior endurance may be explained by the fact that there is a reduction in the severe internal notch effect arising from the flaky graphite structure. This improvement is an important result of the change in structure. The heat and growth-resistance properties also show marked superiority in nodular cast iron. Flake graphite makes the grey iron easily oxidizable and it is found that grey irons are susceptible to destructive growth at high temperatures. The machinability of nodular cast iron is generally superior to that of grey iron. The material can also be readily welded following the techniques established for grey irons. Casting quality of nodular cast iron is excellent. Fluidity is about the same as grey iron of like composition. It is, however, observed that spherulitic iron has a distinct tendency towards piping.

Applications

Nodular cast iron constitutes a new high-duty cast iron with great flexibility in its mechanical properties. The product bridges the gap between cast iron and cast steel. In the cast condition it is a superior cast iron of high strength, high elastic modulus and good ductility. It can be heat treated to improve its properties further and bringing it close to cast steel. An important feature is its low cost.

The material is likely to have numerous applications in the automobile and agriculture implement industries and in the manufacture of castings for use in railways. Crankshafts, pumps, compressors, valves and heavy industrial equipment, such as rolls, rolling mill housings, are other instances where the high strength and rigidity of the new material may be useful. It may also find application in the manufacture of pipes, textile and electrical machinery, marine equipment, etc.

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Inventory of Research Equipment & Materials

The UNESCO Science Co-operation Office for South Asia at Delhi is undertaking to compile an inventory of research equipment and materials available in universities and other research laboratories in the region. The information so collected will help scientists in formulating plans of research and to facilitate co-operation among workers interested in any particular branch of research. The inventory would give an idea of the present condition and the future needs of scientific materials in this region and help to promote closer co-ordination in research and development on an international scale.

The survey will cover only specialized apparatus and will include information on apparatus, manufacturer, date of procurement, price or estimated cost and its present condition and serviceability. Rare chemicals isolated from natural sources or synthesized artificially including enzymes, hormones and other biologicals not available commercially and pure cultures of micro-organisms collected and maintained in the region will constitute another list. It is proposed to include mainly those types of cultures which are intended for special studies or for industrial research.

Additional points of information on which data should be collected are invited by the UNESCO Science Co-operation Office for South Asia, University Buildings, Delhi.

The Distribution of Anthocyanins*

R. WILLSTATTER (1913-1916), the most important of the pioneers in the field of anthocyanins, isolated many of these colouring matters in a pure condition and proved that they are glucosides of the colour nuclei, the anthocyanidins. The botanist Molisch (1905) was actually the first to show that the anthocyanins could be crystallized outside the plant. In 1907 a synthetic method was discovered in Perkin's Laboratory in Manchester, of quite general applicability to the whole group of benzopyrylium salts, of which the anthocyanins were later shown to be members. In spite of many difficulties, eventually Robinsons and his co-workers were able to synthesize all the anthocyanidins and the more important anthocyanins.

The anthocyanins are isolated in the form of oxonium salts, usually the chloride, and on hydrolysis with hot 10-15 per cent hydrochloric acid they break down into anthocyanidin chloride and glucose or other sugars. The three chief anthocyanidins are pelargonidin, cyanidin and delphinidin. In addition a methyl ether of cyanidin (peonidin) and three methylated delphinidins, malvidin, petunidin and hirsutidin, are known.

In monoglucosidic anthocyanins the sugar is always attached to the hydroxyl in position-3. The monoglucosides of pelargonidin, cyanidin and malvidin are callistephin, chrysanthemin and oenin respectively. The 3-galactoside of cyanidin is idaein. The diglucosidic anthocyanins may be 3-biosides, e.g. mecocyanin is cyanidin 3-gentio-bioside and antirrhinin is cyanidin 3-rhamnoglucoside. In an important group, glucose units are attached to different hydroxyls. The 3 : 5-diglucosides of pelargonidin, cyanidin, delphinidin and malvidin are pelargonin, cyanin, delphin and malvin respectively.

The properties of the individual anthocyanins are highly characteristic and distinctive and the possession of pure synthetic samples afforded an essential basis of comparison. This applies not only to the recognition of known anthocyanins in plant material but also to the study of any anthocyanin exhibiting unusual behaviour. The most generally useful properties are, however, the " distribution numbers " between immiscible solvents and various colour reactions, especially because the study of these does not always necessitate the isolation of the pigments in a pure condition. The ferric reaction, a deep-blue colouration produced in neutral or slightly acid solutions, either aqueous, alcoholic or amyl alcoholic, indicates free hydroxyls in positions -3′ and -4′ and is, therefore, positive for cyanidin, petunidin and delphinidin only. Petunidin and delphinidin alone are at once destroyed by aerial oxidation in alkaline solution. This serves to distinguish petunidin from cyanidin. The behaviour of anthocyanidins and anthocyanins in solutions of varied *p*H depends on the number and position of the hydroxyl groups and is largely independent of the nature of other substituents. The presence, however, of co-pigments has a large effect.

The most striking result obtained on the chemical side is the prevalence of the anthocyanins based on the three main types, pelargonidin, cyanidin and delphinidin. There are just a few exceptions. Gesnerin, the anthocyanin of *Gesnera fulgens* (orange flowers), is one such. The anthocyanidin was soon recognized as one that had already been synthesized (5 : 7 : 4′-trihydroxy flavylium chloride) and then the anthocyanin itself (5-glucoside) was synthesized. This is the first case noted of the occurrence of an anthocyanin with no substituent in position-3. To this category belongs carajurin, the main constituent of the rare cosmetic pigment " Carajura ". It is the colour base of carajuridin chloride (5 : 4′-dimethoxy-6 : 7-dihydroxy flavylium chloride). This may originate from an anthocyanin similar to gesnerin.

A very important group is that of the nitrogenous anthocyanins easily distinguished from the usual types by their quite different behaviour. The best-known example is betanin in the common beet but the group is

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* Summary of the Dr. Bimala Churn Law Lecture delivered by Prof. Sir Robert Robinson, in January 1950, at the Indian Association for the Cultivation of Science, Calcutta.

fairly well represented. Little is known about the chemistry of these colouring matters but the composition of two of them suggests that they may be ordinary anthocyanins in which amino acid residues are attached to the benzene rings by means of the amino group. Synthetic compounds of this type have been made and show similar properties.

The nitrogenous anthocyanins are found in five related orders only. Similarly, there are certain families which produce only one of the three main types, although there are many others in which only two occur and still others in which pelargonidin, cyanidin (or peonidin) and delphinidin (or its methyl ethers) all occur. The occurrence of pelargonidin and delphinidin in the more differentiated plants suggests that the pigments themselves require more steps for their synthesis.

The usual anthocyanins are found in young fern fronds together with some of unusual constitution not yet identified. Anthocyanins are normal constituents of green leaves. Permanently pigmented leaves contain pelargonidin, cyanidin or delphinidin derivatives and autumnal reddening in the vast majority of cases is due to cyanidin glucosides.

It appears that many plants have at hand a ready mechanism for the production of anthocyanin and it is incredible that this should have no deep physiological significance. We do not yet know what this function is. Different parts of the same plant yield different anthocyanins. A variety of Nasturtium (*Tropaeolum majus*, Empress of India) was found to contain pelargonidin 3-bioside in the petals, cyanidin 3-bioside in the sepals and a delphinidin diglucoside in the leaves, indicating that the three types are derived by modification of a common precursor. The conviction that this precursor is changed most naturally into cyanidin glucosides is based on the almost universal appearance of these under conditions of stress (injury, drought, etc.) but it is also derivable from a statistical survey of the colours of flowers.

The influence of climatic conditions is very marked ; there is a high proportion of delphinidin derivatives among Alpine flowers and a preponderance of pelargonidin derivatives in those growing in tropical and subtropical countries.

Finally, there is the very interesting class of leuco-anthocyanins which yield anthocyanidin on treatment with alcoholic hydrochloric acid in presence of oxygen ; the distribution of these colourless substances is very wide. They are nearly always to be found in woods, nutshells as well as in softer structures. Most leuco-anthocyanins are convertible into cyanidin, but some give pelargonidin and some delphinidin.

All related types, catechins, flavones, flavonols, leuco-anthocyanins and anthocyanins are regarded as different manifestations or modifications of a proto-type, a $C_6.C_3.C_6$ structure. It is assumed that this type is derived from two molecules of hexose and one of triose. The linking by aldol condensations requires one of the terminal nuclei to be less oxidized than the other and, in fact, cyanidin is the natural result by dehydration without oxidation or reduction.

The genetics of flower colour is a subject demanding full and separate treatment. Dr. Scott-Moncrieff has suggested as the result of complete genetic study of dahlia that the anthocyanins are produced from two substances, one of which is always present in sufficient amount and the other in limited amount. The relation of this to $C_6.C_3.C_6$ hypothesis is evident, because the substance present in limited amount is presumably the $C_6.C_3$ intermediate. One clear outcome of this work is a definite indication of a relationship between anthocyanin production and flavone production. If the limited component is used to make much flavone, it is not available for anthocyanin and vice versa. There are also intermediate positions and this is very important.

The geneticist can do chemical experiments *in vivo* ; by introducing a new gene, for example, a methylation factor, he can observe its operation on a new anthocyanin. It is probably from researches in this field that we shall get the fullest knowledge of chemical processes affecting anthocyanins.

Finally, attention should be drawn to the existence of complementary genes, the presence of both of which is necessary for the development of anthocyanin. Two further complementary genes are necessary for the production of anthoxanthins. The chemical basis of these and similar phenomena is quite unknown.

Indian Salt Industry

THE Report of the Salt Experts' Committee constituted by the Government of India in April 1948 to advise the Government on the measures necessary to put the salt industry on a sound footing has been recently published. In an exhaustive survey, covering all aspects of the industry, the Committee have suggested measures to increase the production, improve the quality and reduce the cost of salt manufactured and make the country self-sufficient within a reasonably short time.

The production of salt in India has increased from 12,12,000 tons in 1930 to 23,31,000 tons in 1948. The production figures for the two years at different centres and the target figures for 1955-56 are given in Table I.

TABLE I

	1930-31 (tons)	1948 (tons)	TARGET FOR 1955-56 (tons)
Inland Works			
(i) Sambhar	2,73,000	3,16,000	9,46,000
(ii) Didwana	20,000	47,000	
(iii) Pachbadra	45,000	70,000	
(iv) Kharaghoda	1,00,000	1,36,000	
(v) Dhrangadhra	...	58,000	
Marine Works			
(i) West Bengal	...	1,000	30,000
(ii) Bombay	3,82,000	4,50,000	4,65,000
(iii) Kathiawad	25,000	2,93,000	5,15,000
(iv) Kutch	...	65,000	
(v) Madras	3,63,000	8,10,000	9,20,000
(vi) Orissa	...	20,000	60,000
(vii) Travancore	...	61,000	75,000
Rock Salt Mines			
Mandi	4,000	4,000	65,000
TOTAL	12,12,000	23,31,000	30,75,000

The present production (23,31,000 tons) falls short of the estimated consumption by 2,98,000 tons and this is being met by imports. The country's requirements in the next 5 years is expected to go up to 3 million tons.

The bulk of the salt produced in India is from sea brine and salt is raised by solar evaporation in numerous places distributed along the sea-board stretching from Bombay to Calcutta. Rock salt deposits occur in Mandi State and inland salt lakes are found at Sambhar, Didwana and Pachbadra in Rajasthan. The methods of salt production have remained more or less unchanged for decades and the quality of salt raised from a large number of the salt-producing areas is sub-standard. The production sites have not been selected with proper regard to economic advantages and factors such as initial density and continuity of supply of brine, rainfall distribution, temperature, relative humidity, wind velocity, surface of exposure, impermeability of soil and protection of sites against floods and dust storms. The Committee have examined these factors in detail and have made valuable recommendations appropriate to each area for improving the production and quality of salt. The measures recommended include (1) maintenance of a high ratio between crystallizers and condensers ; (2) removal of bitterns regularly and draining off the crust before lifting ; (3) leaving behind a layer of salt on the crystallizing beds to form a clean floor ; (4) setting up of control laboratories ; and (5) the consolidating of small uneconomic holdings into units with a minimum area of 100 acres each.

Several improvements have been suggested to enable the existing works at Sambhar Lake area to work more satisfactorily. As a first measure the Committee have recommended a detailed survey of the lake bed. A modified design of a percolation canal has been prepared to replace the present system of canals, and to reduce the present crystallizing area at the works and convert it into condenser area. The present practice of throwing away of bitterns from crystallizers is harmful and is likely to affect quality of brine and of the salt produced, and should be discontinued. It is preferable to harvest two grades of salt, one between 26°-29° Be. and another between 29°-32° Be. instead of a single crop. Large-scale production of salt in pans under the direct control of Government and the use of improved methods of lifting brine from the wells and the installation of mechanical washing plants and the establishment of a research station to study the problem of byproduct recovery and the production of salt of standard quality are other measures recommended.

The methods now followed for producing salt at Didwana are unsatisfactory and the salt produced is unfit for human consumption. Advantage is not taken of the wide seasonal fluctuations in temperatures prevailing here to bring about a separation of sodium sulphate and salt. A careful and planned investigation of salt production in this area, and also in other inland areas now operating under private management, is recommended. The latter include Kuda works in Dhrangadhra and areas in Rajasthan, Kutch and E. Punjab.

Recovery of Byproducts

The recovery of byproducts from the inland and marine resources has not received adequate attention. With the exception of the salt worked out at Mithapur, Kharaghoda, Dhrangadhra and Travancore, no attempt has been made to recover the valuable byproducts such as magnesium chloride and sulphate, bromine, iodine and sodium and calcium sulphates. Table II gives an idea of the quantities of byproducts that could have been recovered from 23·3 lakh tons of salt produced in 1948.

As a potential source of sodium sulphate, the Didwana Lake remains largely unexplored. The lake bears a resemblance to the Dale Lake (California) where temperature fluctuations are taken advantage of to separate the salts. This method can be adapted with advantage in this area and as much brine as possible lifted during the cold season and subjected to pre-cooling to separate out sodium sulphate.

Sodium sulphate as an industrial raw material is of special interest to India. Its utilization for the production of vital chemicals, caustic soda and sulphuric acid deserve consideration. The Committee recommends the exploitation of these sources under Government control.

Gypsum is now being recovered at Adirapatnam by *Messrs Mettur Chemicals*, at Jamnagar, Kandla and, more recently, at Mithapur. The Committee are, however, of the opinion that the processes employed for the recovery of byproducts at many of the centres are not efficient and improvements are essential to obtain a satisfactory recovery.

Distribution of Salt

The distribution of salt in the country, at present, is effected through a zonal system under which the principal regions of production and consumption are grouped under 8 foci of distribution (FIG. 1). The Committee consider that the present railway freight for salt is excessive and should be revised and be put on the same footing as foodgrains to reduce wholesale and retail prices.

Model Factories & Research Units

In order to organize the Indian salt industry on modern lines and make it operate economically and efficiently, the Committee consider it essential for the Government to set up model factories as demonstration units in the principal salt-producing tracts. These factories should have an area of 100 acres and should produce common salt required for human consumption as well as for industry, mixed salts of potassium and magnesium and other byproducts such as gypsum and sodium sulphate. The estimated capital outlay for each model factory will be about Rs. 2 lakhs and should be borne by the Government. Seven such factories, two in Bombay, three in Madras and one each in Travancore and Orissa, are to be set up. The model factories located at Bombay, Madras and Travancore should have research units attached to these for investigating into methods of improving the quality and yield of salt and of recovering byproducts. A separate research station is to be set up at Sambhar Lake to tackle technical problems pertaining to inland salt resources.

TABLE II

	COMMON SALT	BYPRODUCTS						
		$CaSO_4$	$MgSO_4$	Na_2SO_4	KCl	$MgCl_2$	Na_2CO_3	Bromine
Marine salt works	17,00,439	95,593	1,48,076	...	76,849	3,39,804	...	5,755
Kharaghoda and Dhrangadhra	1,93,606	6,757	9,024	...	7,812	87,399	...	1,180
Sambhar	3,16,495	...	...	44,799	668	...	20,043	229
Didwana	47,391	...	...	18,076	...	...	8,588	...
Pachbadra	69,985	2,938	11,018	...	...	2,253	...	...
TOTAL	23,27,916	1,05,288	1,68,118	62,875	85,329	4,29,456	28,631	7,164

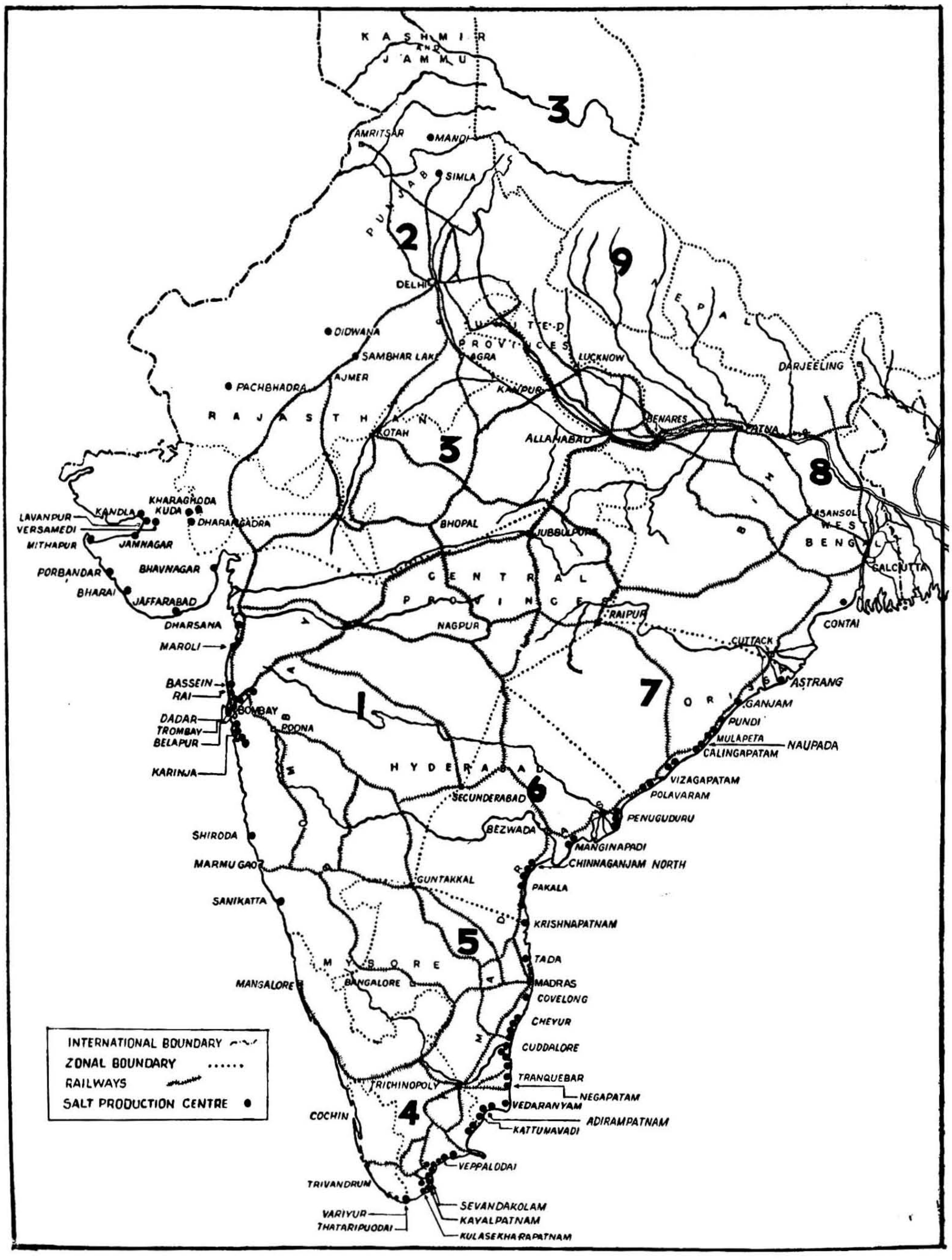

FIG. 1 — MAP OF INDIA SHOWING SALT PRODUCTION CENTRES AND THE ZONES OF DISTRIBUTION DURING 1949. DISTRIBUTION ZONES: 1. BOMBAY; 2. SAMBHAR (R.S.S. DIVISION); 3. KHARAGHODA; 4. TUTECORIN; 5. ADIRAPATNAM, MADRAS AND CUDDALORE; 6. PENUGUDURU; 7. NAUPADA; 8. CALCUTTA; 9. DHRANGADHRA.

Quality of Salt

According to the Committee the Draft Specification issued by the Indian Standards Institution prescribing a minimum sodium chloride of 96 per cent for edible salt is on the low side and should be raised to at least 97·5 per cent and maximum limits to be prescribed for other impurities.

The methods of drawing samples from bulk consignments and of assaying the samples should be standardized and made available in the form of a code of practice.

Salt Advisory Committee

To implement the steps recommended for the development of the industry, the setting up of a permanent Salt Advisory Committee consisting of representatives of Government, manufacturers, consumers and importers is recommended. The Committee is to advise Government on all questions dealing with production, distribution, import and export and any other matter that may arise from time to time.

The Committee is in favour of small manufacturing concerns and associations in different parts of the country federating into bigger regional units and ultimately forming an All-India Federation of Salt Manufacturers.

The levy of a salt cess at the uniform rate of one anna per md. of salt on the entire salt produced in the country is suggested. It is recommended that the heavy chemical industries should be allowed a rebate equal to the cess collected on the salt consumed.

In order to carry out the programme outlined, it is considered that the present organization and set-up of the Salt Department should be reorganized and adequately staffed to provide technical assistance both to Government and to industry.

The Committee is not in favour of opening new salt works in the Madras area until the factories improve the quality of salt produced and make it acceptable to the Calcutta market and till a demand for export develops. The existing works would increase their production by more than 12 lakh tons by improving the methods of manufacture and by properly realigning their factories. The setting up of a large factory at Contai under the management of the Central and West Bengal Governments is recommended with a view to encourage the development of salt industry in West Bengal.

The potential capacity of the existing salt works in the country is estimated at 40,26,000 tons per annum. The Committee conclude that, subject to the implementation of its recommendations, it is within the reach of the industry to meet not only the present requirements but also attain the target figure by 1955-56.

REVIEWS

Analytical Chemistry and Chemical Analysis, 1948, Proceedings of the International Congress on Analytical Chemistry, Utrecht, Vol. II (Elsevier Publishing Co. Inc., New York, Amsterdam, London, Brussels ; London distributors : Cleaver-Hume Press Ltd.), 1948, pp. x + 437. Price 25*s*.

THE PUBLICATION IS A REPRINT OF THE issue of *Analytica Chimica Acta*, 1948, **2**, pp. 417-854, and the pagination remains unaltered. The book is valuable as a full account of the proceedings of the Congress in Utrecht in 1948 which established a new status for analytical chemistry. The Congress covered very wide grounds, divided into five sections and consisted of formal lectures, presentation of original papers and plenary sessions. All the lectures and papers are printed in full followed by a summary in English, French and German, along with the discussions that took place.

In Section 1, entitled " General Methods and Standardization ", papers on statistical aspects of chemical analysis, the place and task of analytical chemist in industry, rationalization, standardization and codification of analytical methods and recent developments in gas analysis, organic elementary analysis, isotopes as tracers and analysis with mass spectrograph are included.

Section 2, entitled " Electrical Methods ", surveys methods and recent developments in polarography and amperometry and is covered by eminent authorities like Heyrovseky and Kolthoff. Other papers of interest are those on controlled potential electrical analysis, electrical methods in the analysis of water generally in industry and a continuous reading vacuum-tube voltmeter. In all the methods the problem of precision and sensibility was considered.

Section 3 is " Emission Spectrography ". The papers in this section are to be published in *Spectrochimica Acta.*

Section 4 on " Optical Measurements and Physical Methods of Separation" contains odd combination of titles but contains a masterly review on the recent developments in chromatography and is followed by papers on the analysis of hydrocarbon mixtures by absorptive percolation and analysis of hydrocarbon oils by thermal diffusion. Optical measurements are covered by a survey of colorimetric and photometric absorption analysis, indicating the accuracy obtainable with different types of instruments : two reviews on the analytical application of infra-red spectrophotometry in general and in powders and a method of determination of vitamin D_2. Research papers on the measurement of width instead of intensity of Raman lines for quantitative work and on the influence of reagent concentration on colorimetric determination of copper are presented.

Three papers, one on determination of traces of oxygen in water in this section and two in the next section on determination of trace elements in biological material by spectrographic or photocolorimetric procedures are presented.

Section 5 deals with microbiological methods. A review on microbiological methods of analysis deals with all aspects, stresses the necessity of statistical evaluation of errors of assays and calls for cautious interpretation of results. Two papers on details in the use of lactic acid bacteria for microbiological assay in general and assay of tryptophane follow. Other two papers deal with the use of *Aspergillus niger* for the estimation of trace elements like potassium, copper, magnesium and molybdenum by weighing the mycelia or by a photronic measure of colour of spores. It is rather surprising that at an International Congress session there were no papers on biochemical methods. This is a very important branch of analytical chemistry and we hope in future sessions this defect will be rectified.

Most of the papers have been followed by lively discussions. The main functions of such international congresses are comparison of various methods with a view to determining sensitivity, reproducibility, ease and quickness, standardization of procedure and codification and discussion of new methods developed. Judging from such standards, the Congress has been a success.

To the reviewer the most significant of the papers are the opening address and the theses on standardization and codification and rationalizing of analytical methods.

A significant point, arising out of the discussions of these papers, is the definite need for continued research on the accuracy and sensitivity of analytical methods in general, our knowledge of the lower limit of applicability of a method and the effect of variations in procedure being very unsatisfactory.

Trends in most countries, fortunately, are for standardization of routine analytical procedures including chemical glassware, apparatus, etc., though many still remain of a national character. Also " analytical methods when published should be printed in a standard format to facilitate comparison and standardization and as a safeguard against lack of details important for the execution of the method ". This plea for codification is particularly significant since this has not yet attained even a national character. International congresses, such as the one reviewed, should bring in a study of such national standardization into an international standard, and it is gratifying to note that these papers have stimulated considerable discussion in the Utrecht Congress.

President C. J. van Nieuwenburg has sketched the progress of analytical chemistry to a status equal to any other branch of research and emphasizes the point that because of the demand for greater speed and accuracy and the need for handling small and micro-quantities of material, the classical gravimetric and volumetric methods are being replaced and supplemented by physico-chemical and physical techniques. But we rather agree with Dr. Wenger, who has critically summarized the proceedings of the Congress, in feeling that there has been undue emphasis on automatization and physical methods. Many physical methods have to remain as aids to classical fundamental chemical analysis. Besides, the classical methods present the advantage of being useful without the necessity of costly apparatus not in the reach of ordinary worker or small laboratories.

Of very great significance to scientists in India is the fact that modern analytical chemistry is becoming a specialized science with its interest in optical, electrical and microbiological methods besides the classical methods and makes high demands in the training of its users. It becomes imperative that intensive efforts should be undertaken for the training of analytical chemists as a class and conduct research in chemical analysis than is hitherto being done in this country, if we are to keep abreast of other countries. Analytical chemistry should be made a subject of special study in universities and research institutions.

The Netherlands Chemical Society which organized the Congress, and the publishers of the proceedings, the *Elsevier Publishing Co.*, deserve our sincere thanks. This book should find a place as an indispensable reference work in all scientific laboratories.

V. S. GOVINDARAJAN

Aircraft Structures, by David J. Peery (McGraw-Hill Book Co. Inc., New York), 1950, pp. xxii + 329. Price $ 3.00.

THE WEALTH OF THE MATERIAL COVERED IN David J. Peery's book *Aircraft Structures* is not readily seen at a glance from the chapter headings. The author has done a remarkably thorough job in presenting the basic material for the analysis of semi-monocoque as well as truss type of structure in a concise manner. In his work he has attempted to present a simple basic treatment of aircraft structures with preliminary emphasis on fundamental structural theory. This, of course, does not in any way alter the position regarding the analysis of aircraft structure, though new material and new construction methods are developed.

The reviewer agrees with the author that most of the theory outlined in the text-book is applicable to any design requirement and for any material. The author has covered a variety of topics in eighteen chapters and a large number of worked-out examples are given at the end of each chapter, thus bringing home to the student the types of problems that are confronted with in actual practice, while stressing an aeroplane.

There are certain noteworthy features about this volume. They are : the analysis of monocoque structures with cut-outs, bending trusses induced due to torsion, shear lag analysis and explanation of the buckling of cylindrical shell by means of non-linear theory. The determination of the spanwise air-load distribution, a topic which is usually not covered in text-books on aircraft structures, is also included in this volume. The reviewer feels that it is a bit advanced for undergraduate students.

Whatever may be the justification of the author in regard to the sequence of the material presented in the book, the reviewer feels that the topics are not arranged in order ; for chapters on preliminary design data should have been dealt with at first. An aeronautical engineer should first know the aeroplane layout and applied and design loads before he actually proceeds to analyse the structure. In this respect there seems to be a serious slip on the part of the author.

Most of the methods outlined in the book are up to date and are employed in factories by practising engineers, particularly the shear analysis of multi-cells and the analysis of incomplete tension field beams. Chapters sixteen, seventeen and eighteen need special mention. In chapter sixteen, the author has dealt in detail with the methods for the determination of deflection in either truss type of structure or semi-monocoque structure by means of the method of virtual work and Castigliano's theorem. In chapter seventeen, statically indeterminate structures are treated ; such topics as the stress analysis of fuselage rings, multi-cell wing structures, etc., are covered. In chapter eighteen, a group of special methods are presented, such as the moment of area method and conjugate beam method for the determination of the deflection of beams, truss deflection by elastic loads, beam column and moment distribution method for both continuous beams and continuous beam columns.

The author feels that this volume serves as a text-book for undergraduate course. But in the opinion of the reviewer, it is a bit unwieldy for a student to cover all the topics in one year and certain portions are too advanced for study in undergraduate course. However, the author is to be congratulated for introducing some of the complicated topics into undergraduate level, and this book should prove a welcome addition to the teacher, the student and the practising engineer.

V. CADAMBE

Electronics in Engineering, by W. Ryland Hill, McGraw-Hill Electrical & Electronic Engineering Series (McGraw-Hill Book Co. Inc., New York), 1949, First Edition, pp. 274. Price $ 3.50.

ELECTRONICS IS BEING APPLIED WITH EVER-increasing tempo in many branches of science. Electronic instruments are being employed with advantage for control, detection and measurement in the fields of physics and engineering. Electronic instrumentation is an essential necessity for research in many branches of physics, especially in nuclear physics and radioactivity. Research workers and students of physics and advanced engineering, therefore, find a positive need for an understanding of the fundamental principles of electronics and its applications so as to enable them to apply this knowledge for problems of control and measurement in their respective fields.

Electronics has a vast literature, meant only for the advanced student and the specialist. The publications on electronics for the use of laymen and amateurs are prolific. Neither of these give a thorough and comprehensive view of the fundamental principles of electronics and its application for research workers and students who have to employ electronic instruments in their research. The book under review, entitled *Electronics in Engineering*, is designed as a text for this class of students in physics and advanced engineering. The work deals with the theory and analysis of fundamental electronics and explains practical applications to illustrate the uses of electronics in various fields of physics and engineering. The book, therefore, will be found useful to these students.

This work is divided into sixteen short chapters to enable the student to select the subject that interests him in his specific problems. Of the sixteen chapters, the first discusses the atomic structure and methods by which the electrons are emitted out of metals. The second chapter explains the thermionic law and describes the different types of emitters and diodes and their respective efficiency. In this chapter there is also a brief account of contact rectifier and the copper oxide and the selenium rectifiers. The third chapter gives a brief account of single-phase rectifier circuits. The fourth chapter gives the theory and explains the operative principles of a triode, tetrode, a pentode and a beam power tube with their respective characteristics.

The fifth chapter, after giving an account of various forms of electrical discharge in rarified gases and vapours, describes gas-filled tubes, their operation, characteristics and efficiency. An account of the theory, design, construction and operation of different types of photo-sensitive devices is given in the sixth chapter. The seventh chapter describes briefly various forms of electronic control circuits which are very frequently used in industry and pure research. The eighth chapter deals with different types of circuits used in poly-phase rectifiers.

An elementary treatment of wide band and tuned amplifiers with a discussion of R.C. coupled, direct coupled and transform coupled units, both of the power amplifying and the push-pull type, their operation and frequency response is given in the ninth chapter. The tenth chapter gives the theory of feedback with a quantitative feedback expression and describes negative and positive feedback and their applications in R.C. coupled amplifiers and cathode followers. The eleventh chapter gives a short account of resonance and tuned amplifiers, the functions of the resonant circuit in a tuned amplifier and tuned power amplifier. The twelfth chapter deals with an elementary theory, design, construction of different types of oscillators and their application in high frequency heating. In this chapter a brief account of frequency control and wide range oscillators are discussed.

The thirteenth chapter explains the theory of amplitude of modulation and demodulation and the general operation of superheterodyne receivers. The fourteenth chapter deals with a cathode-ray oscilloscope, its design, construction, operation and application for observing repeating wave forms, plotting curves, comparing two frequencies for measurement and calibration, recording single-sweep transients, timing by Z-axis modulation, and recording continuously a large number of cycles of a non-repeating wave. In chapter fifteenth an account is given of different types of transducers for translating signals from one form to another. It gives the principle and the method of operation of persistence strain gauge and the differential transformers used for very small mechanical measurements. The last chapter of this book describes the theory and principle of operation of vacuum-tube voltmeter used for both a.c. and d.c. voltage measurements.

The author should be congratulated for bringing out this valuable work. I have no doubt that the work would be found useful by research workers and students. The book should be a valuable addition to scientific and technical libraries.

SWAMI JNANANANDA

Recent Advances in Radio Receivers, by L. A. Moxon, Modern Radio Technique Series, Edited by J. A. Ratcliffe (Cambridge University Press), 1949, pp. ix + 183. Price 18*s*. net.

THE BOOK MAINLY DEALS WITH THE PROBLEM of inherent " noise " in a receiver, its origin and measurement and discusses the advances made in the methods for improving the signal-to-noise ratio. It is this inherent noise in a receiver which ultimately puts a limit on the smallness of signal which can be usefully received. Any improvement in this respect increases the efficiency and performance of a receiver.

The contributions of the various stages of a receiver to the noise factor are fully discussed and methods of improving it are explained. The discussion of the circuit design has, no doubt, special reference to short-wave receivers such as radar and television receivers but the new ideas introduced can be usefully adopted for an improved noise factor in other broadcast receivers.

What an average reader will most appreciate is the exclusion of all intricate mathematics from the discussion without imparing in the least the physical exposition of the subject. Formulae do appear, and sometimes their derivations too, but only when they are necessary to give precision to design considerations.

The book, however, will be found most useful by those who have kept themselves abreast with the developments in radio technique till the outbreak of World War II and who now wish to know the advances that have been made in the technique during the war years. Coming as it does from an author who has himself made considerable contributions to these advances, the book is of interest.

A. S. BHATNAGAR

The Economic Prospects of Chemical Industries in India, by A. K. Madan, Technological Director, Messrs Industrial Chemicals (India), Bombay (Thacker & Co. Ltd., Bombay), 1950, pp. 402. Price Rs. 20.

THIS IS A BOOK WITH A PURPOSE ; ITS PUBLICATION is opportune. It opens with a general survey of the industrial and other problems facing the country ; it is followed by a chapter on mineral and other resources, three chapters dealing with reviews of various chemical industries and six on chemicals required in a number of industries. In the concluding part, brief accounts are given on the materials of construction in the chemical industry, labour welfare in chemical industries and industrial training. Four indices are included.

The author has endeavoured to provide adequate information on the availability of raw materials for different industries ; as was reviewed the development of various chemical industries in the country with particular reference to their potentialities. The book will prove particularly useful to those engaged in trade and business and it provides detailed information on the types of chemicals manufactured in India, chemicals which are imported and chemicals required in twenty-two industries. Data on production and trade given in Appendix B are specially useful.

The first part of chapter III dealing with resources is well written. The later portion, however, lacks precision and fails to bring out the bearing of the subject discussed on chemical industries. The information given in chapter V, " Fertilizers Including Ammonium Salts ", is not always to the point. An important omission in the publication is the absence of a bibliography of references. We hope the author would remedy this defect in the next edition. The printing and get-up of the book are good.

The book represents a laudable effort and can be recommended not only to the average business man as a reference volume on Indian chemical industries, but also to the student of chemistry who is interested in a general survey of the chemical industry in India.

SEN GUPTA

Frequency Modulated Radar, by David G. C. Luck (McGraw-Hill Book Co. Inc., New York), 1949, pp. xviii + 466. Price $ 4.00.

FREQUENCY MODULATED RADAR, AS DISTINGUISHED from pulse radar, is comparatively a new technique and any book dealing with the principles and possibilities of f-m radar is always welcome.

The principle of the f-m radar is well known. With this, the range is measured from the change in the frequency during the time interval between the instant of transmission and the receipt of the signal reflected from the target. But if the target is moving, there will be a shift due to Doppler effect and this will give the speed of the moving object also. The various aspects of this problem have been dealt in the book with the help of simple mathematics.

The book describes first the general principles of range determination, including some aspects of motion of aircrafts and missiles. Some types of f-m radar system developed and used in World War II have been described, e.g. radar altimeter AN/APN-1, low altitude automatic bombing equipment AN/APG-4 and AN/APG-6 (XN).

The author has taken pains to explain most of the problems from first principles and the materials have been presented in a manner which will be very helpful even to readers entirely unfamiliar with the specialized subject of f-m radar.

S.P.V.

NOTES & NEWS

Scientific Research in Industry

IN A LEADING ARTICLE APPEARING in a recent issue of *Nature* (1950, **166**, 41) the place of scientific research in industry has been discussed. The article refers to a debate held in the British Parliament on the question of the fullest possible development and utilization of resources with a view to ensuring effective progress in industry and various other fields ; the later part of the article is devoted to a critical appreciation of the problems discussed during the debate in the light of a recent publication, *Co-operative Industrial Research*,* by Prof. R. S. Edwards.

Many aspects of the question were discussed during the debate, including technical and higher technological education, the balance, distribution and remuneration of scientific and technical man-power and the general structure of research organization in Britain. How far the results of research are being effectively used in industry and whether the work of the research associations and that of the Department of Scientific Research was fully made use of by industry ; whether the research associations are fitted for the creative and inventive work on which the industrial progress finally depended ; and whether there is sufficient collaboration and co-ordination of the research units under various Departments of State, were some of the important issues discussed.

The debate brought forth a number of facts and suggestions. It was felt that for the small or even medium sized firms to set up independent laboratories might be a waste of scientific man-power. To bring scientific information to the smaller progressive firms, it was suggested that institutions such as Chambers of Commerce should give training fellowships in industry on condition that they employ a scientific man of the highest standard, who would be encouraged to maintain his academic contacts as well as gain the widest knowledge of the industry and its problems.

The organization of co-operative research and fundamental aspects to appraise fully the place of research associations in the industrial economy of United Kingdom and their future are the issues discussed in the book by Prof. R. S. Edwards. Prof. Edwards has attempted to ascertain by means of a fairly wide canvas of industrial opinion, what industry thinks of research associations. The book provides a useful insight into industrial opinion on the possibilities and limitations of co-operative research. Compulsory levy for financing research associations is advocated as a measure for the future development of co-operative research. Overlapping of research association's programme is regarded of slight importance ; a note of caution is sounded against attempts to eliminate overlapping of research programmes by excessively large organizations and ponderous schemes for co-ordination.

The value of research associations pursuing fundamental research in solving problems economically in the long run and also as a measure of sustaining the quality of the staff and the scientific standing of the association was stressed.

It is pointed out that research into the constitution and behaviour of materials, on which research associations are at present concentrating, is particularly suited to co-operative research effort. Work on the scientific and technical aspects of specification and on the devising of standards is considered a valuable function of research associations. " Market Research ", in general, is an inappropriate study for research associations. It is felt that research associations should co-operate in those operational research studies which are most closely associated with the scientific and technical aspects of industries in which they are interested and full weight should be given to the information, advisory and testing services of the associations in any scheme of expansion.

The location of a research association or institution is considered an important factor in its success or failure. It is indicated that *proximity to the industry served may be far more vital than proximity to another research association with which facilities or services may be shared.*

One argument put forward against the conduct of sponsored research by research associations rests on the embarrassment arising out of secrecy of a particular project.

The effective use of man-power and of material resources must depend on the right choice of subjects. This is pointed out as one of the essential questions to which an answer must be found if an opinion is to be formed on the value of research associations.

The most important factor in the future development of research associations will be the quality of the staff they succeed in attracting, and the associations must be able to create conditions and opportunities which will attract competent men. While it is made clear that given capable direction and competent staff the co-operative research association is a valuable form of industrial institution, it is pointed out that it does not follow that the research association movement should be developed at the neglect of other forms of research organization.

Electronic Telescope

THE ELECTRONIC TELESCOPE DEScribed in a recent issue of *Discovery* (1950, **11**, 172) is reported to be either actually in operation in France or in a very advanced state of development.

The idea of the electronic telescope represents an interesting conjunction of a number of lines of research. The use of infra-red radiation to form an invisible image on a screen, electrons from which are accelerated *in vacuo* to form a similar but more intense image in visible light on a second fluorescent screen, is the basic principle underlying the design of the instrument. It has many features similar to the electron microscope and embodies modern vacuum and high-tension techniques.

The conventional photographic plate in a telescope is replaced by a vacuum tube, carrying on its

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* *Co-operative Industrial Research*, by Prof. R. S. Edwards (Sir Issac Pitman & Sons Ltd., London).

inner face a thin layer of caesium. The luminous parts of the image cause the ejection of electrons from this caesium layer into the vacuum tube. In effect a luminous picture of a part of the sky is formed which emits no light but electrons. The electrons can be rendered more energetic by putting two electrodes into the tube and applying an electrostatic potential of about 50,000 V. between them. This device is similar to the one developed for an electron microscope and all the electrons emitted from a point of the original picture are received on a photographic plate and produce a blackening of the plate.

One of the greatest advantages claimed, as far as light intensity goes, is that a 20″ telescope can be made to perform as well as a 200″ telescope.

The operation of such an instrument poses some intricate problems; for instance the vacuum system will require very powerful pumps and, in addition, the presence of very high voltages will make the working conditions far from simple.

Electronic Polarometer

AN ELECTRONIC POLAROMETER designed for greater accuracy and higher speed than was obtainable with existing commercial palorographs was described at the Physical Methods Group meeting of the British Society of Public Analysts held recently (*Chem. Age*, 1950, **62**, 780).

The instrument measures the maximum polarographic current rather than the usual " average " current. The measurement which is made without affecting the emf. applied to the cell involves adjustment of a potentiometer until an electronic null point indicator is balanced; the current is then read off from the potentiometer to an accuracy of 1 in 1,000. For rapid operation, the principle of tangent slope compensation is used which enables diffusion currents to be obtained directly without the need for the complete plotting of the polarographic wave or graphical construction. Several further improvements on this instrument have been made in a commercial model built by *Mullard Electronic Research Laboratories*. A very stable electronic battery circuit and a method of current measurement specially suited for a small polarographic wave preceded by a large one have been introduced. For use in conjunction with the polarometer, a dropping mercury electrode has been designed, which incorporates a thermostat, capable of taking ten cells at a time, and is controlled to within 0·05°C.

Manufacture of Solvents

METHODS OF SOLVENT MANUFACTURE based upon direct synthesis from lower saturated and unsaturated hydrocarbons, developed commercially within the last 15 or 20 years, are reviewed in the *Modern Methods of Organic Solvent Manufacture* by J. L. Edgar, Royal Institute of Chemistry (Lectures and Monographs and Reports, 1950, No. 2).

Petroleum Solvents — A major development is in the methods of precise fractionation combined with azeotropic and extractive distillation. The waste gases from petroleum cracking plants form the basis of a major synthetic chemical industry. The gas stream can be separated into ethane-ethylene, propane-propylene and butane-butylene cuts by the hypersorption process in which the lighter gases are adsorbed selectively on activated charcoal and are then stripped from the absorbent; this process is, for example, capable of giving recovery of 98 per cent ethylene with a purity of 92 per cent from a stream containing hydrogen, methane, ethane, ethylene, propane and propylene.

A process has recently been brought into operation in England whereby not only aliphatic solvents but also a wide range of aromatic compounds are obtainable. This is the " Catarole " process being operated by *Petrochemicals Ltd.* The feedstock is a light petroleum fraction which is cracked in the vapour phase at 600°-700°C. and at low pressure. A copper catalyst is employed. The yield of gaseous products varies from 45 to 63 per cent. These are separated by fractional distillation into fuel gas, methane, ethylene, a C_3 fraction and a C_4 fraction. The hydrocarbons are later used for the manufacture of a range of solvents and derivatives. The liquid product is first stabilized and then distilled in 3 stages for the separation of the aromatic constituents.

The direct hydration method of ethylene was first operated on a commercial scale by the *Shell Chemical Corporation*, America. The method offers advantages because it eliminates the costly use of sulphuric acid. A solid catalyst is employed and corrosion problems are, therefore, greatly reduced.

A new plant to be installed by the *Shell Chemical Manufacturing Co.* at Stanlow is to manufacture a wide range of solvents employing gas oil as the feedstock, the cracking conditions being such that the quantity of cracked residue produced together with those gaseous fractions not required for chemical manufacture is sufficient to supply the fuel requirements of the entire chemical and auxiliary plants. The cracking is carried out in the vapour phase at high temperature and low pressure and the products from the cracking furnaces are separated into two fractions, a light fraction with an end point of 190°C., and a heavy fraction which is used as fuel oil. The light fraction is then separated by a process which is a combination of absorption and fractional distillation methods into fuel gas which contains all the hydrogen, methane, ethane and ethylene, a high purity C_3 cut which contains about 92 per cent propylene, a high purity C_4 cut, a C_5 cut which is recycled to the cracking furnaces and a highly aromatic distillate which contains high percentages of benzene and toluene. After suitable treatment the distillate will either be incorporated in motor fuel or it may be utilized as an aromatic solvent.

Besides the above processes, the manufacture of new solvents has been made possible in U.S.A. by the manufacture of allyl chloride by the direct chlorination of propylene. This process has now been used as the initial step in the manufacture of synthetic glycerol. The process employs high purity propylene which is chlorinated without the aid of a catalyst at 500°C. and at pressures only a little above atmospheric pressure resulting in the production of allyl chloride. The reaction is highly exothermic and is allowed to take place in adiabatic reactors with very short residence times. The allyl chloride is separated from the other reaction products, from hydrogen chloride and from residual propylene by distillation and is obtained in a high state of purity. Allyl chloride may then be hydrolysed to give allyl alcohol to give glycerol and other useful solvents and chemicals, e.g. epichlohydrin. From di-allyl ether, which is produced as a byproduct in the manufacture of allyl alcohol, acrolein may be produced which, although itself not a solvent, is a most important intermediate in the manufacture of numerous other synthetic chemicals and solvents.

Levulinic Acid

THE PREPARATION OF LEVULINIC acid from sucrose and the use of sodium levulinate as an antifreeze are described (*Research*, 1950, **3**, 140).

The essential steps in the formation of levulinic acid from aldoses and ketoses are: aldose or ketose → 1,2 ene-diol → 5-hydroxy methyl furfural → levulinic acid + formic acid. Levulinic acid is produced in much the same yield from glucose, fructose, sucrose or starch. When 250 gm. of sucrose was heated with 600 c.c. HCl of various concentrations, levulinic acid yields obtained are from 34 to 42 per cent of the theoretical. Levulinic acid was obtained in high yields using hydrobromic acid as a catalyst and using 3 per cent concentration of sucrose with 8 per cent hydrobromic acid when the yield is 79 per cent. Yields almost as high were obtained when sucrose was heated with hydrochloric acid containing 1 per cent sodium bromide. The following procedure for the preparation and isolation of levulinic acid is used: Starch is preheated with dilute HCl (1·5 to 2·5 per cent) at 100°C. and the mixture is then heated in a pressure digester at 190°-200°C. (with mechanical agitation). The temperature is raised at the rate of 1° to 4°C. per min. for 50 to 60 min. The degradation of sugar maintains the desired temperature for a further half an hour. The mixture is then filtered free from a granular humid material partly neutralized to *p*H 1·9 and evaporated to small bulk. NaCl which separates is centrifuged off and the mother liquor is subjected to steam distillation under vacuum when a relatively pure form of levulinic acid of light colour together with a residual tar is obtained. This tar has now been found to yield a further amount of levulinic acid by subjecting it to steam distillation.

Cane juice has been found to be as efficient as pure sucrose in the preparation of levulinic acid. The juice is evaporated to a syrup and heated in sealed tubes with acid reagents. The acid formed in the reaction is isolated by the same solvent reaction process as that for pure sucrose.

A two-stage process has been developed for the preparation of 5-hydroxy methyl furfural and levulinic acid from sucrose. The sucrose is heated with oxalic acid, phosphoric acid, maleic acid, even very dilute hydrochloric acid, in an autoclave at 150° to 160°C. for 3 hr. The reagents degrade only the fructose half of the sucrose molecule to 5-hydroxymethyl furfural. After the weak acid treatment humid material is filtered off and hydroxymethyl furfural is removed from the solution by continuous extraction with ethylacetate. The aqueous residue is evaporated to remove dissolved solvent, the appropriate amounts of hydrochloric acid and sodium bromide added and the mixture heated as before to convert the residual glucose into levulinic acid.

The sodium salt of the acid has been found to be an efficient antifreeze, within the limits set by an eutectic point in the region of 40 per cent w/v. Being solid, it is more convenient to transport than glycol. The behaviour of the aqueous solutions at temperatures up to boiling is satisfactory in respect to freedom from frothing and stability of *p*H and freezing point. Laboratory corrosion tests, using metals or combinations of metals likely to be present in car systems, have given satisfactory results except for some thinning of solder at soldered joints. Addition of 1 per cent w/v of sodium chromate or phosphate reduces the attack.

Chromatographic-spectrophotometric Determination of Vitamin A

A METHOD FOR THE DETERMINATION of vitamin A in petrol-ether extracts obtained from different materials employing both chromatographic and spectrophotometric techniques is described (*Acta Chemica Scand.*, 1950, **4**, 618).

Before the new international regulations for the determination of vitamin A had been accepted in 1949, it was possible to determine the content of vitamin A in fish liver oil without purification of the solution obtained after saponification and ether extraction of the liver oil, prior to the measurement of the absorption spectrum. The conversion factor 1600 compensated to some extent for the impurities present in the solution. In the new international regulations prescribing the conversion factor 1900, it is required to separate vitamin A from the interfering impurities for its estimation.

The vitamin extract is prepared by saponification and subsequent extraction with ether. The ether extract is completely freed from all fatty acids by washing once with water, twice with alcoholic KOH and finally twice with water. The ether solution is evaporated to dryness and the residue dissolved in petroleum ether.

To prepare the column for chromatography some scoured wool is placed at the transition from the broader to the narrower part of the adsorption tube. The adsorbent (dicalcium phosphate) is introduced in small proportions suspended in petroleum ether. Each time the powder is allowed to settle and then pressed together by suction. The tube is filled with the adsorbent to 1 to 1½ cm. from the top and then the column is ready for chromatography.

A suitable quantity of the vitamin extract corresponding to 150 to 600 gm. vitamin A is sucked through the column and washed with 25 to 50 c.c. pure petroleum ether (b.p. 70°C.). The column is inspected in ultra-violet light where the vitamin A should be visible as a yellowish-green fluorescent zone in the column. If such a zone is not visible, the solution contained too little or no vitamin A or the adsorber is too poor. In the latter case a stronger adsorbent had to be applied. When the vitamin is adsorbed satisfactorily to the dicalcium phosphate, the chromatogram is developed by continued washing with a petroleum ether-ethyl ether mixture (50 : 1) until the yellowish-green fluorescent vitamin A zone appears at the very bottom of the column. A clean silicon flask is inserted and a mixture of petroleum ether-ethyl ether (50 : 1) is added until all vitamin A is eluated. The fraction is transferred to a volumetric flask of suitable size which is filled up with petroleum ether so that the solution contains 2 to 4 μgm. of vitamin A per c.c. This solution can be used directly for the determination of the adsorption curve in a Beckmann spectrophotometer.

If the vitamin A from the solution available for chromatography cannot be absorbed on dicalcium phosphate, aluminium oxide should be used. If aluminium oxide proves too strong, dicalcium phosphate, which has been heat treated more efficiently than normal, may be used.

Values for the adsorption at 310, 325 and 350 mμ with and without chromatographic separation of extracts from whale liver oils, cod liver oils, liver paste, butter, milk, vitaminized oats and fodder mixtures showed that the absorption curves after chromatography fall very closely to the adsorption curve of vitamin A, a criterion in favour of the specificity of the chromatographic-spectrophotometric method.

In experiments with pure vitamin A, losses during chromatography were found to be $\frac{1}{2}$ to 2 per cent.

Polarographic Determination of Titanium

A SIMPLE AND RAPID POLAROGRAPHIC method for the determination of titanium in paint pigments has been described (*Canad. J. Res.*, 1950, **28**, 128).

An *E. H. Sargent & Co.* Model XX polarograph was used with an ordinary electrolytic cell with an internal anode, maintaining a temperature of 25° ± 0·2°C. All the wave heights were measured by the slope-intercept method. The reagents used were: concentrated sulphuric acid (sp. gr. 1·84); potassium bisulphate (A.R.), acid tartaric (A.R.), 25 per cent solution; titanium dioxide (A.R.). 7 gm. of potassium bisulphate crystals were mixed thoroughly with 0·3 gm. of the dry pigment and 20 c.c. of sulphuric acid added, the mixture covered, heated to fume off sulphur trioxide for 20 min. and swirling occasionally. It was cooled and transferred to a 100 c.c. volumetric flask, keeping sample and washings to less than 50 c.c. 50 c.c. of tartaric acid solution was added, made up to the mark and mixed. A portion was transferred to a polarographic cell, deaerated and polarographed. The overall time required for a single determination of titanium by this method is 1 hr. When several samples are run at the same time, each additional sample requires about 8 min. Besides filtration, the maintenance of Jone's reductors required in the usual method is avoided.

To test the precision of the polarographic method, 5 samples from *Canadian Titanium Pigments Co.* containing about 29·9 per cent TiO_2 were analysed polarographically. The maximum deviation from the mean was 2·0 per cent and the average deviation 1·1 per cent. The preparation of the samples contributed to the largest amount of error. The values, on the whole, are in very good agreement with those determined by conventional volumetric and gravimetric methods.

Rapid Immersion Silvering

A NEW METHOD OF SILVERING developed at the Printing, Packaging and Allied Trade and Research Association is described (*Chem. Age*, 1950, **63**, 14).

Most methods of silvering by the chemical reduction of an aqueous silver solution suffer from the defect that only a small portion of the reduced silver is deposited as a mirror. The remainder is deposited either on the walls of the containing vessel or is precipitated in the solution. Apart from the wastage of silver involved, this sludge is objectionable since it may spoil the mirror during its formation. Increased efficiency in the methods employed (i.e. the proportion of precipitated silver deposited as a mirror) depends on the reduction of the rate of reaction by the addition of various inhibitors.

Addition of 10 to 15 per cent pyridine to a 1 per cent ammoniacal solution of silver did not facilitate deposition of silver on the addition of hydrazine sulphate. It was found that on a surface which has been previously treated with stannous chloride and washed with water, a heavy silver mirror was rapidly deposited. Despite the high rate of deposition maintained on the surface sensitized by the above treatment, very little silver precipitation occurred in the bulk of the solution or on the walls of the containing vessel and the solution remained perfectly clear and still usable 24 hr. after preparation, during which time a number of silverings can be made.

When the process was recommended as a practical means of heavily silvering plastics in the manufacture of special electrical components, it was found that the results obtained were markedly dependent on the source and quality of the pyridine used, and that no differential inhibition of silver reduction occurred when a sample of purity greater than 99·9 mol. per cent, as established by the freezing point, was used. Investigations carried out at the Chemical Research Laboratory, D.S.I.R., London, showed that the satisfactory results were due to a small amount of a surface-active agent contained in pyridine. When a sufficient amount of a surface-active agent was added to pure pyridine, differential inhibition of silver reduction was obtained. It was also established that the variable behaviour of different pyridine samples was attributable to the varying proportion of surface-active agent present. The desired results could be reproduced by adding a suitable proportion of *Fixanol C* (cetyl pyridinium bromide) to " inactive " pyridine, so that the process becomes completely controllable.

Good differential inhibitions have been obtained by adding ammonia and cyclohexylamine instead of pyridine in suitable concentration together with cetyl pyridinium bromide, using solutions of the order of 0·001 per cent. The following is a recipe: The surface to be silvered is pretreated by being wetted with a solution of 10 gm. $SnCl_2$ in 20 c.c. HCl (A.R.) and 80 c.c. water. The surface is then rinsed with a 5 per cent silver nitrate solution, well washed with distilled water and kept under water until required. Two silvering solutions are prepared. Solution 1 consists of 10 c.c. of *Fixanol C* solution (0·005 per cent), 16 c.c. of 1·25 per cent hydrazine sulphate solution. Solution 2 comprises 70 c.c. of 1 per cent solution of ammoniacal silver nitrate prepared by adding 0·8 per cent ammonia to 1 per cent silver nitrate solution until the precipitate just redissolves. These two solutions are mixed just before use. The amount of *Fixanol C* solution is adjusted to give satisfactory results. No exact quantity can be recommended. The process has proved useful as a tool to investigate the catalytic effect of silver, platinum and various other metals on the chemical reduction of metals from their aqueous solution. The method should be of considerable use wherever the rapid and efficient deposition of a heavy silver film is required. The process has already proved useful in the Telecommunications Research Laboratory to obtain a thick film of silver on to the inside of tubes. This operation is employed with a degree of precision in applications where the spray method is not practicable. It is considered that the process should prove useful for instrument manufacture and for laboratory requirements.

Recovery of Spent Lubricating Oils

A METHOD FOR THE RECOVERY OF used lubricating oil by a process of chemical washing employing a simple washing tank having an arrangement for mechanical agitation and steam heating is as follows: The tank is half filled with oil to be refined and while stirring, a vegetable oil (coconut or groundnut), amounting to 2 per cent by volume of the lubricating oil, is slowly added and the mixture heated to about 180°F. by letting in steam. Sufficient caustic soda lye (15°Be.) is then added to saponify the vegetable oil and to leave a little in excess. Stirring is continued for 6 hr. at 180°F. after which as much fresh water as can be conveniently handled is added and stirring continued for a further period of 4 hr., maintaining the temperature at 180°F. Steam is then turned off and stirring stopped. The sludge is allowed to settle at the bottom and when the whole mass has cooled, it is drained off from the bottom. Sufficient amount of fresh water is again added, steam let in to raise the temperature to 180°F. and the process repeated as before. Usually two washings are sufficient to free the oil from alkali. The washed oil should be examined and filtered and tested for its specific gravity, viscosity and other physical properties before use.

The oil refined by this method has been found to be similar to original oil in its behaviour when used for lubricating purposes.

C. P. CHACKO

Phosphate Fixation

RESEARCH WITH RADIO-ISOTOPE phosphorus has shown that only about 10 per cent of applied phosphate is utilized by a crop and that iron and aluminium precipitate the soluble phosphate out and interfere with its assimilation. Fixation is more rapid in acid soils ; at a *p*H of 6·0 considerable amounts of available phosphates are precipitated out by iron and aluminium.

Recent research has shown that phosphate fixation is greatly reduced by some of the organic acids produced when organic matter decomposes in the soil. Iron and aluminium form stable compounds with the organic acids and the phosphate remains free. The most effective of the acids are citric, oxalic, tartaric, malic and malonic — all those which are produced in largest amounts when bacteria decompose organic matter in the soil. The effect of liming in reducing phosphate fixation is now considered a microbiological and not merely a chemical effect. By reducing the soil's acidity, bacterial action is stimulated and the production of the organic acids which repress fixation increased. The threefold presence of organic matter, fertilizers and the lime is, therefore, essential to active, lasting soil fertility (*Farming*, June 1950).

Aluminium Sterling Silver

STERLING SILVER ALLOYS CONTAINing aluminium have been investigated for their fire-stain and working properties (*Bull. Design & Res. Centre*, 1950, No. 8).

When sterling silver containing about 1 per cent of aluminium is heated in air, a thin film of aluminium oxide is formed on the surface. This prevents oxygen penetrating the metal and oxidizing the copper and the fire-stain is restricted to a very thin layer on the surface which is readily removed in the final buffing and polishing. Alloys with an aluminium content ranging from 0·8 per cent to 2 per cent have been investigated. Below 0·9 per cent the aluminium oxide film is not sufficient to prevent staining. Over 1·5 per cent, the working properties and colour of the silver are affected. An alloy containing 92·5 per cent silver, 6·5 per cent copper and 1 per cent aluminium required frequent annealings to achieve softness and ease of working. When heated to high temperatures (over 690°C.), this alloy did not show grains or the " orange peel " defect as in the case of the standard alloy. The soldering of the aluminium sterling is more difficult especially with harder solders. By scraping off the aluminium oxide from the surface, however, the alloy can be soldered with enamelling solders and subsequently enamelled in a furnace at 850°C.

The silver aluminium alloy has a density 0·2 per cent less than that of the sterling silver.

Mould Cleaning

A NEW TECHNIQUE OF CLEANING moulds in rubber industry is described (*Rubber Age & Synthetics*, April 1950).

The moulds are immersed in hot fused salts at a specified temperature for about 30 min., depending on the size of the mould. After withdrawal of the moulds from the salt, they are washed thoroughly in water and then carefully dried. The application of a special brightening solution gives a lustrous finish. The process is equally effective on light alloy type moulds also. In the case of composite moulds, washing and drying has to be more thorough to avoid risk of corrosion due to sweating at the intricacies between the dissimilar metals. Washing in boiling water followed by a rinse in a solution of sodium bichromate (3 to 4 oz. per gal. at 200°F.) is recommended. The equipment required is a gas or electricity heated bath of a cubic capacity twice or thrice that of the largest mould to be treated. The process is time-saving, efficient and easy to operate. The salt used is quite inexpensive, of low viscosity at the operating temperature, highly soluble in water, non-poisonous and does not emit objectionable fumes. The " drag-out " loss of salt is very low and can be reduced to negligible proportions by allowing the moulds to drain after lifting from the bath.

Details of the process are obtainable from the *Electric Resistance Furnace Co. Ltd.*, Weybridge, Surrey.

New Staple Fibre

A COPOLYMER OF ACRYLONITRILE and vinyl chloride, previously known as Vinyon N, has now been produced as a staple yarn under the new name " Dynel " by *Carbide & Carbon Chemicals Corporation*, New York.

The fibre has the following characteristics : high resilience, warmth, resistance to moth attack, dimensional stability, rapid drying, resistance to acids, alkalies and mildews and suitability for dyeing with acids or acetate dyestuffs. The fibre is particularly adapted to the manufacture of blankets, curtains, carpets, sweaters, shoe fabrics, snow and ski units, rain wear, tarpaulins, insulation fabrics, dye and laundry nets, etc. The moisture regain of Dynel is less than 0·5 per cent under standard conditions.

Freeze-drying Apparatus

A NEW TYPE OF FREEZE-DRYING apparatus using infra-red rays as a head surface for the liquid in the ordinary freeze-drying method has been developed in the U.S.A. (*Chem. Age*, 1950, **62**, 780).

The infra-red wave band absorbed by water lies mainly between 20,000Å and 80,000Å units. This energy, emitted by a series of electrically charged fine wires, is absorbed directly by the water and evaporated. The process needs a tenth of the time required by the older methods and the material need not be kept at so low a temperature. A much lower vacuum suffices for obtaining satisfactory results.

Census of Industries

THE SECOND STATUTORY CENSUS of manufacturing industries published by the Directorate of Industrial Statistics, Ministry of Industry and Supply, Government of India (Second Census of Manufactures in India, 1947, The Manager of Publications, Delhi 1950, Vols. I and II, pp. 762, price Rs. 21/14) covers manufacturing establishments registered under Section 2(j) of the Indian Factories Act, 1934. 29 industries out of the 63 groups recognized in the census are covered in the report (TABLE I).

The first census of manufacturing industries in India conducted under the Industrial Statistics Act of 1942 related to the year 1946 and was published in the year 1949. In the report of the second census the position during the year 1946 has also been shown in the various charts for purposes of comparison.

Like the first report, the report of the second census also gives statistics relating to capital and labour employed, quantity and value of fuel and raw materials consumed, the quantity and value of products and byproducts and the value *added* by manufacture in each province for each industry. Information relating to each industry is prefaced by a short summary and amplified with diagrams and charts. The data given shows an all-round progress in industrial development. The number of factories existing in the area covered by the census was 5,643 in 1947 against 5,013 in 1946, the percentage distribution being Madras, 25 per cent, West Bengal, 23 per cent and Bombay, 16 per cent. Rice milling had the largest number of factories followed by general engineering and vegetable oils, forming 26 per cent, 21 per cent and 16 per cent respectively of the factories in existence. The total productive capital in the 29 industries (TABLE I) was Rs. 404 crores in 1947 against Rs. 367 crores in 1946. Cotton textiles (Rs. 132 crores) ; jute (Rs. 52 crores), sugar (Rs. 45 crores), iron and steel (Rs. 33 crores), vegetable oils (Rs. 31 crores) and general engineering (Rs. 27 crores) account for 79 per cent of the productive capital in the 29 industries. The 29 industries used 68 lakh tons of coal (valued at Rs. 29 crores) in 1947 as against 60 lakhs (valued at Rs. 23 crores) in 1946. The iron and steel industry consumed 31 lakh tons, cotton textiles 14 lakh tons, jute 6 lakh tons, cement 5 lakh tons and paper 3 lakh tons. The quantity of purchased electric power consumed was 13·2 million kWh. against 12·3 million kWh. in 1946.

The value added by manufacture (which is a measure of the increase in the total value of commodities added on by the manufacturing process and is calculated by subtracting the cost of materials, supplies, containers, fuel, purchased electric energy, contract work and the depreciation of fixed assets from the total value of products and work done by the industry for customers) was Rs. 242 crores in 1947 against Rs. 211 crores in 1946. Bombay contributed 36 per cent, West Bengal 25 per cent, U.P. 11 per cent, Madras 10 per cent, Bihar 10 per cent and other provinces and states 8 per cent. The cotton textile industry contributed 42 per cent, jute 15 per cent, sugar 11 per cent, iron and steel 7 per cent, general engineering 6 per cent and other industries 19 per cent.

TABLE I

	Industry	Registered factories in existence	Productive capital employed Rs.	Value added by manufacture (value of products less value of raw materials and fuels less depreciation) Rs.
1.	Wheat flour	70	1,98,17,824	45,26,687
2.	Rice milling	1,479	9,69,54,018	1,58,66,976
3.	Biscuit making	39	1,24,04,764	91,00,276
4.	Fruit and vegetable processing	24	23,21,787	7,12,489
5.	Sugar	166	44,68,70,025	25,57,47,117
6.	Distilleries and breweries	53	2,49,75,513	96,58,114
7.	Starch	11	50,95,114	3,83,240
8.	Vegetable oils	910	31,37,52,074	6,72,81,055
9.	Paints and varnishes	30	2,71,58,156	1,71,43,484
10.	Soap	43	5,21,01,151	2,54,95,128
11.	Tanning	70	1,95,86,938	1,01,28,525
12.	Cement	14	7,49,45,426	1,48,82,383
13.	Glass and glassware	144	2,72,93,294	1,71,30,903
14.	Ceramics	52	1,99,64,494	98,14,533
15.	Plywood and tea-chests	35	1,24,09,192	40,37,587
16.	Paper and paper board	38	6,74,17,155	3,00,17,967
17.	Matches	36	2,11,21,583	2,60,36,625
18.	Cotton textiles	554	1,31,91,92,538	1,02,53,12,431
19.	Woollen textiles	44	3,81,95,769	4,35,73,896
20.	Jute textiles	99	51,78,31,935	36,41,30,071
21.	Chemicals	191	15,73,55,706	8,00,43,582
22.	Aluminium, copper and brass	158	12,44,43,039	4,54,29,773
23.	Iron and steel	104	33,11,90,755	17,99,94,394
24.	Bicycles	11	70,45,578	31,65,283
25.	Sewing machines	6	46,05,315	16,33,079
26.	Producer gas plants	4	2,18,573	92,866
27.	Electric lamps	7	51,65,996	14,84,569
28.	Electric fans	45	1,82,86,944	87,99,620
29.	General engineering and electrical engineering	1,206	27,23,07,626	15,06,01,201

Tables of Biological Tests

THE FIRST TWO NUMBERS OF VOL. I of *Summary Tables of Biological Tests* have been published by the Chemical Biological Co-ordination Centre of the National Research Council of the United States. Tables are arranged according to the type of test employed. The first number contains anti-bacterial, arachnidicide, fungicide, insecticide, plant growth regulator, insect and rat repellency, rhodenticide, mammalian toxicity, anti-malarial, brucellosis and cancer tests, and the same together with snail control and rickettsia are detailed in number two. The test techniques are described and the chemicals tested are listed alphabetically (*Chemical Abstracts* system) with their structural formulae (*Nature*, 1950, **165**, 804).

The publication is available free from *National Research Council, Washington D.C.*

Announcements

Chemical Research Committee, C.S.I.R.—The various Committees and Sub-committees in Chemistry, namely the Heavy Chemicals and Chemical Industries Research Committee, the Electrochemical Research Committee and the Dyestuffs Sub-committee, under the Council of Scientific & Industrial Research, have been amalgamated into one comprehensive committee known as the Chemical Research Committee with effect from April 1950, for a period of 3 years, with the following personnel: Prof. J. W. McBain (Chairman) ; Dr. J. C. Ghosh, Dr. W. D. West, Prof. P. Ray, Dr. B. B. Dey, a representative of the *Indian Chemical Manufacturers' Association*, Dr. K. Venkataraman, Dr. Mata Prasad, Dr. S. S. Joshi and the Director, Scientific & Industrial Research (Members).

Statistical Laboratory, Allahabad — A statistical laboratory has been recently inaugurated in the University of Allahabad and the working of the laboratory is planned on the lines of the Brookings Institute of America. The laboratory offers a 3-year course in statistics and aims at promoting quality control and increased production in industry through the application of statistical methods. The Government of India have made an initial grant of Rs. 50,000 towards its establishment.

New Middle East Institute — The Columbia University of New York is establishing a Near and Middle East Institute to promote knowledge by research, teaching and dissemination of information in the following countries : Greece, Turkey, Iran, Afghanistan, Pakistan and other countries in this region. For 10 years the expenses of the Institute will be shared equally by the Columbia University and the participating countries and thereafter the American University will assume full responsibility for future financing. The Government of Pakistan has agreed to contribute $25,000 annually as its share in support of the Institute (*UNESCO*).

UNESCO Facilities for Scientists Abroad — With a view to assisting touring scientists to establish closer contacts with scientists in adjacent countries through which they pass on their journey and to enable them to discuss and exchange information on problems of mutual interest, it may be possible for UNESCO centres to make arrangements for their stay and to arrange their programme in those places. The expenses for these arrangements are to be borne by the zonal Science Co-operation Office. Scientists from south Asia region may contact the UNESCO Science Co-operation Office, University Buildings, Delhi, for details.

Indian Pulp & Paper — The fifth anniversary number of this journal (July 1950, Price Rs. 4) contains useful articles relating to various technical and economic aspects of the pulp and paper industry in India. The developments in the industry in European countries are also reviewed. Among other interesting articles published in the journal, mention may be made of "Review of the Indian Paper Industry", "Research and Technical Training for the Indian Paper and Board Industries", "The Nomogram in the Paper Mill", etc.

The First General Assembly of the International Council for Building Documentation will be held in Paris from 23rd to 31st October 1950. The object of the Assembly is to promote international co-operation through the exchange of documentation facilities between the various national and international organizations concerned.

Indian Pharmaceutical Congress, 1950 — The third session of the Indian Pharmaceutical Congress will be held at Calcutta on the 30th and 31st December 1950 under the Presidentship of Dr. J. C. Ghosh, Director, Eastern Higher Technical Institute, Calcutta.

The First International Universities Conference will be held at Nice from 4th to 10th December 1950. The object of the Conference is to create an International Association of Universities. 126 universities from 38 countries have agreed to participate.

Errata

This Journal, 1950, **9B**, No. 9, September 1950, article entitled " The Elastic Properties of Single Jute Filaments : III — Nature of the Torsional Rigidity Modulus ", page 220, L.H. col., line 11, *for* " from the middle " *read* " from the crop, the middle" ; page 221, R.H. col., line 43, *for* "investigation[2]" *read* "investigation[7] " ; page 222, Table III, column headings 5, 8 and 11, *for* "$\frac{W_1}{W_2}$" *read* "$\frac{W_2}{W_1}$" ; page 224, caption Fig. 3, *add* " (arbitrary scale) " *after* " Dynes sq. cm.", and *insert* " Raw ●-●-●, Batched o - - o - - o ".

SUGARCANE RESEARCH IN INDIA

CHEMICAL AND BIOLOGICAL MEASURES FOR CHECKING the damage caused to surgarcane by pests and diseases, the use of fertilizers to raise the yield of sugarcane and the suitability of different varieties of cane for different conditions of soil and climate are some of the main lines of research undertaken by the Indian Central Sugarcane Committee at its various research stations during the year ending 31st March 1949.

To augment the production of sugarcane, specially the yield of cane per acre by intensive methods of cultivation, the Committee have launched 5-year development schemes in various states with the help of a special grant of Rs. 75 lakhs from the Government of India. Targets of production have been fixed for cane. The important lines of work undertaken include better irrigation facilities, distribution of manure and fertilizers on a subsidized basis, supply of improved and disease-resisting varieties of cane, arrangement of varietal and manurial demonstration plots on cultivators' fields, determination of appropriate cultural, agronomic and rotational practices. The Committee have acquired a large farm at Lucknow to establish the new Institute of Sugar Technology and Sugarcane Research which is expected to be the largest institute of its kind in Asia. A small sugar factory will also be erected at the site for providing research and teaching facilities.

The Coimbatore Sugarcane Station of the Committee continued to supply suitable varieties of sugarcane for trial under the various soils and climatic conditions obtaining in different states. Some Coimbatore canes have already been adopted for cultivation overseas, e.g. in South Africa, Lousiana, Argentina, Brazil, Egypt, Portuguese East Africa, and Australia.

Studies on (1) the photo-periodic factor in relation to flowering; (2) the effects of manurial and irrigation treatments on flowering; and (3) chemical composition of flowering and non-flowering varieties were continued during the year. The different treatments of photo-period, irrigation and manure bridged up the disparity in flowering between early and late varieties. The exploration of *Saccharum spontaneum* and allied species from South India (Madras, Travancore, Mysore and Coorg) has been completed and 152 types have been collected; among these 130 belong to *S. spontaneum*, 10 to *E. arundinaceus*, 10 to *Sorghum halepense*, 4 to *Bambuseae* and 15 to grasses. The *spontaneums* show good adaptability under divergent ecological conditions. Certain types exhibit drought, frost and salt resistance, erect habit and profuse tillering and are expected to widen the scope of sugarcane breeding by enabling the introduction of these qualities in future commercial canes.

Under the scheme for research on diseases of sugarcane in operation at the Indian Agricultural Research Institute, New Delhi, a large number of parent cane varieties were inoculated for testing their resistance to red rot. The highly resistant varieties were *S. spontaneum* (Glagah, Java), *S. spontaneum* (Coimbatore), Co. 301, 393, 408, 411, 413, 440, 627 and 631.

29 isolates of *Collectoriclium falcatum* collected from different cane varieties and localities were tested for their virulence on 10 selected cane varieties of varying genetic composition and susceptibility to red rot. Field experiments have shown that (1) *Trichogramma* was able to effect a check on the stem borer *Argyria sticticraspis* by parasitizing a good percentage of the eggs; (2) the *Trichogramma* released plots always showed a higher parasitization than the non-treated ones; (3) the high parasitization of egg masses in the treated plots had brought about lower egg, larval and pupal populations as well as lesser borer infestation; and (4) plots with higher parasitization also gave increased yields of cane at the time of harvest. Following these conclusions breeding laboratories for the mass production of *Trichogramma* have been set up at Walchandnagar and at Nellikuppam for releases of the parasite in larger areas of sugarcane. A good laboratory host was found for the first time in the larvae of the grain moth *Corcyra caphalonica* for the mass multiplication of the larval parasite *Stenobracon*. Experiments carried out at Shahjahanpur to test the effects of lead arsenate (5 per cent), corrosive sublimate (0·25 per cent), DDT (5 per cent), gammexane (80 lb. per acre) and phenyl (1 : 50 in water) on the germination of setts and on the activity of terimites showed that (1) setts treated with phenyl gave the highest germination, the chemical exercising a stimulating effect on the buds; (2) DDT was most effective in preventing termite damage, while gammexane was ineffective when the soil alone was treated; and (3) 20 to 30 lb. of gammexane dust per acre applied in furrows prevented termite damage without impairing germination of buds. Trials at Pusa yielded an increase of 72 mds. per acre in the treated plots.

Experiments on the availability of nutrients from different organic and inorganic manures, in the Shahjahanpur tract, have revealed that ammonium sulphate became available to the crop within a fortnight, oil-cakes after about a month and bulky organics after about 2½ months of application. With respect to sucrose content of the cane, the manurial treatments were in the following descending orders: farm-yard manure, groundnut cake, town compost, press-mud, ammonium sulphate and castor cake. Sugarcane per acre, however, was highest in the ammonium sulphate treatment followed by press-mud, groundnut cake, castor cake, town compost, earth and farm-yard manure.

Work on *gur* chemistry was started in the U.P. and a preliminary study of *gur* yields of cane varieties showed that best quality of *gur* was obtained from Co. 313, 453 and 527. Amongst a number of clarificants tried, groundnut proved most efficient and *gur* so obtained absorbed less moisture and showed better keeping quality. High phosphate, low chlorine, low organic non-sugar residues and nitrogen were characteristic of finies yielding good quality jaggeries. Wilt disease investigations on sugarcane in Bihar showed that the *organisms* responsible for the disease was associated with red rot in Co. 331 in the Bhagalpur district. The disease, however, existed independently in Co. 313, 331, 385, 393, 453, 508; B.O. 3 and 9. The isolates from wilted tissue consisted of *Cephalosperium sacchari* Butl. and *Fusarium moniliforma* either singly or in association, but usually the former was obtained.

Bionomical studies at Jullundur station showed a direct relationship between the number of cane at harvest and the height of cane as well as the yield. Different varieties were classified on the basis of their relative resistance to different pests. Co. L 17 and Co. L 22 were found resistant to pyrilla and Co. L 21 and Co. L 22 to top-borers and Co. L 17 and Co. L 9 to the new pyralid borers.

Technological research was mainly concerned with improvements in technique and equipment for the manufacture of *gur* and *Khandsari* sugar. Improved processes evolved at Bihar (Moradabad) Research Station have made it possible to obtain a recovery of about 7·22 per cent of cane sugar as against 5·5 per cent usually secured by the indigenous processes and the quality of sugar compares favourably with that of the ordinary vacuum pan factory sugar.

The effect of storage on the keeping quality of *Khandsari* sugar showed that the fall in purity was the largest in the case of sugars having a low *safety* factor, a relationship between the percentage of water and non-sugars. The Indian Institute of Sugar Technology is demonstrating an improved process and equipment for the manufacture of sugar by the open pan system at the important *Khandsari* producing centres.

Experiments conducted at the Indian Institute of Sugar Technology, Kanpur, and the Indian Veterinary Institute, Izatnagar, have shown that molasses mixed with cane-bagasse can be utilized as a good feed for milch and draught cattle.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE ANNUAL REPORT OF THE INDIAN ASSOCIATION for the Cultivation of Science for the year 1949-50 records considerable progress in its developmental and other activities. The construction of the new research laboratories at Jadavpur is nearing completion. The new department of organic chemistry was inaugurated during the year and efforts are being made to have a department of theoretical physics also.

The Association received a grant of Rs. 4,00,000 from the Government of West Bengal and a loan of Rs. 80,000 from the Government of India towards the construction of the new research laboratory buildings. The Council of Scientific & Industrial Research also financed two research schemes: (1) X-ray Investigation on Coal and (2) Construction of Osmometer for High Polymer Research.

In the X-rays and Magnetism Department, the structure of phenanthrene crystal has been determined by the Fourier synthesis method. The X-ray diffraction technique has also been employed for examining the process of glass formation and dispersion of salts in glass systems, for identification of minerals in coal samples, for studying the efficiency of coal-washing, investigation of carbonization process, determination of the changes in orientation of cellulose in infected tracheids and estimating the silica contents in dusts from mines.

Investigations on the influence of high temperature on the paramagnetic susceptibilities of a number of Tutton salts showed in a number of cases a considerable change of orientation of the principal magnetic directions with temperature. Thermo-e.m.f. of metal semi-conductor junctions have been found to be much higher than those corresponding to metal-metal junctions working between the same temperatures and so the former type of junctions are found to be very useful for low temperature measurements.

In the Department of Optics, investigations on (1) the origin of low frequency Raman lines due to organic compounds in the solid state; (2) molecular structure of organic compounds in different states as revealed by their Raman spectra; (3) fluorescense and absorption spectra of diamond crystals of different qualities at different temperatures; and (4) absorption of U.H.F. radio waves by organic liquids were carried out during the year. The results of investigations on the Raman spectra have shown that intermolecular field has great influence on the Raman spectra in the liquid state owing to random orientation of the molecules and in the solid state this influence changes as the orientation becomes a regular one. Investigations on the fluorescence of diamond have led to the conclusion that the fluorescence is due to impurity. The frequency of the radio waves in the region of absorption peaks exhibited by some organic liquids shows that the frequency of hindered rotation of the polar molecules in these liquids is much smaller than that of the new lines observed in the Raman spectra of these compounds in the solid state and, therefore, these lines are produced due to some other causes.

Works on high polymers has been limited to fundamental studies on the process of formation of various plastics, e.g. polytyrene, polymethyl methacrylate, nylon, etc. Some new catalysts for polymerization, e.g. iron oleate, aluminium stearate, etc., have been discovered and the mechanism of their activity has been investigated. A simple method for determining the molecular weight of nylon has been developed.

Investigations in physical chemistry have chiefly centred round detergents, surface-active agents and soaps with reference to their formation and electrical properties.

INDIAN PATENTS

The following is a list of a few of the Patent Applications notified as accepted in the *Gazette of India*, Part II, Section 1, for July and August 1950.

Organic Chemicals

41208. Manufacture of salts of leuco compound and leuco sulphuric ester derivatives of vat dyestuffs : *Treating the vat dyestuff with a metal in a neutral liquid in presence of organic quaternary ammonium halide* — I.C.I. LTD.

42275. Process for the improvement of fastness properties of dyeings and printings produced from water-soluble dyestuffs : *The dyeings or printings are after-treated with an aqueous compound containing the grouping*—$N=C=N$— CIBA LTD.

Food & Kindred Products

42512. Extraction and separation of sugars and/or edible syrups from the molasses from a cane or beet-sugar factory : *Dissolving molasses in an alcohol-water solvent, filtering after the solution and treating it with lime* — DR. C. A. KLOPPENBURG

Metal & Metal Products

42082. Method of casting metal ingots : *Forming a shell of silicate material having a melting point below the metal-pouring temperature and then pouring molten metal at a temperature at least 1,200°C. into the shell* — THE LINDE AIR PRODUCTS CO.

Rubber & Rubber Products

42918. Improvements in driving means for crepe rubber rolling mills : *Motor having an outgoing shaft running at a slow speed is directly geared to a roller to be rotated* — AKTIEBOLAGET SVENSKA KULLAGERFABRIKEN

41572. Novel rubber products : *Copolymerizing styrene and like compounds with lesser amount of butadiene and the like in an aqueous rubber dispersion and subsequent treatments* — DUNLOP RUBBER CO. LTD.

43354. Methods of compounding rubber : *Forming a dispersion of the hardenable resin in the vulcanizable rubber* — DUNLOP RUBBER CO. LTD.

Stone, Clay & Glass Products

43029. Manufacture of glass objects : *The glass ribbon is deposited on the mould and as a result of the difference of pressure on either side of the mould engages the surface of the mould* — N. V. PHILIPS' GLOEILAMPENFABRIEKEN

Plastics & Plasticizers

41338. A plastic material from shellac and resinols like bhilawan shell liquid or cashew shell liquid : *Interacting shellac and resinols like bhilawan shell liquid or cashew shell liquid under steam pressure until a homogeneous product is obtained* — S. SIDDIQUI, SARIN & VARMA

41339. Moulding powders from shellac and resinols like bhilawan shell liquid or cashew shell liquid : *Interacting shellac and resinols like bhilawan shell liquid or cashew shell liquid under steam pressure curing the reaction product and then incorporating fillers* — SIDDIQUI, SARIN & VARMA

41340. Production of moulding powders from shellac and bhilawan resins : *Filler particles with shellac deposited on them, blended on hot rollers with bhilawan resin*—SIDDIQUI, SARIN & VARMA

PATENTED INVENTIONS OF THE C.S.I.R. —*Continued from page* 388

in patent No. 32237, the efficiency of expulsion is reduced by the need for conveying superheated steam to a separate vessel wherein the nuts are kept. Further, a separate heating arrangement has to be provided for the vessel containing the nuts ; and in this arrangement the nuts or shells nearer to the walls of the vessel are liable to get over-heated.

The present apparatus ensures speedier expulsion, avoids the need for a separate superheating arrangement and also eliminates local over-heating of the walls of the vessel in which the nuts are treated.

The apparatus consists of a steam jacket (2 in FIG. 1), wherein steam is superheated and which is also provided with means for conveying the nuts or shell into the presence of superheated steam inside the jacket. The apparatus is also provided with means for removing the expelled liquid.

The oil-bearing shells are received in a perforated vessel or retort (1) placed inside the steam jacket (2). An even distribution of steam within the inner retort (1) is secured by varying the diameter of the perforations (4) of the inner retort with reference to their proximity to the steam inlet (11 and 12).

The steam jacket (2) and the inner retort (1) may be made of metal, preferably copper, and it is preferred to make them of semi-circular (vide FIG. 2) or semi-elliptical cross-section. Only the flat top (3) of the inner retort is perforated. One end of the inner retort is permanently closed. The opposite end which receives the perforated tray (15) carrying the nuts is provided with a lid (6) which can be hermetically closed. The outlet (8) of the inner retort (1) projects outside the outer steam jacket (2). The steam jacket as well as the inner retort have arrangements for taking a thermometer.

Patented Inventions of the Council of Scientific & Industrial Research

EXPULSION OF LIQUID FROM THE NUTS OR SHELLS OF BHILAWAN OR CASHEW

Patent No. 32237

S. Siddiqui & A. A. Khan

The processes hitherto employed for expulsion of the shell liquids have been found to have an adverse effect on some of the valuable chemical constituents of the liquids such as bhilawanol in the case of bhilawan shell liquid or anacardic acid and cardol in the case of cashew shell liquid. This fact constitutes a serious limitation for a variety of uses where it is essential to have the constituents intact.

In this process the expelled shell liquid is obtained in more or less the same condition in which it exists in the nuts. It consists in exposing bhilawan or cashew nuts in a closed vessel (A in Fig. 1) to superheated steam at temperatures ranging from 150° to 300°C. The vessel A is kept at a temperature of 150° to 200°C. by a steam jacket J or electrical heating. The expelled liquid is collected in a receiver R_1 through an outlet D_1 at the bottom of the vessel A and may be fractionated into (i) steam non-volatile, higher boling fractions and (ii) steam volatile, lower boiling fractions. The vessel A, in which the nuts are packed, is heated to 110° to 150°C. prior to the letting in of the super-heated steam.

The expelled shell liquid is comparable to that obtained by solvent extraction. The process is, moreover, cheaper and quicker than hitherto known processes for obtaining the shell liquid.

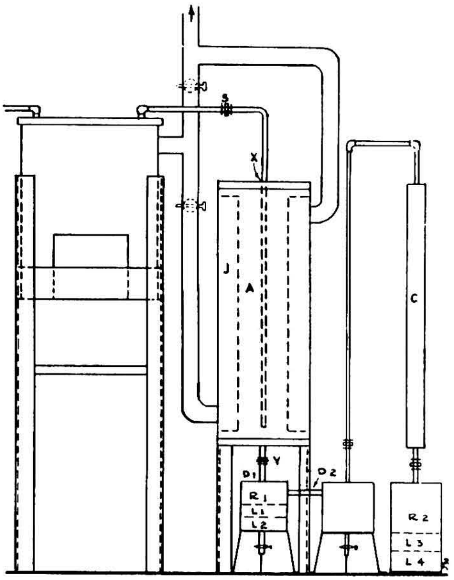

Fig. 1.

Patent No. 34873

S. Siddiqui & A. A. Khan

This patent is for an improved apparatus for the expulsion of liquid from the nuts or shells of bhilawan or cashew. In the apparatus described

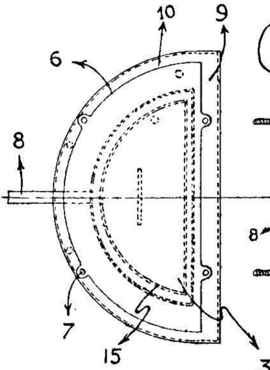

Fig. II

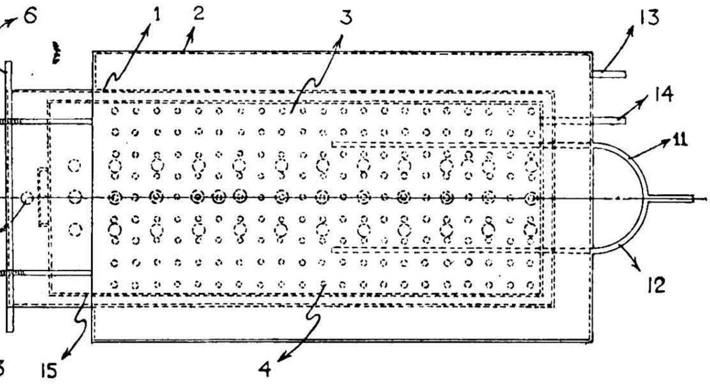

Fig. I

(*continued on page* 387)

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Simple & Efficient Pentode Scalers

P. N. SUNDARAM, S. K. SURI, A. SAGAR & U. C. GUPTA
National Physical Laboratory of India, New Delhi

The design, construction and operation of a number of simple and efficient pentode scalers operating on the power-of-two principle have been described. These scalers have a fairly high resolution and give reliable performance. The circuits employed are sensitive only to pulses of negative polarity. The units operate with only one potential supply (+250V., D.C.) in addition to the heating units and the need for batteries or auxiliary power supply for grid bias and coupling valves or other complicated units is done away with.

THE scalers described here operate on the power-of-two principle. They employ pentode vacuum tubes of the type of 6C6 or 6SJ7-GT or 6SJ7 or 57. These scalers like those of Stevenson and Getting[1], Reich[2] and others[3] as well as those which employ triode vacuum tubes are modifications of the well-known multivibrator circuit[4]. These scalers are, in general, based upon the principle of retroaction between a pair of vacuum tubes. The symmetry of the circuit of the pair renders the retro-action to have two states of stable equilibrium. In one state, one tube of the pair has low impedance and, therefore, is conducting while its mate has high impedance and, consequently, is blocked. In the other state the situation is reversed so that the former tube is non-conducting while the latter is conducting.

The symmetrical coupling of the pentode vacuum tube pair with which the retroactive circuit is formed may be effected by any one of the various methods described by Regener[5]. Most of the existing circuits employ one or the other of these methods of coupling. The present scaler circuits differ from most of the existing circuits in so far as they employ a method in which the resistance couplings have been applied between the plates and the screen grids of the opposite of the pair of the circuit of each scale-of-two as shown in Figs. 1 and 2.

In a symmetrical system such as that illustrated in Figs. 1 and 2, when one of the tubes of the pair, say T_2, is blocked, the currents in R_2 and R_3 are the plate current and the screen current respectively of the tube T_1. In this state if the suppressor grid is made negative by a pulse of the order of 8 or 10 volts, the plate current of tube T_1 is cut off and all the current goes to the screen grid developing a state of stable equilibrium. As soon as the suppressor returns to zero potential, the system falls into a mode of ignition in which the tube T_1 is blocked and the currents in R_3 and R_2 are the plate and screen currents respectively of tube T_2.

It is obvious that only a negative pulse applied to the supressor grid of this pair trips the circuit from one state of stable equilibrium to the other while the situation of the circuit is reversed by means of "retentivity" furnished by R_4, R_5 and C_2. After the pulse is over, if one of the tubes, say T_1, is conducting and its mate is blocked, the current through R_4 produces an additional negative bias on the control grid of T_1 in excess of the bias furnished by the current through R_6 which is common to both tubes. This extra negative bias on the control grid which lasts for a period of $t = (R_4 + R_5) . C_2$ survives the triggering pulse in order to reverse the position of the state of stable equilibrium which has been brought forth by the pulse. The transmission of the

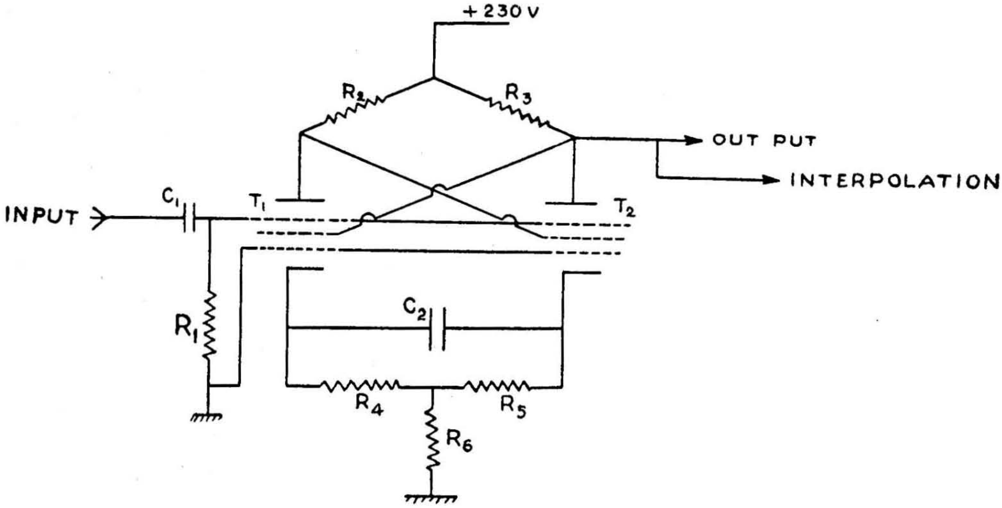

FIG. 1 — CIRCUIT CONNECTIONS OF SCALE-OF-TWO. $R_1 = 1\,m\Omega$; $R_2 = R_3 = 0{\cdot}1\Omega$; $R_4 = R_5 = 500\Omega$ $R_6 = 1500\Omega$; $C_1 = 0{\cdot}0001\,\mu F$; $C_2 = 0{\cdot}1\,\mu F$; $T_1 = T_2 =$ 6SJ7.

successive pulses of negative potential repeat the process, producing in each plate alternate positive and negative potential changes. If these potential changes of either of the tubes of the pair is transmitted to a thyratron-operated mechanical recorder, which is sensitive only to positive pulses, the scaling action of the counting rate to half the value is accomplished.

The circuit is sensitive only to pulses of negative polarity and is unaffected by the pulses of positive potential since they are absorbed by the electron current. Because of this property which is unique, two or more units of scale-of-two may be joined together without the necessity of any coupling elements in order to have scalers of multiple-power-of-two. The single units such as the one shown in Fig. 1 may be arranged side by side, connecting positive to positive, negative to negative and output to input to secure scaling action of higher powers of two. In this way scale-of-one thousand twenty-four, scale-of-two hundred fifty-six, scale-of-sixty-four, and scale-of-sixteen have been designed and constructed for counting with high counting rate nuclear particles such as alpha particles, beta particles and gamma or X-photons. One of the units (scale-of-256) is shown in Fig. 3.

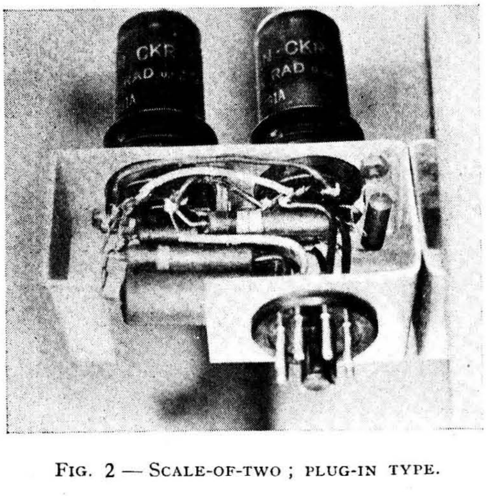

FIG. 2 — SCALE-OF-TWO ; PLUG-IN TYPE.

The construction of these scalers of higher-powers-of-two is simple and straightforward. The relative simplicity of the design and construction has been tested by joining as many as fourteen units of scale-of-two to obtain a scaling ratio 1 : 16384. The construction of this scale-of-sixteen thousand three hundred and eighty-four did not present any serious difficulty. As the scaling is increased, plate and grid voltages and the circuit components, however, have become more critical in value.

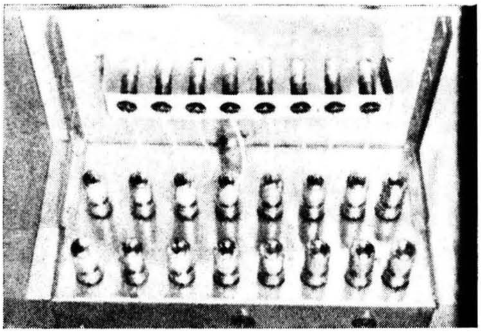

FIG. 3 — SCALE-OF-256 ; BACK VIEW.

The interpolation of these scalers are effected by the neon lamp interpolation method which employs miniature neon lamp in each unit of scale-of-two of the multiple-power-of-scale-of-two. These lamps are connected through a suitable resistance across the plate of the second tube of each pair to the ground. They are lit every time their coupled tubes are driven to non-conducting state and they correspond to the number of counts 1, 2, 4, 8, 16, 32, and so on. The sum of numbers assigned to the neon lamps lit gives the number of pulses scored over and above the number recorded by the mechanical counter. The actual counts for a given run is the sum of pulses scored by the neon lamps lit and the counts recorded by the mechanical counter.

These scalers have a fairly high resolution. A scale-of-two unit such as the one shown in Figs. 1 and 2, with a few minor adjustments in the circuit components, is found to have a resolution of the order of ten microseconds. The scaling units are efficient and sensitive and they, unlike most of the scalers described in literature, are practically insensitive to external radio frequencies and other external disturbances, since the control grids of the pentode vacuum tubes are kept at ground potential. Hence they do not require additional screening arrangement even if glass pentode tubes are employed in the circuits.

The present designs are of the simplest type and have proved stable and reliable. Each of the scaler units requires only one potential supply (+ 250 V., D.C.) in addition to that of heating. The units do not require batteries or auxiliary power supply for grid bias. They need no coupling valves or other complicated units. Each scale-of-two unit is very compact. The instrument is light and hence easy to transport for outdoor or high altitude work.

The authors are greatly indebted to Dr. Swami Jnanananda for his personal guidance and interest in the work.

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Studies in Possible Anti-malarials: Part XIII — Biguanido-aryl-arsenicals*

A. C. ROY & P. C. GUHA

Department of Organic Chemistry, Indian Institute of Science, Bangalore

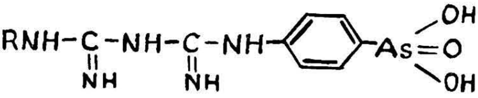
A series of biguanido-arsenicals have been prepared and their physical and chemical properties described. Some of the biguanido-arsonic acids have been reduced to the corresponding arseno-derivatives in order to study the efficacy of these trivalent arsenic compounds as chemotherapeutic agents.

IN spite of intensive anti-malarial therapy, a percentage of cases of acute malaria, particularly of benign tertian and quartan forms, suffers from repeated relapses, even for years. The modern view about the mechanism of relapses[1,2] is based upon the existence of the parasites in the liver. According to this theory, parasites in the blood may be destroyed by the action of quinine, atebrin, etc.; the endothelial parasites which are resistant to the action of known drugs survive and can again cause an infection of erythrocytes.

The only hopeful approach is to search for a new drug which can free the system from these resistant forms. For this, various synergy treatments have been advocated with organo-metallic compounds. Antimony tartrate, quinine with stovarsol, Na-cacodylate, etc., have been used without much success. Recently organo-arsenicals have again come into the field. A good percentage of cases of chronic malaria has, according to Goldman[3], been cured by a single injection of Mapharside (3-amino-4-hydroxy-phenylarsine oxide).

Further studies of Sinton[4] showed that the intravenous injection of sodium stovarsal (3-acetylamino-4-hydroxy-phenyl arsonic acid) in benign tertian malaria has produced a "true cure" in a number of cases. Stewards[5] has suggested that a combination of quinine with Mapharside makes a more efficacious remedy than quinine alone. Recently Bose[6] has shown that monkeys infected with a highly virulent strain of malaria and having repeated relapses even after treatment with atebrin[7], could be permanently cured of the infection by additional injection of an arsenical drug, and with this sequence of treatment on relapsing cases of human malaria[8], the results were very satisfactory. Again Paludrine[9,10], which is a substituted biguanide, is said to be the least toxic and the most potent of all existing anti-malarials.

The above results suggest that it would be interesting and worth while to prepare new compounds in which there will be a continuation of the biguanide residue as also of arsenic acid and to study their anti-malarial properties. With this object in view, a number of new biguanido-arsenicals of type A have been synthesized (the pharmacological results will be published later on).



TYPE A

R=H, C_6H_5 ; p-Cl.C_6H_4- ; p-MeO.C_6H_4- ; p-CH_3-C_6H_4 : ; p-AcNH-C_6H_4- ; etc.

It is now widely accepted by pharmacologists[11] that pentavalent arsonic acid becomes therapeutically active only on reduction to the trivalent state in the body. In view of these observations, some compounds of the type A have been reduced with hypophosphorus acid and potassium iodide to the corresponding arseno-derivatives (type B).

The yellow arseno-compounds are fairly stable, are practically insoluble in water and possess no definite melting points ; their hydrochlorides melt with decomposition.

Diazotized p-arsanilic acid coupled readily with alkaline cyanoguanidine to give the triazene compound which, however, could not be denitrogenated to the corresponding

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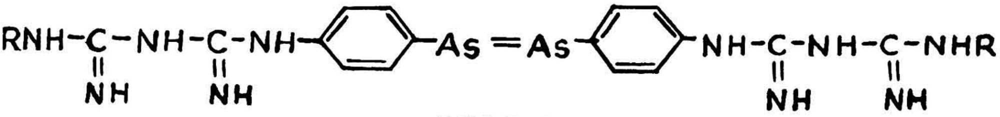
* A note on this work has been published in *Curr. Sci.*, 1948, **17**, 126.



TYPE B

R=aryl radical.

p-cyanoguanidophenyl arsonic acid by any of the existing methods[13]. It seems, the presence of negative groups like $-ASO_3H_2$ hinders denitrogenation (loc. cit., Bami[13]).

Experimental

p-Arylbiguanidophenyl arsonic acids (type A) have been synthesized by reacting cyanoguanidine and arylcyanoguanidines with excess of *p*-arsanalic acid hydrochloride in dilute alcoholic medium. The arsonic acids were separated out from the reaction mixture with dilute alkali and purified. Compounds No. 1 and 10 (TABLE I) were crystallized from a large volume of hot water; the others being insoluble in hot water and common organic solvents, were purified by precipitating with acid from alkaline solution. They were soluble both in acids and in alkali and were colourless.

Sodium salts were prepared by dissolving the acids in minimum quantity of dilute alkali and precipitating by absolute alcohol. The separated sodium salts were crystallized from alcohol. All the acids excepting No. 10 and their sodium salts contained water of crystallization and did not melt even at 300°C. Anhydrous compound No. 3 was prepared by heating the sodium salt of N^5-*p*-chloro-phenyl-(N')-*p*-biguanidophenyl arsonic acid containing 5 molecules of water of crystallization at 120°-30°C. under *vacuo* for 5 hr.

Hypophosphorus acid was prepared by the method of Mari[12].

$p:p^1$-Di (N^5-*p*-arylbiguanido) arsenobenzene (type B) was prepared by reducing the corresponding pentavalent arsonic acid compound with 3 per cent hypophosphorus acid and 3 per cent potassium iodide in an atmosphere of nitrogen at 40°-50°C. After filtration and heating again at 50°-55°C. for 2 hr., the arseno-compound separated out as a cake which was separated by filtration. The precipitate was washed with 10 per cent caustic soda solution followed by 5 per cent warm caustic soda solution, water and alcohol. All these operations were carried out in an atmosphere of carbon dioxide. The hydrochlorides of these compounds were prepared by heating with dilute hydrochloric acid; on cooling the hydrochlorides separated out and were recrystallized from dilute alcohol.

TABLE I — TYPE A

COMPOUND		FORMULA	FOUND, %		REQUIRED, %	
R	*X*		*N*	*As*	*N*	*As*
1. *p*-ClC_6H_4-	H	$C_{14}H_{15}O_3N_5AsCl, 2H_2O$	14·90	16·60	14·90	16·74
2. *p*-ClC_6H_4-hydrochloride	...	$C_{14}H_{15}O_3N_5AsCl, 2HCl$	14·06	...	14·46	...
3. "	Na	$C_{14}H_{14}N_5O_3AsNaCl$	16·06	...	16·10	...
4. C_6H_5-	H	$C_{14}H_{16}O_3N_5As, H_2O$	17·90	18·76	17·76	17·14
5. "	Na	$C_{14}H_{15}N_5O_3AsNa, 4H_2O$	14·30	15·75	14·85	15·92
6. *p*-OCH_3-C_6H_4-	H	$C_{15}H_{18}N_5AsO_4, H_2O$	16·17	17·34	16·47	17·64
7. "	Na	$C_{15}H_{17}AsNaN_5O_4, 5H_2O$	13·65	14·00	13·48	14·45
8. *p*-CH_3-C_6H_4-	H	$C_{15}H_{18}O_3N_5As, H_2O$	16·91	18·10	17·11	18·33
9. "	Na	$C_{15}H_{17}O_3N_5NaAs, 4H_2O$	14·41	14·90	14·43	15·46
10. H	H	$C_8H_{12}AsN_5O_3$	22·95	24·75	23·25	24·87
11. H	Na	$C_8H_{11}AsN_5O_3Na, 6H_2O$	16·00	17·10	16·22	17·40
12. *p*-ACNH-C_6H_4-	Na	$C_{16}H_{18}AsO_4N_6Na, 5H_2O$	15·08	13·51	15·38	13·73

TABLE II — TYPE B

COMPOUND *R*	FORMULA	FOUND, %		REQUIRED, %	
		N	*As*	*N*	*As*
1. *p*-ClC_6H_5-	$C_{28}H_{26}N_{10}As_2Cl_2, 2·5H_2O$	17·88	19·11	18·25	19·55
2. *p*-ClC_6H_5-hydrochloride	$C_{28}H_{26}N_{10}As_2Cl_2, 2HCl, 2H_2O$	16·75	17·87	16·86	18·07
3. *p*-CH_3-C_6H_4-	$C_{30}H_{32}N_{10}As_2, 4H_2O$	18·01	19·10	18·56	19·89
4. *p*-CH_3-C_6H_4-hydrochloride	$C_{30}H_{32}N_{10}As_2, 2HCl, 2H_2O$	17·42	18·41	17·69	18·96
5. *p*-OCH_3-C_6H_4	$C_{30}H_{32}O_2N_{10}As_2, 2H_2O$	18·12	19·50	18·66	20·00
6. *p*-OCH_3-C_6H_4-hydrochloride	$C_{30}H_{32}O_2N_{10}As_2, 2HCl, 2H_2O$	17·29	17·85	17·03	18·24

The compounds and the analyses are recorded in Tables I and II.

Acknowledgement

Our thanks are due to the *Council of Scientific & Industrial Research*, under whose auspices the work has been carried out, for their kind permission to publish the results.

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Application of Dilatometry to Powder Metallurgy

J. H. ANDREW & G. S. TENDOLKAR
University of Sheffield

A modified horizontal dilatometer has been designed and used to study volume changes of pressed copper powder specimens during heating. The characteristic of the curves showing the relationship between linear expansion and temperature vary with particle size and compacting pressure. Porosity and gas absorption are the two factors which influence expansion in the early stages of heating. Surface tension is the dominating factor at high temperature.

LINEAR changes accompanying transformations in the solid state can be quantitatively measured with the help of a dilatometer. In its simplest form the dilatometer consists of a vertical silica tube, one end of which is closed, containing a small silica rod which serves as a support for the test specimen. The latter is a cylindrical rod about an inch in length. In contact with the upper surface of the specimen is a silica rod extending through the top of a furnace in which the dilatometer is heated. The movement of the specimen relative to the container is indicated on a dial gauge, which magnifies the displacement. A thermocouple in contact with the body of the specimen registers the temperature at the instant at which the reading on the gauge is noted.

Other types of instruments, e.g. Chevenard dilatometer[1], and devices which take advantage of the measurable change in capacity of electrostatic condensers[2], when the distance between the plates is altered, have been employed for measuring dimensional changes in solids subjected to heating. The cathode-ray oscillograph has also been employed in dilatometry[3].

The technique of powder metallurgy involves first the compression of metal powder to the required shape, followed by heat treatment during which sintering takes place. It is during the latter process that changes in the properties of the pressed compact are brought about. The compact undergoes expansion or contraction depending upon the compacting pressure, sintering temperature, particle size and furnace atmosphere. A study of dimensional changes in compacts during sintering provides information on the process of sintering and the dilatometer has been employed by a few workers in such studies[4,5].

Experimental

Metal powder compacts invariably undergo oxidation when heated in air even at low temperatures. It is necessary, therefore, that the dilatometer should be so designed as to permit the heating of the test specimen in a neutral or reducing atmosphere. It is more advantageous to use a horizontal dilatometer than a vertical one. The powder compacts are of low strength and are liable to bend when heated in a vertical position under their own weight. The dilatometer described in our studies (FIG. 1) consists of a refractory tube A-A, fitted at both ends with brass flanges B-B, piecene wax being used at the joints to render them airtight. The joints are provided with water-cooling coils M. The flanges are provided with connections C and D for circulating hydrogen or other gas. A small copper tube soldered to one of the flanges facilitates thermocouple connections.

One side of the quartz tube is closed by a round brass wall W, exactly fitting the face of the flange and supported on a small ring R fitted on the inside of the flange. The contact faces of the flange and the brass wall are ground and greased and when placed in position they make a tight fit. The second flange (fitted on the other end of the tube) is closed with a bell jar H which rests on the face of the flange, plasticine being used for the joint. The test specimen S is kept inside the tube in the uniform temperature zone and rests between two silica tubes, a platinum-platinum-rhodium thermocouple passing through one of them. A small hole, $\frac{1}{16}''$ in diameter and about half an inch in depth, is carefully drilled along the length at one end of the specimen and the thermocouple is inserted into it so that the correct temperature of the specimen is indicated. The thermocouple leads L are taken out from the inside of the tube through the outlet as shown in Fig. 1.

Two compression springs (not shown in FIG. 1) press the brass wall on to the flange tightly. The silica rod is provided with a collar. A light spring between the collar and another collar fitted to the brass rod of the flange assures that the specimen is all the while in contact with its accessories. A Mercer dial gauge G on the end of the silica rod records the linear changes.

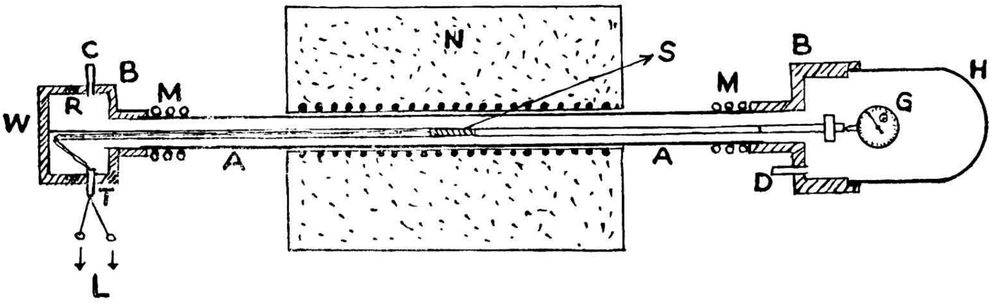
The pressed compact (3″ long × 0·375″ broad × 0·25″ to 0·35″ thick, depending upon the compacting pressure used) when heated attains a temperature of 500°C. in 20 min., 800°C. in 32 min., and 1,000°C. in 45 min. This heating rate is maintained in all experiments.

Platinum-platinum-rhodium thermocouple is rendered brittle when heated in hydrogen and has to be annealed after each experiment. The method employed for annealing is to pass an electric current through it until the wires become white hot.

Single metal powders were used in these studies to avoid complications due to alloying when powder mixtures are heat treated. Two grades of copper powder, viz. —200 to —300 mesh and —325 mesh copper fine, both prepared electrolytically and supplied by *Powder Metallurgy Ltd.*, were employed in these studies. The specific surface of the former was 280 sq. cm./gm. while that of copper fines was 4,000 sq. cm./gm.

Observations

The characteristic dilatation curves of copper —200 to —300 mesh (Copper C) and copper fines (Copper F), each pressed at



A-A, refractory tube ; B-B, brass flanges ; M, cooling coils ; C and D, hydrogen inlet and outlet ; T, soldered copper tubing ; W, brass wall ; R, supporting ring ; S, test specimen ; L, thermocouple leads ; G, dial gauge ; N, furnace ; and H, bell jar.

FIG. 1 — BELL-JAR HORIZONTAL DILATOMETER.

25 and 45 tons per sq. in., are shown in Fig. 2. There are three change points in the curves for both C25T and C45T (Copper C pressed at 25 tons and 45 tons respectively). The first straight-line relationship extends up to 150°C. for C25T and 125°C. for C45T. The coefficients of linear expansion in these ranges are $16{\cdot}5 \times 10^{-6}$ per °C. and $16{\cdot}76 \times 10^{-6}$ per °C. respectively. Pure copper has approximately the same coefficient of expansion. The second straight-line relationship extends up to about 300°C. for C25T and up to 400°C. for C45T. The coefficient of expansion is higher, the actual values being approximately 18×10^{-6} per °C. in both cases. The third straight-line relationship extends up to 600°C. for C25T and up to 725°C. for C45T. In this range the coefficient decreases for C25T ($17{\cdot}9 \times 10^{-6}$ per °C.) but increases considerably for C45T ($20{\cdot}15 \times 10^{-6}$ per °C.).

Changes in the dilatation curves of Copper F25T and Copper F45T (copper −325 mesh pressed at 25 tons and 45 tons respectively) can also be similarly divided into three ranges. These ranges and the corresponding coefficients of linear expansion are given in Table I.

TABLE I — COEFFICIENT OF LINEAR EXPANSION OF COPPER POWDER COMPACTS AT DIFFERENT TEMPERATURE RANGES

Copper F25T		Copper F45T	
Temp. range, °C.	Coefficient of linear expansion	Temp. range, °C.	Coefficient of linear expansion
20–190	$14{\cdot}7 \times 10^{-6}$	20–160	$15{\cdot}23 \times 10^{-}$
190–300	$17{\cdot}99 \times 10^{-6}$	160–250	$20{\cdot}83 \times 10^{-6}$
300–480	$16{\cdot}33 \times 10^{-6}$	250–500	$15{\cdot}1 \times 10^{-6}$

Fig. 2 shows that the temperature at which the shrinkage and expansion just balance each other is higher for Copper C than for Copper F. This temperature is about the same for Copper F25T and Copper F45T, and it is higher for C45T than for C25T. When the temperature at which the overall contraction sets in is reached, the specimen contracts very rapidly and the dial gauge " runs out ". The dilatation curves are, therefore, not continued above this temperature.

Discussion

A powder compact cannot be expected to expand like a metal rod, and if at any temperature the rate of contraction becomes relatively more than the rate of expansion, then, in the absence of any other factor, there should be an overall contraction instead of an expansion. Other factors which should be taken into consideration are : (1) *Adsorbed gases* : The amount of gas adsorbed is greater on fines than on coarse powders. Trzebiatowski showed that the apparent surface of a copper powder made up of cubic particles, 1 mm. side, is 0·67 sq. m./gm. The true surface may be 100 times this figure as shown by Bowden and Rideal[6]. Assuming an adsorbed film of a gas one molecule thick, the possible gas content would be 0·36 c.c./gm. as calculated by Trzebiatowski. (2) *Entrapped gases* : Gases may be entrapped during sintering or they may get entrapped as they are evolved when the temperature is raised. The entrapped gases affect the volume of the specimen, the expansion depending on the readiness with which the gas escapes. Recrystallization and grain growth, involving reduction in total surface, also influence the evolution of gases.

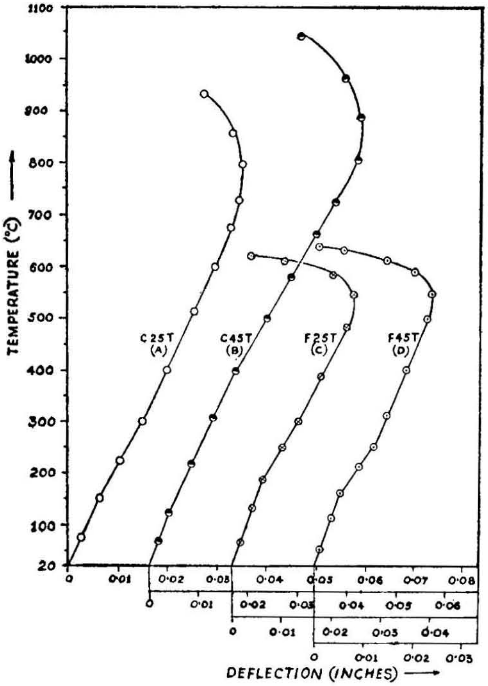


FIG. 2 — HEATING CURVES BY THE DILATOMETRIC DETERMINATIONS.

Taking all these factors into consideration, the observations may be interpreted as follows:

First Range — The coefficient of linear expansion for C25T and C45T in this range is the same as that of the pure metal. It is less for Copper F but increases with pressure. The coefficients are closely related to porosity. While heating the pores are gradually closed and, as the porosity of copper F is high (*c*. 30 per cent), considerable expansion is taken in by the pores and the coefficient of expansion is, therefore, low.

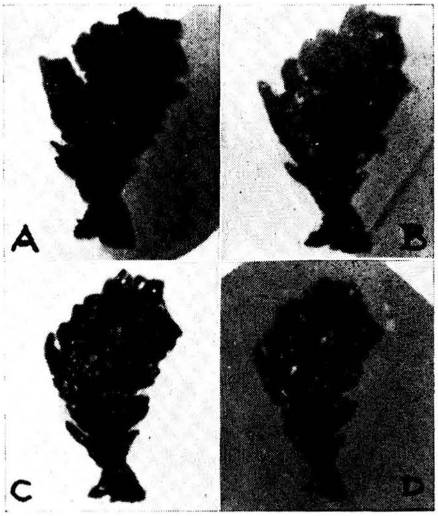
Second Range — The coefficient of expansion in this range is higher than that in the first range. In the case of Copper F, it is much more than that in the case of Copper C. It is true that the coefficient of linear expansion of copper increases with temperature, but this alone does not account for the large increase observed, especially in compacts of Copper F. It is possible that the adsorbed gases evolved during the heating are partly responsible for the high value observed.

Third Range — In this range the coefficients decrease in all cases except in the case of C45T. It is probable that in this case the entrapped gases cannot escape readily as the inter-particle channels are more tightly closed than in C25T. Also, in this range recrystallization and grain growth take place (as shown by microscopic examination), resulting in a reduction in the total surface. More gas would be evolved and this would also affect the expansion.

This effect is not noticeable in the case of Copper F45T as the porosity is still quite high (about 40 per cent) and is uniform throughout the specimen.

The main difference observed in the curves of powders Copper C and Copper F is at the bends. In the case of Copper F the bends are rather sharp.

The nature of the force which brings about shrinkage can be well understood by studying a single powder particle heated to different temperatures. In Fig. 3 are represented the changes which the particle suffers when heated to 875°, 950° and 1,000°C. in succession. A close examination shows that the particle shrinks and the edge gets rounded as the temperature increases. The force which brings about shrinkage, and consequent diminution of surface, is akin to the surface tension. The inward pull on the atoms at the surface is due to cohesion as a result of which the surface has a free energy. The effects of free energy or surface tension are not manifested in changes of form in solids except when the mobility is sufficient for the atoms to move as, for instance, at high temperatures.



A, original particle; B, heated to 875°C.; C, heated to 950°C.; and D, heated to 1,000°C.

FIG. 3 — SHRINKAGE OF A PARTICLE WHEN HEATED TO DIFFERENT TEMPERATURES (X 75).

The particles of a powder, on account of their high irregular surface, possess surface energy, and this would be naturally more for fine particles than for coarse ones. It must be noted that the photographs refer to a coarse powder in −40 +100 range. The particles in this range can be handled fairly easily. The effect of temperature on very fine particles must be more pronounced.

Thus it is safe to assume that the coalescence force is the effect of surface tension and the high surface tension of fines accounts for the greater shrinkage (and hence sharp bends in the curve) observed in Copper F compacts.

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Chemical Examination of Castor Oil Gel—Part I

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Castor oil gel is the ultimate product of the prolonged heat treatment of castor oil. About 40 per cent of it is soluble in common organic solvents. The soluble and the insoluble portions were converted into their methyl esters and subjected to vacuum distillation. From the analysis of the methyl esters it has been ascertained that about 75 per cent of the insoluble portion is composed of a mixture of di- and tri-carboxylic acids.

CASTOR oil gel resulting from prolonged heat treatment of castor oil is insoluble in common organic solvents and, at present, it has few industrial uses. With a view to finding some applications for this product a detailed examination of the gel has been undertaken.

The principal change occurring during the heating of castor oil is the dehydration of ricinoleic acid chains leading to the formation of glycerides of 9:11 and 9:12 linoleic acids. Further heating results in polymerization and in the formation of the glycerides of dimerized linoleic acid and its isomers. The investigations of Petit[1] and Champtier and Petit[2] have established the cyclohexenic or hydro-aromatic nature of the dimeric fatty acids. Bradley and Johnston[3] have indicated the possibility of the formation also of a small amount of trimer. As long as cyclization reactions occur within, rather than between, the fatty acid molecules, only the functional groups are affected without any increase in molecular weight. The next stage, according to Rossman[4], is probably the cyclization of large polymer molecules by intramolecular reaction leading to gelation[5]. Flory's theory[6] of gel formation assumes the formation of an intricate network of a large number of molecules formed exclusively by intermolecular reactions. Bradley's theory[7], on the other hand, suggests that the gel state is due to a mechanically interlinked mesh of cyclized polymer molecules of limited size. According to this view some intramolecular reactions as well as polymerization is essential for gelation and formation of insoluble and infusible forms. Similar views are held by Farmer[8].

The possibility of the existence of monomeric fractions in the gel is not excluded in the above theories. Bradley and Pfann[9] have isolated monomeric fractions to the extent of 24·3 per cent from the hydrolysates of the insoluble gel obtained during the heat treatment of a mixture of oiticica and sardine oils. Bradley and Johnston[10] also postulated the existence of cyclic monomers due to thermal decomposition of linoleic acid and oleic acid chains during gelation.

The castor oil gel used in the present investigation was prepared from fresh medicinal castor oil of low acid value. The oil was heated at 280°-300°C. in an air bath. 50 c.c. samples of the heated oil were taken out after every 3 hr. and their physical and chemical characteristics were determined. The results obtained are given in Table I.

TABLE I

	ORIGINAL OIL	SAMPLES TAKEN AFTER			
		3 hr.	6 hr.	9 hr.	11 hr. (just before gel formation
Sp. gr., 40°C.	0·9603	0·9467	0·9424	0·9534	0·9557
Viscosity, 40°C. (centistokes	280·2	196·3	319·0	4128·3	6679·2
Ref. index, 25°C.	1·478	1·475	1·4805	1·4840	1·4845
Acid val.	2·63	11·87	15·62	25·44	19·87
Sap. val.	183·5	197·8	206·2	223·0	209·0
Iod. val. (Wijs)	88·0	99·25	115·3	106·3	103·5
Iod. val. (Woburn B)	92·6	105·6	124·5	115·0	112·4
Diene val. (Ellis and Jones	14·8	26·6	26·4	12·9	12·8
Acetyl val.	149·5	126·6	69·90	Gelling takes place	

The molecular weight of the oil after heating for 11 hr. (just before gelation) was 1,144 as determined by Rast's camphor method.

1. *Solvent Extraction of the Gel* — The soluble phase from the brownish-yellow gel was removed by grinding and refluxing with two solvent mixtures A and B, filtering the solution and repeating the treatment till no more soluble portion could be extracted. The collected extracts were combined, freed from solvent and dried to constant weights *in vacuo*. The yields and characteristics of the soluble fractions are given in Table II.

TABLE II

	PETROL ETHER (B.P. 40°-60° C.) 1 PART + ACETONE 2 PARTS (A)	BENZENE 1 PART + ETHYL ALCOHOL 1 PART (B)
Yield of soluble fraction, %	39·2	41·2
Sp. gr., 40°C.	0·9825	0·9835
Viscosity, 40°C. (centistokes)	2641·4	2691·8
Ref. index, 25°C.	1·478	1·479
Acid val.	64·6	63·4
Sap. val.	230·5	230·6
Iod. val. (Wijs)	64·5	64·4
Iod. val. (Woburn B)	66·9	66·3
Acetyl val.	34·7	34·5
Diene val. (Ellis and Jones)	15·1	14·8
Mol. wt. (Rast's method)	650·4	654·8

The solvents were removed from the extracted gel by heating *in vacuo* at 100°C. The saponification value of the 2 samples of the gel were 260·0 and 257·5 respectively.

2. *Methyl Esters of Soluble & Insoluble Fractions* — 200 gm. of extracted (solvent mixture B) gel were refluxed for 4 hr. with alcoholic potash and, after separating the unsaponifiable fraction from the hydrolysate by ether extraction, the free acids were freed by acidification with sulphuric acid, extracted with ether and dried at 120°C. They were converted to their methyl esters and the polymerized esters were separated from the unpolymerized fractions by distillation under reduced pressures. A known quantity of esters was subjected to vacuum distillation and the esters volatilizing at 1 mm. pressure were collected. The methyl esters of the soluble fraction of the gel and of the oil heated up to the point of gelation were also separated as above. For the sake of comparison the methyl esters of the original castor oil were also similarly treated. The yields and characteristics of the different esters are given in Table III.

Fractionation of Polymers

For the fractionation of the residual methyl esters of the soluble and insoluble parts of the gel and those of castor oil heated to the point of gelation, the solvent segregation method[11], recommended by Bradley and Bernstein, was adopted[12].

103 gm. of the esters dissolved in 50 c.c. benzene were shaken up into 200 c.c. of 1 : 1 mixture of acetone and 99·5 per cent methyl alcohol in a separating funnel. Water was added till opalescence appeared and the mixture set aside till the separation of the two layers was complete. The lower layer was drawn off. The residual fraction was freed from solvent by distillation *in vacuo*. This was fraction 1. Three further fractions were obtained by successive additions of water to the solution. From the final liquid the last fraction was obtained after complete removal of the solvent. The physical and chemical characteristics of the fractions from the different methyl esters are given in Table IV.

Discussion

When castor oil is heated at 280°-300°C., its specific gravity, viscosity and refractive index decrease in the initial stages followed by an increase, while the acid, saponification, iodine and diene values follow a reverse order. Determination of these values has been followed up to the gelation stage.

The molecular weight of the oil heated to the gelation point is 1,144. Bradley and Pfann[9], however, on the presumption that 8 molecules of linoleic acid glyceride are interlinked, estimated that the molecular weight of the gel obtained from a mixture of oiticica and sardine oil is 7,317. But some intramolecular reaction along with polymerization is essential for gelation to the insoluble and infusible form.

A study of the characteristics of the methyl esters of the original castor oil, of oil heated to the gelation point and of the two fractions of the gel lead to the following observations:

1. The percentage of methyl esters which can be recovered by distillation at 1 mm. pressure at 260°C. decrease in the following order: original castor oil, castor oil just before gelation, soluble portion of the gel and insoluble portion of the gel. The distillates are of low molecular weight.

TABLE III

	ORIGINAL OIL			CASTOR OIL JUST BEFORE GELATION			SOLUBLE FRACTION OF THE GEL			INSOLUBLE FRACTION OF THE GEL		
	Total	Distillate	Residue	Total	Distillate	Residue	Total	Distillate	Residue	Total	Distillate	Residue
Yield, %	...	78·0	22·0	...	46·9	53·1	...	25·0	75·0	...	13·0	87
Sp. gr., 40°C.	0·9124	0·9081	...	0·9193	0·9031	0·9604	0·9397	0·9053	0·9787	0·9495	...	0·9843
Viscosity, 40°C. (centistokes)	17·20	13·5	...	21·48	6·27	101·4	31·54	...	171·2	125·5	...	267·7
Ref. index, 25°C.	1·4622	1·4618	1·4745	1·466	1·4595	1·4765	1·4705	1·445	1·470	1·478	1·422	1·483
Acid val.	8·7	1·5	18·2	5·3	3·1	9·0	8·5	3·7	9·2	8·7	7·9	8·9
Sap. val.	180·1	186·2	198·6	205·0	213·0	198·9	223·8	265·0	202·8	237·6	355·0	280·6
Iod. val. (Wijs)	88·4	88·1	99·4	99·15	120·4	84·45	60·1	59·34	67·8	60·12	44·02	66·01
Iod. val. (Woburn B)	93·8	94·3	102·5	103·5	128·8	92·98	65·5	60·46	72·16	65·34	46·32	67·75
Diene val. (Ellis and Jones)	16·1	7·03	9·4	9·0	10·87	6·34	5·1	4·9	4·8	7·3	4·8	5·03
Acetyl val.	148·0	...	...	24·0	...	...	29·8	...	...	21·0	...	...
Mol. wt. (Rast's)	...	...	551·6	...	276·3	564·5	...	254·2	564·0	...	252·1	580·3

TABLE IV

	CASTOR OIL HEATED TO THE POINT OF GELATION						SOLUBLE FRACTION OF THE GEL					INSOLUBLE FRACTION OF THE GEL					
	Original	1	2	3	4	5	Original	1	2	3	4	Original	1	2	3	4	5
Weight, %	...	19·54	14·86	17·98	17·27	30·35	...	35·81	10·85	15·97	37·37	...	35·34	10·50	10·50	14·23	29·43
Ref. index, 25°C.	1·4765	1·477	1·477	1·477	1·4763	1·475	1·480	1·481	1·481	1·480	1·479	1·483	1·4837	1·4840	1·4830	1·4820	1·481
Iod. val. (Wijs)	84·5	88·0	86·0	86·4	85·5	85·9	67·8	67·8	67·85	67·42	68·21	66·01	65·21	67·01	68·79	68·93	62·24
Iod. val. (Woburn B)	92·9	92·0	94·4	95·7	94·9	92·5	72·16	69·69	72·18	73·67	73·58	67·75	74·45	72·05	74·3	75·27	64·63
Sap. val.	198·9	196·2	199·0	197·8	198·0	201·8	202·8	204·8	205·7	203·8	214·1	230·6	225·0	225·7	230·4	228·9	241·5
Sap. equivalent	282·0	285·9	282·0	283·6	283·3	278·6	276·1	273·9	272·7	275·2	262·0	242·8	249·3	249·0	243·4	245·0	232·2
Mol. wt.	564·5	590·0	575·3	564·4	557·2	543·3	564·0	569·9	559·0	555·9	531·8	580·3	586·4	578·5	576·4	570·6	565·4
Basicity of the acid	2·0	2·06	2·04	1·99	1·97	1·95	2·04	2·08	2·05	20·3	2·03	2·39	2·25	2·32	2·36	2·38	2·43
No. of iod. atoms used per molecule	3·74	4·1	3·9	3·8	3·8	3·8	3·0	3·1	3·0	2·9	2·9	3·0	3·0	3·1	3·1	3·1	2·8

2. The molecular weights of the residual methyl esters in all cases vary between 551·6 and 580·3. When the residual fractions of the methyl esters are fractionated by the solvent segregation method, a regular gradation in the characteristics is observed. The molecular weights correspond nearly to that of the dimer of linoleic acid in all cases.

3. The number of double bonds per molecule, calculated from Wijs iodine values for residual esters just before gelation, is 2, while for that of the soluble and insoluble fractions of the gel is nearly 1·5. The latter value may be due to the presence of esters of dienic and mono-olefinic acids.

4. The basicity values of the acids of various fractions show that whereas the acids of the residual methyl esters, segregated from the castor oil just before gelation and those of the soluble portion of the gel, showed a basicity of 2, similar fractions from the insoluble portion of the gel give values varying from 2·25 to 2·43 indicating them to be the mixtures of dicarboxylic and tricarboxylic acids. Since the molecular weight of the fraction is below 586·4, the formation of any trimer of linoleic acid is ruled out. The presence of some tricarboxylic acid can presumably be, therefore, explained on the scission and reunion of alkyl chains in different molecules of the dimer in glycerides.

5. The hydrolysed product of the castor oil gel may advantageously be used for the preparation of elastomers and higher polymers after condensing with glycols and other polyhydric alcohols. The hydrolysed material, either as such or after modification with drying oils, may be used as a coating composition. The di- and trivalent salts of the hydrolysate have already given satisfactory results as substitutes for estergum and oil varnishes and as solvent lacquers. Work on the hydrolysis of castor oil gel under steam pressure is in progress.

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Extraction of Germanium from Sphalerite Collected from Nepal—Part I

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A method for the extraction of germanium from the magnetic fraction of the mineral sphalerite has been described. The fraction which is shown to be magnetite contains 0·24 per cent germanium.

IN a previous communication[1], we described a magnetic fraction of the mineral sphalerite collected from Nepal. On chemical analysis, this fraction was found to be mainly ferric oxide with a coating of ferrous sulphide. It contains germanium to the extent of 0·24 per cent. That the mineral is magnetite has also been confirmed by X-ray analysis. Coal ash, euxenite and some specimens of zinc blende are known to contain germanium in small quantities, but its association with magnetite has not been reported.

Experimental

Analysis of the Mineral — The spectrogram revealed the existence of iron, silicon, lead (trace) and germanium.

Total Iron — A weighed amount of finely powdered mineral was dissolved in 1 : 1 hydrochloric acid and the total iron estimated by titration with potassium dichromate after reduction with stannous chloride.

Silica was estimated by the usual method, and the value verified by determining the loss in weight by treatment with hydrofluoric acid.

Sulphur — The mineral was decomposed with sodium peroxide and the sulphur estimated as barium sulphate.

Ferrous iron was estimated by decomposing the mineral with 5 c.c. of concentrated hydrochloric acid and 10 c.c. of hydrofluoric acid in an atmosphere of carbon dioxide, and subsequent titration with potassium dichromate using diphenylamine sulphonate as indicator.

Germanium — Of the various methods known for the estimation of germanium[3-5], Orliac's colorimetric method[5] with slight modification was found to be the most convenient. A weighed amount of the mineral was carefully roasted at 500°C. in an electric furnace and transferred to an all-glass distillation apparatus. 40 c.c. of 1 : 1 hydrochloric acid were added and the flask gently heated in a current of air. The distillate was collected in a flask containing dilute caustic soda solution and a drop of phenolphthalein indicator solution. After the distillation was complete, the solution was acidified with dilute hydrochloric acid and the volume made up to 100 c.c. To 10 c.c. of this solution, 1 c.c. ammonium molybdate solution (9 per cent) and 10 c.c. of alkaline potassium stannite solution containing 5 gm. of hydrated stannous chloride and 300 gm. of potassium hydroxide per litre were added and the total volume made up to 40 c.c. A series of standard solutions of germanium tetrachloride were

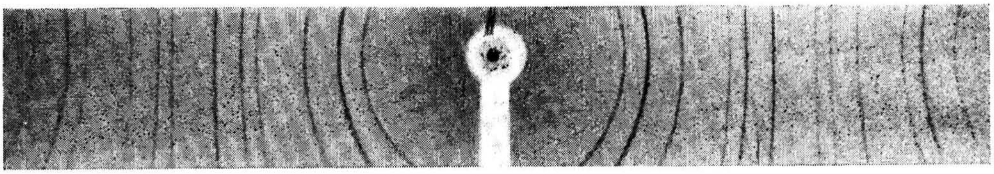

FIG. 1 — X-RAY POWDER DIAGRAM OF THE NON-MAGNETIC PORTION FROM THE MINERAL SPHALERITE.

prepared and the same volume of ammonium molybdate and alkaline stannite were added and the total volume in each case made up to 40 c.c. After an interval of 5 min. the transmittancies of the solutions were determined in a Lumetron photo-electric colorimeter, using 440 mμ filter, and a standard graph was constructed. From this graph germanium in the mineral was found to be 0·24 per cent.

The results of the analysis are tabulated below :

	%		
Total iron	69·5	Fe_2O_3	66·28
Ferrous iron	23·1	FeO	27·02
Sulphur	1·19	FeS	3·27
Silica	2·16	SiO_2	2·16
Germanium	0·24	GeO_2	0·34
			99·07

The mineral is apparently magnetite with a coating of ferrous sulphide. This has now been confirmed by X-ray powder diagram kindly supplied by Mons. Pierre Urbain, Director, Hydrological Institute, Sorbonne, Paris. The rontgenogram is reproduced in Fig. 1.

Extraction of Germanium Dioxide — None of the methods employed by Winkler for the extraction of germanium from Argyrodite was adopted, as the associated elements in this mineral are quite different from those in Argyrodite. After various trials the final procedure adopted was based upon the volatility of germanium tetrachloride and is an elaboration of the procedure described by Buchanan[2].

160 gm. of the finely powdered mineral were roasted in an electric muffle at about 550°C. for 12 hr. when all the sulphide was converted to sulphate and oxide. The roast ore was transferred to an all-glass Claisen flask. 400 c.c. of 1 : 1 hydrochloric acid were added and germanium tetrachloride distilled off in a current of hydrochloric acid gas till the volume is reduced to one-fourth. This distillation was repeated with further additions of hydrochloric acid. A rapid stream of hydrogen sulphide gas was then passed through the distillate for about 15 min. when a milky precipitate of germanium disulphide was obtained (for complete precipitation, the acid strength was maintained at 4N to 6N by the addition of concentrated hydrochloric acid). The mixture was set aside in a stoppered bottle for 48 hr., the sulphide separated by filtration and washed with 6N sulphuric acid saturated with hydrogen sulphide till it was free from chloride. The precipitate on the filter paper was treated with aqueous ammonia (about 8N) and the filtrate collected. The germanium disulphide was thus obtained as the thio-salt. The filtrate was evaporated, hydrogen peroxide added and again evaporated to dryness. The dried mass was carefully heated to remove ammonium sulphate completely, transferred to a crucible with water, evaporated and finally ignited to germanium dioxide at 600°C. The yield was 330 mg.

The spectrum of germanium dioxide thus obtained reveals the existence of traces of iron, lead, phosphorus (impurities from the hydrogen peroxide used).

Acknowledgement

Our grateful thanks are due to Prof. P. B. Sarkar for his keen interest in this investigation, and to the *Council of Scientific Industrial Research* for granting a scholarship to one of us (R. K. Dutta).

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Factors Affecting the Properties of Typical Zircon Porcelain — Part I

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Lime is a useful flux in zircon bodies, whether it is added as calcium-ziroconium silicate, whiting or wollastonite. These fluxes either individually or in combinations do not markedly influence the maturing characteristics and fired properties of typical zircon porcelain bodies processed by the dry-press method. The forming pressure rather than the pressing technique is important in the control of fired density. All the three fluxes are suitable, when used individually, for the production of earthenware and semi-vitreous bodies.

AN appreciable amount of work[1-8] has already been done on zircon porcelain compositions and useful fluxes such as whiting and calcium-zirconium silicate in zircon porcelains have also been investigated in this laboratory by previous workers[3]. The present investigation was undertaken to study the relative merits of different methods of incorporating the alkaline earth fluxes in typical zircon porcelain compositions[4].

Experimental

The raw bodies were so compounded that the fired body composition in each case was as follows:

Weight per cent Composition

		%
Al_2O_3,	$2\ SiO_2$	19
ZrO_2,	SiO_2	72
CaO		9
		100

Dividing by the Respective Molecular Weights

Al_2O_3,	$2\ SiO_2$	19/222 :	0·09 mol
ZrO_2,	SiO_2	72/182·9 :	0·39 mol
CaO		9/56 :	0·16 mol
			0·64 mol

Hence, mol per cent composition of the body was, in each case, as follows:

$$\begin{array}{llcl} & & & \% \\ Al_2O_3, & 2\ SiO_2 & \dfrac{0{\cdot}09 \times 100}{0{\cdot}64} & = 14 \\ ZrO_2, & SiO_2 & \dfrac{0{\cdot}39 \times 100}{0{\cdot}64} & = 61 \\ CaO & & \dfrac{0{\cdot}16 \times 100}{0{\cdot}64} & = 25 \end{array}$$

Mol per cent composition of fluxes in various raw bodies is indicated in Fig. 1, and the composition of the raw body is calculated as follows. Each mol of calcium-zirconium silicate supplies a mol of CaO and a corresponding mol of ZrO_2, SiO_2. This was taken into consideration and the proper adjustment made when adding zircon to the body. Wherever wollastonite was used as a source of CaO, it provided a corresponding mol of SiO_2. This amount

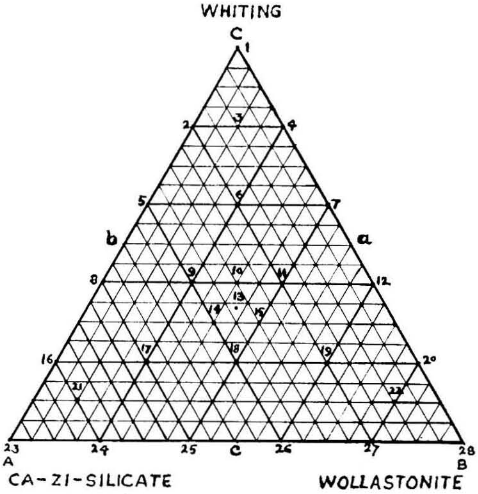


FIG. 1 — MOL PER CENT COMPOSITION OF FLUXES IN RAW BODIES.

of silica provided by wollastonite was considered as excess silica in that particular body and it was not taken into account when adjusting the molecular composition of the body. In making these calculations the theoretical and not the actual molecular weights of the raw materials were used.

The following raw materials were used :

1. *Milled Zircon (Titanium & Alloy Manufg. Co., Niagra Falls, New York)*

Analysis

	%
ZrO_2	64·3
SiO_2	35·0
Others	0·7
TiO_2	0·1
Fe_2O_3	0·05
Reported fineness	0·1 retained on 325 mesh
Determined fineness	0·27 retained on 325 mesh

2. *Calcium Zirconium Silicate (Titanium & Alloy Manufg. Co., Niagra Falls, New York)*

Analysis

	%
ZrO_2	52
SiO_2	26
CaO	22
Reported fineness	0·1 on 325 mesh
Determined fineness	0·19 on 325 mesh

3. *Florida Kaolin (Edgar Plastic Kaolin Co., Metuchen, N.J.)*

Analysis

	%
Al_2O_3	36·75
Fe_2O_3	0·80
CaO	0·15
TiO_2	0·18
MgO	0·20
SiO_2	46·95
KNaO	0·24
Ignition loss	14·95

4. *Whiting (Columbus Dental Manufg. Co., Columbus, Ohio)*

Analysis

	%
$CaCO_3$	98·5
MgO	0·5
SiO_2	0·8
Al_2O_3	0·1
Others	0·1

5. *Wollastonite — CaO, SiO_2 (Foote Mineral Co., Philadelphia, Pa.)*

Analysis

	%
SiO_2	49·8
Al_2O_3	2·7
CaO	46·5
Fe_2O_3	1·1
Observed fineness	14·0 retained on 200 mesh (mainly coarse red sand) ; ground to pass through 200 mesh by wet grinding before being used

The compositions of the raw bodies are given in Table I. The body in each case was prepared by wet ball-milling and drying in a steam-heated drier (temperature 60°C.) and subsequently pulverized in a " Braun " disc pulverizer, avoiding excessive fines.

The test specimens were formed by dry pressing in a steel die at 4,000 p.s.i., using a manually operated Carver laboratory press. 7 per cent by weight of a 5 per cent dextrine solution was used as the binder in preparing the pressing batch. Discs, 2" in dia. (3 sq. in. in area) and approximately ¼" thick, were prepared for the vitrification studies. The following bar specimens were prepared for those bodies (three end members of the tri-axial, i.e. Nos. 1, 23 and 28)

TABLE I — EFFECT OF FLUX SELECTION ; BODY COMPOSITION IN PERCENTAGE BY WEIGHT

Body No.	Zircon, %	Florida kaolin, %	Whiting, %	Ca Zr SiO_5, %	Wollastonite, %
1	64·6	20·9	14·5	0·0	0·0
2	60·1	21·2	11·7	7·0	0·0
3	62·2	21·0	11·6	3·5	1·7
4	64·3	21·8	11·5	0·0	3·4
5	55·4	21·5	8·9	14·0	0·0
6	59·8	21·1	8·8	7·0	3·4
7	64·0	20·7	8·7	0·0	6·7
8	50·6	21·7	6·0	21·6	0·0
9	55·0	21·3	6·0	14·0	3·4
10	57·4	21·2	5·9	10·5	5·1
11	59·5	21·0	5·9	7·0	6·8
12	63·7	20·6	5·8	0·0	10·0
13	57·1	21·4	4·8	10·9	5·8
14	55·0	21·3	4·4	14·0	5·1
15	57·2	21·1	4·4	10·5	6·8
16	45·8	22·0	3·1	29·2	0·0
17	50·4	21·6	3·0	21·5	3·5
18	56·0	21·2	3·0	14·0	6·8
19	59·2	20·9	2·9	6·9	10·1
20	63·4	20·5	2·8	0·0	13·2
21	45·0	21·6	1·5	28·6	1·8
22	61·2	20·7	1·4	3·5	13·3
23	40·9	22·4	0·0	37·1	0·0
24	45·5	21·0	0·0	29·0	3·5
25	50·2	21·5	0·0	21·4	7·0
26	54·7	21·2	0·0	14·0	10·2
27	59·0	20·8	0·0	7·0	13·3
28	63·1	20·3	0·0	0·0	16·4

included in the final study of fired properties.

12 specimens, each of $5'' \times 1'' \times \frac{1}{2}''$, for the determination of the following : (a) total shrinkage and fired transverse strength ; (b) warpage during firing ; (c) fired translucency and broken bars were employed for bulk and apparent specific gravity and per cent absorption. 2 specimens, each $5'' \times \frac{1}{2}'' \times 1\frac{1}{2}''$, were prepared for the determination of the coefficient of thermal expansion.

The specimens for the determination of the fired translucency were wedge shaped (0-½″) with a " clipper " abrasive wheel.

The test pieces were dried in a steam-heated drier (60°C.) and subsequently fired in a muffle type electric glober kiln. The temperature was increased at the rate of 350°F. per hour to within 2 cones of the ultimate end point.

A soaking period of 3-4 hr. was allowed.

Water absorption tests were conducted in the conventional way and per cent absorption was considered as the criterion of the progress of vitrification.

The shrinkages were determined as follows :

$$\text{Per cent total shrinkage} = \frac{\text{Formed length} - \text{fired length}}{\text{Formed length}} \times 100$$

A Dillon testing machine was used for the determination of fired transverse strength.

Translucency was determined by sliding a wedge-shaped test piece from the thickest to the thinnest end over a narrow slit in the cover of a box containing a 60-watt Mazda lamp. The thickest cross-section (measured to an accuracy of 0·001″) of the specimen where the slit was just visible was reported as the translucency value. An average of 4 measurements, using 2 specimens, is reported.

The thermal expansion determinations were made in a fused quartz tube dilatometer designed by the U.S. Bureau of Standards in which the expansion of the test bar ($5'' \times \frac{1}{2}'' \times \frac{1}{2}''$) is measured by an Ames dial graduated to 0·001″.

Discussion

Effect of Flux Selection on Maturing Characteristics — The results of the effect of flux selection upon the maturing characteristics of the various bodies are presented in Table II. It is evident from Table II that the vitrification range was in no case greater than one Orton cone which is shorter than that preferred for commercial firing. The use of the fluxes, individually or in various combinations, does not show any difference in influencing the maturing characteristics of vitreous bodies ; the effect was somewhat more pronounced in porous bodies.

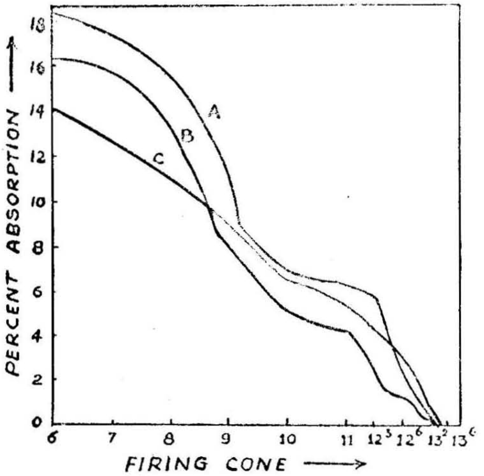
TABLE II — EFFECT OF FLUX SELECTION ; PER CENT ABSORPTION VS. FIRING CONES

BODY NO.	FIRING CONES							
	8^6	9^6	10^6	11^6	12^6	13^6	14^6	15^6
1	15·40	10·60	6·80	6·30	2·00	0·00	O.F.	O.F.
2	16·48	8·65	5·47	5·21	2·08	1·39	O.O.	O.F.
3	17·12	9·38	5·32	5·16	2·24	0·04	O.F.	O.F.
4	20·45	13·70	10·24	9·56	6·35	0·10	O.F.	O.F.
5	14·75	9·05	4·22	2·46	1·54	0·00	O.F.	O.F.
6	15·40	11·39	7·16	5·92	5·78	1.41	O.O.	O.F.
7	16·62	13·84	10·56	10·15	5·55	0·00	O.F.	O.F.
8	13·28	8·35	6·62	5·97	1·98	0·00	O.F.	O.F.
9	13·87	9·45	7·16	6·07	4·05	0·00	O.F.	O.F.
10	13·55	11·64	8·60	6·46	5·68	0·10	O.F.	O.F.
11	17·62	11·06	8·95	8·54	5·40	0·08	O.F.	O.F.
12	15·90	14·82	12·30	7·47	6·34	0·00	O.F.	O.F.
13	18·13	12·05	9·14	8·90	6·79	0·19	O.F.	O.F.
14	16·07	10·75	8·76	7·86	4·93	0·08	O.F.	O.F.
15	14·43	12·57	9·06	7·15	5·54	0·13	O.F.	O.F.
16	14·35	8·51	5·22	3·31	2·66	0·97	O.O.	O.F.
17	16·16	9·58	6·89	4·98	3·23	0·00	O.F.	O.F.
18	15·89	11·74	9·25	8·04	6·02	1·89	O.O.	O.F.
19	18·36	10·97	8·85	8·06	6·48	0·09	O.F.	O.F.
20	14·08	12·82	10·95	9·11	6·83	0·00	O.F.	O.F.
21	15·01	9·90	7·81	5·98	4·89	0·50	O.F.	O.F.
22	13·64	10·68	7·66	6·11	4·88	0·07	O.F.	O.F.
23	13·30	7·90	5·04	4·20	1·20	0·00	O.F.	O.F.
24	15·82	9·46	5·05	4·88	2·84	0·18	O.F. (S.O.F.)	O.F.
25	15·63	10·77	7·88	4·57	3·70	0·10	O.F.	O.F.
26	14·46	11·08	7·95	5·56	4·13	0·09	O.F.	O.F.
27	14·89	9·14	7·29	6·40	2·79	0·07	O.F.	O.F.
28	10·90	8·35	6·38	5·30	2·40	0·00	O.F.	O.F.

O.F. — Over-fired. S.O.F. — Slightly over-fired.

Table II, when considered with reference to Fig. 1, indicates that all the three fluxes, when used individually, are suitable for the production of earthenware and semi-vitreous bodies. The absorption figures of bodies 1, 23 and 28 at cones 9, 10 and 12 show that at these temperatures calcium-zirconium silicate is more effective as a flux than the other two. It is also clear that for any temperature below the point of vitrification, a combination of whiting and calcium-zirconium silicate or of wollastonite and calcium-zirconium silicate yields a considerably greater fired density than a combination of whiting and wollastonite. The increased activity of calcium-zirconium silicate is further evidenced by the temperature vs. absorption data for the bodies 4, 7, 12, 20 and 28 on the one hand and 3, 6, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21 and 22 on the other. The gradual increase in the proportion of calcium-zirconium silicate in the body results in increased fired density.

Fig. 2 shows the progress of vitrification of the three end members of the series and curve A shows that at low temperatures whiting bodies are somewhat more porous than the other two ; this is evidently due to the evolution of CO_2 from whiting in the earlier stages of firing. It is further evident that whiting is not a suitable flux for vitreous (0-0·5 per cent absorption) bodies, or earthenware bodies in the region of 10-12 per cent absorption, even though it may be satisfactorily used for porous bodies in the region of 15-18 per cent absorption, or semi-vitreous bodies in the region of 0·5-7 per cent absorption. Curve B similarly indicates that calcium-zirconium silicate is not suitable in the region of 0-0·5 per cent, 5-10 per cent or 10-12 per cent absorption, while curve C indicates the suitability of wollastonite for earthenware (10-12 per cent) and semi-vitreous (5-7 per cent) bodies. The typical one cone (Orton) vitrification range for vitreous bodies was observed in each case.



A, 1 : whiting ; B, 23 : Ca-Zr silicate ; C, 28 : wollastonite.

FIG. 2 — FIRING CURVES FOR BODY NOS. 1, 23 AND 28.

Effect of Flux Selection on Fired Properties — Data presented in Table III show that all the three representative bodies were markedly deficient in fired transverse strength as compared to 20,000-25,000 p.s.i. for commercial zircon porcelains which is possibly due to the dry-press method of forming. A later study by the author (to be published later) revealed that the conventional wet processes of fabrication including casting and extrusion highly improved the transverse strength.

TABLE III — EFFECT OF FLUX SELECTION ON FIRED PROPERTIES OF PORCELAIN BODIES*

	Body No.		
	1	23	28
1. Firing cone	13^3	13^3	13^3
2. Per cent fired absorption	0·071	0·078	0·010
3. Fired transverse strength in lb. per sq. inch	14566	13570	14305
4. Bulk specific gravity	3·56	3·65	3·62
5. Apparent specific gravity	3·60	3·67	3·63
6. Per cent total shrinkage	12·52	13·71	10·05
7. Fired warpage represented in inch per inch	0·091	0·063	0·066
8. Translucency in inches	0·148	0·169	0·125
9. Coefficient of thermal expansion $\times 10^{-6}$	4·83	4·91	4·89

* Body No. 1 — using whiting as the flux.
Body No. 23 — using calcium zirconium silicate as the flux.
Body No. 28 — using wollastonite as the flux.

It is quite possible that the other properties studied here are also affected by the method of forming, but to a lesser degree.

With the exception of colour, the effect upon the fired properties is almost the same for all the three fluxes. The fired colour was white for body 23, light cream for 28 and dark cream for 1. Depending upon the usage of the finished product, the differences in the fired colour might be important in the selection of the flux.

Effect of Different Pressing Techniques & Forming Pressures — This phase of the study was initiated because previous experience of the author indicated that friction of the die at the edges of the specimens resulted in somewhat local porosity. It was, therefore, expected that pre-densing at the edges of the pressing batch and/or the application of two or more pressure cycles might give uniformity in the density of the fired bodies. Table IV shows that an increase in forming pressure up to 6,000 p.s.i. results in gradually decreased porosity. This effect is, however, relatively slight for the increase from 3,000 to 4,000 p.s.i. but quite appreciable for increases from 4,000 to 5,000 and 5,000 to 6,000 p.s.i. There appears to be no advantage in increasing the pressure beyond 6,000 p.s.i. It is also interesting to note that the forming pressure rather than the pressing technique is important in the control of fired density. Pre-densing at the edges of the pressing batch, which would normally be expected to be beneficial apparently, had no significant effect.

TABLE IV — EFFECT OF DIFFERENT PRESSING TECHNIQUES & FORMING PRESSURES ON FIRED ABSORPTION

(*Body No. 23 — dry-pressed, cone 12^6*)

FORMING PRESSURE (p.s.i.)	EDGES OF SPECIMENS PRE-DENSED BEFORE PRESSING	NO. OF PRESSURE CYCLES	FIRED ABSORPTION, %
3000	No	Single	1·65
3000	No	Double	1·45
3000	No	Triple	1·58
3000	No	3 cycles*	1·58
3000	Yes	Single	1·68
3000	Yes	Double	1·32
3000	Yes	Triple	1·57
3000	Yes	3 cycles*	1·97
4000	No	Single	1·31
4000	No	Double	1·29
4000	No	Triple	1·29
4000	No	3 cycles*	1·09
4000	Yes	Single	1·51
4000	Yes	Double	0·95
4000	Yes	Triple	1·25
4000	Yes	3 cycles*	1·36
5000	Yes	Single	1·30
5000	Yes	Double	0·81
5000	Yes	Triple	0·92
5000	Yes	3 cycles*	1·07
5000	No	Single	0·92
5000	No	Double	0·68
5000	No	Triple	0·95
5000	No	3 cycles*	1·10
6000	No	Single	0·57
6000	No	Double	0·57
6000	No.	Triple	0·40
6000	No	3 cycles*	0·55
7000	No	Single	0·76
7000	No	Double	0·43
7000	No	Triple	0·20
7000	No	3 cycles*	0·47

* A multi-stage cycle employing three pressure applications of increasing intensity was used.

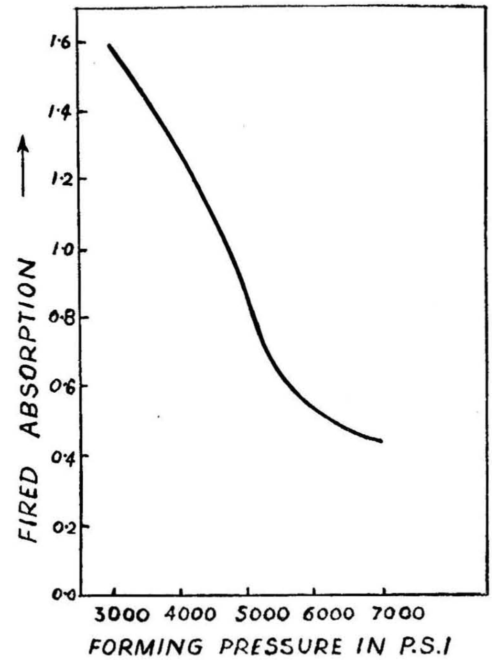


FIG. 3 — EFFECT OF FORMING PRESSURE ON FIRED ABSORPTION ; BODY NO. 23, DRY PRESSED, CONE 12^6.

Conclusions

Lime (CaO) is a useful flux in zircon porcelain bodies whether it is added as calcium zirconium silicate, as whiting or as wollastonite. As regards the maturing range, however, none of the fluxes are of any outstanding merit for the development of vitreous zircon porcelains processed by the dry-press method. The effect of flux selection is more pronounced in porous rather than in vitrified bodies. Calcium-zirconium silicate is more effective as a flux than whiting or wollastonite. These fluxes are more effective individually than in combinations.

In the dry-press method of forming, an increase in forming pressure results in decreased porosity (the optimum effect being obtained at 6,000 p.s.i.). The forming pressure rather than the pressing technique is important in the control of fired density.

But for the fired colour, flux selection has no appreciable effect upon the fired properties of zircon porcelains.

Compared to commercial zircon porcelains, these bodies were markedly deficient in transverse strength. This deficiency has been attributed mainly to the method of forming.

Acknowledgement

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Letters to the Editor

SEARCH FOR MICROFOSSILS IN THE NEOBOLUS SHALES OF THE SALT RANGE, PUNJAB

PROF. B. SAHNI AND HIS COLLABORATORS have found remains of vascular plants in the rock samples of the Saline Series and on this evidence have assigned to it an Eocene age. This observation has been confirmed by A. K. Ghosh[1] and his co-workers at Calcutta. Ghosh and his associates have also examined beds overlying the Saline Series for microfossils. Strangely enough they have discovered in all these beds microfossils of the same general nature as from the Saline Series. They have macerated one sample of the Neobolus Shales and from it reported "numerous pieces of wood often with uni- to multi-seriate bordered pits and a round pitted spore with triradiate scar". The Neobolus Shales are acknowledged to be definitely Cambrian. The finding of remains of vascular plants in them is most unexpected, for the earliest land plants are universally believed to have first appeared only in the Middle Silurian. With a view to confirm these interesting discoveries I examined two samples of Neobolus Shales.

The samples are registered as *S.* 83 and 36/547. Sample *S.* 83 is a dark grey micaceous shale on the surface of which is visible an impression of a Neobolus shell. It was collected by Prof. Sahni from Khewra in 1945. 36/547 is a grey micaceous shale with a light chocolate hue. It was collected from "north of Rawal, Eastern Salt Range, Punjab". This sample was kindly given to me for examination by the Geological Survey of India.

About 50 gm. of each sample were broken to small pieces, brushed and, after passing through a flame, dropped separately in about 100 c.c. of filtered commercial nitric acid. After a week, the acid was decanted off and some filtered distilled water was added to the settled rock material. The material was then lightly shaken so that while the heavy rock particles remained at the bottom, the lighter ones along with the organic remains, if any, may float upwards. The muddy solution containing the lighter portion was poured into another vessel and left for settling. The clear liquid was decanted off and the sediment was washed free of any traces of acid by filtered water. The residue was left in aqueous ammonia overnight, after which the alkali was washed off. It was then treated with hydrofluoric acid to dissolve the silica. After washing out the acid, the residue was treated with caustic soda solution. Thus as much of the rock matter as possible was eliminated before examining the residue for microfossils. After washing, the residue was transferred to a watch glass and given a light rhythmic shake so that the possible organic remains may migrate towards the centre. In this way the clearer portion was separated from the heavier one containing the greater part of the organic matter. To ensure that no organic remains escaped notice, both portions were examined.

No microfossils were found in 36/547. In *S*. 83 two tiny objects of a doubtful nature were noted, but they do not seem to represent any plant structure. The first is a small flake-like object with a large number of small specks on the surface. The other looks like a membrane folded into an irregular shape. My examination of the Neobolus Shales has failed to reveal any recognizable plant remains. There is, therefore, no evidence available at present on the strength of which the already established Cambrian age of the Neobolus Shales can be questioned.

I am grateful to Prof. T. M. Harris, F.R.S., for the improved maceration technique employed in this work.

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INVESTIGATIONS ON THE PREPARATION, PROPERTIES & NUTRITIVE VALUE OF RICE SUBSTITUTES FROM TUBERS & MILLETS

CONSEQUENT ON THE PRESENT SHORTAGE OF rice and other staple foods, it has become increasingly necessary to make up the deficit through other sources. Among these, the most promising are tubers, e.g. tapioca and sweet potato, which can be produced more abundantly than cereals. Tapioca and sweet potato are deficient in proteins and are, therefore, by themselves, poor substitutes for cereals. In an earlier paper[1] from this laboratory it has been shown that incorporation of groundnut cake flour to the extent of 20 per cent with tuber flours makes up for the deficiencies of the latter and the nutritive value of a mixture of tapioca flour (80 parts) and groundnut cake flour (20 parts) is superior to that of rice. More recent investigations (unpublished) have shown that the replacement of 25 per cent of rice or wheat by tapioca or sweet potato flour does not lead to any deterioration in the overall nutritive value of poor rice or wheat diets, as judged by the rate of growth of young rats.

In suggesting alternate food substitutes for rice, we have to take into consideration not only their nutritive value but also their acceptability from the psychological point of view. Food in the form of flour, though readily acceptable to wheat and millet eaters, is not psychologically acceptable to rice eaters accustomed to eating food in the shape of grains. Investigations were, therefore, undertaken to explore the possibility of preparing rice substitutes from tapioca (with and without the addition of groundnut cake flour) and also from millets.

The possibility of preparing rice-like grains from various sources has been investigated by a number of previous workers. Particular reference may be made to the pioneering work of Bhatnagar and his associates who produced rice-like grains from broken rice (private communication). More recently, rice-like grains have been produced in other countries from wheat flour which were used as substitutes for rice during the last war. Tuber flours have not, however, so far been used for such a purpose because of certain practical difficulties. Millets offer more scope in this direction.

For the processing of maize, the grain is first steeped in water containing a trace of sulphur dioxide (0·02 per cent) for two days till the skin is softened. It is then washed and crushed with addition of fresh water. The resulting paste is passed through fine sieves to separate the skin from starch and protein. The mixture of the latter could be used as such or sent over tables so as to separate as much of the gluten as possible if a white product is desired. Groundnut cake flour (10 per cent) and dicalcium phosphate (0·5 per cent) are then added to provide extra protein, B vitamins and minerals. Sufficient water (one and a half times the weight of the mixture) is added and the mixture cooked to a thick pasty mass. This is then pressed through a perforated disc into strands of about the same thickness as rice. These strands are partially dried in the sun or in a drier at about 45°-50°C. and cut mechanically into small pieces of the same size as natural rice grain and finally dried completely.

For the processing of a mixture of tapioca flour and groundnut cake flour, the following method which is similar to that employed commercially for the manufacture of sago from tapioca starch is adopted. The method of pre-cooking does not work satisfactorily in the case of tapioca.

Tapioca flour or a mixture of tapioca flour with groundnut cake flour or jowar (*Sorghum vulgare*) flour is moistened with water (about 50 c.c. water being added to 100 gm. of the mixture). The moist flour is granulated by passing it through a wire-mesh (6-8 to an inch) and then shaken in trays with a cloth bottom for 20-30 min., when the flour is converted into round grains. The wet grains are roasted in a metallic vessel with a trace of deodorized hydrogenated oil over an electric heater until the grains gelatinize and harden. The roasted grains are finally dried in the sun or in a drier at 50°-55°C.

The appearance and cooking quality of different samples of rice substitutes are given in Table I.

TABLE I

Sample No.	Composition	Appearance	Appearance & taste of the cooked product
1	Maize starch, 89 parts + groundnut cake flour, 10 parts + salt mixture (Steenbock), 1 part	Dull white	The cooked product has a dull white appearance; acceptable taste
2	Maize flour (dehusked), 89 parts + groundnut cake flour, 10 parts + salt mixture (Steenbock), 1 part	Light yellow	The cooked product has a light-yellow colour ; acceptable taste
3	Tapioca flour, 99·5 parts + dicalcium phosphate, 0·5 part	Dull white	Cooks to a pasty mass similar to sago ; taste, good
4	Tapioca flour, 89·5 parts + groundnut cake flour, 10 parts + dicalcium phosphate, 0·5 part	Light brown	Cooked product rather pasty ; taste, good
5	Tapioca flour, 69·5 parts + jowar flour, 25 parts + groundnut cake flour, 5 parts + dicalcium phosphate, 0·5 part	Light brown	Cooks like unpolished rice, the cooked grains remaining separate from one another
6	Tapioca flour, 70 parts + groundnut cake flour, 20 parts + broken rice, 10 parts	do	Cooked product rather pasty ; taste, good
7	Tapioca flour, 70 parts + groundnut cake flour, 20 parts + wheat, 10 parts	do	do

From the data given in Table I, it will be evident that the cooking quality of the rice substitutes prepared from maize and also from a mixture of tapioca, jowar and groundnut cake flour (No. 5) is better than that of rice substitutes prepared from tapioca flour and groundnut cake flour. This is due to the fact that the cereal starch, on cooking, sets to an opaque jelly, whereas the tuber starch sets to a glassy and pasty mass. Further experiments were, therefore, carried out to improve the cooking quality of tapioca flour and starch.

Schoch[2] ascribed the difference in the cooking quality between cereal and tuber starches to the presence of polar fatty acids in the latter. He reported that after the removal of fatty acids from maize starch and rice starch by solvent extraction, the fat-free starches on cooking gave more transparent and glutinous gels than untreated starches. In view of the above findings, the effect of incorporation of certain higher fatty acids, viz. stearic, palmitic and oleic acids, on the cooking quality of rice substitutes prepared from tapioca flour and sago from tapioca starch was studied. The results showed that the incorporation of higher fatty acids at 1 per cent level definitely improved the cooking quality, the cooked product appearing opaque and less pasty. The cooked products had an agreeable flavour and taste.

The nutritive value of two of the rice substitutes (Nos. 6 and 7 in TABLE I), as compared to rice, was determined by the rat-growth method. Groups of young rats, about 4 weeks old and weighing 45-50 gm. (8 in each group), were fed for a period of 8 weeks on three different diets, one based on rice and the other two diets based on rice substitutes (Nos. 6 and 7). The other constituents were the same in all the three diets. The results are given in Table II.

TABLE II — AVERAGE WEEKLY INCREASE IN BODY WEIGHT OF YOUNG RATS FED ON DIFFERENT DIETS FOR A PERIOD OF 8 WEEKS

Diet No.	Quantity of rice or rice substitutes in the diet*	Average initial body wt., gm.	Average final body wt., gm.	Average weekly increase in body wt. gm.
1	Raw milled rice (78·5%)	50·2	81·5	3·9±0·2
2	Rice substitute No. 6 (78·5%)	49	110	7·6±0·5
3	Rice substitute No. 7 (78·5%)	49	105	7·0±0·37

*All the diets contained the same quantity of other foods, viz. red gram, 5·0 per cent ; non-leafy vegetables (brinjal, potato and raw plantain), 8·2 per cent ; leafy vegetables (amaranth, cabbage, etc.), 2·1 per cent ; crude groundnut oil, 5·0 per cent ; milk powder, 0·9 per cent ; and common salt, 0·3 per cent.

It will be seen from Table II that rice substitutes prepared from a mixture of tapioca flour (70 parts), groundnut cake flour (20 parts) and rice or wheat (10 parts) possess a higher nutritive value than rice.

A study of the nutritive value of other rice substitutes and also the effect of incorporation of fatty acids on the nutritive value and availability of calcium and phosphorus present in them is in progress.

The present investigation has shown that it is possible to prepare substitute grains from maize and tapioca flour which can be used as partial substitutes for rice. Even though the products obtained from a mixture of tapioca flour and groundnut cake flour have a light-brown colour, still the cooked products are quite palatable. They could be cooked either as such or admixed with rice. Consumer trials carried out with different food preparations made out of the rice substitutes showed that they were generally acceptable.

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SPREADING OF HIGH POLYMERS : COPOLYMER OF STYRENE & METHYLMETHACRYLATE

A STUDY OF THE SPREADING PROPERTIES OF high polymers is of interest and is likely to provide information on the relationship between spreading property and molecular structure. The results of our work on the spreading properties of a copolymer of styrene and methylmethacrylate are recorded here.

The surface films were studied by means of a surface pressure balance improvised from a du Nuoy tensiometer[1]. The copolymer studied consists of 70 per cent styrene and 30 per cent methylmethacrylate and was kindly supplied by Prof. S. R. Palit, *Indian Association for the Cultivation of Science*, Calcutta. The solutions for spreading were prepared in freshly distilled benzene, the purity of which was tested by spreading. The results of spreading two solutions of the copolymer, viz. 0·2 per cent and 0·018 per cent, are represented in Fig. 1.

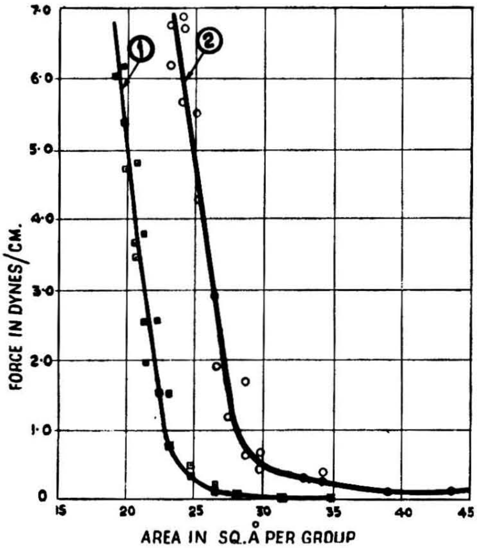

FIG. 1 — SPREADING OF COPOLYMER OF STYRENE AND METHYLMETHACRYLATE ; (1) 0·2 PER CENT SOLUTION ; (2) 0·018 PER CENT SOLUTION.

The limiting area per group should, normally, be independent of the concentration of the solution used for spreading. In the present instance, however, it is found that the extent of spreading depends upon the concentration of the solution. The limiting area per group changes from 28·5 sq. Å with 0·2 per cent solution, to 23·5 sq. Å with 0·018 per cent solution. This phenomenon cannot be explained on the basis of too rapid evaporation giving the polymer molecules insufficient time to orientate into the monolayer, for, tolerably consistent results have been repeatedly obtained for specific areas in independent experiments in which this time factor was by no means constant. The results appear to indicate that polymers in high concentration solutions have a felt-like structure.

Further work on the spreading behaviour of high polymers in solutions of different concentrations is in progress.

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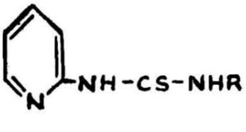
GUANIDINES, THIOUREAS & BIGUANIDES OF 2-AMINOPYRIDINE

COMPOUNDS OF THE PYRIDINE NUCLEUS which may be regarded as the heterocyclic fragment of the molecules of plasmochin and mepacrin have recently been investigated by several authors[1,2]. Schönhofer[3] suggested that the anti-malarial action of mepacrin is connected with the possibility of tautomerism. Curd, Rose and Davey[4] have supported this theory in connection with paludrine. 2 or 4-aminopyridine exhibits tautomerism similar to mepacrin. It was, therefore, considered desirable to synthesize a series of substituted 2-aminopyridines (types A, B and C) and to investigate their anti-malarial properties.

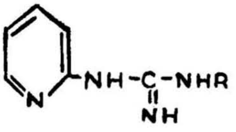
The method used for the synthesis of guanido-derivatives of 2-aminopyridine (type B) consisted in the desulphurization of pyridylthioureas with alcoholic ammonia and mercuric oxide[5-7] at room temperature for 12 hr., followed by refluxing on a water bath for half an hour. Pyridylthioureas (type A) were prepared by refluxing 2-aminopyridine in alcoholic solution with the appropriate mustard oil. Pyridylbiguanides (type C) were synthesized by fusing 2-aminopyridine hydrochloride with the appropriate cyano-guanidines.

The properties and analyses of compounds are recorded in Table I.

The compounds are being examined for anti-malarial activity. Full details will be published later.



TYPE A



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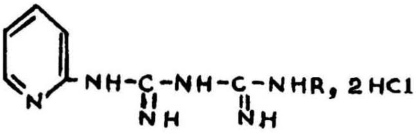

TYPE C

TABLE I

No.	SUBSTITUENT	TYPE OF THE COMPOUND	M.P., °C.	FORMULA	FOUND N %	REQUIRED N %
1.	$\left.\begin{matrix}CH_3\\CH_3\end{matrix}\right>CH$-	A	129-30	$C_9H_{13}N_3S$	21·35	21·53
2.	$CH_2{=}CH{-}CH_2$-	A	100-1	$C_9H_{11}N_3S$	21·65	21·75
3.	C_6H_5-	A	167	$C_{12}H_{11}N_3S$	18·25	18·26
4.	m-CH_3-C_6H_4-	A	168-70	$C_{13}H_{13}N_3S$	17·01	17·28
5.	P-CH_3-C_6H_4-	A	182	$C_{13}H_{13}N_3S$	16·98	17·28
6.	p-Cl-C_6H_4	A	188	$C_{12}H_{10}ClN_3S$	15·95	15·99
7.	$\left.\begin{matrix}CH_3\\CH_3\end{matrix}\right>CH$-	B	82	$C_9H_{14}N_4$	31·01	31·46
8.	$\left.\begin{matrix}CH_3{-}CH_2\\CH_3{-}{-}{-}\end{matrix}\right>CH$-	B	80-81	$C_{10}H_{16}N_4$	29·06	29·16
9.	CH_2-CH-CH_2-	B	63-65	$C_9H_{12}N_4$	31·50	31·81
10.	C_6H_5-	B	108-9	$C_{12}H_{12}N_4$	26·40	26·41
11.	m-CH_3-C_6H_4-	B	134-35	$C_{13}H_{14}N_4$	24·50	24·77
12.	p-CH_3-C_6H_4-	B	148	$C_{13}H_{14}N_4$	24·61	24·77
13.	p-Cl-C_6H_4-	B	175-76	$C_{12}H_{11}ClN_4$	22·57	22·76
14.	H-	C	272 with previous shrinking	$C_7H_{10}N_6$, 2HCl	33·50	33·60
15.	p-Cl-C_6H_4-	C	212-15(d)	$C_{13}H_{13}ClN_6$, 2HCl	23·23	23·33
16.	p-Br-C_6H_4-	C	210-2(d)	$C_{12}H_{13}BrN_6$, 2HCl	20.71	20·74

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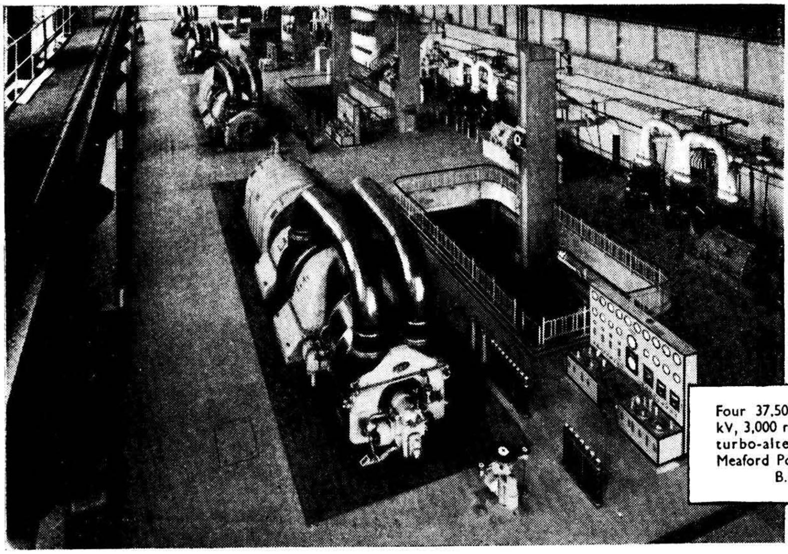

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