# Journal of Scientific & Industrial Research

V. 9, No. 11, NOVEMBER 1950

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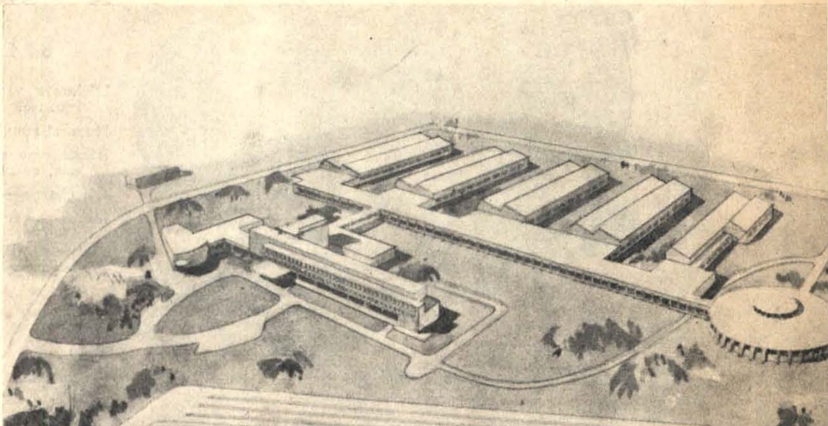

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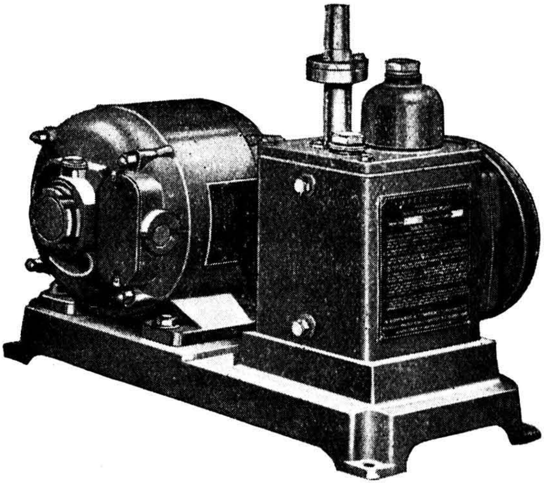

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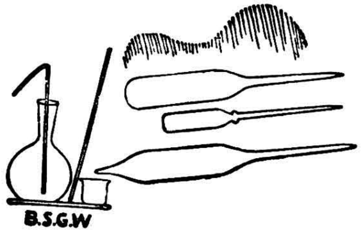

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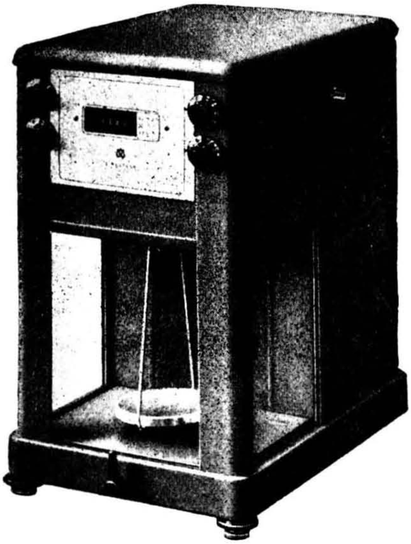

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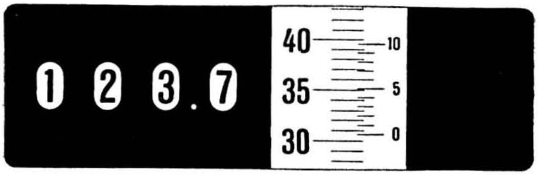

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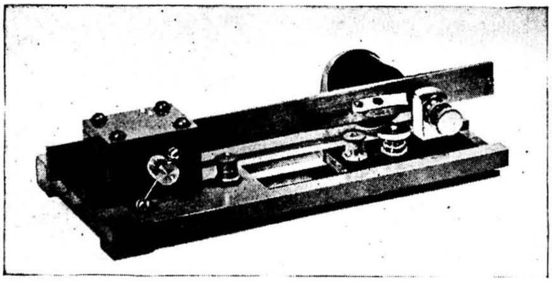

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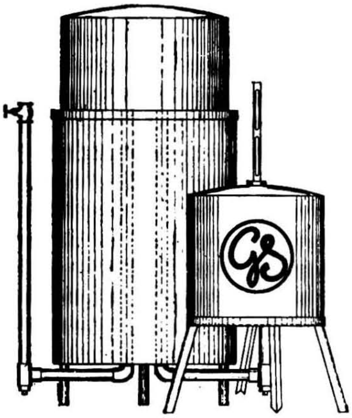

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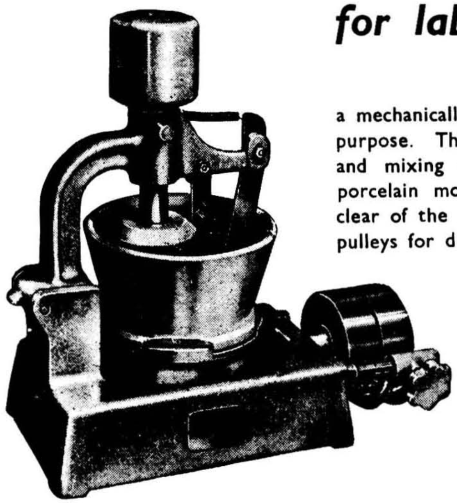

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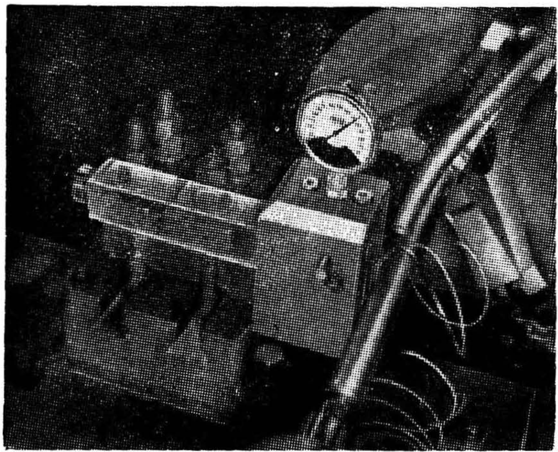

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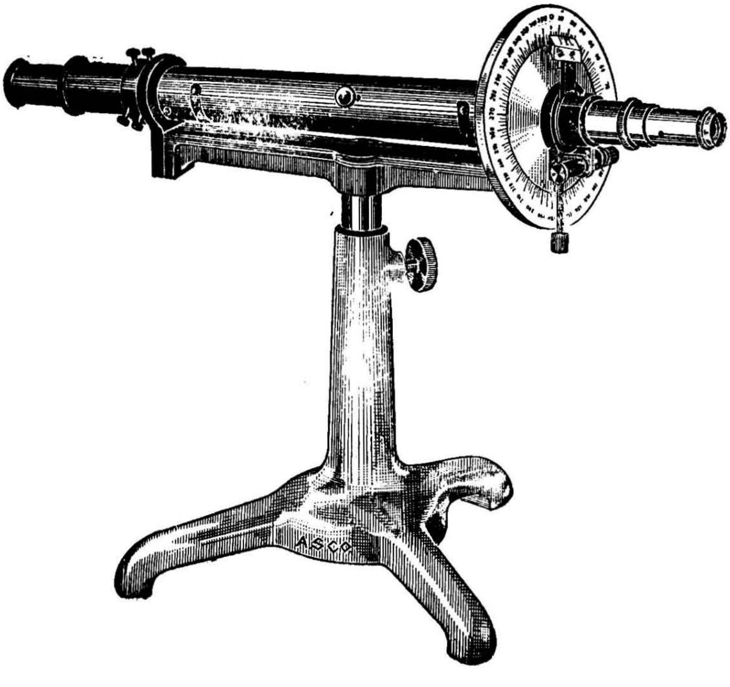

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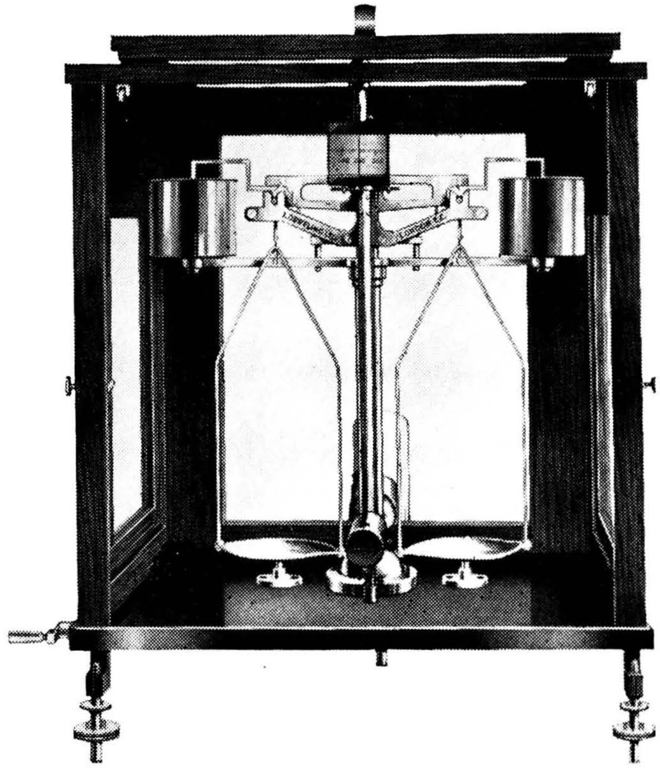

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NEW DELHI

# Power Resources of India & Their Development

THE energy resources of India, according to the assessment of the Indian National Committee, are limited to coal and water power ; natural gaseous fuels are non-existent and liquid fuel resources are negligible. The extent of the energy resources of India and the problems of their development have been discussed in two important papers* submitted to the Fourth World Power Conference recently held in London. It may be pointed out in this context that a survey of the power resources of different countries in the world reveals that there are but few countries which have truly large supplies of natural energy in the form of either fuel ( coal and oil ) or of water power ; the natural resources of energy are unevenly distributed throughout the world. From the available data relating to India's resources, and the attention that is being paid to their conservation and planned development, India's position appears to be fairly satisfactory and there is justification for the hope that adequate power would be available to meet all the needs of future industrial expansion.

## Hydro-electric Power

" It has been estimated that India's ultimate water-power potential may amount to about $25 \times 10^6$ kW. A systematic and comprehensive survey of the water-power potential of India has not yet been undertaken, since the cost of such a survey would be out of proportion to its practical value. Nevertheless, many preliminary hydro-electric surveys have been undertaken, and the probable continuous capacity of water-power sites has been ascertained. The total potential continuous capacity of such sites investigated amounts to $8{\cdot}5 \times 10^6$ kW., of which only about $0{\cdot}5 \times 10^6$ kW. has so far been developed. Since World War II, both Central and State governments have evinced considerable interest in the large-scale development of hydro-electric resources and it is evident that they intend to exploit them to the fullest extent of their financial capacity. It is anticipated that projects likely to be implemented within the next ten years will probably total over $2{\cdot}5 \times 10^6$ kW. With the notable exception of the Tata Company, which still operates the biggest hydro-electric system in India, the State has already taken up the development of several major hydro-electric schemes. This is in marked contrast to steam-power generation, which is mostly in the hands of private enterprise but is limited in its scope to urban areas. The present policy of the Government aims at a large-scale electrification of rural areas from major hydro-electric power services interlinked by provincial grid schemes, with the result that responsibility for the generation and transmission of power may eventually pass largely into the hands of the State.

## The Development of Coal Resources

" The reserves of good coking coal in the country may not exceed $700 \times 10^6$ to $750 \times 10^6$ tons, and at the present rate of output these resources would be exhausted in about 65 years. Workable coal resources in the Indian Union may be estimated at approxi-

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* *An Assessment of Energy Resources and a Record of Their Development in India*, by the Indian National Committee, Paper No. 12, Section A, Fourth World Power Conference, London, 1950.

*The Fuel Situation in India*, by Dr. J. W. Whitaker, Paper No. 5, Section B1, Fourth World Power Conference, London, 1950.

mately $15,000 \times 10^6$ tons, but this estimate must be considered conservative, as prospecting in many parts, notably in Central India and Central Provinces, is still only in its infancy. The resources in the Karanpur field, even after allowing for a very large portion which is still only partially proved, are undoubtedly much larger than had ever been anticipated. It is believed, however, that there is no reason for anxiety over the resources of good quality non-coking coals, both high and low volatile, or of low-grade coals.

" The present output of coal is about $30 \times 10^6$ tons. There is no doubt that in the future, with the industrialization of the country, the consumption of coal will increase. The largest proportion of the coal raised is consumed by the railways. In the near future the railway consumption of coal is not likely to fall, but it is hoped that the *type* of coal utilized will be largely, if not entirely, *non-coking*. The public utility power stations use only a small percentage, but the direct consumption in industrial installations is quite substantial. Industrial works such as mills, factories and engineering works will, no doubt, increase, and their consumption of coal will grow correspondingly, while the amount required for electricity generation will similarly increase, especially in or near the coalfields. Bunker and export coal figures will also show an upper trend.

" The railways have made, and are making, efforts to increase their fuel efficiency and economy, and are investigating the possibilities of the powdered-coal gas-turbine locomotive. The climatic conditions in India are somewhat adverse and the coals themselves with their high ash content will be difficult to employ for this purpose unless suitable filters or separating cyclones capable of operating at high temperatures can be devised. Nevertheless, the problems are being attacked, as success will mean a reduction of coal consumption of about 50 per cent — a saving of Rs. 7 or 8 crores per annum.

" In connection with powdered coal, many of the high ash coals of India can well be burned in this form at thermal electricity generating stations. The efficiency of such boiler plant is now very high, even when the ash content is as much as 50 per cent. This manner of utilization is a possible outlet not only for medium and lower-grade coals ( whether coking or not ), but also for the coal-washery refuse which has a high content of combustible matter.

" India's production of oil is only 6 per cent of her requirements, and in 1948 India imported about $589 \times 10^6$ Imperial gallons of mineral oils valued at 30 crores of rupees. In view of this position, attention has been given to the production of motor spirit and other fuels from coal by low-temperature carbonization and also by Fischer-Tropsch synthesis. The estimated coal consumption for making synthetic petrol in 1952 is nearly $2{\cdot}25 \times 10^6$ tons ; the consumption would eventually rise to about $3{\cdot}25 \times 10^6$ tons."

Considerable attention has been recently devoted to the conservation of the limited resources of high-grade metallurgical coal and the more extensive utilization of non-coking coals. The Fuel Research Committee of the Council of Scientific & Industrial Research has initiated and sponsored many schemes of research bearing on beneficiation and utilization of low-grade coals. Indeed, the utilization of low-grade coals has now become a world problem. During the recent World Power Conference this subject came up for discussion. There is evidence that in many countries high-grade coal seams have been largely worked out and the quality of mined coal is falling from year to year. Mechanization has also contributed to the production of rather inferior grades of coal. More attention is, therefore, being diverted to the development of efficient methods of treating and using coal in the major coal-producing countries of the world. The work of the Fuel Research Committee, particularly on the washability and blending of coals, has yielded results of great practical value. The work on washability of coals has shown that many of the seams hitherto considered useless for coking are amenable to improvement by washing and are capable of yielding fractions quite suitable for coke manufacture. The work on coal blending has extended still further the possibilities of using coals hitherto considered unserviceable for coke manufacture. The Committee has undertaken other problems of research of far-reaching significance, among them the desulphurization of Tertiary Assam coals, coal blending and coking.

" In the matter of the development of coal resources, the Government of India fully appreciate the national importance of this problem. They have recently taken on hand the work of rationalizing the industry, and they are also taking steps to conserve the limited resources of high-grade metallurgical coal. Among the possible lines of approach now under consideration, mention may be made of the following :

(a) The enforcement of a programme for raising different grades of coal in relation to national requirements.

(b) The electrification of major collieries with a view to mechanizing the various coal-raising operations.

(c) The installation of large central power stations in order to achieve greater fuel efficiencies, and the consequent closing down of a large number of small industrial power plants.

(d) The large-scale electrification of railways which will minimize the inefficient burning of coal in locomotives.

(e) A restriction on the direct burning of high-grade coal so as to conserve supplies for metallurgical purposes."

# Board of Scientific & Industrial Research
## Twenty-fifth Meeting, New Delhi

THE twenty-fifth meeting of the Board of Scientific & Industrial Research was held in New Delhi on September 25, 1950. The meeting of the Governing Body of the Council was held on September 26. The Hon'ble Pandit Jawaharlal Nehru presided.

The following eight new schemes of research were sanctioned by the Governing Body on the recommendation of the Board:

1. Reaction kinetics of the vapour-phase thermal decomposition of mercury and zinc dimethyls : DR. LOURDU M. YEDDANAPALLI, *Madras.*
2. Anti-bacterial and anti-fungal compounds from naphthalene : SRI M. L. KHORANA, *Bombay.*
3. Production and properties of low carbon alloy steels containing manganese : DR. SCHRADER, *Jamshedpur.*
4. Production of aluminium metal by the electrolysis of molten anhydrous aluminium chloride : DR. E. G. RAMACHANDRAN, *Bangalore.*
5. Pilot-plant investigation on the production of power alcohol from bagasse : DR. N. R. KULOOR, *Delhi.*
6. Absorption of microwaves in the 3 cm. region : DR. KRISHNAJI, *Allahabad.*
7. Investigations on R.C. coupled F.M. oscillator : DR. H. RAKSHIT, *Calcutta.*
8. Recording and analysis of the reflection of electromagnetic waves from the ionosphere : DR. K. R. RAMANATHAN, *Ahmedabad.*

The Governing Body of the Council of Scientific & Industrial Research recognized the untiring efforts of its Director, Dr. Shanti Swarup Bhatnagar, in bringing into being the National Laboratories in the face of such difficulties, and recorded a resolution appreciating his services in the cause of scientific advancement in the country.

The Council of Scientific & Industrial Research decided to call a conference of the Directors of the National Laboratories and the members of the Planning Commission to prepare a list of essential articles which are not produced in India and which would not be available in case of emergency, and to devise ways and means of producing these articles. The Directors of the National Laboratories were requested to get into touch with industries for drawing up a list of problems to be investigated and for assigning priorities.

The manufacture of synthetic petrol from raw materials available in the country was considered an important project demanding immediate attention. The Council recommended to the Planning Commission to give immediate consideration to the report of the Committee appointed by the Council to go into this question and to give the project the highest priority in national planning. The Committee, consisting of Mr. J. R. D. Tata, Mr. G. D. Birla, Seth Kasturbhai Lalbhai, Lala Shri Ram, Dr. S. S. Bhatnagar, Dr. J. C. Ghosh and Dr. D. N. Wadia, was requested to examine the question of importing crude oil and refining it in India and to submit their report by the end of this year.

The Council of Scientific & Industrial Research decided to investigate the possibility of exploiting gypsum, copper pyrites and other resources for the production of sulphur and sulphuric acid. In the absence of naturally occurring deposits of sulphur in the country, these projects should receive urgent consideration and the Council recommended to the Government of India to put up a pilot plant for the production of sulphur and sulphuric acid from gypsum.

The establishment of a Regional Coal Survey Station at Kamptee in Madhya Pradesh was approved by the Board. This station will work under the direction of the National Fuel Research Institute and will serve the Pench, Wardha and Chanda valleys and the Singareni coalfields. The initiation of pilot-plant experiments at the National Fuel Research Institute on coal-washing, low temperature carbonization, production of coke from weakly coking coals, briquetting of coal and pressure combustion of powdered coal was approved. A list of priorities is being drawn up for undertaking these investigations, and it has been decided to approach the Government of India and the industry for necessary funds.

The Governing Body of the Council approved the constitution of the Board of Engineering Research and accepted its recommendation that the Council of Scientific & Industrial Research should conduct a survey to assess the facilities available for engineering research in India. Five expert committees have been set up for civil, mechanical, electrical and radio, hydraulic and aeronautical engineering research aspects. In view of the large number of hydro-electric and irrigation development projects under contemplation, the Board recommended that research in hydraulic engineering, with particular reference to machinery, should receive prior and urgent consideration.

The appointments of Prof. Charles Crussard as Director, National Metallurgical Laboratory, Jamshedpur, of Sir Edward Mellanby as Director, Central Drug Research Institute, Lucknow, and of Dr. Ernst Zipkes as Director, Central Road Research Institute, New Delhi, were approved by the Governing Body.

# Characteristics of the Ionosphere over Calcutta (August 1950)

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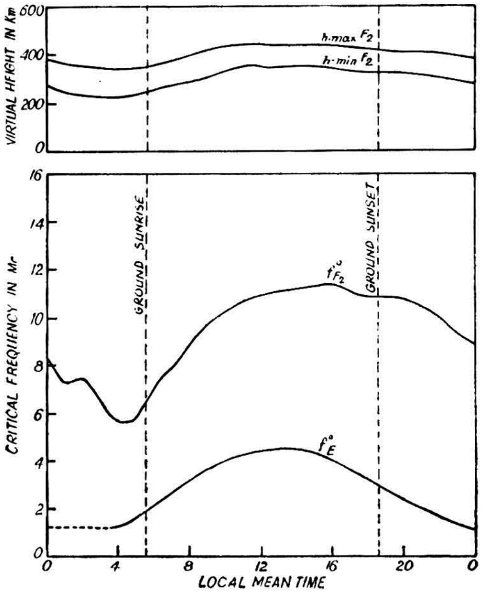
THE following are the ionospheric data observed at Calcutta for the month of August 1950.

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 November 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.

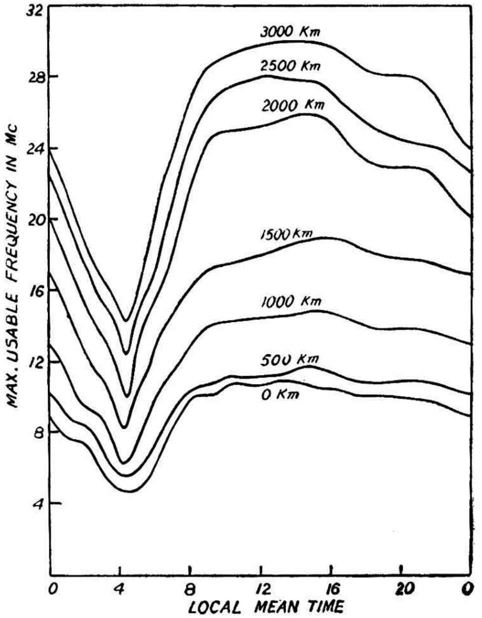


(5 HR. 54 MIN. AHEAD OF G.M.T.)
FIG. 1 — AUGUST 1950.

Sporadic E ionization was found to occur frequently during afternoon and early part of the night in most of the occasions. In the present month region $F_2$ ionization was found to rise slowly in the morning and the maximum value was reached in the afternoon. No abnormality was observed in the region F during night time.

TABLE I

| MONTH & YEAR | DATE | HOURS<br>L.M.T. | $f^{\circ}E_s$<br>Mc. | $^{h}E_s$<br>Km. |
|---|---|---|---|---|
| August 1950 | 3 | 17.00 | 6·40 | 150 |
| | | 18.00 | 6·00 | 150 |
| | | 21.00 | 5·00 | 135 |
| | | 22.00 | 3·55 | 120 |
| | 4 | 16.00 | 8·50 | 150 |
| | | 17.00 | 8·00 | 150 |
| | | 18.00 | 7·00 | 135 |
| | | 21.00 | 5·25 | 120 |
| | 8 | 05.00 | 4·25 | 105 |
| | | 06.00 | 4·50 | 105 |
| | | 07.00 | 4·20 | 120 |
| | 11 | 16.00 | 4·30 | 120 |
| | | 17.00 | 4·70 | 120 |
| | | 18.00 | 4·90 | 105 |
| | | 20.00 | 4·50 | 105 |
| August 1950 | 12 | 07.00 | 3·90 | 105 |
| | | 09.00 | 4·25 | 120 |
| | 16 | 17.00 | 4·50 | 120 |
| | | 18.00 | 4·75 | 120 |
| | | 19.00 | 5·00 | 120 |
| | | 20.00 | 4·50 | 105 |
| | 22 | 17.00 | 4·70 | 120 |
| | 25 | 17.00 | 8·00 | 150 |
| | | 18.00 | 3·25 | 135 |
| | | 19.00 | 3·10 | 120 |
| | 26 | 08.00 | 3·50 | 105 |
| | 28 | 17.00 | 3·00 | 120 |
| | | 18.00 | 3·20 | 120 |
| | 29 | 08.00 | 6·80 | 120 |
| | | 10.00 | 6·95 | 135 |
| | | 17.00 | 3·60 | 120 |
| | | 21.00 | 3·45 | 120 |
| | | 22.00 | 2·25 | 105 |
| | 30 | 09.00 | 6·45 | 120 |
| | | 10.00 | 8·25 | 135 |
| | | 18.00 | 3·85 | 120 |
| | 31 | 23.00 | 4·05 | 105 |



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

# The Central Food Technological Research Institute, Mysore—Opening Ceremony, October 21, 1950

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THE Central Food Technological Research Institute, Mysore, was declared open on October 21, 1950 by the Hon'ble Shri C. Rajagopalachari. The Rajapramukh, the Maharaja of Mysore, presided.

Declaring the Institute open, Shri C. Rajagopalachari emphasized the need for technological research as a supplement to agricultural research for augmenting the food resources of the country and for maintaining proper nutritional standards. The Institute would, he observed, " make research in evolving suitable methods for the fortification of foods and the production of supplementary foods and dietetic accessories. All problems of food which require close and high level scientific research would fall within the orbit of the Institute." He paid a tribute to the zeal and organizing ability of Dr. Shanti Swarup Bhatnagar " who has been the chief instrument in the establishment of many research institutes in our land at a great pace ". He also announced the appointment of Dr. V. Subrahmanyan as the Director of the Central Food Technological Research Institute.

The Prime Minister, Pandit Jawaharlal Nehru, in his message, referred to the opening of the national laboratories and research institutes as " one of the remarkable developments in India during the last three years ". " We have put up some magnificent laboratories, not only impressive to look at, but I hope, the homes of productive effort and work. It is ultimately on the basis of work done in our research institutes and laboratories that we can progress in most directions. We have laid good and true foundation for scientific progress. It is for the young scientists of India to take advantage of the great opportunities offered to them and thus help in building up the new India.

" We have given top priority to the production of foodgrains or subsidiary foods. It is obvious that food is of the first importance and its value cannot be judged merely in money terms. We cannot depend on imports for our food and, therefore, we have laid down a target for food sufficiency. This is the 1951-52 season. In spite of all difficulties and disasters, we still adhere to that target and are trying to work up to it. We hope to succeed. It must always be remembered that food production has the highest priority.

" How can science help in this? The primary responsibility is of our Department of Agriculture. Science can help in agriculture greatly. It can also help in various other processes. It is more particularly with these other processes that this Institute will be concerned. I hope the work done in this Institute will bear fruit not in developments on paper and in scientific journals but in terms of human values and in increase of suitable food for our people. I look forward to good work being done there for the benefit of the nation."

The Institute is located in the magnificent Cheluvamba Mansions, which was given over to the Central Government as a gift.

The scope and functions of the Institute include development of improved methods of storage of different food materials, microbiological and biochemical changes attendant on various types of spoilage, reclamation and utilization of infested or otherwise affected food materials, and processing of foodstuffs with a view to improving their keeping quality and facilitating ready usage, refrigeration, freezing, gas storage, dehydration, canning, etc. The Institute will also study problems concerning food industries and food sanitation.

# American Quest for Iron Ore

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THE United States of America is one of the few countries in the world which is endowed with large deposits of workable iron ore. It is to the local availability of abundant ore and to improvements in technology in the fields of mining, treatment and transport that that country owes its supremacy as the largest producer of iron and steel in the world. The production of pig iron in that country in 1943 amounted to over 62 million tons and of steel about 89 million tons.

There are three chief iron-ore regions in the U.S.A., viz. the Lake Superior district, the North-eastern region including the Adirondacks and the South-eastern region of Alabama, Georgia, etc. In addition, there are also some scattered deposits in the Western States. It has been estimated that the Lake Superior, the North-eastern and the South-eastern districts have each actual reserves of 1 billion tons of good ore. The Lake Superior district, however, supplies about 85 per cent of the iron ore produced in the U.S.A., while the other two produce about 8 per cent and 4 per cent respectively, with still smaller quantities derived from the Western States. But, owing to the rapid depletion of easily mineable high grade ores, that country is directing its attention far and wide to secure important iron-ore deposits which may be available in the countries bordering upon the Atlantic.

**World Reserves of Iron Ore**

The latest comprehensive review of the iron-ore resources of the world is contained in a paper by Harry Mikami (*Economic Geology*, January-February 1944). Below is given a statement (TABLE I) which is a summary of this author's findings with regard to most of the countries on which data are available.

The figures for proved and potential ores are of different orders of accuracy for different countries. Those for U.S.A., Great Britain and Western Europe are reliable because a great deal of detailed work has been done by Governmental agencies and commercial interests. In the case of South America, Africa and Asia the figures are only approximate and are likely to be greatly

**TABLE I — WORLD RESERVES OF IRON ORE**

*After Mikami*

| | ACTUAL | | POTENTIAL | |
|---|---|---|---|---|
| | Ore million tons ) | Iron content, % | Ore ( million tons ) | Iron content, % |
| Canada | 100 | 50 | 10,000 | 35 |
| Labrador | ... | ... | 1,000 | 60 |
| Newfoundland | 1,250 | 40 | 2,000 | 40 |
| U.S.A. | 3,800 | 45 | 67,000 | 35 |
| Mexico | 100 | 60 | 100 | ... |
| Cuba | 3,000 | 40 | 12,000 | ... |
| *North America, total* | 8,250 | | 92,100 | |
| France | 4,500 | 35 | 6,000 | 35 |
| Germany | 800 | 32 | 2,000 | 30 |
| Austria | 200 | 35 | 200 | ... |
| Great Britain | 3,100 | 30 | 7,000 | 30 |
| Norway | 300 | 35 | 1,000 | 30 |
| Spain | 800 | 45 | 1,000 | 35 |
| Sweden | 1,250 | 62 | 1,250 | 60 |
| U.S.S.R. | 3,100 | 45 | 15,000 | 35 |
| Others | 620 | | 550 | |
| *Europe, total* | 14,670 | | 34,000 | |
| China | 500 | 40 | 700 | 35 |
| India | 3,600 | 60 | 10,000 | 40 |
| East Indies | 100 | ... | 1,500 | ... |
| Philippines | 500 | 47 | 500 | ... |
| U.S.S.R. | 1,400 | 45 | 2,400 | ... |
| Others | 280 | | 335 | |
| *Asia, total* | 6,100 | | 15,435 | |
| Australia | 400 | 60 | ? | ... |
| Brazil | 4,000 | 60 | 11,000 | 40 |
| Venezuela | 100 | 60 | 1,000 + | 45 |
| Peru | 100 | 60 | ? | ... |
| Chile | 120 | 60 | ? | ... |
| *South America, total* | 4,320 | | 12,000 + | |
| Algeria | 160 | 50 | ... | ... |
| Rhodesia | ... | ... | Large* | 30 |
| Sierra Leone | 20 | 55 | Large* | 55 |
| Fr. Guinea | ... | ... | 2,500 | 45 |
| South Africa | 1,000 | 55 | 7,000 | 45 |
| Others | 60 | | 100 | |
| *Africa, total* | 1,240 | | 12,000 | |
| WORLD TOTAL | 35,280 | | 165,570 | |

* Included in the total.

exceeded when the data attain the same degree of accuracy and detail as in the case of the U.S.A. Taking India as an example, the estimate of high grade hematite ores in Bihar and Orissa given recently by Dr. F. G. Percival of the *Tata Iron & Steel Co.* is 8,000 million tons as against the previous estimates of 3,600 million tons. This ignores the hematite and magnetite ores of Central Provinces, Mysore, Madras and Bombay whose total may amount to 3,000 million tons though the magnetite ores will require beneficiation. In addition, large quantities of high and low grades may come to light if detailed drilling is undertaken. Finally, we have enormous quantities of laterite in several areas, and especially over the Deccan traps, which contain 25 to 35 per cent iron and which at some future date will become economically workable.

The iron content of the world total of the actual or proved iron ores is, according to Mikami, about 16·2 billion tons. Of this 2·4 billion tons are in Brazil, 2·2 in India, 2 in U.S.S.R., 1·7 in the U.S.A., 1·6 in France, 1·2 in Cuba, 0·9 in Great Britain, 0·8 in Sweden and 0·6 in South Africa.

Of the above-mentioned countries, the U.S.A. is consuming its reserves at a much faster rate than other countries. The consumption increased to the abnormally high figure of over 100 million tons per year during the Second World War. Table II gives the despatches of ore from the mines in the U.S.A. and the part of Canada in the Lake Superior region, while Table III gives the steel production of important countries for 1939, 1943 and 1946.

TABLE II — SHIPMENTS OF IRON ORE FROM MINES IN U.S.A. & THE LAKE SUPERIOR REGION OF CANADA

( *In thousands of long tons* )

| | 1942 | 1943 | 1944 | 1945 | 1946 |
|---|---|---|---|---|---|
| Minnesota (Mesabi, Vermillion and Cuyuna) | 75,300 | 69,971 | 66,586 | 62,831 | 50,010 |
| Michigan and Wisconsin (Menominee, Gogebic and Marquette) | 17,709 | 15,991 | 15,270 | 13,130 | 9,578 |
| Canada (Michipicoten and Steep Rock) | 487 | 451 | 499 | 1,019 | 1,440 |
| *Total Lake Superior* | 93,496 | 86,413 | 82,355 | 76,980 | 61,020 |
| North-eastern (N.Y., N.J., Penn.) | 3,080 | 3,190 | 3,500 | 3,620 | 2,240 |
| South-eastern (Ga., Ala., Tex., Mo.) | 9,210 | 8,530 | 7,400 | 6,660 | 6,450 |
| Western (Wyo., Utah, N.M., Cal., Ariz., Nev., Wash.) | 1,480 | 2,450 | 2,960 | 2,760 | 2,170 |
| TOTAL | 107,266 | 100,583 | 96,215 | 90,020 | 71,880 |

TABLE III — OUTPUT OF STEEL IN THE MORE IMPORTANT COUNTRIES

( *In millions of long tons* )

| | 1939 | 1943 | 1946 |
|---|---|---|---|
| U.S.A. | 47·1 | 79·3 | 59·5 |
| Canada | 1·3 | 2·6 | 2·1 |
| United Kingdom | 13·2 | 13·0 | 12·9 |
| Sweden | 1·1 | 1·2 | 1·2 |
| France | 7·8 | 5·0 | 4·3 |
| Belgium | 3·1 | 1·6 | 2·2 |
| Luxembourg | 1·8 | 2·1 | 1·3 |
| Germany | 22·0 | 30·0 | 2·7 |
| Czechoslovakia | 2·3 | 2·6 | 1·7 |
| Poland | 2·0 | 1·5 | 1·2 |
| Italy | 2·4 | ... | 0·6 |
| U.S.S.R. | 18·5 | ... | 18·0 |
| Japan | 6·6 | 7·7 | 0·6 |
| India | 1·0 | 1·4 | 1·2 |
| Australia | 1·2 | 1·7 | 1·3 |

It will be seen from Table I that the most important resources are to be found in the U.S.A., Canada ( including Newfoundland ) and Cuba in North America ; U.S.S.R., Great Britain, France, Germany and Sweden in Europe ; India and East Indies in Asia ; Brazil and Venezuela in South America and South Africa and Sierra Leone in Africa.

The Lake Superior region contains probably the richest group of deposits in the world. There are several hill ranges in the States of Michigan, Minnesota and Wisconsin and also in the adjoining parts of Canada. Of these areas the Marquette Range of Michigan was opened up in 1854 and later the Menominee, Gogebic, Vermillion, Mesabi and Cuyuna Ranges were discovered and opened up more or less in the order named. Amongst these, the Mesabi Range is the most important and contains the famous huge open pit — The Hull-Rust-Mahoning — which is 3 miles long, 1½ miles wide and nearly 400′ deep and produces 30,000 tons or more per day. On the Canadian side the well-known areas are Michipicoten, Steep Rock, Atikokan, Gunflint and Animikie which contain some important deposits. In the Goulais river area the *Algoma Steel Corporation* has recently proved the existence of 50 million tons of magnetic ore which can be worked by open pit methods. The Steep Rock deposits were opened up in 1942 by interests connected with *Cleveland-Cliffs Iron Co.* and are producing increasing tonnages every year.

The present estimates of reserves of workable ore in the chief areas of the United States are as follows :

*Lake Superior Area* — Direct shipping ores, 1,300 million tons, of which 800 million tons would be available for open pit mining. The rest of the ore will have to be won by underground mining but its cost would be much higher than in the case of open pit mining. At present the open pit mines are responsible for about 80 per cent of the production and the underground mines about 20 per cent. The magnetite type ores of the North-eastern district in New York State and the hematite ores of the South-eastern district in Alabama State are estimated to amount to about 1,000 million tons each.

Regarding the reserves of taconite, which is the low grade primary material of the iron formation, the proved ores containing 25 per cent or more iron have been calculated to amount to 467 billion tons ( 1 billion = 1,000 millions ) to a depth of 1,250′ in highly inclined strata and 400′ in gently dipping strata. The potential reserves of taconite have been estimated at 67 billion tons ( 35 per cent iron ), of which 12 billion tons are in the adjoining area of Canada. As mining is now conducted in some places at a depth of 3,500′, the above estimates may need revision, but there may also be reductions to be made since some of the ores may not be amenable to beneficiation. Taconite is a mixture of an iron silicate mineral with other minerals. The iron silicate has been converted by natural processes into different proportions of hematite, magnetite and siderite. The rich ore beds represent the completely altered and enriched taconite. Taconite in general contains about 25 to 35 per cent of iron in the form of iron ore and in practice it would need 4 tons of taconite for recovering 1 ton of iron, after beneficiation and smelting.

Taconite has, therefore, to be beneficiated in order to recover from it utilizable iron ore. The process of concentration to be applied will depend on the mineral content and grain size. When the ore mineral is magnetite, it can be crushed to a size of 100 to 200 mesh and the magnetite concentrated by electromagnetic separators. If it consists of hematite, it may have to be crushed to 300 mesh, roasted under reducing conditions to convert the hematite into magnetite and the magnetite then separated. Flotation has also been used to separate the hematite. Since the concentrate is in a fine powdery form, it is agglomerated or pelletized so that the material becomes sufficiently hard and compact to be charged into furnaces. Other processes like sintering and briquetting are also receiving attention.

Beneficiation of taconite has been receiving attention since the early twenties, although it assumed urgency only during the last few years. A plant for beneficiation was erected by the *Mesabi Iron Co.* at Babbitt in Minnesota some 25 years ago but it was not successful. Much work was also done in the Mines Experiment Station in the University of Minnesota under the direction of Dr. E. W. Davis. Encouragement has recently been given for the pursuit of this question by reduction of tax by the States concerned. According to the new law, the beneficiated product will pay a tax of only 6 cents per ton at the time of shipping it away from the plant.

Several of the steel producers and ore companies have been studying beneficiation during the last decade or so. The Battelle Institute, the Mines Experiment Station at Minneapolis, *Picklands Mather, Hanna, Oliver, Jones & Laughlin, Cleveland-Cliffs, U.S. Steel* and others have been actively engaged in this research. The State of Minnesota has also a research station at Hibbing.

The *Erie Mining Co.* ( *Picklands Mather, Bethlehem* and *Youngstown Companies* ) has a pilot plant for beneficiating magnetite-bearing taconite at Aurora. This plant, which has a capacity of 200,000 tons per year, cost 2 million dollars. The full-scale plant which will shortly be put up is expected to produce 2·5 million tons of agglomerated concentrates per year.

The *Reserve Mining Co.* ( *Oglebay Norton, Armco* and *Wheeling* ), which has large reserves of taconite, has plans to build a plant of 10 million tons finished product capacity per year, which will be composed of four units. It is stated that the capital cost of mining equipment and beneficiation plant will be around $ 10 per ton of finished product for large-scale production.

An important requirement in beneficiation is the reduction of the silica content in the concentrate to 12 per cent or less. This necessitates fine grinding to —300 mesh for most taconites. If a concentrate containing up to 15 per cent silica would be acceptable to the steel industry, the solution of the problems will be easier. Magnetic roasting is another important problem which is being attacked vigorously in order to reduce cost. Magnetic separation of fine materials is also beset with difficulties and studies are under way for better control of the magnetic fields and better separation as well as for quicker demagnetization. Flotation is an effective process in ores containing crystalline hematite and research is leading to the reduction of costs.

There is no doubt that in the course of another 2 or 3 years appreciable tonnages of taconite concentrates will be used by the smelters. It is expected that, as the natural ores of Lake Superior get depleted, the production of taconite concentrates will rise to 20 or 30 million tons per annum.

### Recent Improvements in Technique

In the large pits like Hull-Rust, the ore is loaded direct into railway wagons by power shovels, the pits being large enough for taking down a regular train into them. In the smaller open cast operations, large trucks are generally used for the transport of ore. The power shovels have buckets with capacities ranging usually from 4 cu. yd. to 7 cu. yd. In 1941, only about 100 heavy duty trucks for haulage of ore were in operation but in 1949 the number has increased to about 700. The capacity of the trucks, which was originally 15 tons, has been enlarged to between 20 and 30 tons, while 40 ton units are now undergoing trials. A number of belt conveyers are in operation for hoisting the ore from the pits, the usual width of the belt being 30″ and the length varying a great deal, from about 200 yards to as much as a mile. The lift of the ore ranges up to a maximum of 380′ while the speed of the conveyer varies usually from 500′ to 550′ per minute. Much work has been done to improve the quality of belts and a belt life of 6 to 10 million tons ore haulage has been achieved.

At present, about 30 per cent of the ore won in the Lake Superior region undergoes some process of beneficiation, not so much for any considerable improvement in grade, but for supplying the smelters with a uniform grade over a long period. The average ore shipped has an iron content of 51 to 54 per cent.

The most common mode of concentration of ore is by means of heavy-media separation. The newest equipment in this line is the Hardinge counter-current separator which has proved quite satisfactory. A great deal of fine ore of $\frac{1}{4}''$ to $\frac{1}{8}''$ size is now being successfully separated and utilized. Classifier overflows are treated by Dorrco sizers in order to recover the fines. The Dutch State cyclone separators have also been recently installed and their usefulness is being studied. Other processes in use are new type of jigs, washing in Humphrey spirals and flotation.

### Present Sources of Iron Ores

There are some 10 major iron and steel companies in the U.S.A. with steel ingot capacity varying from 1·5 million tons to 31·3 million tons per year. Of these the largest is the *United States Steel Corporation*, the others being *Bethlehem*, *Republic*, *Jones & Laughlin*, *National*, *Youngstown Steel & Tube*, *Armco*, *Inland*, *Sharon* and *Wheeling Steel Companies*. Most of these have their own mines but practically all buy also heavily from iron-ore mining companies, the chief of which are *Picklands, Mather & Co.*, *Cleveland-Cliffs Iron Co.*, *M. A. Hanna & Co.*, *Oliver Iron Mining Co.* and *Oglebay Norton & Co.* ( *see* TABLE IV ). The *U.S. Steel Corporation* has the largest reserves in the Lake Superior area, *M. A. Hanna & Co.* coming second in importance in their holdings. The *Oliver Iron Mining Co.* is a subsidiary of the *U.S. Steel Corporation*. *Picklands, Mather & Co.* manage iron-ore mines for *Bethlehem* and *Youngstown* interests and are also part proprietors and managers of the *Erie Mining Co.* which will process increasing tonnages of low grade ores. A firm called the *Reserve Mining Co.* is operated jointly by *Oglebay Norton & Co.*, *Armco* and *Wheeling Corporations*. *M. A. Hanna & Co.* is affiliated with *National Steel* and is now an important factor in the development of new ore fields in Labrador. Table IV gives at a glance the present as well as future sources of ore which will feed the steel industry of the United States.

Even in the early part of this century, before the First World War, it was considered that the Lake Superior deposits were almost inexhaustible. It is said that in 1913 the *U.S. Steel Corporation*, which was the holder of the largest reserves, gave up some of its holdings containing well over 300 million tons. Even in later years, perhaps because of the heavy tax burdens on ore reserves,

TABLE IV

| Steel companies and ingot capacity (million tons) | Present source of ore | Mining companies supplying ore to steel companies: *Picklands, Mather & Co.* | *Cleveland-Cliffs Iron Co.* | *M. A. Hanna & Co.* | *Oliver Iron Mining Co.* | *Oglebay Norton Co.* | Future sources of ore |
|---|---|---|---|---|---|---|---|
| *U.S. Steel Corporation* (31·3) | Lake Superior, Alabama, Utah | ... | ... | ... | × | ... | Taconites and Venezuela |
| *Bethlehem Steel Corporation* 14·2) | Lake Superior, Penn., Chile, Cuba | × | × | ... | × | × | Mexico, Cuba, Venezuela, Chile and taconites |
| *Republic Steel Corporation* (4·8) | Lake Superior, Alabama, Adirondack | ... | × | ... | × | ... | Labrador, Liberia |
| *Jones & Laughlin Steel Corporation* (4·8) | Lake Superior, Adirondack | ... | × | ... | ... | ... | ... |
| *National Steel Corporation* (4·2) | ... | ... | ... | × | × | ... | Labrador |
| *Youngstown Steel & Tube Co.* (4·1) | Lake Superior | × | ... | ... | × | ... | Labrador and taconites |
| *Armco Steel Corporation* (3·6) | Lake Superior | ... | ... | × | × | × | Labrador and taconites |
| *Inland Steel Co.* (3·4) | Lake Superior | ... | ... | × | × | ... | Ontario |
| *Sharon Steel Corporation* (1·7) | ... | ... | ... | ... | × | ... | ... |
| *Wheeling Steel Corporation* (1·5) | Lake Superior | ... | ... | × | × | × | Labrador and taconites |

NOTE: (×) indicates the ore supplier (or subsidiary) to the steel-making firm against which it occurs.

some of the other companies are reported to have wished that they did not have as much reserves as they possessed at that time! But, after the Second World War, by the end of which the reserves of the easily mineable ore had been seriously depleted, came the realization of the possible shortage in the near future. At the end of 1949, the reserves of direct shipping ores of the Lake Superior region were estimated to be only 1,290 million tons, about 53·5 per cent of this (690 million tons) being held by the *U.S. Steel Corporation.* Some of the other companies are badly off as they hold less than 40 million tons each. The present reserves of the high grade ores will last only some 20 years by which time the shortage will have to be met by foreign ore or by beneficiated taconite. The annual consumption of steel in the immediate future is expected to be of the order of 90 million tons, for which over 100 million tons of good ore will have to be supplied. It is, therefore, that, since the Second World War, the search for new deposits and research on beneficiation of taconite had been greatly intensified and accelerated. Most of the countries bordering the Atlantic Ocean have been searched and good deposits located, especially in Canada, West Indies and Venezuela.

The following figures of local output of iron ore in the U.S.A. and imports from other countries will give an idea of the present sources which supply ore to the U.S. steel industry. The figures refer to the year 1949:

DOMESTIC PRODUCTION

| | *Tons* |
|---|---|
| Lake Superior region | 68,927,000 |
| South-east area | 7,444,000 |
| North-east area | 3,778,000 |
| Western area | 4,238,000 |
| Other areas | 594,000 |
| TOTAL | 84,981,000 |

IMPORTS

| *Country* | *Tons* | *c.i.f. per ton,* $ |
|---|---|---|
| Algeria | 415,501 | 5·53 |
| Brazil | 354,509 | 6·59 |
| British W. Africa | 49,648 | 6·03 |
| Canada | 1,595,518 | 6·63 |
| Chile | 2,627,007 | 2·62 |
| Cuba | 11,589 | 2·14 |
| Mexico | 169,823 | 1·68 |
| Netherlands | 7,114 | 9·00 |
| Philippines | 4,250 | 9·96 |
| Spain | 9,200 | 8·55 |
| Sweden | 2,047,343 | 6·42 |
| Tunisia | 82,815 | 5·12 |
| South Africa | 9,900 | 9·68 |
| TOTAL | 7,384,217 | |

In addition to this, about 10,000 tons were imported, mainly for paints or for research purposes, from various sources.

**Discovery & Development of New Deposits**

*Chile* — The El Romeral deposits in Chile are estimated to contain reserves of over 20 million tons. The *Bethlehem Steel Corporation* has already taken up the development of these deposits and 2·6 and 2·7 million tons respectively were shipped during 1948 and 1949.

*Cuba* — This island contains large deposits of lateritic ore, most of which will need beneficiation. Some small ones in the Pinar del Rio province may contain a few million tons of direct shipping ore. The value of the lateritic deposits lies, however, in their containing nickel and chromium. The *U.S. Steel Corporation* and certain other companies hold concessions in Cuba and will take steps to utilize them in future.

*Liberia* — Search in the African Republic of Liberia by private interests and by the U.S. Geological Survey brought to light the presence of some good deposits of iron ore in the north. The deposits have been leased to the *Liberia Mining Co.*, the control of which is in American hands. The ore is generally a mixture of hematite and magnetite containing 68 per cent iron and low phosphorus, sulphur and silica. The ore is hard so that it can be fed into furnaces as lumps. At least 20 million tons of high grade and an additional tonnage of low grade ore have been proved. The *Republic Steel Corporation* has acquired an interest in the *Liberia Mining Co.* A railway, 45 miles long, is being constructed from the deposits to Monrovia, the capital and chief port in the State, where harbour facilities are being provided to handle about 1 million tons of ore per year. Shipments of ore are expected to start in 1951.

*Mexico* — Mexico has several deposits of iron ore, some of them of fair size, but it is doubtful whether any of them are held by American companies. It is stated that the *Bethlehem Steel Corporation* has control over the La Truchas deposits near the western coast.

*Brazil* — A good deal of attention has been paid to Brazil by American companies for over two decades. Brazil itself has a small iron and steel industry but its rapid development is hampered by the absence of good coking coal in the country. Some Brazilian ore is imported by the U.S.A. Incidentally, research has brought to light some excellent manganese ore deposits. One of these, in the Urucum Mountains, 15 miles south of Corumba in the State of Matto Grosso, is said to contain at least 27 million tons of ore of 46 per cent grade. The *U.S. Steel Corporation* is developing this deposit for an annual production of at least 100,000 tons.

*Quebec-Labrador* — Iron ore was discovered in 1929 in Labrador, which is a cold ice-covered region for half the year, but the first company to explore the area, called the *Labrador Mining & Exploration Co.*, was formed only in 1936. An area of 20,000 sq. miles was taken up in Labrador and some 3,900 sq. miles in the adjacent area of Quebec where it was expected that the ore deposits would continue. In 1942, *Hollinger Consolidated Gold Mines Ltd.* acquired control of the above-mentioned company and a new company was formed called the *Hollinger North Shore Exploration Co. Ltd.* to undertake exploration in the area lying in Quebec ( 3,900 sq. miles ). *M. A. Hanna & Co.* also came into partnership with *Hollinger* in the same year, the combine being called *Hollinger-Hanna Ltd.* Exploration began in earnest only in 1947. A little later, in 1949, the *Iron Ore Co. of Canada* was formed for taking in hand further developments, the partners in this being the *Republic*, *National*, *Armco*, *Erie* and *Youngstown* steel interests. Agreement has been reached regarding the areas which would be exploited on behalf of the steel interests, reserving certain other areas for the Canadian steel industry and for any export of ore which Canada may wish to make.

In addition to the *Hollinger-Hanna* interests already mentioned, there are also others who have taken concessions in the adjacent areas of Quebec and Labrador. To the north-west are *Norancon Exploration (Quebec) Ltd.* controlled by Noranda, Anglo-Huronian and Conwest, the *Fort Chimo Mines Ltd.* ( Frobisher interests ) and the *Quebec-Labrador Development Co. Ltd.*, while in the Labrador area are *Norancon Exploration Ltd.*, *Dome Exploration (Canada) Ltd.* and *Kennco Exploration Ltd.* ( *Kennecott Copper Co.* and *New Jersey Zinc Co.*). The last of these hold deposits of ilmenite and titaniferous magnetite in which they have proved 50 million tons of ore containing 35 per cent titanium. They will be spending 25 million dollars to develop the deposits and 15 million dollars to construct an electric smelting plant of 1,500 tons capacity ( initial ) per day. The smelting plant is

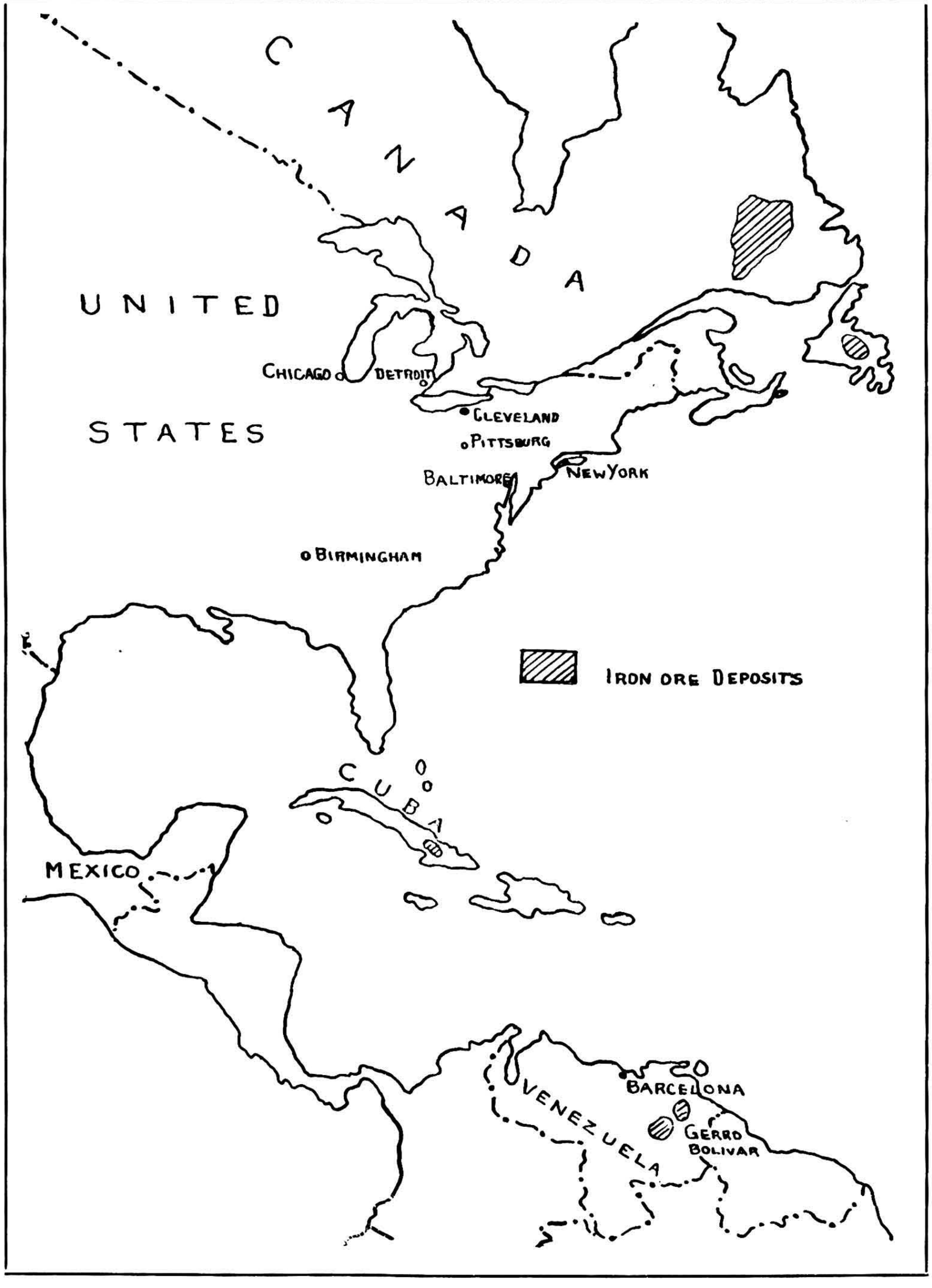

FIG. 1 — NEW DEPOSITS OF IRON ORE IN CANADA AND NORTH AND SOUTH AMERICA.

scheduled to start in 1951 at Sorel in Quebec. Pig iron, which will be got as a byproduct, may amount to 200,000 tons per year, containing 97 per cent iron, 2 per cent carbon, 0·1 per cent silicon, 0·2 per cent titanium, 0·03 per cent phosphorus, 0·1 per cent or less sulphur, 0·04 per cent manganese, 0·05 per cent chromium and 0·05 per cent vanadium. The *Fort Chimo Mines Ltd.* have secured an area of 1,000 sq. miles in which the ore zone is 35 miles long. They will apparently move the ore to Fort Chimo which is 100 miles from the deposits and thence by ship.

The geological structure in which the ore occurs is called the Ungava trough, 350 miles in N.W.-S.E. direction, but the formations are expected to continue beyond the structure in both directions. The area is covered with a thickness of 5′ to 20′ of glacial deposits which accounts for the scarcity of outcrops and for the ores being unrecognized until recently. There are numerous individual deposits in the iron formation, each containing a few million tons, and some quite large.

The deposits in Labrador and Quebec, so far as they have been explored by *Hollinger-Hanna*, appear to hold enormous reserves at and near the surface. A rich zone, 90 miles long, has already been disclosed and there are prospects of this being extended further. By the beginning of 1950, exploration has revealed the presence of at least 400 million tons of high grade iron ore which can be mined open-cast. So far, only 5 per cent of the area is said to have been properly investigated, so that the possibilities of blocking huge reserves are excellent. In the explored area, the deposits are 100 to 300 yds. wide and in most places 200′ thick, while one drill hole is said to have gone through a thickness of 367′ of high grade ore without reaching the bottom of the ore. Apparently, different types of ore are available, some containing over 60 per cent iron while others are lower in iron and contain appreciable manganese.

Typical analyses of ores from Quebec are :

| | *Bessemer,* % | *Non-bessemer,* % | *Manganiferous,* % |
|---|---|---|---|
| Iron | 61·9 | 57·9 | 52·1 |
| Manganese | 0·44 | 0·59 | 6·85 |
| Phosphorus | 0·030 | 0·106 | 0·121 |
| Silica | 6·35 | 7·80 | 6·23 |

Arrangements are afoot to construct a railway, 360 miles long, from the deposits to Seven Islands where the ore will be put on ocean-going freighters for being transported either to the works in the Great Lakes area or to the eastern sea-board of the U.S.A. The capital expenditure on railway, power development ( there are excellent chances of developing 3 million h.p. water-power in the area ), mining equipment, transportation facilities, etc., will be of the order of 200 million dollars, while improvements to the waterway for navigation purposes will cost about 400 million dollars. The latter will be mainly devoted to the widening and deepening of the river route between Montreal and Prescott where, at present, the river can take only vessels with 14′ draft. It is expected that this will be deepened so as to provide for vessels with 30′ draft. When these improvements have taken place, *Hollinger-Hanna* will probably ship 10 million tons of ore per year from this area, and other interests may also ship further substantial quantities.

*Venezuela* — One of the regions which received a great deal of attention during the last decade was the lower part of the Orinoco drainage basin south of the Orinoco and east of its tributary Rio Caroni. There are several deposits of good iron ore here over a length of some 100 miles. The aggregate tonnage in all the deposits may be of the order of 200 to 300 million tons, but individual deposits are only of moderate size, containing from a few million to 50 million tons. The *Bethlehem Steel Corporation's* El Pao deposits are said to contain some 50 or 60 million tons, a part of which can be won by open pit methods. *Hanna & Co.* as well as the *U.S. Steel Corporation* have some concessions in this region near El Pao, La Grulla and Piaoca. The *Bethlehem Steel Corporation* has constructed loading facilities at Palua on the Orinoco. The ore will be sent to Palua by rail and thence by large barges to Puerto Hierro near Guiria on the northern shore of Gulf of Paria where the ore will be transferred to ocean-going freighters. *Bethlehem* hopes to move 2 to 3 million tons of ore per annum from the Venezuela deposits and its plans will cost more than 50 million dollars in the provision of various facilities necessary for mining and transport.

The El Pao-La Grulla area has been declared a " Federal Reserve " by the

Government of Venezuela and in this "reserve" leases can be given only for a period of 40 years. The region has been fairly thoroughly searched and its potentialities gauged. *U.S Steel Corporation* held only small reserves here which were not sufficient to meet its long-term requirements. It was the general opinion that other areas in Venezuela did not contain iron ores. However, the *Corporation* thought it worth while to explore the area south of Orinoco and west of Rio Caroni which had so far not received any attention. The region was soon gone over by plane and aerial photographs taken. The photographs revealed two small ranges of hills locally known as Arimagua and La Parida within 30 miles of each other and 50 miles south of Ciudad Bolivar. Since these hills were thought to be worth examination, in the summer of 1947, a field party was organized to go over the ground, examine the two hills and to conduct a magnetic survey. The work revealed extremely high magnetometer readings which were interpreted as showing the existence of rich deposits of iron ore. Soon after, two diamond drills were sent over to the La Parida and drilling confirmed the magnetometer observations. Three groups of areas, Altamira, Arimagua and Rondon, were demarcated and the *U.S. Steel Corporation* applied for leases over them, totalling about 18,000 acres. As these areas lay to the west of Rio Caroni, they were outside the Government reserve and it was possible to obtain longer leases, for 100 years.

La Parida proved to be a really rich and spectacular find and systematic drilling was conducted through 1947 and early 1948. The hill is somewhat smaller in area than the famous Hull-Rust-Mahoning property in the Lake Superior region. The ore bed is about 18,000′ long with an average width of 1,200′. The ore analysed over 63 per cent iron, 0·11 per cent phosphorus, 0·005 per cent sulphur, 2·29 per cent silica, 1·53 per cent alumina, 0·10 per cent manganese and 0·135 per cent titanium. The average depth of the ore was determined as around 150′. The ore reserves are probably in excess of 1,000 million tons and *U.S. Steel Corporation* has been granted lease of 100 years' duration so that it can plan development on a long-term basis. La Parida has now been renamed Cerro Bolivar.

The *Corporation* has been carrying out surveys for a railway which will lead nearly straight north to the coast near Barcelona, a distance of 274 miles. If this proves satisfactory it will be used for hauling some 15 million tons of ore per year, each train carrying about 10,000 tons of ore. This railway will need a large bridge, about 4½ miles long, across the Orinoco near the city of Ciudad Bolivar. There is a port at Barcelona, but it will have to be improved in order to enable this large tonnage to be handled properly. The construction of the railway and improvements to the harbour are expected to cost over 110 million dollars. An alternative plan is also under consideration. This will involve the construction of a railway, 90 miles long, from the Cerro Bolivar deposits to the river bank near the confluence of the Orinoco and the Caroni. From there the ore will have to be carried down the Orinoco and its branch, the Macareo. The *Corporation* is planning to transport the ore to America in giant ships which will have a capacity of 45,000 tons. Such a project would necessitate the deepening of the river to a depth of 34′ to 38′ so that large ocean-going freighters can go to the point of loading on the river. The railway is expected to cost 50 million dollars while the dredging of the river will cost 18 million dollars with an annual maintenance charge of over 1 million dollars. The distance to be dredged along the river is 170 miles. Even with all this expenditure, it is expected that the ore obtained from Cerro Bolivar can be landed at Baltimore on the Atlantic shore of America at a price approximating to that of the Labrador ore. Only the high grade direct-shipping Lake Superior ore will be cheaper, but beneficiated taconites will definitely cost more. It is expected that in about another decade the *U.S. Steel Corporation* will be drawing between 10 to 15 million tons from Cerro Bolivar and probably 10 million tons of beneficiated taconite from the Lake Superior region. The latter project, i.e. the beneficiation of taconites, is expected to cost more than 600 million dollars to this *Corporation.*

The *U.S. Steel Corporation* has also secured some concessions in the Piacoa and La Grulla areas in the Government reserves, east of Rio Caroni. These deposits contain ores of variable composition and are much smaller in size than those of Cerro Bolivar.

The comparative costs of ore from the different areas, as estimated by Lippert ( *see* reference at the end of the paper ), are given below. This is based on the standard value of $ 7.20 per ton of Mesabi ( Lake Superior ) non-bessemer ore at ports on the Lake Erie. Out of this, the shipper gets $ 4.71 after paying rail and water freight.

| *Ore* | *Iron content,* % | *Natural iron,* % | *Lake Erie price,* $ | *Price per unit of iron, cents* |
|---|---|---|---|---|
| Labrador | 59·3 | 53·4 | 7·72 | 14·5 |
| Venezuela | 63·8 | 59·0 | 8·54 | 14·5 |
| Taconite nodules ( Lake Superior ) | 65·4 | 65·0 | 9·40 | 14·5 |
| Natural ore ( Lake Superior ) | 58·2 | 51·1 | 7·14 | 14·0 |

It will also be useful to compare the distances from some of the sources to the industrial areas in the United States. This is given below :

| *Labrador* | *Miles* |
|---|---|
| Deposits to Seven Islands ( rail ) | 360 |
| Seven Islands to Erie ports (water-way ) | 882 |
| *or* Seven Islands to Baltimore ( ocean ) | 1700 |
| *Mesabi Range ( Lake Superior )* | |
| From deposits to Duluth ( rail ) | 92 |
| Duluth to Erie ports ( water-way ) | 837 |
| Duluth to Baltimore ( water-way and ocean ) | 3417 |
| *Venezuela* | |
| Cerro Bolivar to Orinoco river port ( rail ) | 91 |
| Orinoco river port to mouth of river ( water-way ) | 170 |
| Mouth of river to Baltimore ( ocean ) | 2280 |
| *or* Cerro Bolivar to Barcelona ( rail ) | 274 |
| Barcelona to Baltimore ( ocean ) | 2190 |
| Barcelona to Mobile ( ocean ) | 2190 |
| Mobile to Birmingham, Alabama ( rail and water ) | 280 |
| *Liberia* | |
| Deposits to Monrovia port ( rail ) | 45 |
| Monrovia to Baltimore ( ocean ) | 3900 |

## Conclusion

This story has some moral lessons for us in India. Our resources of high grade iron ore ( containing over 60 per cent iron ) in Bihar and Orissa are estimated to be of the order of 8,000 million tons, but this should not lead us to believe that the deposits are inexhaustible, as the Americans thought of theirs barely 30 or 40 years ago. It is necessary for us to take a long view and adopt all measures of conservation so as to prevent waste in mining and to plan long-term utilization. I remember that some years ago a mining engineer of an iron and steel-making firm in India told me that his company would not bother to work and charge into the furnace iron ore containing less than 63 or 64 per cent iron. It is, of course, easy to do this when there is plenty of such ore, but even if his company held 100 years' supply at the present rate of consumption, the reserves will contract considerably if it expands its production. At present, some very high grade powdery ore ( containing as much as 65 to 68 per cent iron ) is occasionally mined but it is, so far as I know, not utilized just because it will cost the companies something to convert it into an agglomerate or sinter before use. Again, it would be well worth working a certain amount of low grade ore and mix it with high grade ore so as to be able to maintain an average of a moderately high grade, say 58 to 60 per cent, over a long period of time rather than exhaust the high grade ores and progressively go down to the lower grades. This is exactly what has happened in America. In the latter part of the last century and the early years of the present century there was still plenty of 60 per cent ore available in the U.S.A., but that time is now past and the average ore now shipped analyses to only 52 to 53 per cent iron. To maintain even this average, it is apparently necessary to beneficiate about a third of the total production of the Lake Superior ores.

It would, therefore, seem worth while to learn from the experience of other countries and adopt all possible measures of conservation in India, even though, at present, the resources might appear to be very large and even inexhaustible. The availability of these large resources gives hope of our being able to expand the production of steel to, say, 10 million tons per year in about 15 years' time and perhaps 20 million tons in about 25 years' time. In order to do this, we shall have to utilize our resources in the most careful manner. All countries have passed through a stage of prodigality in utilizing nature's bounties, but sooner or later the realization comes that such wastefulness is harmful to the long-term interests of the country. It behoves us, therefore, to use our resources wisely and well.

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# Professor Charles Crussard

THE APPOINTMENT OF PROF. CHARLES Crussard as the Director of the National Metallurgical Laboratory, Jamshedpur, has been announced.

Born in 1916 of an old family of scientists, Prof. Crussard entered Ecole Polytechnique, Paris, in 1934 and graduated at the head of his class. After that he had two years of further studies in the School of Mines in Paris and also obtained his degree from the University. From then on he has been mostly engaged in research. He spent one year in the Metallurgical Laboratories of the steelworks of the French Navy and then worked under eminent scientists like Prof. Chevenard and Dr. Jolivet.

PROF. CHARLES CRUSSARD

In 1942 Prof. Crussard was appointed the first Director of the " Centre de Recherches Metallurgiques de l'Ecole des Mines ", a research laboratory sponsored by the School of Mines and the French steel and aluminium industry. In 1945 Prof. Crussard was sent on a 5-month mission to U.S.A. to see the wartime developments of the metallurgical processes and techniques. He has been a member of committee for the establishment of the IRSID laboratory, a research organization under the French Steel Industry Committee. He was specially charged with the planning of the Physical metallurgy laboratory, the construction of which has just started. He was appointed Professor of Physical Metallurgy of the School of Mines in 1948 and is mainly interested in the physics of metals. He has published numerous papers of his researches on plastic properties, creep, recrystallization, electrical properties, heat treatment, etc., of metals and alloys.

# Magnetic Resonance Absorption in Microwave Spectroscopy

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WHEN a paramagnetic salt is placed in a magnetic field, absorption lines are observed in the microwave region corresponding to the Larmor precession frequency of the resultant electron spin of the paramagnetic ion. This was first observed by Zaboisky[1] and by Cummerow and Halliday[2]. The orbital momentum vector is quenched by the internal electric field and the spin vector alone is left to act about the applied magnetic field. This mechanism by which the orbital angular momentum is quenched and the spin left free is generally accepted to be the Stark splitting of the orbital states of the ions by the electric field.

Such Stark splittings have been observed in the case of chrome alum by Weiss[3]. Also the Stark splitting and $g$ factors of the ground state has been evaluated by Whitmer, Weidner, Hsiang and Weiss[4] from the position of the absorption peaks. They also have extended the theory for the computation of the Stark splitting to extend to include (110) orientation. Similar computations have been made independently by Kittel and Luttinger[5] for chrome alum for the (100) orientation. Due to the energy levels the free ions are broken down making it possible to observe the magnetic dipole transitions even without an external magnetic field.

Gorter and his co-workers have investigated the absorption in paramagnetic substances at low frequencies and without any applied static magnetic field. Equipment limitations prevented their reaching frequencies of the order of the reciprocal of the time of relaxation. Kip and Arnold at *M.I.T.* have improved on this method with a view to studying the nature of paramagnetic relaxation. Absorption has been measured by observing the change in Q of a resonant cavity in which a sample was placed. They made a single re-entrant cylindrical cavity, the frequency of which could be changed in steps from 300 Mc./s. to 480 Mc./s. Measurement of Q is accomplished by comparison of the power transmitted through a calibrated attenuator.

Bleaney and Penrose[6] have studied the crystalline Stark splitting of paramagnetic resonance absorption in ammonium chrome alum as a function of temperature. They found the Stark splitting to decrease linearly with decrease in temperature until a temperature of about 85°K was attained when a sharp discontinuity occurred representing a large increase in the splitting at lower temperatures. They think that the discontinuity is due to a realignment of the crystalline field at such a low temperature. A common property of the salts of the hydrated iron group is that the spin of the paramagnetic ion is free to orient itself in a magnetic field, but that is not the case in an electric field. The lack of freedom of the spin in orienting itself also has the consequence that the Curie-temperature, computed from the susceptibility of the salt on the supposition that the spin is perfectly free, is not the true temperature. Some estimates of these have been computed by Van Vleck on the basis of the assumed distributions of charges in the neighbourhood of the paramagnetic ion.

Weiss has computed the splitting due to electric field in the case of ammonium chrome alum from measurements made at room temperatures on the resonance absorption at 3·20 cm. His analysis shows that the $g$ value of the chromic ammonium sulphate is 1·97 and the splitting can be explained by the assumption of cylindrical electrical field, the magnitude of the splitting being $\delta = 0{\cdot}15 \pm 0{\cdot}01^{-1}$ cm. The constants of the electric field are found to be $\bar{Q} = 1500^{-1}$ cm. and $\bar{a} = 180^{-1}$ cm. The corresponding quantities computed by Van Vleck are $1000^{-1}$ cm. and $60^{-1}$ cm. respectively.

Resonance absorption in potassium copper sulphate has been used by Kip and Arnold as a method of investigating qualitatively the exchange coupling between the two paramag-

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netic ions in the unit cell of this salt. There is found to be appreciably less exchange coupling in the $K_2Cu(SO_4)_2.6H_2O$ than in $CuSO_4.5H_2O$ previously investigated by them. They built an optical apparatus by means of which a crystal can be accurately oriented with respect to a static magnetic field in a microwave resonant cavity. The crystal is first oriented by optical methods and is then transferred in a way which preserves the orientation to the rotatable polystyrene shaft which holds the crystal at the centre of the microwave cavity. Their measured values of $g$ were found to be slightly different from those from magnetic susceptibilities. They found two separate absorption peaks corresponding to two tetragonal axes of different orientations which give two different $g$ factors. In a similar experiment on $CuSO_4.5H_2O$ there was *but one absorption* peak located at the mean of the two expected resolved peak positions. This is explained as a result of exchange coupling between the two $cu^{++}$ ions. Exchange coupling is much less in $K_2Cu(SO_4)_2.6H_2O$ in which $Cu^{++}$ ions are more dilute.

Magnetic resonance has been observed in the case of ferromagnetic substances as well, but the work in this is comparably less. This was first observed by Griffiths and confirmed by Yager and Bozorth[10]. They found that the observed frequencies in ferromagnetic materials were several times greater than those predicted theoretically for Larmor frequencies of electron spins. This ferromagnetic resonance phenomenon is the analog of the Purcell Torrey-Pound nuclear resonance experiment. Griffiths tried to explain this anomaly in the frequency by the assumption of Lorentz cavity force.

Kittel[11] showed that this assumption is not justified and has given an excellent theoretical interpretation of this anomalous Larmor frequencies. He showed that it is important to consider the dynamic coupling caused by the demagnetization field normal to the surface of the specimen, with the result that the appropriate Larmor frequency in such a case should be calculated using field strength $= (BH)_{\frac{1}{2}}$ instead of H as in the paramagnetic case. According to Kittel, Larmor frequency $W_o$ is given as

$$W_o = \gamma\ (BH)^{\frac{1}{2}}$$

where $\gamma$ = gyromagnetic ratio and
$(BH)^{\frac{1}{2}}$ = fictitious field.

Kittel calculated the Larmor frequencies of Fe, Co, Ni and found very good agreement with the experimental values as given below :

*Angular Frequencies for Resonance* $\times 10^{-10}$

| | *D.C. field* | *Calculated values* | | *Experimental frequencies* |
|---|---|---|---|---|
| | | *For H* | *For* $(BH)^{\frac{1}{2}}$ | |
| | | Mc./s. | Mc./s. | Mc./s. |
| Fe | 2800 (oe) | 5·0 | 14·5 | 15·4 |
| Co | 510 | 0·9 | 5·3 | 5·9 |
| Ni | 5000 | 8·8 | 13·5 | 15·4 |
| | 3800 | 6·7 | 10·9 | 13·2 |
| | 1030 | 1·8 | 4·9 | 5·9 |

Later Kittel showed that the correct form of the Larmor theorem depends on the shape of the ferromagnetic material used. For a small sphere the usual form $W_o = \gamma H$ gives satisfactory values. He took the gyromagnetic ratio as equal to the electron spin value.

Yager and Bozorth have designed experiments to test Kittel's theory and to evaluate the gyromagnetic ratio. They chose experimental conditions to suit the simplifying assumptions made in Kittel's theory. They used supermalloy which has very low crystal anisotropy and is probably the most easily saturable material. The static field was applied in the plane of the foils and at right angles to the r.f. magnetic field. The rosonant frequency of the cavity for the dominant mode of the wave guide was 24,050 Mc./s. They observed a sharp resonance at an applied field of 4,950 oersteds corresponding to $H = 4{,}920$. This gives a value of 2·17 for Lange's splitting factor $g$. This value is considerably higher than the value 1·91 reported by Barnett[12] for an alloy of similar composition. A value of $g$ greater than 2 is not expected and hence Yager and Bozorth conclude that a refinement of Kittel's theory is required.

Kip and Arnold found that value of $g$ without using the value of the saturation magnetization M in the equation

$$h\nu = g\ (BH)^{\frac{1}{2}}\ M$$

where B is the Bhor magnetron. They attempted to eliminate the use of M by measuring the resonance absorption at two frequencies. Runs were made at 9,274 Mc./s. and 23,914 Mc./s. both at room temperature and at liquid nitrogen temperature. The value of $g$ obtained by them are as under :

| | *Room temp.* | *Liquid nitrogen temp.* |
|---|---|---|
| $g$ | $2{\cdot}14 \pm 0{\cdot}075$ | $2{\cdot}07 \pm 0{\cdot}08$ |

**TABLE OF PARTIALLY KNOWN & UNKNOWN COMPOUNDS WHOSE MAGNETIC MOMENT DETERMINATIONS CAN BE UNDERTAKEN**

| NAME OF ISOTOPE | ISOTOPE % | SPIN | MAGNETIC MOMENT | SOLUBLE COMPOUNDS |
|---|---|---|---|---|
| ${}_{12}Mg^{25}$ | 11·5 | ... | Not known | $MgCl_2$, $6H_2O$, $Mg\ (Cr\ (SO_4)_2)_2 \cdot 12H_2O$, $Mg\ Br_2$, $6H_2O$. |
| ${}_{12}Mg^{26}$ | 11·1 | Zero | ... | |
| ${}_{24}Cr^{53}$ | 9·43 | ... | Not known | $Cr\ Br_3\ 6H_2O$, $CrO_3$, $Cr_2\ (SO_4)_3$, $18H_2O$ |
| ${}_{25}Mn^{55}$ | 100 | 5/2 | 3·0 | $Mn\ Br_2$, $Mn\ Cl_2$, $Mn\ (No_3)_2$ |
| ${}_{27}Co^{59}$ | 100 | 7/2 | 2·7 | Chlorate, chloride, nitrate |
| ${}_{33}As^{75}$ | 100 | 3/2 | 1·5 | Pentaoxide, arsenic acid |
| ${}_{38}Sr^{87}$ | 7·00 | 9/2 | —1·1 | Iodide ( hydrate ), chlorate, permanganate chloride, nitrate |
| ${}_{47}Ag^{107}$ | 51·9 | 1/2 | —0·10 | Perchlorate, fluoride, nitrate |
| ${}_{47}Ag^{109}$ | 48·1 | 1/2 | —0·19 | |
| ${}_{49}In^{113}$ | 4·5 | 1/2 | 5·52 | $In\ F_3$, $3H_2O$. X X |
| ${}_{49}In^{115}$ | 95·5 | 9/2 | 5·52 | |
| ${}_{53}I^{127}$ | 100 | 5/2 | 2·812(3) | Some o the iodides given above |
| ${}_{56}Ba^{135}$ | 6·59<br>1·32 | 3/2<br>3/2 | 0·837<br>0·935 | Acetate, perchlorate iodide |
| ${}_{79}Au^{197}$ | 100 | 3/2 | 0·195 | $AuCl_3$ only |
| ${}_{82}Pb^{207}$ | 22·64 | 1/2 | 0·6 | Acetate, perchlorate, nitrate |

The theoretical value of $g$ is 2·00 if the magnetic field is entirely due to electron spin.

It is clear from this brief review that there is a very good scope for studying the closely spaced energy levels in the case of paramagnetic substances by microwave spectroscopy. Also for the ferromagnetic crystals very useful data can be obtained for studying their structure and microwave spectroscopy in this field offers great possibilities.

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# Desilverization of Lead Bullion — Literature Report No. 13

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LEAD smelting in India from indigenous lead ore was started on a small scale in 1944 by the *Metal Corporation of India Ltd.* with its smelter located at Tundoo, about 11 miles from Dhanbad. Their mines are situated at Zawar, 25 miles from Udaipur. The lead sulphide concentrates, as delivered to the smelter, contains about 10 oz. of silver to the ton and lead bullion produced assays between 20 and 26 oz. silver per ton ( 0·06122 per cent and 0·07960 per cent ). After refining to remove impurities like iron, copper, etc., the lead ingots, containing most of the silver in the ore, are marketed. Silver is not separated at present from the lead and it is finding its way to the market with the commercial lead. This is not only a national loss, but a silver content over 0·002 per cent is considered as an objectionable impurity in the lead which, obviously, restricts the use of this lead to a very great extent. Production of lead in 1948 amounted to only 562 tons, but with the starting of their ore-dressing plant, the output is expected to increase considerably and the silver problem will assume greater importance.

The problem of desilverization of lead bullion was submitted for investigation to the National Metallurgical Laboratory by the *Metal Corporation of India Ltd.* This report attempts to give all information on the subject available from current literature, i.e. the various processes adopted in other countries, their limitations, etc.

### Smelting Process

Lead occurs in nature in various forms, but the most common is the sulphide, galena. This mineral is very often associated with zinc sulphide ( sphalerite ). Varying amounts of silver and gold are also present which make a valuable byproduct and these precious metals consequently allow a poorer grade of lead ore to be mined than the same grade of straight lead ore.

The various smelting methods for lead ore are outlined below :

*Roast Reduction or Blast Furnace Method* — The sulphide ore is first crushed to suitable size and mixed with iron ore and limestone and charged into cast-iron sinter ports. After lighting, a stream of air is drawn through the charge. The sulphur of the ore is burnt to sulphur dioxide and the whole mass is oxidized and gets agglomerated. The resulting porous mass, called " sinter ", is charged into the blast furnace with requisite amount of coke which reduces the oxides of lead into metal. The gangue material in the ore combines with the flux to form a fusible slag, a calcium iron silicate. The slag is tapped through the slag notch while the metal is syphoned out and cast into bars.

*Roast Reaction Method* — This is carried out in a reverberatory furnace. Rich sulphide ore is first heated in an oxidizing atmosphere when a part of sulphur is burnt away. It is then heated strongly in a reducing atmosphere when the oxidized portion of the ore reacts with the sulphide with the production of metallic lead.

*Precipitation Method* — Galena and scrap iron are charged into a blast furnace along with the requisite amount of coke as fuel. The sulphur of the galena combines with the iron to form a matte and metallic lead is set free. Some of the sulphide is also converted into oxide and sulphate which react with the sulphide to form sulphur dioxide and metallic lead. Oxidized ore also is charged sometimes in the blast furnace.

### Impurities Generally Present in "Base Bullion"[1]

The impure lead ( base bullion ) produced from blast furnace or other smelting operations contains a large number of impurities, which have to be removed before marketing. The impurities are derived from the gangue present in the ore and from various raw materials used during the smelting process, i.e. iron ore, limestone, scrap iron, coke. Some iron also finds its way into the lead from the cast iron kettles during refining and desilverization. The common impurities present are copper, iron, zinc, silver, gold, antimony, bismuth, tin, cadmium, nickel, cobalt, tellurium and selenium.

### Maximum Permissible Impurities in Refined Lead[2]

The maximum impurities permitted in refined lead are given below as specified by the American Society for Testing Materials ( A.S.T.M. Designation B29-40 ).

### Effects of Alloying Elements[3]

The effects of various alloying elements on the properties of lead are : (1) addition of alkali and alkaline earth metals in very small

|  |  | CORRODING LEAD | CHEMICAL LEAD | ACID LEAD | CU LEAD | COMMON DESILVERIZED LEAD |  | SOFT UN-DESILVERIZED LEAD |
|---|---|---|---|---|---|---|---|---|
|  | % |  |  |  |  | A | B |  |
| Silver | Max. | 0·0015 | 0·020 | ·002 | ·002 | ·002 | ·002 | ·002 |
|  | Min. | ... | 0·002 | ... | ... | ... | ... | ... |
| Copper | Max. | 0·0015 | 0·080 | ·080 | ·080 | ·0025 | ·0025 | ·040 |
|  | Min. | ... | 0·040 | ·040 | ·040 | ... | ... | ... |
| Silver and Cu together | Max. | 0·0025 | ... | ... | ... | ... | ... | ... |
| Arsenic | Max. | 0·0015 | ... | ... | ... | ... | ... | ... |
| Antimony and tin together | Max. | 0·0095 | ... | ... | ... | ... | ... | ... |
| Arsenic, antimony and tin together | Max. | ... | 0·002 | ·002 | ·015 | ·015 | ·015 | ·015 |
| Zinc | Max. | 0·0015 | 0·001 | ·001 | ·002 | ·002 | ·002 | ·002 |
| Iron | Max. | 0·002 | 0·002 | ·002 | ·002 | ·002 | ·002 | ·002 |
| Bismuth | Max. | 0·05 | 0·005 | ·025 | ·10 | ·15 | ·25 | ·005 |
| Lead ( by difference ) | Min. | 99·94 | 99·90 | 99·90 | 99·85 | 99·85 | 99·73 | 99·93 |

quantities results in superior qualities to lead-base bearing metals, but resistance to corrosion is decreased; (2) aluminium, when added even in small quantity (0·5 per cent), the lead has got less tendency to attack the iron of the kettle and to oxidize; (3) antimony, when added even up to 0·5 per cent, hardens the lead appreciably. It is added up to 16 per cent in bearing metals; (4) bismuth along with tin forms a series of very fusible alloys; (5) cadmium up to 0·25 per cent increases the strength; (6) calcium in amounts from 0·0025 per cent to 0·1 per cent makes lead suitable for cold working and improves some properties such as creep resistance; (7) magnesium effects some age hardening but is detrimental to corrosion resisting property. Precipitation of magnesium phase also causes lead alloys to disintegrate; and (8) nickel and sulphur reduce the tendency of segregation in some alloys of lead.

### Refined Lead Produced by the Metal Corporation of India Ltd.

The refined lead produced by the *Metal Corporation of India Ltd.* analyses as follows:

| | |
|---|---|
| Bismuth | ·0018 to ·0024% |
| Antimony | ·0160 to ·0235% |
| Iron | ·0029 to ·0030% |
| Nickel | ·0032 to ·0045% |
| Copper | ·0098 to ·0107% |
| Silver | 20 to 26 oz. per ton (·06122 to ·07960%) |

Lead is marketed at present by the *Metal Corporation of India Ltd.* without being desilverized. A ton of the lead contains on an average 23 oz. of silver which, at the present market rate, will fetch over Rs. 100. As a silver content over 0·002 per cent (0·72 oz./ton) is not allowed by many of the lead consumers, this impurity has to be separated from the lead. The loss now being incurred in this respect will assume serious proportions when production is stepped up in the near future.

### Desilverization Methods[1,4]

The following are the standard methods of desilverization of lead:

1. *Cupellation Process* — If an alloy of lead and silver is melted and exposed to a blast of air, the lead oxidizes and is removed as litharge. The silver and gold which have no affinity for oxygen are left behind.

2. *Pattinson Process* — The principle of the Pattinson process lies in the fractional crystallization of pure lead, when molten lead containing silver is allowed to cool. The lead containing 0·009 per cent of silver or more is cooled until a certain proportion, for instance seven-eighths of the total lead, has crystallized; the crystals are removed by means of a perforated ladle. The portion remaining liquid is then nearer to the eutectic composition than the original alloy and is hence richer in silver. The crystals which separate consist of pure lead. Since a portion of the separated lead always retains mechanically a small portion of the silver-rich alloy, it is necessary to remelt the crystals and repeat the above process.

The liquid portion is transferred to another pot and the process of crystallization is repeated until the final products are almost pure lead, containing not more than 0·0001 per cent of silver and an alloy of the eutectic composition. Since this alloy solidifies at constant temperature, it is evident that the process of fractional crystallization cannot be carried out any further.

3. *Parkes Process* — This method of separating silver from lead, by the use of zinc, depends on (1) a greater affinity of gold and silver for zinc than for lead, and (2) the insolubility of zinc-silver alloys in lead which is saturated with zinc. The process consists, in brief, of stirring 1 to 2 per cent of zinc into a bath of molten lead heated to above the melting point of zinc (419°C.) and allowing the mixture to cool, whereupon a crust rises to the surface of molten lead containing nearly all the silver and gold. This crust containing most of the silver and gold is removed by means of perforated ladles. A repetition of zinc addition, in smaller quantity after reheating, gives again a crust but of lower silver content and leaves a molten lead that is practically free from silver, containing usually not more than 0·20 oz. of silver and gold per ton.

The zinc crust (2,000 to 15,000 oz. of silver/ton), which contains considerable lead besides the zinc and precious metals, is distilled in retorts for the recovery of zinc and to obtain an enriched retort bullion, which is cupelled to produce an alloy of silver and gold, with litharge as a byproduct.

4. *Betts Electrolytic Process* — Base bullion is cast into anodes and refined lead gets deposited in the cathode. The cathode

consists of cast refined lead sheets of $1\frac{1}{32}$ in. thickness. The electrolyte is a solution of lead fluosilicate, the composition of which varies considerably, representative values being 80 gm./litre each of lead and free $H_2SiF_6$, corresponding to a total $SiF_6$ content of 135 gm./litre. Voltage used is approximately 0·45 with a current density of 15 to 18 amp./sq. ft. The temperature should be between 30° and 40°C. The precious metals along with other metallic impurities are thrown down as anode slime from which the precious and other metals are recovered.

### Comparative Merits & Demerits of the Processes

1. *Cupellation Process* — This process is applicable to lead very rich in silver. It has become obsolete as an independent process for desilverization due to heavy metal losses ; labour and operating costs are also very high. It follows Parkes or Pattinson processes for refining the gold and silver.

2. *Pattinson Process* — The lead cannot be enriched more than 500 to 600 oz. of silver per ton as a result of which a considerable quantity of lead has to be handled for cupellation resulting in much metal loss and higher labour and operating cost. The process is elaborate as it requires repeated recrystallization, large number of operating kettles, sometimes up to 15, and as many as 11 recrystallizations. The silver content of the resulting desilverized lead ( 0·3 to 0·5 oz./ton ) is higher than that obtained by Parkes process ( 0·2 oz./ton or less ).

3. *Parkes Process* — The alloy obtained is very rich in silver, 2,000 to 15,000 oz./ton. The operating cost is low. The zinc can be used again and again with very little loss. It requires less operations, perhaps two additions of zinc, sometimes even one is sufficient to complete the process and only one or two kettles will be required. It produces commercial lead very low in silver, 0·1 to 0·2 oz. per ton. Smaller amounts of gold and silver can be recovered by this process and loss of both silver and lead is much lower. This process requires purer bullion as the impurities present consume zinc. Furnace lead containing 4·5 per cent of metallic impurities will consume 2·87 per cent of zinc whereas softened lead will require 1·75 per cent of zinc. The residual zinc in the desilverized lead has to be removed by a refining operation.

(4) *Betts Electrolytic Process* — It produces lead of exceptional purity and at the same time recovers all the metallic impurities contained in the bullion. It is most suited where bismuth content is high or where the total impurity is very high. It is also suitable where the fuel cost is high in comparison with the rates for electric power.

### Conclusion

Of all the desilverization methods, Parkes process appears to be the simplest. But, before the addition of zinc, the furnace lead has to be thoroughly softened by removal of impurities like iron, copper, antimony, etc. As regards the quantity of zinc to be added in the first and second stages, there are differences of opinion[8]. The most suitable additions have to be determined by actual experiments. A modification of the Parkes process uses an alloy of zinc and aluminium ( 0·5 per cent )[5-7] which recovers all the silver in one operation. The separation from lead of the zinc-silver crust is better when the zinc-aluminium alloy is used.

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# REVIEWS

**Earth Current Results at Tucson Magnetic Observatory (1932-1942),** by W. J. Rooney, Researches of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, Publication 175, 1949.

THE EXISTENCE OF EARTH CURRENTS (i.e. induced currents quite distinct from any artificial currents) was first postulated by Davy in 1821, but the proof of their existence was obtained only after the discovery of electromagnetic induction. In 1847 Barlow adduced evidence of earth current flow from measurements on telegraph lines in England, and when the existence of earth currents was shown to be universal rather than a local phenomenon, extensive investigations were undertaken on this subject.

Systematic and continuous observations of earth currents have been carried out at a number of European stations, viz. Greenwich, Berlin and Paris and several valuable observations have been made. The study of earth currents was revived at Ebro (Spain) in 1910, and the Ebro records covering the period 1910-1938 are the most valuable and extensive records yet made. More recently, installations for continuous recording on duplicate lines has been made at Watheroo (Western Australia) and at Huancayo (Peru). The use of duplicate lines provides independent records and serves as a check on the operation of measuring systems. Both these stations were operated by the Carnegie Institution of Washington. In March 1931, continuous registration of earth current potentials was undertaken at the Tucson Magnetic Observatory as a co-operative project of the U.S. Coast and Geodetic Survey, the Bell Telephone Co. and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The period of operation (1932-1942), a little over eleven years, covered a full and typical sunspot cycle, a fact which has enhanced the value of the records for purposes of correlation with allied phenomena. The observations and findings of the Observatory are given in this report.

*Measurements & Apparatus* — Direct measurement of earth currents is not possible. Information on their magnitudes, direction and other characteristics must be inferred from measurements of potential combined with records or estimates of resistances to their paths of flow. Potential measurements are generally made by the use of galvanometers which have two pairs of pointers lying on lines of different azimuths and which determine the magnitude and direction of the potential gradient. Registration of earth current potentials at Tucson was made on two lines, one from Tucson to Mammoth, a little under 60 km. distant and a little to the east of north of Tucson, and the other from Tucson to Wilco which is a little over 90 km. away in a nearly easterly direction.

The measuring instrument employed at the Tucson Magnetic Observatory consists of two Leeds and Northrup portable lamp and scale galvanometers with a single filament lamp and drum recorder. The galvanometer elements carried spherical mirrors with a focal length of one meter. The only optical instrument, in addition to the spherical mirrors, was a single cylindrical lens behind the recorder slit to bring the light beam to a spot focus on the recording paper. The current sensitivity of the galvanometer was about $2{\cdot}5 \times 10^{-9}$ amp. per mm. deflection on the drum, which was higher than required in view of the long lines used. This permitted the use of higher resistance (1·5 megohms) in series with the galvanometer, so that the total resistance of the measuring circuit was not appreciably affected by minor variations in line resistances or in contact resistances at the electrodes.

Connection between the recording apparatus and the electrodes was made over telephone lines. The lines were all of overhead open-wire type. The electrodes used were web-shaped grids of lead wire. The common electrode located on the ground of the Tucson Observatory was built up of five concentric circular loops of wire, with eight radial arms connecting the loops and meeting at the centre of the grid to form a core to which the connection to the line was made.

*Discussion* — The absolute values of potentials recorded on any earthed line include the potential differences due to earth current flow and the potential difference which depends on the electrochemical activity at the electrodes, but these do not indicate any current flow. On short lines, the electrochemical potentials are usually predominant and may be hundred times as great as those due to earth current flow. Since these electrode potentials are independent of the distance between the electrodes, their significance decreases as the length of the line is increased. The daily mean values at Tucson, which represent chiefly electrode potential and changes in them from day to day, indicate mostly slow variations, usually only a few per cent of the maximum and minimum values recorded during any day. Too much significance should not be attached to the mean daily values but the differences between individual values and the means for periods over a month or longer are important. For this reason studies were restricted largely to the analysis of variations in recorded potentials. While the basic data are usually compiled in a large number of tables in the form of mean values for each hour and each day, the discussion is confined mainly to variations of monthly and yearly mean values.

*Solar Diurnal Variation* — The variation easily amenable to analysis and statistical treatment is the solar diurnal variation. From the voluminous data presented in this volume, it is found that a definite and consistent difference exists between the diurnal variations recorded on calm days and those on disturbed days, but in general the differences are small.

The station at Tucson is a middle latitude station. The chief features of such a station are a large flow of current towards the equator, one in the forenoon and the other in the afternoon, and a definite double rotation of the current, which is large during daylight hours and small at night.

*Relation to Solar Activity* — Variations both in frequency and intensity of disturbances, corresponding to variations in solar activity, have been observed in all the records of earth current flow. There is also a relationship between normal earth current activity and solar activity which is quite distinct from the disturbance effects.

There is close correlation between sunspot numbers and the range of diurnal variation in earth currents.

*Seasonal Changes* — The seasonal changes are chiefly changes in intensity, accompanied by minor shifts in phase relationship between the two components of current. Such changes are described quantitatively. The Tucson Observatory, however, is located in the so-called " transition belt " where the diurnal variations of the magnetic elements pass from higher latitudes to the equatorial level and the circulatory current systems in the ionized layers of the upper atmosphere are alternately north ( summer ) and south ( winter ) of the station. For this reason, the seasonal changes in earth current flow are much more complex and cannot be readily evaluated.

*Lunar Diurnal Variation* — Lunar diurnal variation is important because of its bearing on the critical appraisal of several theories advanced to account for the magnetic variations and earth current flow. Preliminary evaluation of the data relating to lunar diurnal variation at Tucson has been carried out by the method of Chapman and Egedal. The records used were those for a single year ( 1932 ) and a definite lunar diurnal variation with a markedly double period was found. Its magnitude is about one-fifth of the solar diurnal variation. Because of the large and complex seasonal changes at Tucson, it was found that a single year's record was not sufficient to demonstrate accurately the changes in lunar variations with the phase of the moon.

AJIT GUIN

**The Properties of Metallic Materials at Low Temperatures,** Vol. I, by P. Litherland Teed ( Chapman & Hall Ltd., London ), 1950, pp. viii + 222. Price 21s. net.

THIS IS THE FIRST OF A SERIES OF MONOgraphs on " Metallic Materials " published under the authority of the Royal Aeronautical Society. The author has made a special study of the literature relating to the influence of low temperatures on the mechanical properties of metals and attempted in this book to write a critical appreciation of the present state of knowledge of this increasingly important subject.

The influence of low temperatures on metallic materials had been recognized in early times but in modern times mechanical refrigeration and the ever-increasing number of its industrial applications has necessitated knowledge of the physical consequences of low temperatures in relation to engineering materials. Flying in stratosphere is now making a similar and more exacting demand. The author points out the inadequacy of the present-day knowledge on the subject but feels that " it is still possible to draw certain conclusions, some reassuring and some creating a certain feeling of apprehension " from the existing knowledge.

The author has compiled and reviewed the experimental results of various research workers on the influence of low temperatures on the main mechanical properties — limit of proportionality, yield stress and ultimate stress in tension and compression ; yield stress and ultimate stress in shear ; yield stress in bearing; elongation and reduction of area; notched-bar impact strength and notch sensitivity under static loading; Young's modulus — shear modulus, bulk modulus and Poisson's ratio. The experimental results available are not very complete. Admittedly, it is not yet possible to predict either on the basis of extrapolation or of calculation, the mechanical properties of a metallic material at one temperature from an experimentally derived knowledge of these at another. Accordingly, only brief references to such theories have been made in the text.

In this review similar alloys have been grouped in each chapter. Mainly a few ferrous alloys ( austenitic stainless and other ferritic alloys ), aircraft aluminium alloys, a few magnesium and copper alloys and nickel, tin and lead have been included in the survey.

The book is an excellent critical survey of the existing published literature on the subject and would be of great assistance to research workers in the field as well as to engineers and designers as a reference book. Considering the very specialized nature of the book the price of 21*s*. is not excessive.

M. S. MITRA

**Principle of Aerodynamics,** by James H. Dwinnell ( McGraw-Hill Book Co. Inc., New York ), 1949, pp. xi + 533. Price $4.00.

IN RECENT YEARS, MANY NEW BOOKS ON aerodynamics are coming out, both for classroom study and professional use. Every book has some distinctive feature about it, depending upon the author, where he is attached to — a teaching institution, or research and development laboratory or industry.

The book under review is distinctively a new text, giving an up-to-date introduction to the theoretical and practical aspects of aerodynamics. The scope of the principles outlined in the book is no doubt absolutely essential for a basic text-book on aerodynamics. This can be attributed to the fact that the modern high-speed heavy bombers, rockets and jet planes have radically changed the pre-war conception of the aerodynamic design of aircraft. Today, an aeronautical engineer is called upon to deal with the design of supersonic aircraft, fitted with jet engines. In this respect this book presents entirely new materials for a student who is on the threshold of his career as an aerodynamic engineer.

The author has also endeavoured to bring home the many problems that are being confronted with by engineers engaged in the development of modern aircraft. There are fifteen chapters and some of them are complete in themselves. So much so, the student can easily omit a few advanced topics on his first reading and then go back to them for completion. Detailed discussions on some advanced topics like fluid dynamics, airfoils, viscosity, compressibility, power plants and performances, etc., are given in some chapters. The outstanding features of the volume are the large number of photographs of exceptional quality, a bibliography and two appendices giving a vast amount of experimental data useful for the purpose of comparison with the theory outlined in it.

The author has, however, skipped one important topic, namely the discussion on spanwise airload distribution. In many cases he has set for students as problems the so-called simple proofs of fundamental principles, which only go to show to a remarkable degree the originality exhibited by the author.

The reviewer feels that this book will serve as a text-book for many years to come.

V. CADAMBE

**The Chemistry and Metallurgy of Miscellaneous Materials: Thermodynamics,** National Nuclear Energy Series, IV, 19B, Edited by Laurence L. Quill (McGraw-Hill Book Co. Inc., New York), 1950, pp. 329. Price $3.00.

THE WORK ENTITLED " THE CHEMISTRY AND Metallurgy of Miscellaneous Materials: Thermodynamics " will be of special interest to chemists and metallurgists. The book is a collection of papers dealing with the reports and summary articles of the plutonium project on chemistry and metallurgy of miscellaneous materials including thermodynamical aspects of the plutonium project.

The volume consists of ten papers dealing with the reports and summary articles contributed by various authors. The first paper mainly concerns itself with temperature-composition diagrams of the liquid-solid phase equilibria between the 6 salt pairs obtained from the bromides and iodides of strontium and barium. These diagrams are presented in the light of data obtained in the investigation of low-melting high-molecular weight salt baths. The second paper which deals with " Temperature-composition Diagrams of Metal-metal Halide Systems " explains all the phase diagrams of different systems by thermal analysis.

The third paper which describes " The Thermodynamic and Physical Properties of the Elements " gives tables of heat contents, vapour pressures, heats of vaporization and entropies of vaporization for more than 60 elements. The fourth paper which deals with " Thermodynamic and Physical Properties of Nitrides, Carbides, Sulphides, Silicides and Phosphides " describes and discusses the tables of free energies, heats and entropies of formation at 298°K for many nitrides, carbides and sulphides. A table of stable gaseous compounds is presented for the 3 temperatures, 1,500°, 2,000° and 2,500°K, for the pressure range $10^{-3}$ to $10^{-5}$ mm. Hg. to help in interpreting high-temperature reactions in vacuum systems. This paper also includes a second table of all possible refractory nitrides, carbides and sulphides for the same temperature and pressure ranges as those given for stable gaseous species. This paper further discusses briefly the application of the refractories in the construction of high-temperature high-vacuum systems. The fifth paper, which deals with " The Thermodynamic Properties of Common Gases ", gives tables of free energy, entropy and other thermodynamical data for common gases of importance in high-temperature reactions. It also gives references to tables of thermodynamic functions of many of the less common gases. The sixth paper which deals with " The Thermodynamic Properties of the Halides " includes 5 valuable tables of the thermodynamical properties of the liquid and solid halides of all the elements. It includes also 5 appendices of which the first shows the relations between the various thermodynamic properties of elements, compounds and solutions, the second shows the use of lattice energies in estimating and checking heats of formation of compounds, the third explains the use of heats of solution in estimating and checking heats of formation of compounds, the fourth illustrates the use of the tables for various thermodynamical calculations and the last indicates the order of arrangement of the chemical elements in the tables. The seventh paper of the work, which deals with "The Fusion and Vaporization Data of the Halides ", gives tables of melting points, heats of fusion, heats of vaporization, boiling points and vapour pressures of the halides with discussion of the factors affecting volatility. The eighth paper, which deals with " The Thermodynamic Properties of Molybdenum and Tungsten Halides and the Use of These Metals as Refractories ", presents a brief summary of the high-temperature chemistry of the metals molybdenum and tungsten halides, laying stress on the suitability of the metals as refractories. This paper indicates conditions for non-attack of the metals by halogens, hydrogen halides and other halogen compounds. It also presents the methods of preparation of the halides and their high-temperature properties. The ninth paper which deals with " The Heats of Formation of CeS, $Ce_3S_4$ and $Ce_2S_3$ at 25°C. " concerns itself with the measurement of heats of solution of these materials at 25°C. Using rhombic sulphur as the standard state, heats of formation are calculated and the results are interpreted and correlated with other experimental data. The final paper of this work which deals with " The Heat of Reaction of the Cerous-ceric Couple in 0·5 Molal Perchloric Acid at 25°C." describes calorimetric determination of the heat of reaction of the cerous-ceric couple in 0·5 molal perchloric acid by estimation of heat of the reaction of ceric ion with hydrogen peroxide. Oxalic acid and hydrogen peroxide were used as thermochemical standards. Results of using the former were unsatisfactory while those which were obtained by using hydrogen peroxide indirectly were found to be satisfactory.

This work presents a very wide range of data which is found scattered in various records and summaries of the plutonium project. The subject-matter is authentic and reliable and is useful to the students and research workers in the fields of metallurgy, crystal chemistry, refractories, rare earths, etc. This volume should prove a very valuable reference literature on these subjects.

A. K. CHATTERJI

**Electrical Engineering Economics,** Vol. I, by D. J. Bolton (Chapman & Hall Ltd., London), 1950, Third Edition, pp. xi + 292. Price 25*s*. net.

THE AIM OF THE AUTHOR IS TO GIVE TO practising engineers and students a good account of elementary economics that concerns the electrical engineers and its application to practical problems. Volume I, now under review, is divided into two parts.

Part I deals with general principles, standard definitions and explanations of economic problems and engineering formulae. The principles of productivity and other engineering aspects are made intelligible and useful to engineers.

Part II deals with the general problem of economic choice of electrical plant. The various problems and variable factors have been stated and methods suggested to work out a complete theory and practice of economic choice.

This volume is intended to enable engineers and others interested in power development schemes to assess the cost of the electrical service and compare alternatives. This will help in setting up criteria for the design and choice of engineering plant.

Chapters I to III deal with the principles of the capital investment, sinking fund total and annual depreciation. Chapters IV and V deal with the transfer of the undertakings and productivity. The economics of this is explained by formulae and suitable examples.

Chapters VI to XII deal with the methods of arriving at the proper size and capacity of the plant, principles involved in assessing the utility and life of the various types of equipment such as transformers, motors, power cables and lamps by taking into consideration their efficiency and special design characteristics and their cost.

The economics of overloading for prescribed periods admissible by the engineering standards are also discussed. A very useful set of appendices supplement the details given in the book.

This book will be a valuable asset for power engineers connected with the design of large undertakings involving big capital. The economic principles explained in the book can be conveniently applied to items in different countries.

B. K. R. PRASAD

**Industrial Microbiology,** by Samuel Prescott & Cecil Gordon Dunn (McGraw-Hill Book Co. Inc., New York), Second Edition, 1949, xii + 923. Price $ 8.50.

THE FIRST EDITION (1940) OF THIS PUBLICation has been so popular amongst scholars, research workers and technologists engaged in the field of microbiology that a revised edition, bringing up to date the information on the subject, has really been quite welcome. The rapid developments in the field of fermentation technology and the extension of its scope in industrial production, both in technique and variety during the past decade, have necessitated the rewriting of some chapters of the first edition and the addition of five new chapters on saccharification, yeast production and yeast products, 2, 3-butanediol, itaconic and related fermentations, and antibiotics. The chapters on yeast have been combined into a single chapter in this edition and expanded by incorporating much new material on food and fodder yeasts, riboflavin production and discussion of methods of industrial operation. These aspects have a special reference to industrial applications and possible future developments.

The authors have done justice to the subject and, in its revised form, the book is useful both to the research worker and the technologist. The former will find a mine of information for further research and the exhaustive bibliography, provided at the end of each chapter, is a valuable research aid. The technologist will find in the book a valuable guide which he can consult for information on the practical problems of processes and techniques. It may be observed, however, that in the attempt to cover a vast and rapidly developing field within the compass of a single volume, the treatment of the different aspects of industrial microbiology has become somewhat uneven. For instance, the discussion on textile microbiology — particularly on the important aspect of retting — is not as exhaustive as one would have wished. The book is well got-up and it is refreshingly free from printing errors.

S.A.C.

**Electronic Valve : Book I — Fundamentals of Radio-Valve Technique,** by J. Deketh ( Philips Electrical Co. ( India ) Ltd., Calcutta ), 1949, pp. 022 + 535. Price Rs. 24.

THE WELL-KNOWN RADIO MANUFACTURING firm of Holland, Philips, have undertaken the publication of a series of books on electronic valves of which the present volume forms book I, thus making obvious the choice of its title and scope. It is intended primarily " to give engineers and technicians not specialized in radio and allied techniques an impression of the construction and functioning of radio valves and their applications in receiving sets and other electronic apparatus ". Notwithstanding its chief appeal to the practical men, university graduates and research workers specialized in radio and communication engineering and accustomed to study theoretical treatises will do well to read this book for useful practical hints that may prove beneficial in the design and construction of special apparatus. The book gives explanations of various phenomena associated with an electronic valve and the physical principles underlying them without giving elaborate mathematical details and yet not creating the impression of having avoided mathematical treatment wherever felt necessary.

First five of its thirty-three chapters deal with physical concepts and basic principles of electronic emission, electron ballistics and secondary emission. Chapters VI, VII and VIII are devoted to construction and manufacture of valves of various types. Illustrations are given of the machinery used at various stages of construction and of the test gear. Information of this kind is not available in other books. Chapters IX to XXVII deal with the linear and non-linear characteristics of a valve and the usual circuits based upon them such as amplifiers, oscillators, rectifiers, etc. Frequency conversion, negative feedback and AVC find a chapter each as also tuning indicators and AGC. Effects of hum due to mains voltage and microphones are discussed in chapters XXVIII and XXIX respectively. The last three chapters are devoted to ageing effects and power supply considerations.

There are nine appendices covering such topics as units, D.C. and A.C., and oscillating circuits, as also useful tables and graphs. The book ends with a list of relevant Philips publications on the subject and a reference list of books for further studies.

The style is simple and direct with some continental influence on the language at places. It deserves a place on the book-shelf of every one interested in the practical side of electronics.

N. B. BHATT

## Publications Received

INTRODUCTION TO THE TRANSFER OF HEAT & MASS, by E. R. G. Eckert, McGraw-Hill Book Co. Inc., $ 4.00

TESTING RADIO SETS ( Fifth & Revised Edition ), by J. H. Reyner, Chapman & Hall Ltd., 22*s*. 6*d*.

AN INTRODUCTION TO ELECTRONICS, by J. Yarwood, Chapman & Hall Ltd., 28*s*.

INDIAN SUGAR STATISTICS, Ministry of Agriculture, Rs. 1/4 or 2*s*.

HYDROLOGY ( The Fundamental Basis of Hydraulic Engineering ) ( Second Edition ), by Daniel W. Mead, McGraw-Hill Book Co. Inc.

GENERAL CHEMISTRY ( Second Edition ), by Timm, McGraw-Hill Book Co. Inc., $ 4.50

PHYSICO-CHEMICAL CONSTANTS OF PURE ORGANIC COMPOUNDS, by J. Timmermans, Cleaver-Hume Press Ltd., 95*s*.

PIEZOELECTRIC CRYSTALS & THEIR APPLICATIONS TO ULTRASONICS, by Warren P. Mason, Macmillan & Co. Ltd., 56*s*.

SOILS — THEIR PHYSICS & CHEMISTRY, by A. N. Puri, Asia Publishing House, Bombay, $ 7.00

THE PROPERTIES OF ASPHALTIC BITUMEN, by J. P. J. Pfeiffer, Cleaver-Hume Press Ltd., $ 6.00

ATOMIC PHYSICS, by Wolfgang Finkelnburg, McGraw-Hill Book Co. Inc., $ 6.50

# Medicinal & Industrial Aspects of Fungi

UNDER the joint auspices of the Society of Fermentation Technologists and the Society of Pharmacology & Experimental Medicine, India, a symposium on the Medicinal and Industrial Aspects of Fungi was held during August 1950 at the Indian Institute of Science, Bangalore. Seven papers reviewing recent developments in the following fields were presented : (1) pathogenic fungi, (2) fungi and immunological changes, (3) culture and maintenance, (4) nutrition and metabolism of fungi and (5) industrial aspects dealing with production of acids, antibiotics and enzymes by fungi.

The pathogenic fungi form a heterogeneous group consisting of actinomycetes, certain molds and mold-like fungi and a number of yeasts and yeast-like organisms for which, it was pointed out, no satisfactory system of classification exists. Two major groups, those causing (1) superficial mycosis and (2) deep-seated mycosis, were considered with particular reference to the more common fungus infections, namely Aspergillosis, Dermatophytoses Maduromycoses and Sporotrichosis.

The use of fungal infections as a means of investigating immunological phenomena was the subject-matter of another paper. Considering the fact that the tubercle and diphtheria bacilli are more closely related to the fungi than are the " true bacteria ", these forms, it was held, could be regarded as connecting links between the bacteria and fungi proper, some of which are pathogenic for man and lower animals. Fungal infections should be considered in the differential diagnosis of many obscure infections. It was pointed out that many immunological phenomena have been demonstrated with experimental fungal infections and the close analogy of fungal infections to diseases like tuberculosis and leprosy was cited as examples.

Culturing and maintenance of fungi with reference to their biochemical performance ( production of acids, antibiotics and enzymes ) was stressed as a major problem and should claim the attention of microbiologists dealing with fungi of industrial importance. The advantages and simplicity of the method of studying the biochemical activity of fungi on solid media by incorporating test substances like starch, neutralizing agents or bacteria during growth were discussed.

The general tendency of fungi towards " spontaneous change " under different cultural conditions was pointed out as an important problem for investigation and the necessity for efficient methods of maintaining organisms to give reproducible performances was stressed.

The nutritional and metabolic performance of fungi were dealt with in another interesting paper. The peculiarities of mold fermentation and the influence of environmental conditions on these were discussed. The adoption of more modern and efficient techniques of submerged fermentation was stressed. Improvements in metabolic performance in industry of organisms employed by judicious selection of strains and induced mutation was emphasized.

The industrial production of organic acids by fungi using cheap carbohydrate substrates was discussed in another paper. The production of citric acid using *Aspergillus niger* by the surface and submerged fermentation was described, stressing the rôle of the trace elements in the process. The production of gluconic acid using shallow rotary drums and semi-continuous fermentation methods and the conditions under which other acids like kogic and gallic were produced were indicated.

Recent research in antibiotics has emphasized the need for drugs complementary or supplementary to penicillin. Isolation of potent strains is of utmost importance. Irradiation with X-rays and ultra-violet rays to evolve suitable strains and the influence of substrate composition, minerals and trace elements, nitrogen source and added nutrients on the production of penicillin were presented in a paper entitled "Production of Antibiotics". The production and purification of amylases were discussed in a paper " Production of Enzymes from Molds ". Methods of continuous fermentation employing submerged fermentation, their advantages over conventional methods were described. Factors affecting the production of diastase by *Aspergillus oryzae*, with particular reference to trace element nutrition and the influence of the sources of carbon and nitrogen in the substrate were described. The use of antiseptics for the control of bacterial contamination in industrial practice and the action of specific antiseptics on the sporulation and amylase production were described.

T. N. R. RAO

# NOTES & NEWS

## Atomic Standards

THE U.S. NATIONAL BUREAU OF Standards is considering the possibility of replacing the present standards of time, length and mass by a complete set of primary standards which would remove the need for making corrections necessitated by irregularities in the motion of the earth and for maintaining arbitrary standards (*Nature*, 1950, **166**, 167).

The establishment of primary standards based on atomic properties could be carried out along the lines adopted for establishing the standard of length in terms of the wavelength of a selected spectral line. Preliminary measurements reported by the U.S. National Bureau of Standards, the National Physical Laboratory and the International Bureau of Weights and Measures permit present definition of the metre as 1,831,249·2 wavelengths of the green radiation characteristic of mercury 198 in standard air. To make this independent of possible variations in air density, the atomic metre could eventually be defined as a number of waves *in vacuo*. Similarly the unit of time — the standard second — could be defined as the duration of a certain number of oscillations of an electromagnetic field the frequency of which lies at the centre of some well-defined microwave absorption line. The ammonia molecule has already been used for this purpose in the atomic clock. Its spectral absorption band has the constancy of the mid-frequency like the spectral lines in optical spectroscopy. This is further improved due to the high Q of the ammonia gas which is about 1,00,000 at N.T.P. The mass unit could be based upon the absolute measurement of gyromagnetic ratio of the proton, making use of these definitions of length and time. For example, unit field strength of magnetic induction can be defined as that field in which protons would precess at the rate of 4257·84 cycles per second. Similarly the unit of current and force can be defined. A set of working definitions is given as under: *Atomic Metre* — The length equal to 18,31,249·2 wavelengths from the "5,460·7532 A" line of mercury 198 in standard air. *Atomic Second* — The time required for 2,38,701 $\times 10^5$ oscillations of the 23,870 Mc. or 3,3 line of $NH_3$. *Atomic Ampere* — The current flowing in an infinite solenoid of 1,000 turns per atomic metre which gives proton nuclear resonance at a frequency of 53,505·6 cycles per atomic second in a sample located at the centre of the solenoid. *Atomic Newton* — 5 million times the force exerted on each atomic metre length of either of the two infinite parallel wires separated by one atomic metre and carrying one atomic ampere. *Atomic Coulomb* — charge transported by one atomic ampere in one atomic second; and *Atomic kilogram* — The mass which experiences an acceleration of one atomic metre per atomic second squared, when acted upon by a force of one atomic Newton.

## Permanent Magnet Electron Microscope

A NEW TYPE OF CONSOLE ELECTRON microscope in which the cumbersome electromagnetic devices used in earlier models have been replaced by permanent magnets has been designed at the *Radio Corporation of America*.

The new model has magnets in bucking arrangement or in configurations, disposed either radially or parallel to the optical axis of the lens. The intricate coil systems of the electromagnet and the specially stabilized electronic circuits with batteries for providing constant voltage to the lenses employed in the earlier models have been eliminated in the new design by using about 4 lb. of magnetic steel. This arrangement has made the microscope very much simpler in alignment and more stable in operation. A constant resolution on all accelerating voltages can be obtained, a factor useful in the calibration and standardization of electromicrographs. Focussing in earlier models is done by slowly varying the current feeding the objective lens whereas in the new model the accelerating voltage can be varied (through a known range) to get sharp electromicrographs since the lenses are of permanent type. The model has, however, limited applications as its magnification range is between 1500 X and 6000 X and the resolution is not better than 100 Åμ. The instrument would be useful in industry for the solution of a variety of problems such as rapid and easy determination of particle size, thickness of films, etc.

## Synthesis of Ethylenic Compounds

A NEW METHOD FOR THE SYNTHESIS of unsaturated compounds, particularly those containing one or more ethylenic groups adjacent to a carbon atom, has been recently developed (*Chem. Age*, 1950, **63**, 91). Alkyl lithium derivatives are first prepared and these are made to react with the secondary components.

Isobutenyl bromide reacts readily with lithium metal in dry ether. Carbonization with excess solid $CO_2$ and isolation of the products yield a mixture of 2 : 5 dimethylhexa-2 : 4-diene, β : β-dimethylacrylic acid and phorone.

The method is a complement to the procedure employing acetylenic precursors and provides a new route for the synthesis of many types of ethylenic compounds which are not easily available.

## Recent Applications of Lithium

HIGH PRICE OF LITHIUM HAS SO far limited its large-scale use in industry. Recent improvements in supplies and production techniques have made available lithium and its compounds for use in lubricants, low temperature porcelain enamels and others.

Water-soluble lithium derivatives of alizarine and anthraquinone type wool dyes have been produced with lithium carbonate. A patent describes the use of lithium carbonate within the range of 0·3 to 3 parts per 100 parts by weight of ground and dried coffee for preserving its flavour and freshness. A low temperature dry cell for operation at temperatures down to −60°F. has been developed. The cell contains LiCl for maintaining the electrolyte in a liquid condition. Flash-light dry cells containing such a formulation were operative for 100 min. on a closed circuit test at −40°F. whereas ordinary dry cells delivered no energy. Application of lithium chloride and nitrate to wheat seedlings reduces their susceptibility to powdery mildew and brown rust, smaller doses stimulate growth. Finely powdered lithium fluoride prevents explosion of mixtures of methane and air. The adsorbent property of lithium hydroxide can be made use of in the preparation of gas absorbents by mixing one part of lithium monohydrate with 4 parts of 20 per cent sodium silicate solution and dehydrating. The mass is porous and does not become gummy with use.

Lithium hypochlorite is a soluble, stable, solid chlorine bleach and loses only about 2 per cent of available chlorine in 53 days as against 30 per cent lost in 40 days in the case of sodium hypochlorite ( *C.T.J.*, 1950, **126**, 1421 ).

### Silver-lined Chemical Plant

THE WIDER USE OF SILVER IN THE construction of chemical plant has hitherto been hampered by cost considerations. Recent experience has shown that on account of its valuable properties, silver can be more economically employed even at current price levels in chemical, electrical and food industries with advantage. The high initial cost of the plant is largely offset by the recovery value when a plant or vessel is taken out of commission ( *Chem. Age*, 1950, **63**, 196 ).

The heat transfer characteristics of silver and silver-lined chemical plant compare favourably with those of nickel or stainless steel. The high thermal conductivity of silver, coupled with its freedom from corrosion, enables very high overall transmission coefficients to be obtained. To overcome its mechanical weakness and liability to sulphur tarnish, silver is alloyed with copper and other metals. For use under corrosive conditions, however, 99·99 per cent silver is preferred. In the construction of tubes and coils subject to low working pressures, massive silver can be used to make up for the tensile strength. For service at higher pressures, silver tubes and pipes are backed with a stronger metal by drawing down together a pair of heavy walled tubes, one of silver and the other of base metal. In heat exchangers, the silver tubes are expanded to fit tightly in the tube plates, which are usually of base metal sheathed with silver on the contact face and through the holes. Mild steel vessels can also be given a bended lining if the steel shell is not too heavy. Bending is, however, not possible in thick-walled vessels such as high pressure autoclaves ; the method adopted is to make the lining slightly over-sized and press it into place.

Uniform coatings of silver as thin as 0·001″ or thinner can be applied by electro-deposition or metal spraying but are too porous for chemical process work. A promising method is the cladding of a silver sheet on a base metal plate before fabrication. This would considerably reduce the initial cost of silver-lining and extend its range of application.

### Evaluation of Metal Finishes

THE INSTRUMENTS AND TECHniques which have been developed for the evaluation of surface roughness of metal finishes are described and their possible usefulness to the metal finisher assessed in a paper presented at the recent 37th Annual Convention of the American Electroplaters' Society.

The microscopic methods, such as the Schmaltz light-cutting technique and those involving perpendicular or taper sectioning are of limited utility since these are limited by optical factors to give a resolution of about 8 microinches only. It is possible to extend the microscopic methods to give a resolution of one microinch when they are used in conjunction with interference phenomena. The Zeiss interference microscope is useful in the study of surfaces having a roughness range of 2 to 80 microinches. The surface can be inspected without special preparation at a magnification of 664 X and can be scanned by moving the specimen with a mechanical stage. Proper interpretation of the interference patterns permits the making of measurements in three directions from a single observation. Photographic records can be made of areas 0·007″ dia. The microscope can be used on soft materials, exact peak-to-valley measurements can be made and a better idea of the general texture as well as the exact details of the surface imperfections such as scratches, nodules and pits obtained. For matte surfaces, and internal measurements, electromechanical roughness gauges, actuated by a tracer arm equipped with a diamond stylus, have been successfully employed over ranges of 0·5 to 3,000 microinches. Plastic replicas, which are easily and economically prepared, can be used with simple optical projectors for the comparison of surfaces against accepted standards down to about 2 microinches. Experimental methods for obtaining numerical values of roughness from plastic replicas have been described but commercial instruments for this purpose are not yet available. The electron microscope is a potent tool for the study of surfaces, but high equipment costs and involved operational techniques limit its general utility.

### Photo-transistor

A NEW TYPE OF "ELECTRIC EYE", much simpler, smaller and sturdier than the present photo-electric cell and capable of performing most of the functions of an ordinary vacuum tube is being perfected at the *Bell Telephone Laboratories* ( *J. Franklin Inst.*, 1950, **249**, 516 ). Because of their smaller size and long life, the photo-transitors should find many applications where it is not practical to use the present photo-electric devices.

The apparatus consists of a small cylinder of the size of 0·22 calibre rifle cartridge containing a piece of germanium. In a small dimple ground into one side of the germanium disc rests the tip of a wire ( the collector ). At this point the disc is only $\frac{3}{1000}$ ″ thick. Light focussed on the opposite, undimpled side of the disc can control the flow of current in the wire, thus making a control device similar in function to a photo-electric cell.

The photo-transitor has a high power output for a photo-electric device, in some cases enough to operate a switch directly without preliminary amplification and gives good response to a rapidly fluctuating light source. It is sensitive to light given off by ordinary incandescent light bulbs and is well suited to operate with these with good fidelity. Another important property of the device is its low impedance.

### Fractional Weights from Zirconium

IN RECENT YEARS PLATINUM AND aluminium fractional weights are substituted with tantalum and gold ones. More recently zirconium has been found to offer some advantages over these metals ( *J. Franklin Inst.*, 1950, **250,** 39 ).

Zirconium satisfies the rigid specifications for such purposes and is available in sufficient quantities in a high state of purity. As the melting point ( 1,857°-1,860°C. ) is not high, the metal can be fused easily. Its buoyancy correction is +0·041 mg. in comparison with −0·070 mg. for tantalum and +0·302 mg. for aluminium.

Four small weights, 50 mg., 20 mg., 20 mg. ( one dot ) and 10 mg., were produced from one sq. cm. sheet of the metal weighing approximately 0·077 gm. They were cleaned with redistilled alcohol, allowed to dry at room temperature ( 32°C. ) for two days. Σ ( 100 mg. ) zirconium was compared with the fiducial weight by the method of substitution taking six observations, the lapse of time between the first and the last being 18·5 months. The difference noted was −0·002 mg. Composite values represented by Σ ( 100 mg. ) Zr. were also determined before and after intercomparisons. The calibration data for the individual pieces were in agreement to the nearest microgram. Control determinations on the standard centigram ( S 10 mg. ) and their intercomparison with zirconium weights gave identical values ( 10 mg. ) Zr. − ( S 10 mg. ) = 0·000 mg.

It would be advantageous to use zirconium specially for the decigram and centigram groups of weights. Aluminium may still be employed for the milligram group to maintain a suitable relation between area and thickness.

### Strain Tester for Rubber Products

AN AUTOMATIC PRECISION STRAIN testing machine for evaluation of rubber and rubber-like compounds has been developed ( *J. Franklin Inst.*, 1950, **250,** 62 ).

This tester measures the percentage elongation of a virtually motionless specimen at a definite time after the application of a pre-chosen stress. This stress is determined by loading the specimen friction-free in proportion to its thickness in millimeters. It predicts the cure time required to give a desired percentage elongation. Precise measurement of extension set for a specified stress may be obtained since specimens can be stressed for a uniform time interval. Effect of storage on elasticity can now be obtained from one batch only per cure.

The machine is automatic and any unskilled operator can easily obtain all data needed for evaluations. The automatic property of this tester reduces human errors to a minimum and a timer accurately controls all components of an operation cycle. The maximum operation period is only 80 sec. The protective controls give warning when an operation is abnormal, indicating that the data for that particular cycle are not to be used. Also, no change in weight loading for a particular cycle is possible since a solenoid locks the weight combination.

### A Simple Microculture Slide

AN INEXPENSIVE AND EASILY manipulated slide for microscopic examination and microphotography is described ( *Science*, 1950, **112,** 53 ).

The slide which is used in conjunction with 18 mm. cover slips is a standard 1″×3″ glass slide, 3 mm. thick with an unpolished channel ½″ wide and slightly less than 1 mm. deep, located ¾″ from one end of the slide. Cover slips and slides are sterilized separately, and immediately prior to use a cover slip is placed over the channel without cement or wax of any kind, thus forming a small open chamber. Melted seeded agar is allowed to flow under the cover slip by capillarity until part of the space is filled. The inoculated culture slide may then be inoculated in a moist chamber such as a Petri dish containing a piece of moist cotton.

The slide makes possible the rapid production of temporary mounts and gives satisfactory permanent mounts.

### New Flow Valve

A COMPACT, GLANDLESS, FLOW valve which can be remotely controlled by pneumatic, hydraulic or electrical means has been designed at the *Tiltman Langley Laboratories* ( *Chem. Age*, 1950, **63,** 187 ).

The valve consists of a central body, spherical at the input end with a supply hole drilled through it. The hole connects with a piston chamber at the outlet end of the component, in which moves a spherically ended and mushroom shaped piston. A bypass connects the upstream end of the piston to the outlet of the valve. When the bypass is closed, the pressure built up against the piston is greater than the flow pressure acting on the downstream end and this moves the piston to close the main flow. Opening the bypass relieves the load on the piston which moves back, opening the flow passage to the main fluid flow.

The small cross-sectional size of the valve enables it to be installed in a pipe run without requiring special clearances between adjacent pipe and the straight through flow avoids pipe bends or constrictions. The valve being glandless, there is no risk of fire when inflammable liquids are handled. Danger of corrosive liquids affecting the valve components is obviated since it can be fabricated from any material—even glass or carbon. Without power services a remote control can be obtained by utilizing the fluid flow pressure. Electrically operated, the valve will control flows of 30 g.p.m. at pressures up to 500 p.s.i. using only 0·33 amp. from a 24 V. supply.

The possible applications of the valve include handling of corrosive material, remote control of water or gas supplies and fire sprinkler systems using the valve operated from fusible plugs to supply water immediately at high pressures.

### Newsprint from Indian Woods

INVESTIGATIONS ON RAW MATERIALS suitable for the manufacture of newsprint in India carried out at the Forest Research Institute, Dehra Dun, have revealed that satisfactory mechanical pulps can be produced from paper mulbery ( *Broussonetia papyrifera* ), a fast-growing broad-leaved species which can be easily cultivated on a large scale in the country ( *Indian Forest Bulletin No.* 143 ).

A series of grinding experiments on the wood were carried out to arrive at a suitable combination of various process variables which would yield news grade mechanical pulp possessing maximum strength properties. Hotgrinding ( between

65° and 80°C.) and a pocket pressure of 16·8 lb. per sq. in. gave larger production of pulp per unit time and the pulp had better strength properties than those obtained by cold grinding. Beyond 80°C. and at higher pressure, the pulp is darker in shade, has poor strength properties and high power consumption although the rate of production increased.

Mill-scale tests made with a mixture of 70 per cent mechanical pulp and 30 per cent bleached bamboo pulp showed that the strength characteristics of the newsprint were practically the same as those of imported newsprint. The colour and formation ( look-through ) of the experimental newsprint were superior and its quality was softer than the foreign sample. The paper gave a successful printing trial except for the ink absorption which was rather high. This could be brought down by proper calendering.

The Indian *Picea morinda* ( spruce ) and *Alues pindrow* ( fir ) were also found suitable, but due to heavy fellings of these species from the more accessible areas and the difficulties and cost of transport from more remote areas, their utilization is considered uneconomical. A detailed field survey to collect information regarding available supplies and costs of these species, delivered to a mill site, is recommended to ascertain their potentialities.

## Battery Separators from Indian Woods

EXPERIMENTS CONDUCTED AT THE Forest Research Institute, Dehra Dun, on the possibility of manufacturing battery separators from Indian woods are described in *Indian Forest Bulletin No.* 147, published recently. The following timbers were investigated : deodar ( *Cedrus deodara* ), kail ( *Pinus excelsa* ), spruce ( *Picea morinda* ) and fir ( *Abies pindraw* ). The pretreatment consisted of boiling the separators from these woods in 2 per cent caustic soda for 2 hr. followed by repeated boiling in water and thorough washing in cold water after each boiling and finally bleaching in 10 per cent sulphuric acid for 24 hr. and washing. Deodar needed as many as 10 washings to remove alkali. Some of the separators of fir and deodar were further heated with glycerine containing 10 gm. of thymol in 20 gm. of lemongrass oil for 15-20 min. at 115°-20°C. The treatment appreciably changed the electrical resistance of the separators which compared favourably with that of Port Orford cedar (0·045 ohms) after 7 weeks' immersion. Battery performance tests showed that internal resistance of the cells at the 47th cycle was of the same order and magnitude as in the case of Port Orford. The discrepancies in the voltage of the cells as directly measured and as derived from the cadmium potentials of the plates were negligible. The cells recorded a normal cadmium potential progress during the discharge. The voltage variation at high current discharge was not erratic and the diffusion of the electrolyte was normal without any internal short circuiting. Tests conducted over a period of a year and a half showed that the condition of the plates was good in the case of spruce separators and fair with those of fir. The plates of cells fitted with Port Orford cedar, deodar and kail, separators became brittle. The bursting strengths of fir separators were the best, followed by those of spruce and deodar. They were better than Port Orford cedar separators in this respect. Glycerine treated separators gave higher strengths. Sediment deposits in Port Orford cedar were maximum, followed by deodar and kail.

## Resinous Wood Adhesives

TANNINS EXTRACTED FROM BARKS of *Acacia mollissima* ( black wattle ), *Eucalyptus crebra* (narrow leaved red ironbark ), *Callitris glauca* ( white cypress pine ) and *Callitris calcarata* ( black cypress pine ) and from the woods of *Eucalyptus redunca* ( wandoo ) and *Eucalyptus consideniana* have been investigated for their use in the production of wood adhesives ( *Australian J. App. Sc.*, 1950, **I**, 54 ).

The rates of condensation of these tannins with 8 per cent formaldehyde were assessed by measuring the gelation times. Calcarata tannin was the most reactive ; a 40 per cent solution gave a gelation time of 65 min. at 4·5 *p*H. *C. glauca*, *A. mollissima* and *E. redunca* tannins came next in the order of their reactivity. There is a rapid change in gelation time with formaldehyde concentration up to about 10 per cent. Good adhesive strengths are obtained within this range. Reactivity is similar at *p*H values of 2 and 8.

Adhesives were prepared by two methods. In the first method a resin was prepared by heating a solution of the tannin extract or its alcohol-soluble fraction with formaldehyde in aqueous alcohol. The adhesive was prepared from this resin by adding paraformaldehyde, alkali and filler. The resin has a shelf life of 15 days at 25°C. and of several weeks at 10°C. In the second method the adhesive was obtained by adding paraformaldehyde and filler to an alkaline solution of the tannin. This solution does not gel on standing but some tannins give a precipitate which can be delayed by adding glycerol.

Different formulations were tried for cold-press and hot-press adhesives. Best cold-set adhesives were obtained from *A. mollissima* and *C. calcarata* tannins. Compared with commercial resorcinol-formaldehyde and urea-formaldehyde adhesives, these tannins require a short assembly time and have a short pot life. Their bond strengths are lower except that in resistance to boiling water the tannin adhesives are far superior. Satisfactory hot-press adhesives were obtained from *A. mollissima*, *C. calcarata*, *C. glauca* and *E. crebra* tannins having shear strengths and water resistance similar to the phenolic resins used in industry. They set in a short time at lower temperatures than the phenolic adhesives unless these contain a polyhydric phenol or are catalysed with strong acid. The resinous adhesives require relatively little formaldelyde, the quantity varying from 4 to 8 per cent on the weight of tannin extract. The drawback of short pot life is offset by the ease and simplicity of preparation.

## Mortars in Building Construction

A VARIETY OF MORTARS ARE USED in building work and the one chosen for any particular class of work has to be a compromise, since no one mortar possesses all the desired properties. Recommendations, based on experimental trials, are given in a bulletin recently issued by the Building Research Station of the Department of Scientific Research, London ( *National Building Studies, Bull. No.* 8, price 1*s.* )

Good working qualities, water retention and freedom from major cracking are useful characteristics of mortar mixes containing lime and those with a high proportion of cement give early strength and durability. A mortar containing both lime and cement has the best combination of properties, the proportions of each being varied to suit the particular set of conditions. The following types of mixes to suit a variety of conditions and purposes are recommended: *Brick work and block construction :* Cement mortar is recommended where dense strong mortar is essential, for example, bricks used for carrying heavy loads or in special constructions below ground dam-proof course. *Cement-lime mortar :* (a) 1 : 1 : 5-6 cement-lime-aggregate should be used with all normal types of constructions likely to be exposed to severe conditions. It is not recommended for use with sand-lime or concrete bricks having a dry shrinkage greater than 0·025 per cent; (*b*) composition 1 : 2: 8-9, cement : lime : aggregate is suitable for building normal brickwork in spring or summer except where the exposure conditions are severe and can also be used with sand-lime and concrete bricks or concrete blocks having a drying shrinkage greater than 0·025 per cent; (c) 1 : 3 : 10-12, cement-lime-aggregate is recommended for internal work only, under spring or summer conditions. This mortar has a low frost resistance and is, therefore, unsuitable for external brick-work. Hydraulic lime-aggregate ( 1 : 2-3 ) is suitable for normal brick-work construction. A richer mixture should be used under conditions of severe exposure. Lime mortars ( other than hydraulic ) are liable to break up if they become frozen when wet, and generally should not be used for external work except for thin joints ( as in masonry ) or where the joints are pointed with a mortar of sufficiently high frost resistance. Mortars for masonry ( porous limestone and porous sandstones )—For bedding porous type of limestone or sandstone, a 1 : 3 lime putty : crushed stone aggregate mix is suitable. If a more rapid hardening isre quired, the mortar should be gauged with cement in the proportion of 1:3:12, cement : lime putty : aggregate. For bedding dense sandstones or granite, strong mortar may be used. Suitable mixes are 1 : 2-3, cement : aggregate. Rubble masonry, having a 1:2:9, cement : lime : aggregate mix, is suitable in spring and summer; 1:1:6, cement: lime : aggregate for autumn and winter.

## Coffee Husk as Cattle Feed

PRELIMINARY INVESTIGATIONS conducted at the Indian Veterinary Research Institute, Izzatnagar, point to the possibility of utilizing the pulpy residue from the coffee bean, now a waste material, as cattle feed. Metabolic studies conducted on buffaloes after preliminary feeding of about three weeks on a ration consisting of 1·5 lb. linseed cake and 3·5 lb. coffee husk in the morning followed by 8 lb. of wheat bran ( to meet the dry requirements ) gave the following digestibility coefficients for the various components: crude protein, 33·53 ; ether extract 76·08 ; crude fibre, 18·7 and nitrogen-free extract, 72·42. The nutrients in lb. per 100 lb. of coffee husk on dry basis were : digestible crude protein, 3·38; total digestible nutrients, 42·24.

During the experimental period, the animals maintained good health and no adverse symptoms were observed. There was, however, difficulty in feeding the husk to the animals as they were disinclined to take it in large quantities on account of its unpleasant taste and aroma. Means of increasing the palatability of the material need to be devised before it finds extensive use as a cattle feed.

## Sann Hemp

PRODUCTION AND MARKETING OF sann hemp in India are dealt with in a recent bulletin issued by the Agricultural Adviser to the Government of India ( *Bulletin on the Marketing of Sann Hemp in India*, price Rs. 1/8 ). Valuable improvements have been suggested to obtain better yields and quality of fibre.

The area under the crop is estimated to be 5,85,000 acres with an average annual production of 1,16,000 tons fibre. The average yields per acre of the fibre vary from about 3·5 md. in Bombay to 4·5 md. in the Madhya Pradesh and Orissa, 5 md. in the Uttar Pradesh and Hyderabad, 6 md. in Bihar and East Punjab, 6·5 md. in Madras and 10 md. in Bengal. The three types of fibres are known: white, *Ganjan* or green and *Dewghuddy*, which differ considerably in quality depending on the stage at which it is harvested, methods of retting and washing, and soil and climatic conditions of the area where the crop is grown.

Research work on sann hemp has been confined mainly to selection of better types from the existing strains. *Kanpur* 12 continues to be the best yielder. Two more promising strains, *M* 18 and *M* 35, have been evolved under a scheme sponsored by the Indian Council of Agricultural Research. These are early maturing varieties particularly useful in areas of scanty rainfall. Experiments carried out in the Madhya Pradesh have shown that harvesting done at the pod formation stage gives the best results. The fibre so obtained is superior from the point of colour, lustre and strength.

Stems which are washed and dried after retting yield a finer fibre which can be extracted as and when desired. This is not the case with fibre stripped from wet stems.

## Mathematical Typewriter

A TYPEWRITER FOR PREPARING mathematical reports has been developed at the *Aeronautical Research Laboratories*, Australia. Two standard typewriters are interconnected to form a single unit thereby doubling the number of symbols available for use in mathematical work; foreign language glossaries and dictionaries and for biological papers where italics are constantly used ( *Research*, 1950, **3**, 378 ).

Two Imperial typewriters having interchangeable keyboards are bolted in an angle iron frame and adjusted at exactly the same height. The left-hand keyboard has roman characters and the right-hand keyboard is fitted with mathematical symbols, Greek letters and small figures for subscripts. The tabular keys and back spacers of the two machines are mechanically linked, the former by a torsion rod and the latter by levers. The plunger on the left-hand machine is operated by an electromagnet which presses on the back of the escapement mechanism operating on 10 V., D.C., supplied by a rectifier. The traversing motion of the carriage is controlled by the escapement mechanism of the left-hand machine. A small knife switch replaces the microswitch and enables the plunger of the right-hand machine to enter into the knife switch and make sufficient contact to operate the magnet. To move the carriage from one keyboard to the other, the typist merely pulls down the control bar and holding the bar in the "down" position, moves the carriage in the desired direction until it comes to rest against a stop. The carriage is then in the correct position to continue typing and the bar is restored to the " up " position.

Tabulation can be done on either keyboard by moving the control bar full down to throw a stop and back half way.

## Aluminium Alloy Castings & Sections

TWO USEFUL BULLETINS HAVE recently been issued by the Aluminium Development Association, London, dealing with *Aluminium Alloy Sections for Road Vehicle Bodies & Aluminium Alloy Castings*.

To meet the requirements of road vehicle body structures, a series of aluminium alloy extruded sections have recently been developed. These sections, along with others selected from the general series of aluminium alloy sections specified in B.S. 1161-1944, satisfy most of the requirements of body builders. Simple structural forms have been adopted from these sections and the series consists of angle bars, channels, top-hats and Z-sections. Altogether 32 such sections are described in the present bulletin which is supplemented by brief notes on aluminium and its alloys in their design and building.

*Aluminium Alloy Castings* is a general survey of the various casting methods and characteristics of the different types of castings. Principles of casting design are illustrated to show how small modifications would go to improve the design of a casting and the quality of the product without affecting its cost and functional value. Specified composition and mechanical properties of aluminium casting alloys and a general guide to their selections given as appendices to the bulletin enable the user to choose them to suit his requirements.

## Lignite Deposits in Madras

LIGNITE WAS DISCOVERED ABOUT fifteen years ago in the Vriddhacalam taluk and in the Cuddalore taluk of the South Arcot district, Madras State. The total area proved is 16 sq. miles.

The area is occupied by Cuddalore sandstones of Miocene age composed of soft, often waterlogged sandstone grits and clays. Lignite occurs as a regular bed or seam having a gentle dip ( roughly 1 in 100 ) in an E.S.E. direction at a depth of not less than 140 ft. from the surface. The average thickness found in the various boreholes of the seam is 22 ft. Assuming one sq. mile-foot of lignites equivalent to one million tons, the estimate of the reserve is placed at 352 million tons.

Samples from the lignite cores gave on analysis the following values: moisture, 9·75-35·0 per cent; volatile matter, 23·9-38·5 per cent; fixed carbon, 21·6-37·7 per cent; ash 7·4-32·9 per cent.

The lignite is black and compact when freshly obtained but cracks on drying and becomes dark brown. Calorific value and general assay indicate that the mineral is of good quality.

Lignite seams 35 ft. thick have also been encountered in the Cuddalore-Pondicherry area at a depth of 257 ft. and are considered to be the extension of Neyveli field. Strata of the same age, called Varkala sandstones, occur in Travancore and continue northwards into Malabar and South Kanara lignite beds. Lignite occurrences are also reported near Beypore in Malabar at the foot of a cliff, at the sea shore as well as a few other places near Cannanore and Kasargod in South Kanara.

## Rice Cultivation in Australia

A SURVEY RECENTLY INSTITUTED by the Australian Department of Agriculture into the possibilities of large-scale rice production in the western and northern districts of Australia has shown that factors such as seasonal flooding of areas and normal rainfall were sufficient for extensive rice cultivation making artificial methods of irrigation unnecessary, provided supplies of suitable tropical varieties of rice seed were available.

Water requirements for irrigating rice fields in the Murrumbidgee area are estimated to be 6 acre-feet to the acre. The actual amount required is influenced by the underlying geological and ground-water hydrological conditions, the season, the density of the crop and the layout of the field. The average yield per acre for the last 11 years in this area is of the order of 1·80 tons. Throughout the area the crop is grown on a poor soil, shallow-medium to heavy clay, overlying a stiff clay subsoil which previously proved unproductive when sown to other crops. The same soil has produced successful yields of wheat and oats as rotational crops. Even grain ripening and uniform crops have been ensured by growing two improved heavy-yielding strains of *Caloro*, originally introduced from Japan. Recently two new varieties surpassing standard commercial *Caloro* in both quality and yield have been developed. *Calusa* 177 out-yields *Caloro* by half a ton to the acre and produces an even, dense crop with medium-height strong willong straw about 3 ft. high. *Lady Wright x Caloro* cross-bred also produces heavier crops than *Caloro* and has the advantage of medium to long grain of good quality.

Manurial trials have shown that nitrogen applied as ammonium sulphate is the most satisfactory fertilizer. Fertilizers are applied either through the manure box of the seed drill or combined when the rice seed is sown or big broadcastings in the rice bays after the rice has germinated.

Weed growth, a serious problem, has been controlled and is eradicated by early flooding. Seed is sown at a shallow depth of about 1 inch and germinated by irrigation in the usual way. When the maximum germination has been obtained, the rice seedlings and weed growth are submerged to a depth of a few inches above the plant.

Cutting, threshing, winnowing and cleaning operations are mechanized with the aid of headers. During recent seasons, several fore-cut automatic headers on crawler tractors have been used.

## Electronic Sterilization of Foods

THE ELECTRONIC STERILIZATION OF foodstuffs is becoming an attractive proposition as the amount of energy used up in the process is small and the rise in temperature of the material is only 2 or 3 degrees. In many cases, however, serious changes take place in the food and the prevention of these changes is one of the major problems to be solved before the method can be commercialy adopted (*Food Sc. Abs.*, 1950, **22**, 73).

X-rays, electrons or cathode rays and gamma-rays can be employed. It has been found that larger organisms such as bacteria are more easily killed than smaller ones such as viruses. To kill *B. coli*, a dose of about 5,000γ. is required; in the case of vaccinia virus, about 1,00,000γ. is necessary. Recent work has shown that to sterilize food contaminated with the usual forms of bacteria requires a dosage between one and two million γ units.

The chief problem in producing a beam of electrons suitable for sterilization purposes is the high voltages to be employed. This limits the field to two machines with a third as a future possibility. First is the Van de draaf generator producing a continuous beam of electrons at 2 Mev. and 250 microamp., which can sterilize a few grams of food in the form of a disc, 2 or 3 cm. in dia., and about 0·5 cm. thick, in about $\frac{1}{25}$ of a second. The second type of generator is the Capacitron which delivers the beam at 3 Mev. in the form of a pulse of exceedingly high intensity (about 25,000 amp.) but of very short duration (about one millionth of a second). Two or three of these pulses will sterilize several pounds of food. The microwave linear accelerator is the third type emitting electrons with an energy of 4 Mev. By focussing the beam, a pound of food, one cm. thick, can be sterilized in about 12 sec.

The large doses of irradiation which are required give rise to serious difficulties with regard to the food itself and there is risk of changes in palatability and nutritive value. The more striking effects found are: butter loses its colour and looks like lard; it becomes so rancid that it is inedible. Fresh red meat develops a purple colour and an unpleasant, oily, burnt taste. Fresh white fish loses all flavour and so does orange juice.

## Perennial Cottons

CONVERSION OF THE EXISTING perennial cottons into quality perennials and extending the cultivation of suitable perennials in backyards, as hedge crops, as subsidiary crops in gardens and in waste lands unsuited to food crops are some of the measures recommended to meet the demand for long staple cotton in the country (*Indian Cotton Growing Rev.*, 1950, **4**, 63). Environments favourable to the crop but not to the insect pests have to be created. This is possible by shifts in planting and harvest dates and by developing areas where the meteorological conditions will be adverse for the pests. Resistant South American types like Moco, Quebradinho and Verdao which kill the attacking grub of stem weevil in all stages and to a limited extent the wild *G. thurberi* which resists boll worms, should be tried. In Madras, hybrids have been evolved from crosses between Moco and improved strains of Cambodia to withstand stem weevil. Five varieties from South America which were very vigorous, resistant to cotton stem weevil, long stapled and capable of standing up to periodical pruning were tested. The first generation hybrids between local races of *hirsutum* and other *barabadense* types exhibited pronounced hybrid vigour, out-yielded the *nadam* type, could be retained on the ground for three years with or without pruning and showed considerable resistance to stem attack. Bourbon cotton, acclimatized to the South Canara district, has grown into tree-like shrubs and is reported to yield in two seasonal harvests 5 lb. of seed cotton per bush.

## Chromite Deposits in Orissa

CHROMITE DEPOSITS ESTIMATED AT 2,00,000 to 5,00,000 tons have been found at Nausahi in Keonjhar district in Orissa by the Geological Survey of India as a result of a recent investigation conducted in the area. The deposits occur in a one and a half mile long stretch of rocks in the region. Proximity to the centres of iron and steel industry and to Calcutta Port makes these deposits important.

## Paint Factories for Madras

THE GOVERNMENT OF INDIA HAVE accepted a proposal for the establishment of a paint and a lithopone factory with a production capacity of 10 tons per day and 2,500 tons per annum respectively in Rayalaseema, Madras. Investigations to assess the suitability of various localities in this area for location of these factories and the preparation of detailed plans and estimates are in progress Rayalaseema has abundant raw materials used in the manufacture of paints and varnishes and lithopone. The production of these raw materials in 1948 was: barytes 17,076 tons, steatite 244 tons, yellow ochre 765 tons and red oxide of iron 1,075 tons.

## Radioactive Materials & Stable Isotopes

RADIOACTIVE MATERIALS AND STABLE isotopes from natural sources or produced by irradiation are finding extensive application in fundamental and applied research, but information on these materials is not readily available for want of a consolidated catalogue. A list of the available isotopes and radioactive materials recently issued by the U.K. Atomic Energy Research Establishment at Harwell deals with the preparation and use of radioactive materials, advisory and field experimental services, health hazards and data on the radiations emitted by the materials. β and γ ray sources for radiography and therapy are also included and details regarding packing and transport of these materials are given. The users of these materials for experimental purposes are strongly recommended to discuss the experiment with a representative of Radiochemical Centre, Amersham, or A.E.R.E., Harwell, England, to avoid waste of time and prevent wastage of active material.

## The International Council of Scientific Unions

A DESCRIPTIVE PAMPHLET ("A Description of the International Council of Scientific Unions" Gonville and Cains College, Cambridge, England), recently published by the International Council of Scientific Unions, gives an account of the history, present status and activities of the Council and affiliated bodies and unions. The information is primarily intended to stimulate the interest of nonadhering countries and organizations and the younger generation entering the fields of the natural sciences and includes the history and functions, commissions, publications, assemblies, statutes, annual contribution, member countries, existing agreements with other organizations and present office bearers.

### Board of Engineering Research

AT ITS INAUGURAL MEETING HELD in September 1950 under the chairmanship of Shri A. N. Khosla, the Board of Engineering Research discussed ways and means of initiating and promoting research in various branches of engineering. It was decided to undertake a detailed survey of the existing facilities for tackling problems facing state organizations and industries. Five expert committees on (i) civil and structural engineering, (ii) mechanical engineering including machine tools, (iii) electrical and radio engineering, (iv) hydraulic engineering and (v) aeronautical engineering were constituted to draw up detailed proposals regarding the lines on which research work in various branches should be initiated.

The Board discussed an offer from two industrialists to donate substantial sums of money towards the establishment of two post-graduate engineering research institutions. A sub-committee was formed to examine the proposal in detail.

### British Scientific Publications

THE ROYAL SOCIETY INFORMATION Services Committee have brought out a valuable handbook listing scientific journals of the United Kingdom publishing original scientific papers or critical reviews. It includes a short description of the contents of the journal, its frequency of issue, the current volume number, subscription, size and other useful particulars of over 200 journals. The index gives abbreviations for titles of the journals taken from the current *World List of Periodicals*.

Coupled with the *Bibliography of Scientific Publications for South Asia*, brought out by *UNESCO*, this handbook would serve as a useful compendium for scientific workers and libraries in India. The handbook is published by the Cambridge University Press and is priced 2*s*. 6*d*.

### Announcements

*Building Research Congress* — British professional institutions and learned societies are sponsoring a congress on building research to be held in London from Sept. 11 to 20, 1951. The purpose of the congress is to review the progress made in research in relation to architecture, building and the associated branches of civil engineering. Papers are invited from research workers from overseas. Further details are available from the Organizing Secretary, Building Research Congress 1951, Building Research Station, Bucknalls Lane, Watford, Herts, England.

*The Registry of Rare Chemicals*, 35 West 33rd Street, Chicago, lists the following wanted chemicals: phosphoryl fluoride; ferric bromide (anhydrous); ferrous bromide (anhydrous); zinc carbonyl; ammonium cyanide; *p*-aminoethylbenzene; γ-aminobutyric acid; 2-phenylcyclohexanone; 3-methylpentanol-3; acetylcyanide; 5-methylisoquinoline; acetyl phosphate; perfluoroadipic acid; *n*-decyl mercaptan; *n*-hexadecyl mercaptan; methyl vinylsulfonate; methyl isopropenylsulfonate; perillic acid; scymnol; and coniferyl alcohol.

*The International Union of Geodesy & Geophysics* will hold its 9th General Assembly in Brussels from 21st August to 1st September 1951.

*Indian Science Congress* 1951 — The thirty-eighth session of the Indian Science Congress will be held in Bangalore during January 1951 and not in Calcutta as announced earlier.

*Dr. K. K. Majumdar*, Indian School of Mines and Applied Geology, Dhanbad, has been awarded the William Camphell Fellowship by the Columbia University, and the Fulbright Travel Grant by the Government of U.S.A. Dr. Majumdar will carry out research on flotation of minerals under Prof. A. F. Taggart at the Department of Mineral Engineering, Columbia University.

*Dr. J. N. Mukherjee* has been appointed as the Director and the Head of the Division of Chemistry, Building Research Institute (C.S.I.R.), Roorkee.

*Nuffield Foundation Travelling Fellowships*, 1951-52 — The last date for receipt of applications for the Fellowships has been changed from 31st March 1951 to 28th February 1951.

# Progress Reports

## RICE RESEARCH

Examination of improved types of paddy for their yield performance has been an important feature of the work carried out at the Central Rice Research Institute, Cuttack, during the year 1948-49. As a result of this work two early maturing and high yielding varieties of paddy of Chinese origin, suitable for cultivation under conditions obtaining in Orissa, have been discovered. These varieties mature in 100 days and have been found suitable for the second crop when planted after mid-December (and transplanted within 30 days). The yields vary from 1,000 to 1,800 lb. per acre, thus ensuring the average total yield of about 3,000 lb. per acre without manure and 4,000 lb. per acre with manure.

82 improved types were tested for yield performance during the year against suitable controls and 12 varietal trials were conducted. Of the Orissa *beali* varieties *Benihog* gave significantly higher yield than B. 76 and N. 136. Plr. 7 and DCA 14 recorded 25 and 23 per cent increase in manured plots over the unmanured ones. China 45 and 47 and two Madras types PTB. 10 and *Co.* 13 gave significantly higher yields than the local *Benihog*. The yield data were analysed and the genetic variability component of the progeny varieties estimated. This was found to be significant at 5 per cent level in 5 established strains indicating scope for further selection in these strains.

Manurial trials conducted over a period of three years for broadcast and transplanted paddy indicated a significant response to manuring by groundnut cake and ammonium sulphate. Transplanting gave higher yield than broadcasting, the advantage being more apparent with the late varieties. Ammonium sulphate applied in a single dose at the transplanting stage for early maturing varieties and in two doses for the late varieties gave the maximum response. The average increase in yield per lb. of nitrogen was 15·0 lb. when applied at 20 lb. per acre and 10·2 lb. when applied at 40 lb. per acre. Application of lime also gave an average increase of 16 lb. per acre for every cwt. of lime applied. Application of phosphatic fertilizer in general resulted in increased yields. In the presence of nitrogen-fertilizers, however, phosphatic application did not give any added response.

Response of the crop to spacing was investigated with two varieties, T. 812 and T. 1242. The yield decreased with increased spacing, 6″ to 9″ was found to be the optimum. Trials on single and double transplanting showed that the yield from single transplanting of 30-day old seedlings was significantly higher than double transplanting of 60-day old seedlings.

The Institute undertook a series of statistical studies to determine the optimum size and shape of plots, their arrangements in blocks and their comparative efficiency. A 4′×4′ plot had the maximum efficiency which decreased with the increase in plot size. In view of the practical difficulties of using very small plots for yield experiments and the relative higher increase in C.V. with small plots in fields, it is suggested that plot sizes ranging from 1/750 to 1/500 acre for varietal trials and sizes of 1/150 to 1/160 acre for manurial trials may be used.

Mycological studies during the year were confined to *Helminthosporium* disease of rice and control of spotting in the grain. The spare suspension method of artificial inoculation was not found efficacious as *H. oryzae* wouldn ot sporulate under experimental conditions. A new technique was evolved in which the dry mycelium along with the spores from a 21-day old culture of the fungus on grain in the husk medium was dusted on to the moistened leaves of the seedlings.

Various seed treatments were investigated for their effect on the viability and germination of seeds. Mercurials like Agrano, Agrosan Gn, Granosan were highly toxic in concentrations of $\frac{1}{60}$, $\frac{1}{30}$ and $\frac{1}{15}$ by weight of seed and no germination was obtained. Treatment with T.M.T.D. increased the percentage of germination in Co. 2 by 22 per cent.

Three types of stem borers have been found to attack the rice crop in Orissa: 3 *Sehoenobius incertellus*, *Sesamia inferens* and *Agyria sticticraspis*. The major damage is caused by *Sehoenobius incertellus*. Manuring decreased the incidence of pests. Guesarol 550 (50 per cent DDT) killed all pests 4 hr. after spraying, while Gammexane D.O. 25 (5 per cent benzene hexachloride) took 8 to 10 hr. Vivifex (50 per cent DDT and 30 per cent $CuSO_4$) gave the same result but the plants revived better than in other cases.

The efficacy of various herbicides was examined for the control of water hyacinth and weeds in the rice fields. Two sprayings of the following were found effective against water hyacinth: 2.4-D acid (28 oz. in 150 gal. of water per acre), 2.4-D (36 oz. in 150 gal. of water per acre), 2.4-D sodium salt (30 oz. in 150 gal. of water per acre) and 2 methyl 1-4 chlorophenoxy acetic acid (15 lb. in 150 gal. of water per acre). 30 species of weeds in the field bunds were sprayed with methoxone (10 per cent solution), Chloroxone (80 per cent powder) and Tufor (70 per cent acid powder). Three concentrations of the chemicals were employed. Spraying was done twice with an interval of 10 days between each spraying. None of the grasses and *Cyperaceae* weeds was affected. Weeds belonging to *Malvaceae* and *Sterculaceae* showed a high degree of response while two weeds of *Tiliaceae* were not affected. All *Vitaceae* were easily affected. Of the 4 weeds of *Leguminosae*, only one, i.e. *Sesbania aculeata*, showed some response, *Cassia tora* remained unaffected and *Mimosa pudica* was partly affected. The most commonly occurring weeds, *Croton sparsiflorus* and *Euphorbia sp.*, remained entirely unaffected.

## TIN RESEARCH

DURING THE YEAR 1949, EXPERIMENTAL WORK AT the Tin Research Institute, England, has been concentrated on improving the quality of tin plate, bronze and bearing alloys and on the electrodeposition of tin and tin alloys.

The application of the Francis thickness tester to the measurement of electrolytic and hot-dipped tin-plate coatings has been studied. An instrument built for this work has proved useful and reliable. The possibility of obtaining new bearing components by powder metallurgy are being examined as this method offers a combination of properties not obtainable by ordinary casting methods. Factors affecting the life of tin-base bearing metals are being investigated and two new machines are being set up to assess the performance of alloys. Electrodeposition of tin-alloys ( tin-zinc, tin-lead, tin-copper, etc.), developed at the Institute, has proved useful on steel chassis of radio sets, on bolts and nuts and parts used in the cycle and automobile industries. The coatings have also been adopted as a finish for steel curtain rails, steel skates, electric signalling apparatus and heat exchange equipment. Tin-cadmium alloy is found to be rust resisting ; other similar alloys are also being developed. Apparatus has been designed for assessing the importance of variables under manufacturing conditions and on the corrosion resistance of tin plate.

During the year under review, new offices of the Institute were opened in the United States, Belgium and Holland to extend the service of technical information and assistance to tin-consuming industries. The new buildings under construction at Greenford, England, to have additional space for the headquarters and laboratories are nearing completion.

Several useful publications covering all the major applications of tin have been published by the Institute during the year. Of these *Tin & Its Uses*, *Hot-tinning* and *Notes on Soldering* have evoked wide interest.

## ACTIVITIES OF THE BUILDING RESEARCH UNIT ( C.S.I.R. ), ROORKEE

ONE OF THE IMPORTANT RESEARCH PROJECTS UNDERtaken by the Unit during the year 1949-50 was on the use of indigenous materials in building better houses at a reasonably low cost. A bulletin on this subject ( *Low Cost Houses* ) has been issued by the Unit. Further attempts are being made to reduce the weight of the roof tile to effect an economy in the framework. Light-weight aggregates such as overburnt bricks weighing half as much as the clay are being introduced to replace a part of the clay. Work is in progress on the utilization of lime-sludge ( a factory waste ) as an earth stabilizer ; 2 to 5 per cent lime-sludge with 3 to 5 per cent sodium silicate has good stabilizing properties. The effects of different salts on the physical properties of soils have been studied.

Another important project initiated by the Chemistry Section of the Unit is the study of problems connected with the manufacture of bricks. A number of bricks and brick-earths from all over the country have been analysed and samples of bricks prepared under uniform conditions have been examined for their physical characteristics.

Soil survey studies were carried out in the airfield at Hindan ( Ghaziabad ) for the Engineer-in-Chief, Army Headquarters, New Delhi, to improve the bearing capacity of the soil.

Problems connected with prefabricated houses were investigated jointly by the Unit and the National Chemical Laboratory, Poona. A mould grease consisting of grease and graphite, castor oil and aluminium stearate has been prepared for the new concrete moulds used in manufacturing prefabricated blocks from foamed concrete. Cement-fibre boards have been made from organic fibres such as coir, sisil and jute and mastic compounds for jointing the prefabricated wall panels.

## TATA INSTITUTE OF FUNDAMENTAL RESEARCH, BOMBAY

A PROGRAMME IN COSMIC-RAY RADIATION STUDIES at high altitudes with specially designed photographic plates is being undertaken by the Tata Institute of Fundamental Research, Bombay, in co-operation with Dr. Peters of the Rochester University, U.S.A. The observations will be conducted at Bangalore to start with, where arrangements for the supply of large quantities of hydrogen at high pressure, required for the experiments, are available. The data so far obtained during high altitude flights with balloons at Bangalore have been analysed and the results are being published. A further programme of flights at Bangalore is to be undertaken and in addition to the flights which will be made for the study of cosmic ray intensity at high altitudes, separate flights will also be made for the study of temperatures in the upper atmosphere.

In addition to the non-recurring grant of Rs. 30,000 which the Department of Scientific Research has sanctioned to the Institute on the recommendation of the Scientific Manpower Committee for increasing the laboratory facilities, a recurring grant of Rs. 12,250 has also been sanctioned to the Institute for the year 1950-51 for the institution of 10 additional studentships.

# 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 August and September 1950.

### Plastics & Plasticizers

41223. Improved plastic moulding compositions: *Incorporating borates of alkaline earth metal to the extent of* 1 *to* 20 *per cent by the weight of resin* — I.C.I. Ltd.

### Organic Chemicals

42767. Manufacture of sulphuric esters of the leuco derivatives of vat dyestuffs and anthraquinone dyestuff intermediates: *Reacting leuco derivatives of vat dyestuffs and anthraquinone dyestuff intermediates: Reacting the leuco derivatives of vat dyestuff with* $SO_3$ *in presence of N-alkylphthalimidine* — I.C.I. Ltd.

42853. New vat dyestuff: *Condensing* α : α*-dichloroacedianthrone with two molecular proportions of* 6*-amino-3*′: 4′*-phthaloylacridone*—I.C.I. Ltd.

43288. Preparation of acetals: *Condensation of alcohol and aldehyde is effected in the presence of a liquid which forms an azeotropically boiling mixture with water and one or more of the reactants* — Ruhrchemie Aktiengesellschaft

41922. Oxidation of paraffinic hydrocarbons: *The paraffin is treated with nitro-gases and nitrosulphuric acid containing* 70 *per cent to* 90 *per cent* $H_2SO_4$ — Ruhrchemie Aktiengesellschaft

### Miscellaneous Chemicals

40968. The manufacture of a therapeutically active antibiotic preparation containing Pristimerin and Dulcitol from *Pristimera indica* (Willd.), A. C. Smith, syn. *Hippocratea indica* Willd. (*Celastraceae*): *Roots of Pristimera indica are extracted with an organic solvent other than petroleum ether*—S. S. Bhatnagar, Divekar & Dutta

40969. Manufacture of Dulcitol: *Roots of Pristimera indica are extracted with an organic solvent and thereafter Dulcitol is crystallized from the solvent* — S. S. Bhatnagar, Divekar & Dutta

### Fuels & Lubricants

41722-23. Arrangement for cleaning producer gas: *A chamber having gas inlet and provided with holes which break the gas into jets and then bubbling the gas through water. Consists of a cyclone with an inlet for the gas to be cleaned, a pipe connecting the bottom of the cyclone with a reservoir containing water* — Das Gupta & Khanna

### Metals & Metal Products

43279. Continuous casting process and apparatus: *Pouring molten metal into one end of an open-ended fluid-cooled stationary mould, withdrawing the casting from the opposite end and co-ordinating the pour-rate of the metal with the withdrawal rate of casting to cause continuously a cyclic change in the molten metal level within the mould* — The Babcock & Wilcox Tube Co.

42075. Improved tin and tin alloy plating bath: *Comprising* 60 *to* 85 *per cent by weight of* 4-4 *dihydroxy diphenyl sulphone, balance* 2-4′ *dihydroxy diphenyl sulphone* — Carnegie-Illinois Steel Co.

44301. Production of zinc: *Using a circulating readily fusible metal alloy as a cooling medium for a pool of the molten metal* — The National Smelting Co. Ltd.

### Rubber & Rubber Products

41611. Production of metal reinforced resilient rubber rings and appliances embodying the same: *Supporting a metal spring coiled in a closed circle within an annular moulding space and filling the moulding space with unvulcanized rubber and vulcanizing* — Latex Industries Ltd.

### Stone, Clay & Glass Products

41016. Manufacture of refractory material: *Employing a composition containing calcined fireclay, plastic fireclay and alkali* — The Tata Iron & Steel Co. Ltd.

### Textile & Textile Products

41843. Single yarn hand sizing machine: *Yarn passed through sizing material is spread evenly on a winding frame by means of rotatable screw rod engaging a traverser, the screw rod and the handle adapting the winding frame being connected by means of chain or gear wheels or belt and pulley for drive* — Perez

43309. Wift-winding machine: *To each bobbin winding point corresponds a single control member for operating all control phenomena, said control member being driven by one driving member common to all* — Baumgartner

43538. Fibre drafting elements used in textile spinning: *Fibre drafting element being composed of finely cellular oil-resistant synthetic rubber having unruptured gas-filled cells* — George Angus & Co. Ltd.

### Miscellaneous

43000. Machine for harvesting potatoes and other root crops: *Consisting of a lifting share, an elevator and an angularly disposed conveyer in which the harvesting machine is detachably connected to the tractor* — Crawford

42802. Compositions for sealing electric storage batteries: *Asphalt* 99 *to* 80 *per cent by weight, rubber* 1 *to* 20 *per cent by weight, rubber in the form of latex containing* 30 *to* 60 *per cent rubber solid* — The Electric Storage Battery Co.

# Patented Inventions of the Council of Scientific & Industrial Research

## COPPER-SILICON BRONZES

### Patent No. 36182

D. R. MALHOTRA, B. PRAKASH & B. D. AGRAWAL

COPPER-SILICON BRONZES ARE TIN-FREE ALLOYS possessing physical and chemical properties similar to tin-bearing alloys. They are stronger, more ductile and corrosion resistant than tin-bearing alloys and practically all articles at present being made of tin-bearing alloys can well be made of copper-silicon bronzes, which are, moreover, cheaper to produce. It is essential to develop such tin-free alloys in India as the country is deficient in tin.

The process for the manufacture of copper-silicon bronzes consists in preparing an alloy containing copper, silicon, manganese and iron, adding the " hardner " thus prepared to molten copper and heating the molten metal to allow alloying, with or without the addition of zinc in the end. The metal is then deoxidized with phosphor copper ( 15 per cent phosphorus ) and cast in sand or metal moulds. It is very necessary to maintain neutral or reducing atmosphere during melting. Fused borax is used as a flux along with the deoxidizer.

## MANUFACTURE OF BENZIDINE

### Patent No. 32486

B. B. DEY, T. R. GOVINDACHARI &
S. C. RAJAGOPALAN

BENZIDINE IS AN IMPORTANT INTERMEDIATE FOR dyestuffs and is also used in rubber vulcanization, detection of sulphates in water and identification of blood.

Among known methods of producing benzidine is the electrolytic reduction at a current density of about 10 amp. sq. dm. of nitrobenzene in alcoholic solution or in a solution of potassium or xylene sulphonates. This method has been found to be uneconomical and unsuitable for large-scale production.

The patented method is an attempt to overcome these drawbacks. It consists in the reduction of nitrobenzene in caustic alkali solution in presence of a catalyst such as lead oxide and is characterized in that the current density used is 4 amp. or less per sq. dm. The strength of the alkali solution is 4 to 20 per cent by weight and an immiscible solvent is employed towards the end of the process to ensure the fullest possible reduction. The process is carried out in an electrolytic cell made of the sheet of metal ( cathode ), inside which are placed porous diaphragms containing the anodes. The electrodes are made of sheet iron or monel metal. The porous diaphragms are made of china clay, asbestos or cement.

The current efficiency of the process is only 50 to 60 per cent when reduction is carried out at a current density of 10 amp. sq. dm. It is 90 per cent at 4 amp. sq. dm. and 95 per cent at 2 amp. sq. dm.

## MANUFACTURE OF *PARA*-AMINOPHENOL

### Patent No. 33078

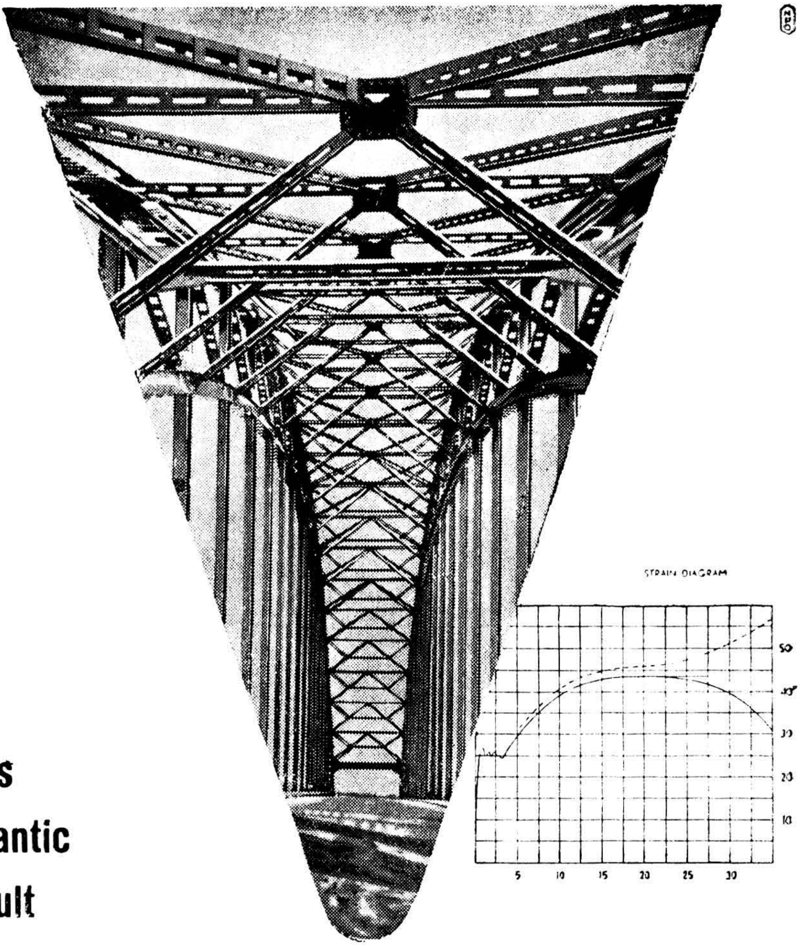
B. B. DEY, T. R. GOVINDACHARI &
S. C. RAJAGOPALAN

*Para*-AMINOPHENOL HAS AN EXTENSIVE RANGE OF applications including its use as a valuable dye intermediate and as a photographic developer.

The present invention provides an improved process for the manufacture of para-aminophenol by the electrolytic reduction of nitrobenzene and is characterized in that the reduction is carried out in the presence of mercury and/or cerium or their salts. The minimum amount of mercury or cerium salt to be used is ½ to 1 per cent of the weight of nitrobenzene.

The apparatus consists of a cell of which the cathode chamber is a vessel made of copper, monel or nickel. A copper salt is also added when platinum, tin or graphite is used. The vessel is provided with stirrers. The anodes are of lead and dip into porous diaphragms containing the anolyte.

Sulphuric acid, 20 to 50 per cent strength, is used as catholyte. A composition consisting of 4·2 litres of $H_2SO_4$ ( d. 1·2 ), 5 gm. mercuric sulphate and a kilo of nitrobenzene will serve as a satisfactory catholyte. The anolyte may be sulphuric acid of any strength between 10 and 60 per cent. The reduction is carried out at a current density of 2 to 4 amp. sq. dm. at 80° to 100°C. Total yields from 1 kg. of nitrobenzene are : 530 to 540 gm. of aminophenol and 150 gm. aniline. A current yield of more than 85 gm. of aminophenol per kW. hr. is obtainable and the method fulfils the requirements of a good electro-chemical process.



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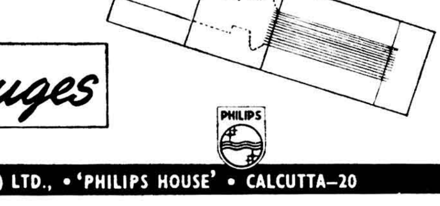

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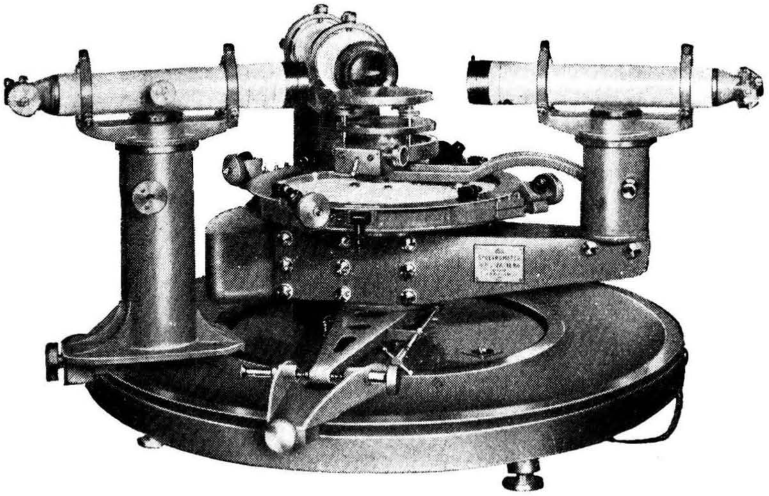

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# A Study of Forbidden Lines in the L-Spectrum of Platinum

G. B. DEODHAR & CHINTAMANI MANDE
*Allahabad University, Allahabad*

**A detailed study of the forbidden lines in the L-spectrum of platinum have been made. Two new lines $\lambda$ 1386·6 and $\lambda$ 1110·6 corresponding to transitions $L_{III}M_{III}$ and $L_{II}$ $M_V$ have been discovered. Three non-quadrupole lines, $\lambda$ 1182, $\lambda$ 943·3 and $\lambda$ 897·9, corresponding to transitions $L_IM_I$, $L_IN_I$ and $L_IO_I$ have been reported for the first time on a plane crystal spectrograph.**

SEVERAL investigators have reported the existence of faint lines in X-ray emission spectra. These lines cannot be explained as normal dipole transitions for which the selection rules derived from theory allow transitions between those energy states only for which $\Delta l = \pm 1$ ; $\Delta j = 0, \pm 1$ except $j = 0$ to $j = 0$. Such faint lines are of two classes :

(1) " Forbidden " lines which fit into the energy level schemes, but involve transitions violating the dipole selection rules, and

(2) those lines which have no place in the energy level schemes, known variously as "non-diagram" lines, "satellites" or "spark" lines.

This paper gives an experimental report on the faint lines of the former type, i.e. "forbidden " lines in the L-spectrum of platinum.

The platinum L-spectrum has been studied by Moseley, Siegbahn, Coster, Dauvillier, Rogers, Lang, Friman, Weber, Idei[1], Kaufman[2] and Y. Cauchois[3]. Amongst the earlier workers, a few forbidden lines were reported by Dauvillier, Rogers and Idei. Later, in a systematic work on the faint lines of several elements of high atomic number, Kaufman reported as many as 11 forbidden lines in the L-spectrum of platinum. Some of these lines were confirmed and some more forbidden lines were obtained by Y. Cauchois, working on the curved crystal focussing spectrograph. An examination of the data of the previous workers revealed several inconsistencies and it was considered worth while to make a detailed study of these forbidden lines in this laboratory.

## Experimental

The spectrograph used was a single crystal instrument of fairly good dispersion, made by Messrs Adam Hilger of London. A well-tried crystal of calcite was used for this investigation. The X-ray tube was of Siegbahn demountable gas type with separate water-cooling arrangements for the cathode and anti-cathode. The target consisted of a sheet of pure platinum. The high-tension equipment consisted of a transformer with a mechanical rectifier. The voltage applied was between 40 and 50 kV., the tube current being about 6 m.a. throughout this investigation. Several plates were taken for which exposures up to 250 milliamp. hr. were given. Measurements were, however, made on only three plates which were quite satisfactory, exposure times being 10, 20 and 30 hr. All measurements were made with reference to the Pt $L\alpha_1$, $L\beta_1$, $L\gamma_1$ and Cu $K\alpha_1$ lines. For the Pt $L\alpha_1$, $L\beta_1$, $L\gamma_1$ lines, the values given by Friman ($L\alpha_1$ = 1310·33, $L\beta_1$ = 1117·58, $L\gamma_1$ = 955·99 X.U.) were taken, and for the Cu $K\alpha_1$, the value 1537·396 X.U. recommended by Siegbahn[4] was used. One of the spectrograms is shown in the figure.

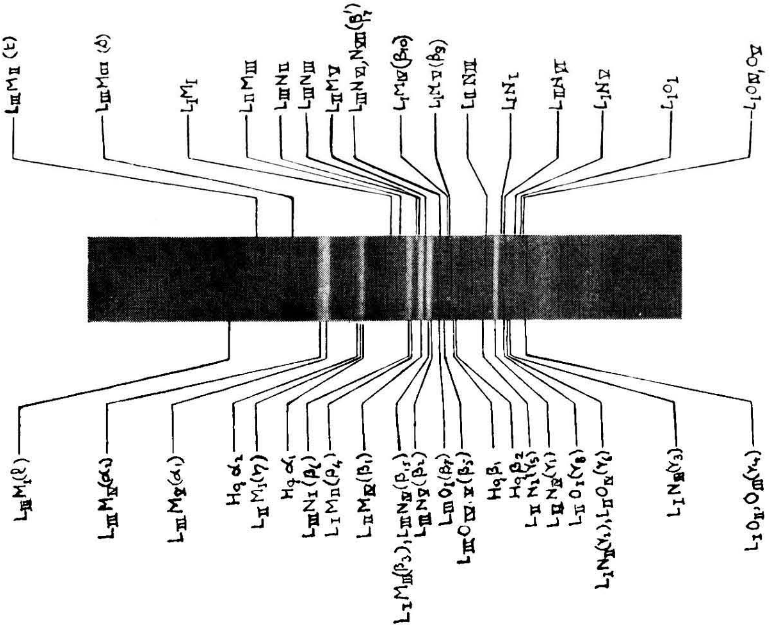

FIG. 1 — THE L-SPECTRUM OF PLATINUM: THE POSITIONS OF THE VARIOUS FORBIDDEN LINES ARE SHOWN ON THE TOP SIDE AND THE ALLOWED TRANSITIONS ON THE BOTTOM SIDE. THE LINES ARE DUE TO THE MERCURY DIFFUSION PUMP WHICH WAS USED FOR EVACUATING THE X-RAY TUBE.

Table I gives the forbidden lines which can be classified as quadrupole transitions, for which the selection rules are $\Delta l = 0, \pm 1, \pm 2$ except $l = 0$ to $l = 0$, and $\Delta j = 0, \pm 1, \pm 2$ except $j = 0$ to $j = 0$ and $j = \frac{1}{2}$ to $j = \frac{1}{2}$.

Table II gives those forbidden lines which cannot be explained as quadrupole transitions.

**Discussion**

1. $\lambda$ 1386·6 ($L_{III}M_{III}$) and $\lambda$ 1110·6 ($L_{II}M_V$)— These investigations have revealed

TABLE I — QUADRUPOLE LINES

| TRANSITION | NAME OF THE LINE | WAVELENGTHS IN X.U.* | | | | | | | | REMARKS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\Delta l$ | $\Delta j$ | Dauvillier | Rogers | Idei | Kaufman | Y. Cauchois | Authors | | |
| $L_I\ M_{IV}$ | $\beta_{10}$ | —2 | —1 | 1059·3 | 1066·0 | ... | 1059·4 | 1059·73 | 1059·0 | Faint | Sharp |
| $L_I\ M_V$ | $\beta_9$ | —2 | —2 | 1052·4 | 1059·9 | 1052·4 | 1051·9 | 1052·36 | 1052·5 | Faint | Sharp |
| $L_I\ N_V$ | ... | —2 | —2 | 912·0 | ... | ... | 912·2 | ... | 912·5 | Faint | Sharp |
| $L_I\ O_{IV}$<br>$L_I\ O_V$ | ... | —2<br>—2 | —1<br>—2 | ... | ... | ... | 891·4 | 892·5<br>891·6 | 891·9 | Faint | Sharp |
| $L_{II}\ M_{III}$ | ... | 0 | —1 | ... | ... | ... | 1164·7 | 1164·3 | 1164·3 | Faint | Broad |
| $L_{II}\ M_V$ | ... | —1 | —2 | ... | ... | ... | ... | ... | 1110·6 | Very faint | Sharp |
| $L_{II}\ N_{III}$ | ... | 0 | —1 | ... | ... | ... | 969·9 | 969·78 | 969·5 | Very faint | Sharp |
| $L_{II}\ N_{VI}$ | ... | —2 | —2 | ... | ... | ... | 937·2 | 937·46 | 937·2 | Faint | Sharp |
| $L_{III}\ M_{II}$ | t | 0 | +1 | 1449·0 | ... | ... | ... | ... | 1450·0 | Faint | Broad |
| $L_{III}\ M_{III}$ | s | 0 | 0 | ... | ... | ... | ... | ... | 1386·6 | Faint | Sharp |
| $L_{III}\ N_{II}$ | ... | 0 | +1 | ... | ... | ... | 1129·1 | ... | 1128·4 | Faint | Sharp |
| $L_{III}\ N_{III}$ | ... | 0 | 0 | ... | ... | ... | 1120·1 | ... | 1120·4 | Faint | Sharp |
| $L_{III}\ N_{VI}$<br>$L_{III}\ N_{VII}$ | $\beta'_7$ | —2<br>—2 | —1<br>—2 | ... | ... | 1076·9 | 1076·3 | 1076·74 | 1077·5 | Faint | Sharp |
| $L_{III}\ O_{II}$<br>$L_{III}\ O_{III}$ | ... | 0<br>0 | +1<br>0 | ... | ... | ... | 1073·9 | ... | ... | ...... | |

* All the values are in X-units. No conversion factor has been applied as recommended by Wood[5] for the facility of comparison with the data of other workers.

TABLE II — NON-QUADRUPOLE LINES

| TRANSITION | NAME OF THE LINE | WAVE-LENGTHS IN X.U.* | | | | | | | | REMARKS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\Delta l$ | $\Delta j$ | Dauvillier | Rogers | Idei | Kaufman | Y. Cauchois | Authors | | |
| $L_I M_I$ | ... | 0 | 0 | ... | ... | ... | ... | 1175 | 1182 | Faint | Broad |
| $L_I N_I$ | ... | 0 | 0 | ... | ... | ... | ... | 943·7 | 943·3 | Very faint | Sharp |
| $L_I O_I$ | ... | 0 | 0 | ... | ... | ... | ... | 897·3 | 897·9 | Very faint | Sharp |
| $L_{II} N_{II}$ | ... | 0 | 0 | ... | ... | ... | ... | 980·5 | ... | ...... | |

*All the values are in X-units. No conversion factor has been applied as recommended by Wood[5] for the facility of comparison with the data of other workers.

the existence of these two new lines which are here reported for the first time. The line $L_{III}M_{III}$ is fairly strong and was measured on plate I. It is interesting to note that this transition ($L_{III}$ $M_{III}$) was found by Dauvillier for 77 Ir and 79 Au, and by Woodall[6] for 79 Au. The line $L_{II}$ $M_V$, though very faint, has been found on plates I and II, so that there seems to be no doubt about its existence.

2. $\lambda$ 1073·9 ($L_{III}$ $O_{II,\ III}$) and $\lambda$ 980·5 ($L_{II}N_{II}$) — The line $L_{III}O_{II,III}$ has been reported so far by Kaufman alone. In spite of many attempts, the authors could not find even the slightest trace of this line. The existence of this line seems, therefore, to be rather doubtful.

The non-quadrupole line $L_{II}N_{II}$ has so far been reported only by Cauchois. In spite of several attempts the authors could not find the slightest trace of this line. Since Cauchois used a curved crystal spectrograph it might have been possible to find a trace of this line in her work. But since, as Cauchois reports, the line is comparatively feeble, it is extremely difficult to distinguish it from the background blackening on such plates as obtained by the authors on a plane crystal spectrograph.

3. $\lambda$ 1450 ($L_{III}$ $M_{II}$) — Among the previous workers this line has been reported by Dauvillier alone. We found a faint trace of this line on plate III.

4. $\lambda$ 1182 ($L_I$ $M_I$) — This transition was reported for the first time by Cauchois. The authors have found this transition, but the line is rather broad and the value is somewhat higher.

5. $\lambda$ 892·5 ($L_I$ $O_{IV}$) and $\lambda$ 891·6 ($L_IO_V$) — These transitions which have a separation of 0·9 X.U. were resolved by Cauchois on the curved crystal spectrograph. It has not been possible for any of the other workers to resolve these transitions.

6. $\lambda$ 943·3 ($L_IN_I$) and $\lambda$ 897·9 ($L_IO_I$) — These non-quadrupole transitions were reported by Cauchois for the first time for platinum. Kaufman has found the $L_I$ $N_I$ line for 77 Ir, 79 Au, 81 Tl, 82 Pb and 83 Bi, but could not observe it in the platinum spectrum. Kaufman also found the $L_I$ $O_I$ line for 73 Ta, 77 Ir, 81 Tl, 82 Pb and 83 Bi, but could not find it for platinum. These lines have been observed by the authors for the first time on a plane crystal spectrograph.

7. Lastly, it is worth noting that so far none of the workers have found any forbidden line for which either $\Delta l$ or $\Delta j$ is three.

**Acknowledgement**

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# Purification of Carbon Rod by Resistance Heating

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**Carbon rod, employed as an electrode in the cathode layer arc for spectrum analysis, has been purified by passing a current of 570 amp. ( maximum ) for 90 sec. through the rod ( 10 cm. length, 7 mm. dia.) in an atmosphere of nitrogen-chlorine mixture. The purified rod contains traces of boron.**

MOST of the impurities in carbon rod may be removed by volatilization at very high temperature, beyond 2,500°C. The method of resistance heating was employed by Russanow, Preuss, Gatterer, Trombe, Foex, Bardet and Hoogland for the purification of carbon rods to be used as electrodes. Hoogland[1] purified carbon rods ( length 20 cm., dia. 7 mm.) by the method of resistance heating ( $i_{\text{max.}} = 650$ amp. for 60 sec. in air ) and the purified rods were analysed by the cathode layer method with an arc current of 5·5 amp. at 220 V.D.C. In the purified rods, the following impurities were still present : the original amount of boron, traces of iron, magnesium, calcium, and traces of tin and copper.

In my previous investigation[2] the method of resistance heating was employed for the purification of " Kino-Homogen " ( German ) carbon rods ( $i_{\text{max.}} = 550$ amp. for 50 sec. in air ). The following impurities were present in the original carbon rod : iron, boron, silicon, copper, nickel, titanium, aluminium, magnesium, sodium, calcium and manganese in large amounts and silver, vanadium, zinc, bismuth, cadmium, tin, gallium, lead, chromium, arsenic, potassium and cobalt in small traces. The purified rod was analysed by the cathode layer method with an arc current of 11 amp. at 220 volts and the purification was more or less the same for most of the elements as that obtained by Hoogland. For copper Hoogland's purification was better. For boron the purification was unsatisfactory as was also found by Hoogland. The object of the present investigation was to study the method of resistance heating in an atmosphere of $N_2$-$Cl_2$ mixture.

## Experimental

The holders, for the carbon rod to be fastened horizontally, consisted of two graphite rods ( each 13 cm. length, 4·5 cm. dia.). Both the graphite rods were drilled at the centre at one end ( 2 cm. depth, 6·5 mm. dia.) and cut into equal halves through it. The carbon rod ( 10 cm. length, 7 mm. dia.) was clamped tightly at both ends ( 1 cm. being introduced at the ends ) into the holes of the graphite holders by means of thick metal strips screwed round the holders at the remote ends. These graphite holders were fitted tightly inside a pyrex glass chamber ( 10 cm. dia., 24 cm. length ) through openings of the side metal plates. Thick asbestos sheets were placed in between the metal plates and the sides of the glass chamber which were also clamped by means of screw arrangements with proper insulation of mica tubes. The chamber was evacuated by a Cenco pump connected to a side tube of the metal plate. Nitrogen from a cylinder was bubbled through carbon tetrachloride and then introduced into the chamber through the other side tube. The graphite rods were connected to the secondary terminals of a special transformer ( primary voltage 220V., secondary voltage 24 ). An ammeter ( 0-100 A ) was inserted in the primary circuit. All the contacts

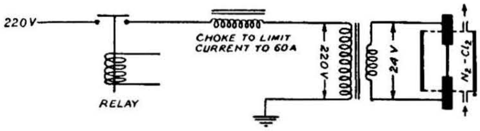

FIG. 1 — ELECTRICAL CONNECTIONS AND OTHER ARRANGEMENTS FOR RESISTANCE HEATING.

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between the carbon rod and the graphite holders and the electrical connections to the graphite rods were good enough to minimize the high transition resistances. Fig. 1 shows the arrangement for resistance heating.

The carbon rod was chemically treated according to the previous method[2] and then dried in an electric furnace at 500°C. This rod was fitted in the graphite holders inside the glass chamber and was heated by allowing a current of 570 amp. maximum ( limited by choke ) to pass through it for 90 sec. in an atmosphere of $N_2$-$Cl_2$ mixture. A continuous current of nitrogen bubbled through carbon tetrachloride was passed through the chamber. The behaviour of the current recorded by the ammeter in the primary circuit is represented in Fig. 2. The length of the carbon rod being only 8 cm., the sag of the rod was almost negligible.

The resistance heated carbon rod was cut into equal halves and then analysed by the cathode layer method with an arc current of 11 amp. at 220 volts d.c. ( time of exposure 1 min.). The results are recorded in Table I.

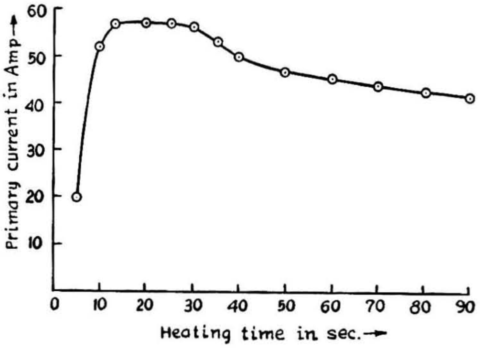

FIG. 2 — BEHAVIOUR OF CURRENT WITH HEATING TIME.

FIG. 3 — CATHODE LAYER SPECTRUM OF "KINO-HOMOGEN" CARBON ROD ( IMPURE ).

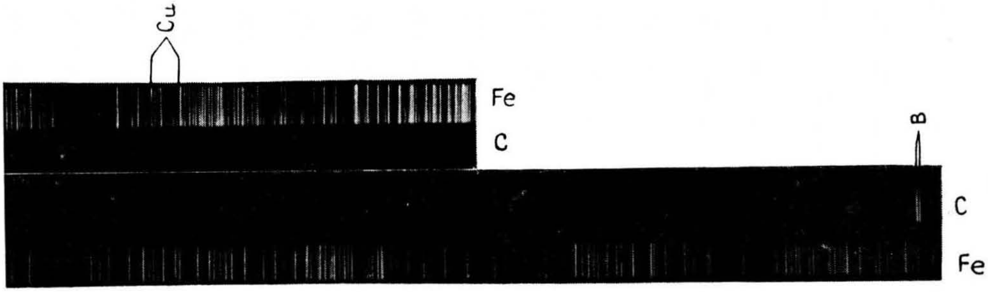

FIG. 4 — CATHODE LAYER SPECTRUM OF CARBON ROD PURIFIED BY RESISTANCE HEATING.

**TABLE I — RESULTS OF SPECTRUM ANALYSIS OF THE PURIFIED CARBON ROD**

*Heated for* 90 *sec. with* $i_{max.}$ = 570A *in an atmosphere of* $N_2$-$Cl_2$ *mixture* ( *arc current* 11 *amp.* )

| ELEMENT | SENSITIVE LINE λ IN I.Å | INTENSITY | HOOGLAND'S RESULTS (Arc current 5·5 amp.) |
|---|---|---|---|
| B | 2497·72<br>2496·80 | + | + |
| Si | 2516·12<br>2881·59 | →o← | ? |
| Mg | 2795·54<br>2802·71<br>2852·12 | →o← | + |
| Ti | 3088·03<br>3371·45<br>3354·63 | →o← | ? |
| Al | 3082·16<br>3092·71 | →o← | ? |
| Ca | 3158·88<br>3179·34 | →o← | (+) |
| Cu | 3247·54<br>3273·96 | →o | ? |
| Fe | 3020·64<br>3021·07 | →o← | + |

Symbols in column 3 : + = considerable amount ; →o← = none to faint traces ; →o = faint traces.

Symbols in column 4 : + = present ; ? = presence uncertain ; (+) = barely observable.

## Discussion

Carbon rod purified by the method of chemical treatment combined with heat treatment by resistance heating in an atmosphere of $N_2$-$Cl_2$ mixture is quite satisfactory for spectrum analysis by cathode layer arc ( TABLE I ). Traces of iron and magnesium, present in Hoogland's purified carbon rod ( by resistance heating in air ), are almost completely removed by this method. This is due to the fact that the presence of $N_2$ and $Cl_2$ gives more volatile compounds than oxides. Considerable traces of copper were present in the purified carbon rod obtained by resistance heating in air[2]. In the present case, copper has also been practically removed. Boron lines ( 2497·72Å, 2496·80Å ) are slightly reduced in intensity. Boron cannot, however, be removed completely by the present method, because this element usually forms non-volatile compounds.

Thanks are due to Prof. P. B. Sarkar and Dr. J. W. Whitaker for their keen interest in the work, to Mr. B. M. Banerjee for providing all facilities and help to work with the transformer and to the Director, C.S.I.R., for the grant-in-aid.

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# Preparation of Phosphanilic Acid & Related Substances

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**Methods for the preparation of phosphanilic acid and related substances have been investigated. The ammonium salt of ω-chlorobenzyl phosphinic acid shows feeble activity against *B. coli* and *S. aureus*. *p-p'*-Diaminodibenzyl phosphinic acid is inactive.**

BHIDE and Kanitkar[1] showed that phosphanilic acid is a powerful bacteriostatic agent for both gram-positive and gram-negative bacteria. For a pharmacological investigation a large quantity of phosphanilic acid was required and methods for the preparation of this compound and related substances were, therefore, investigated.

Phosphanilic acid is prepared from *p*-chlorophenyl phosphinic acid by treatment with ammonia in the presence of cuprous oxide under pressure[2]. *p*-Chlorophenyl phosphinic acid is also prepared by the action of phosphorus trichloride on chlorobenzene in the presence of aluminium chloride. Kosolapoff[3] has shown that better yields of the acid could be obtained by chlorinating the reaction mixture in acetylene tetrachloride followed by the addition of absolute alcohol when diethyl ester of *p*-chlorophenyl phosphinic acid is formed.

With a view to establishing conditions for obtaining the maximum yield of diethyl-*p*-chlorophenyl phosphinate, three series of experiments, viz. (i) changing the duration of heating from 2 to 48 hr.; (ii) changing the quantity of $PCl_5$ from 0·5 to 2 mol. and (iii) changing the quantity of aluminium chloride from 0·25 to 1 mol., have been conducted.

The optimum conditions for preparing the diethyl-*p*-chlorophenyl phosphinate have been found to be as follows:

Phosphorus trichloride — 1 mol.: *p*-chlorobenzene — 1 mol.; aluminium chloride — 0·5 mol.; heating period — 6 hr.

The percentage yield on chlorobenzene is 29·6 per cent of the theoretical.

The optimum conditions for the hydrolysis of the diethyl ester of *p*-chlorophenylphosphinic acid were by heating the ester with 8 times its weight of concentrated hydrochloric acid for 5 hr. on a sand bath. The yield is nearly quantitative.

A number of experiments were also carried out to determine the best conditions for the transformation of *p*-chlorophenyl phosphinic acid into phosphanilic acid, but the original procedure used by Bauer (loc. cit.) was found to be the best. The results of pharmacological investigations will be reported in a separate communication.

It seemed of interest to prepare ω-amino benzyl phosphinic acid, $NH_2\text{-}CH_2\text{-}C_6H_4\text{-}PO_3H_2$, analogous to the corresponding sulphanilamide derivative, marfanil.

Attempts were made to prepare *p*-cyanophenyl phosphinic acid which, on reduction, might yield the marfanil analogue. But the preparation of *p*-cyano-phenyl phosphinic acid by the diazo reaction from phosphanilic acid or treatment of *p*-chlorophenyl phosphinic acid with potassium cyanide under a variety of conditions failed to give the product. Ultimately the following procedure was adopted.

*p*-Toluyl phosphinic acid was chlorinated in acetic acid to yield *p*-ω-chloro-benzylphosphinic acid; m.p. 162°C. This on treatment with ammonia gave the ammonium salt of the desired acid. The acid ammonium salt could be isolated by acidification with hydrochloric acid. Bacteriological tests with *B. coli* and *S. aureus* showed only feeble activity for this compound.

*p-p*′-dinitro-dibenzyl phosphinic acid[4], on reduction with ferrous sulphate and ammonia, gave *p-p*′-diamino-dibenzyl phosphinic acid; m.p. 303°C. This compound, however, did not possess any anti-bacterial activity.

The sodium salt of *p*-nitrophenol and *p*-chlorophenyl phosphinic acid gave *p*-nitro-phenoxy phosphinic acid; m.p., 288°C. All attempts to reduce this acid have so far failed.

## Experimental

*Chlorination of p-Toluyl Phosphinic Acid* — *p*-Toluyl phosphinic acid (4 gm.) was dissolved in acetic acid (30 c.c. of 100 per cent acid) and dry chlorine was passed in sunlight till there was no further increase in weight. The liquid was evaporated to dryness on a steam bath. Distilled water was added to it and again evaporated to dryness. The product was dissolved in dry acetone and precipitated by adding dry chloroform; yield, 1 g.; m.p. 161°C.

The compound is insoluble in benzene, ether, petroleum ether, carbon tetrachloride and chloroform. It is soluble in acetone, methyl alcohol and ethyl acetate; eq. wt. found 102·4; $C_7H_8O_3PCl$ requires 103·2; Cl found 17·42; $C_7H_8O_3PCl$ requires Cl, 17·19 per cent.

*Preparation of the Acid Ammonium Salt of ω-amino Benzyl Phosphinic Acid* — 50 c.c. ammonia were added to the product (1 gm.) obtained by chlorinating *p*-toluyl phosphinic acid and heated on a steam bath for 5 hr. and then evaporated to dryness. The residue was redissolved in water and precipitated by adding hydrochloric acid till acid to Congo red and crystallized from water. This product was insoluble in dioxon, chloroform, ether, petroleum ether, benzene and carbon tetrachloride. It is sparingly soluble in acetone and methyl alcohol. Yield, 0·2 gm. It did not melt up to 350°C. Found: P, 15·44; $C_7H_{13}O_5N_2P$ requires P, 15·2 per cent.

*Reduction of p-p′-dinitro-dibenzyl Phosphinic Acid* — The acid (5 gm.) was treated with a solution of 50 gm. of ferrous sulphate and dilute ammonia. The ferric hydroxide was filtered off and the filtrate concentrated. On acidifying to Congo red *p-p*′-diamino-dibenzyl-phosphinic acid was precipitated and crystallized from water as clusters of needles; m.p. 303°C. Found N, 9·5; $C_{14}H_{17}O_2N_2P$ requires N, 10·1 per cent.

The diacetate was prepared by treating a solution of the acid in pyridine with acetic anhydride. Found N, 7·9; $C_{18}H_{21}O_4N_2P_2$ requires N, 7·8 per cent.

*Preparation of p-nitro-phenoxy Phosphinic Acid* — 4·33 gm. *p*-nitrophenol and 3·33 gm. sodium hydroxide were heated at 130°C. The mass was powdered and mixed with 5 gm. of *p*-chlorophenyl phosphinic acid and 0·5 gm. copper bronze. Dry xylene was added and the whole mass was refluxed for 10 hr. Xylene was removed and the product added to water and made slightly alkaline with sodium hydroxide and filtered. The filtrate was made acidic to Congo red and washed with ether to remove unreacted *p*-chlorophenyl phosphinic acid. The pure compound melted at 288°C.; yield 3·5 gm. Found: N, 4·97; $C_{12}H_{10}O_6NP$ requires N, 4·74 per cent; eq. wt. found 148·9, $C_{12}H_{10}O_6NP$, eq. wt., 147·5.

*Preparation of p-cyanophenyl Phosphinic Acid* — To a mixture of 8·8 gm. of potassium cyanide and 4·74 gm. nickel chloride in 50 c.c. water was added diazotized phosphanilic acid (3·5 gm.) and heated on a water bath for 5 hr. It was made acidic to Congo red with hydrochloric acid and filtered. The precipitate was washed with water, washings added to the filtrate and made alkaline with ammonia. The magnesium salt was precipitated by boiling with magnesia mixture. This was dissolved in acetic acid and the lead salt was precipitated by lead acetate. This was decomposed by adding a calculated amount of sulphuric acid and filtered. The filtrate was evaporated to dryness and the product crystallized from water; yield 0·5 gm.; m.p. *c.* 143°C. The compound also gave a feeble test for chlorine. It could not be further purified. Nitrogen, found 13·28; *p*-cyano-phenyl phosphinic acid requires N, 7·649 per cent.

Attempts were also made to prepare *p*-cyano-phenyl phosphinic acid by heating *p*-chlorophenyl phosphinic acid, potassium cyanide and copper cyanide under pressure. Copper cyanide (5 gm.), potassium cyanide (5 gm.) and *p*-chlorophenyl phosphinic acid (5 gm.) dissolved in methyl alcohol were heated at 150°C. for 6 hr. under pressure. Alcohol was removed and the mass dissolved in sodium bicarbonate and filtered. The filtrate was made acidic to Congo red with nitric acid and filtered. The lead salt was precipitated by adding lead acetate to the filtrate. It was decomposed by the addition of theoretical quantity of sulphuric acid and filtered. The filtrate was evaporated to dryness and the compound crystallized from water. This was identified as *p*-chlorophenyl phosphinic acid.

Use of other solvents in the presence of copper cyanide did not also give the product.

The cost of this investigation was borne by the Council of Scientific & Industrial Research to whom our thanks are due.

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# Extraction of Germanium from Sphalerite Collected from Nepal—Part II

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**A method for the extraction of germanium from the non-magnetic fraction of the mineral sphalerite has been described.**

IN the previous communication[1] we have described the extraction of germanium dioxide from the magnetic fraction (mainly magnetite) of sphalerite. The non-magnetic portion left over was found to contain traces (0·006-0·04 per cent) of germanium.

The spectrogram of this portion revealed the presence of the following elements: lead, zinc, iron, silicon, germanium, tin, copper, cadmium, silver and antimony, of which the first two predominate. The ore was analysed as before and the germanium estimated according to the method already described.

The analytical results are as follows:

| | % |
|---|---|
| Pb | 14·2 |
| Zn | 48·4 |
| S | 27·3 |
| $SiO_2$ | 5·6 |
| Fe | 2·3 |
| Ge | 0·0021 |

From the analytical data, this fraction of the mineral appears to be mainly a sulphate of zinc and lead.

### Extraction of Germanium

A procedure different from the one adopted for magnetite had to be adopted for the extraction of germanium from this fraction. When the ore is treated with sulphuric acid the insoluble lead sulphate formed retains the major portion of the germanium but if the sulphuric acid is completely fumed off, most of the germanium goes into solution and only traces remain over with the precipitates of lead sulphate and sulphur.

The methods of Winkler, Buchanan[2], etc., were found to be unsuitable for the extraction of germanium. Tchakirian's method[3] was finally adopted. The insoluble residue was refluxed with a saturated solution of ammonium bioxalate and, curiously enough, not even a trace of germanium was found in the solution. A new method based on the fact that the insoluble residue containing free sulphur is totally converted to lead sulphide on treatment with concentrated sodium hydroxide solution was adopted. The dismutation of free sulphur in strongly alkaline medium takes place as follows:

$$4S + 60\bar{H} = 2S^{--} + \bar{S}_2\bar{O}_3 + 3H_2O$$

The lead sulphide so formed carried with it the whole of germanium as disulphide and the lead sulphide is separated by treatment with 2N hydrochloric acid.

### Experimental

400 gm. of the ore were decomposed by an excess of 1 : 1 sulphuric acid, the resulting mixture heated to dryness and the excess acid fumed off. A large part of the free sulphur was removed by this treatment. The dried mass was extracted with hot water and filtered. Sodium sulphide, just sufficient to precipitate one-tenth of the total zinc, was added[4]. The filtrate was rejected as spectroscopic examination showed the absence of germanium. The residue was treated with 4N sulphuric acid and digested on a water bath for an hour and filtered. Germanium disulphide was left in the residue and most of the elements including zinc were thus removed. The residue was treated with sulphuric and nitric acids and dried. It was then distilled with 50 c.c. of 1 : 1 hydrochloric acid and the distillate treated according to the procedure already described. Germanium dioxide thus obtained was found from spectroscopic evidence to contain traces of antimony and tin.

When the residue was treated with concentrated sodium hydroxide solution, the whole of germanium was precipitated along with lead sulphide. This precipitate was digested with 2N hydrochloric acid, filtered and washed. Almost the whole of lead goes into solution leaving behind germanium disulphide, silicon dioxide, titanium, silver and traces of lead. Silicon dioxide was the principal constituent. All the vapours issuing during the treatment were collected and found to be spectroscopically free from germanium showing that germanium disulphide is not decomposed by 2N hydrochloric acid. The residue was then treated with sulphuric and hydrofluoric acids and evaporated on a water bath, when all the silica was removed. The mass was then distilled with hydrochloric acid, as previously described, and the germanium dioxide separated. The resulting product contained traces of phosphorus derived from hydrogen peroxide. The yield was 240 mg. of germanium dioxide from 4 kg. of the non-magnetic fraction.

Our best thanks are due to Prof. P. B. Sarkar for his keen interest in the investigation and to the *Council of Scientific & Industrial Research* for financial help to one of us (R. K. Dutta).

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# Studies in Industrial Micro-organisms: Part IV — Vitamin Requirements of 27 Strains of Lactic Acid Bacteria

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**The vitamin requirements of 27 strains of lactic acid bacteria have been determined. *L.C.* 20 NCTC 2171, *L. arabinosus* NCTC 2161, and *S. faecalis* NCTC 2175 have been shown to be suitable for the assay of all B-vitamins excepting thiamin and pyridoxin.**

A STUDY of the vitamin requirements of 27 strains of lactic acid bacteria maintained in the National Collection of Type Cultures, India, Indian Institute of Science, Bangalore, has been carried out with the object of determining their suitability as test organisms for the microbiological assay of vitamins and other growth factors.

## Experimental

*Method of Carrying Cultures* — The stab cultures were carried in an enrichment medium described by Mistry and Sreenivasaya[1]. 100 c.c. of the enrichment medium contained 0·5 gm. of sheep liver extract, 0·5 gm. of *Difco* yeast extract, 0·5 gm. of *Difco* peptone, 0·5 gm. each of glucose and lactose, 1·0 gm. of sodium acetate, 0·5 c.c. each of salts A and B, and 2·0 gm. of agar. The cultures were grown in the enriched broth for 24 hr. at 37°C., transferred to the stabs, incubated till there was visible growth (24 to 36 hr.) and then preserved at 5°C. The stabs were subcultured every month.

The full complement medium in double strength (similar to the one used by Landy and Dicken[2]) was compounded to include all the vitamins and amino acids (as casein hydrolysate supplemented with tryptophane and cystine). The composition of the medium is given in Table I.

Media deficient in a particular vitamin were prepared by omitting the particular vitamin. 5·0 c.c. of the medium were transferred into tubes and plugged with cotton. In the case of folic acid assays, glass caps instead of cotton plugs were used, since cotton was reported to contain appreciable amounts of pteroyl-glutamic acid. Duplicates were run in each case. The tubes were sterilized at 15 lb. pressure for 15 min. incubated for 24 hr. at 37°C. and steamed for 30 min.

Inoculum was prepared by transferring a small amount of growth from the stab culture to 5 c.c. of the enriched medium broth, incubated for 24 hr. at 37°C., aseptically washed three times on the centrifuge with sterile saline ( 0·89 per cent ) and the sedimented bacteria taken up with 25 c.c. of sterile saline.

**TABLE I — COMPOSITION OF THE MEDIUM**

| | |
|---|---|
| Glucose ( anhyd. ) | 4·0 gm. |
| Na. acetate ( anhyd. ) | 2·4 gm. |
| Casein hydrolysate ( acid ) | 0·5 gm. |
| *l*-cystine | 10·0 mg. |
| *l*-trytophane | 10·0 mg. |
| Adenine-guanine<br>Uracil-xanthine | 1·0 mg. each |
| Salts A and B | 0·5 c.c. each |
| Thiamine | 20·0 μg. |
| Riboflavin | 20·0 ηg. |
| Pyridoxine | 100·0 μg. |
| Ca-pantothenate | 20·0 μg. |
| Nicotinic acid | 50·0 μg. |
| Paba | 20·0 μg. |
| Biotin | 100·0 mμg. |
| Folic acid | 500·0 mμg. |
| pH | 6·8 to 7·0 |
| Volume | 100 c.c. |

One drop of the above suspension was added to each of the tubes and incubated at 37°C. for 72 hr. The acid produced during this period was titrated against 0·1N NaOH using bromothymol-blue as indicator.

The results are given in Table II.

A study of the results ( TABLE II ) shows :

(i) most of the organisms, 24 out of 27, need pantothen ;

(ii) riboflavin is required by 10 strains ;

(iii) 15 strains need an external supply of niacin ;

**TABLE II — VITAMIN REQUIREMENTS OF LACTIC ACID BACTERIA**

*( Results expressed as c.c. of 0·1N acid produced per 10 c.c. of the medium )*

| MEDIUM | 1 *L. arabinosus* 2160* | 2 *L. arabinosus* 2161 | 3 *L. arabinosus* 2162 | 4 *L. arabinosus* 2163 | 5 *L. delbruckii* 2168 | 6 *L. delbruckii* 2180 | 7 *L. casei* 2156 | 8 *L. casei* 2157 | 9 *L. casei* 2159 |
|---|---|---|---|---|---|---|---|---|---|
| Full med. ( all vits.) (1) | 16·4 | 17·3 | 16·7 | 14·35 | 11·5 | 14·8 | 11·95 | 13·9 | 11·0 |
| (1)-B$_1$ | 15·8 | 15·45 | 15·8 | 13·9 | 10·5 | 14·8 | 11·95 | 14·35 | 10·5 |
| (1)-B$_2$ | 16·4 | 17·3 | 15·8 | 13·9 | 10·5 | 11·95 | 3·85 | 2·4 | 4·8 |
| (1)-B$_6$ | 16·4 | 17·2 | 16·7 | 13·9 | 11·45 | 11·0 | 10·0 | 8·9 | 10·0 |
| (1)-Pantothen | 2·4 | 3·7 | 3·2 | 2·4 | 11·0 | 2·85 | 3·8 | 3·1 | 4·8 |
| (1)-Niacin | 8·6 | 3·05 | 8·95 | 7·2 | 11·0 | 10·1 | 11·95 | 12·5 | 10·2 |
| (1)-Biotin | 13·9 | 6·7 | 14·3 | 13·5 | 11·1 | 14·35 | 12·5 | 12·30 | 11·45 |
| (1)-Folic | 14·4 | 17·0 | 15·55 | 14·8 | 11·45 | 14·35 | 13·4 | 13·9 | 11·95 |
| Enriched medium | 8·8 | 10·5 | 9·0 | 7·7 | 9·6 | 5·6 | ... | 10·5 | ... |

* Refer to NCTC numbers.

**TABLE II** — *continued*

| MEDIUM | 10 *L. casei* NCTC 2179 | 11 *L. casei* NCTC 2154 | 12 *L. casei* NCTC 2155 | 13 *L. helveticus* NCTC 2167 | 14 *L.C. 15* NCTC 2172 | 15 *L.C. 20* NCTC 2171 | 16 *L.C. 134* NCTC 2182 | 17 *L. pentoaceticus* NCTC 2181 | 18 *S. 30* NCTC 2183 |
|---|---|---|---|---|---|---|---|---|---|
| Full med. ( all vits.) (1) | 14·35 | 14·35 | 14·35 | 11·6 | 10·5 | 19·9 | 9·95 | 5·8 | 11·9 |
| (1)-B$_1$ | 13·35 | 15·30 | 13·9 | 12·2 | 10·8 | 22·0 | 5·3 | 4·4 | 12·0 |
| (1)-B$_2$ | 2·40 | 14·85 | 2·4 | 3·25 | 4·75 | 1·8 | 0·9 | 4·8 | 4·35 |
| (1)-B$_6$ | 8·9 | 14·35 | 11·45 | 12·8 | 10·3 | 16·0 | 9·0 | 2·4 | 12·0 |
| (1)-Pantothen | 3·1 | 2·4 | 3·1 | 5·1 | 3·9 | 2·7 | 2·85 | 3·3 | 4·9 |
| (1)-Niacin | 12·5 | 11·95 | 12·8 | 3·05 | 4·9 | 2·65 | 2·65 | 2·9 | 4·6 |
| (1)-Biotin | 13·35 | 13·4 | 12·65 | 9·35 | 8·6 | 8·0 | 6·7 | 4·8 | 8·75 |
| (1)-Folic | 14·35 | 14·85 | 13·9 | 11·40 | 7·7 | 18·6 | 8·15 | 4·8 | 11·3 |
| Enriched medium | 9·0 | 10·0 | 11·0 | ... | ... | 9·5 | ... | 4·0 | ... |

**TABLE II** — *continued*

| MEDIUM | 19 *S. 200* NCTC 2170 | 20 *S. 223* NCTC 2184 | 21 *S. 253* NCTC 2178 | 22 *S. faecalis* NCTC 2166 | 23 *S. faecalis* NCTC 2174 | 24 *S. faecalis* NCTC 2175 | 25 *S. faecalis* NCTC 2176 | 26 *Leuc. mesenteroides* NCTC 2169 | 27 *Leuc mesenteroides* NCTC 2177 |
|---|---|---|---|---|---|---|---|---|---|
| Full med. ( all vits.) (1) | 11·8 | 12·85 | 5·8 | 9·55 | 12·4 | 14·10 | 11·5 | 13·05 | 22·6 |
| (1)-B$_1$ | 11·3 | 8·8 | 6·0 | 9·5 | 10·5 | 13·6 | 11·5 | 13·0 | 24·0 |
| (1)-B$_2$ | 5·15 | 8·25 | 5·15 | 9·6 | 12·0 | 14·0 | 7·65 | 13·45 | 23·8 |
| (1)-B$_6$ | 12·35 | 11·65 | 4·1 | 6·0 | 3·75 | 5·5 | 2·85 | 13·0 | 22·7 |
| (1)-Pantothen | 4·1 | 4·10 | 4·75 | 3·8 | 2·5 | 2·4 | 7·0 | 2·75 | 6·2 |
| (1)-Niacin | 4·25 | 4·75 | 3·1 | 7·8 | 3·75 | 2·0 | 4·0 | 1·85 | 3·2 |
| (1)-Biotin | 8·6 | 9·25 | 6·2 | 8·1 | 5·4 | 2·4 | 4·4 | 4·04 | 8·3 |
| (1)-Folic | 11·55 | 10·5 | 5·3 | 9·1 | 5·6 | 2·0 | 4·6 | 12·4 | 23·8 |
| Enriched medium | ... | ... | ... | ... | 5·0 | 7·0 | ... | ... | ... |

(iv) biotin has been found to be essential for 8 strains; and

(v) 3 strains respond to folic acid and pyridoxine.

Most of the strains of *L. casei* and related species respond to riboflavin. Folic acid is required by all the three strains of *S. faecalis*[2,3], except that 4 per cent glucose and 2·4 per cent sodium acetate have been used instead of the usual 2·0 and 1·2 per cent respectively. It was thought that the concentration of the vitamins and amino acids used in the 4 per cent sugar medium may be sub-optimal for growth and acid production. A decrease in the sugar percentage or an increase in the concentration of vitamins and amino acids should enhance the percentage of acid produced. For this purpose an experiment was conducted with the three cultures, *L. arabinosus* NCTC 2161, *L.C.* 20 NCTC 2171 and *S. faecalis* NCTC 2175, which are very useful for the assay of many of the B-vitamins. The composition of four media used in this experiment is given in Table III.

The all-vitamin medium D corresponds to that of Roberts and Snell[4]. Media lacking a given vitamin at a time were simultaneously run along with this series. The rest of the experimental procedure was the same as that described earlier. The results are given in Table IV.

The results reveal that with higher dosages of the vitamins, the sugar content of the media remaining the same, there is a higher percentage of the conversion of sugar into acid. The acid production is increased with a threefold enhancement in the concentration of vitamins. When the concentration of the sugar is doubled in the media, the level of vitamin concentration remaining the same, there is not a corresponding increase in the percentage of acid production (TABLE IV). In the case of *L.C.* 20 and *S. faecalis*, the increase is nearly 50·0 per cent, whereas in the case of *L. arabinosus*, whose optimal requirements for vitamins are not so

TABLE III — COMPOSITION OF THE MEDIUM

(*p*H 6·8 *to* 7·0)

| CONSTITUENTS PER 100 C.C. OF THE MEDIA | A | B | C | D |
|---|---|---|---|---|
| 1. Glucose, gm. | 4·0 | 2·0 | 2·0 | 2·0 |
| 2. Na acetate, gm. | 2·4 | 1·2 | 1·2 | 1·2 |
| 3. Casein hydrolysate, *l*-cystine, *l*-tryptophane, salts A and B, adenine-guanine, uracil xanthine, same as before | | | | |
| 4. Thiamin, μgm. | 20·0 | 20·0 | 60·0 | 50·0 |
| 5. Riboflavin, μgm. | 20·0 | 20·0 | 60·0 | 50·0 |
| 6. $B_6$, μgm. | 100·0 | 100·0 | 300·0 | 100·0 |
| 7. Pantothenate, μgm. | 20·0 | 20·0 | 60·0 | 50·0 |
| 8. Niacin, μgm. | 50·0 | 50·0 | 150·0 | 100·0 |
| 9. Biotin, μgm. | 100·0 | 100·0 | 300·0 | 200·0 |
| 10. Folic acid, μgm. | 0·5 | 0·5 | 1·5 | 1·0 |

TABLE V — LACTIC BACTERIA USEFUL FOR THE ASSAY OF B-VITAMINS & THEIR ASSAY RANGES

| VITAMIN | CULTURES | | ASSAY RANGES, MR PER 10 C.C. | |
|---|---|---|---|---|
| | Foreign | NCTC (India) | Foreign | NCTC (India) |
| Riboflavin | *L. casei*[1] 7469 | *L.C.* 20[3] | 0–200[3] | ... |
| | | | ... | 0–150[4] |
| | *Leuc. Mesent.*[2] | ... | ... | ... |
| | | *L. casei* 2157[4] | ... | ... |
| | | *L. casei* 2179 | 0–10 | ... |
| Ca. pantothenate | *L. casei* ATCC 7469 | *L. arabinosus* 2161 | ... | 0–150 |
| | | *L.c.* 20, 2171[5] | 0–120 | 0–500 |
| | | *L. casei* 2157 | ... | ... |
| | *L. arabinosus*[6] ATCC 8014 | ... | 0–200 | ... |
| Niacin | | *L. arabinosus* 2161 | ... | 0–400 |
| | *L. arabinosus*[7] 125 | ... | 0–500 | 0–400 |
| | | *L.C.* 20, 2171 | ... | ... |
| Biotin | *L. casei*[8] 7469 | *L. arabiniosus* 2161 | 0-10 | ... |
| | | *L.c.* 20, 2171 | ... | 0-0·75 |
| | *L. arabinosus* | *L. casei* 2157[9] | 0–4·0 | 0–0·70 |
| Folic acid | *S. faecalis* R[10] | ... | 0·1·0 | ... |
| | A.C.T.C. 8043 | *S. faecalis* 2175 | ... | ... |

TABLE IV — EFFECT OF THE CONCENTRATION OF VITAMIN & CARBOHYDRATES ON ACID PRODUCTION

(*c.c. of* 0·1 *N acid produced per* 10 *c.c. of the medium*)

| VITAMIN MIXTURE | *L.C.* 20 NCTC 2171 | | | | *L. arabinosus* NCTC 2161 | | | | *S. faecalis* NCTC 2175 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | A | B | C | D |
| All vits. | 19·9 | 11·9 | 18·0 | 17·0 | 17·3 | 16·0 | 19·0 | 19·0 | 14·0 | 6·5 | 10·2 | 9·6 |
| Lacking $B_1$ | 22·0 | 12·0 | 18·5 | 17·5 | 15·45 | 15·0 | 18·0 | 19·5 | 13·6 | 6·8 | 9·8 | 9·0 |
| „ $B_2$ | 1·8 | 0·8 | 0·8 | 1·0 | 17·3 | 15·8 | 16·5 | 18·0 | 14·0 | 6·8 | 8·7 | 8·5 |
| „ $B_6$ | 16·0 | 10·0 | 11·6 | 12·0 | 17·2 | 15·0 | 17·0 | 17·0 | 5·5 | 6·0 | 6·8 | 5·5 |
| „ Pantothen | 2·7 | 1·2 | 1·6 | 1·8 | 3·7 | 0·8 | 1·6 | 2·0 | 2·4 | 1·0 | 1·4 | 1·8 |
| „ Niacin | 2·65 | 1·2 | 1·6 | 2·2 | 3·05 | 1·8 | 1·8 | 1·6 | 2·0 | 1·0 | 1·4 | 1·8 |
| „ Biotin | 8·2 | 6·2 | 7·6 | 8·0 | 6·7 | 8·0 | 8·0 | 8·0 | 2·4 | 2·0 | 2·0 | 2·0 |
| „ Folic acid | ... | ... | ... | ... | ... | ... | ... | ... | 2·0 | 1·6 | 1·6 | 2·5 |

high as those of the other two, the increase is only 16 to 20 per cent.

The results obtained with media lacking one of the vitamins at a time confirm the earlier findings and show that increased dosages of other vitamins do not potentiate any rise in acid production, unless the vitamin, *essential and indispensable* to the organism, is present ; in other words, the stability of the organism with respect to its vitamin requirements is not altered in spite of a 300 per cent increase in vitamin concentration.

The following cultures have been found to be useful in the assay of the B-complex vitamins. The assay ranges of our cultures have been compared with those cited in literature.

The two cultures, *L.C.* 20 and *L. arabinosus*, have been extensively used in our laboratory for the assay of B-vitamins in some of the natural extracts.

## Summary

1. The vitamin requirements of 27 strains of lactic acid bacteria have been determined following the method of Snell and the procedure has been described.

2. Pantothen and niacin are required by 24 and 15 strains respectively. Ten strains require riboflavin and biotin is needed by 8.

3. The suitability of some of these strains for the assay of vitamins has been indicated.

4. The effect of the concentrations of vitamins and of carbohydrates on acid production by the organisms has been elucidated.

5. *L.C.* 20 NCTC 2171, *L. arabinosus* NCTC 2161 and *S. faecalis* NCTC 2175 can be used for the assay of all B-vitamins with the exception of thiamin and pyridoxine.

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# Substitution of Coconut Oil in Soap

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**Coconut oil can be substituted with advantage in soap manufacture by mixtures of lauric acid-rich fats such as Pisa fat ( from *Actinodaphne hookeri* ), castor oil, groundnut oil and hydrogenated rosin.**

COCONUT oil is an essential ingredient for the manufacture of high grade soaps and it usually forms 25-30 per cent of the total fat used. The soap is easily soluble in water, giving profuse lather and possessing excellent wetting and detergent properties. As there is a shortage of edible fats in this country at present, there is an imperative need for substituting coconut oil by other fatty materials in the soap and hair oil industries.

The excellent properties of coconut oil soap are mainly due to the presence of lauric and myristic acids as major components of the total fatty acids of coconut oil[1]. The effect of alkyl chain length on the properties of soap such as Herbig number, time of sinking and drop number has been investigated by Shirolkar and Venkataraman[2]. Of the various saturated fatty acid soaps, sodium and potassium myristates have been found to possess the maximum wetting action, foaming and detergent properties at ordinary temperatures. As inedible oils with myristic acid as a major component are not available in sufficient amounts in India, attention has been diverted to the investigation of lauric acid-rich oils. Seeds of *Actinodaphne hookeri, Actinodaphne angustifolia, Cinnamomum camphora, Laurus nobilis, Litsea chinensis, Litsea sebafera, Litsea citrata* and *Litsea zeylanica* are available in Indian forests and their fats have been found by Puntambekar[3], Puntambekar and Krishna[4] and Collins[5] to contain 43 to 96 per cent lauric acid. In the present investigation the seed fat of *Actinodaphne hookeri,* locally known as Pisa fat, is used in place of coconut oil in soap. Its fatty acids consist of 96 per cent lauric acid. Castor oil and groundnut oil mixtures along with Pisa fat have also been tried.

Hydrogenated rosin is a valuable ingredient of soap preparations[6]. Its sodium derivative has been recommended as a substitute for coconut oil in soap[7]. The sodium salt of rosin was used in admixture with other sodium soaps to ascertain whether it can replace coconut oil in soap manufacture. Lather value, hardness, wetting and detergent tests were carried out on each sample of soap. Soaps thus prepared were found to be comparable to the usual tallow-coconut oil soaps in many applications.

## Experimental

In order to obtain alkali-free neutral soaps the oils and fats used in this investigation were first hydrolysed to fatty acids and neutralized by the addition of requisite amounts of a strong solution of caustic soda. The reaction was completed by heating on a water bath for 1 hr. The sodium soap so formed was dried in the sun to a moisture content of about 10 per cent. Hydrogenated rosin was similarly treated. The soap was then milled in a three-roll mill and the moisture content was finally adjusted to 10-12 per cent as determined by the Xylol method[8]. 40 gm. of this material was moulded to a cylindrical cake of $1\frac{5}{8}''$ dia. by pressing for 5 min. under a pressure of about 250 lb./sq. in. at a temperature of 40°C. ± 5°C. The cakes were aged for a week in closed glass vessels. The following determinations were made.

1. *Lather Value* — The lather value was determined by shaking 50 c.c. of 0·2 per cent soap solution in one litre stoppered graduated cylinder for 30 sec. and noting the volume of the lather produced after 5 min. The stability of the lather was found out by noting the volume again after 24 hr. The values were determined at room temperature (25°-30°C.).

2. *Wetting Test* — The concentration of soap required for causing the sinking of a 5 gm. of skein of grey cotton yarn in 25 sec. at 40°C. was determined by Drave's method.

3. *Hardness* — The comparative hardness of different samples of soap was determined by determining the weight (in lb.) required to pierce through and break the cake. A bronze hemisphere, 2 cm. dia., was employed for this purpose. A cement testing machine was suitably modified for carrying out this test.

4. *Detergency Test* — A piece of long cloth was first boiled in sodium carbonate solution, thoroughly washed with water and dried. It was soiled in petrol ether to which carbon black (1 per cent), groundnut oil (2 per cent) and mineral lubricating oil (2 per cent) were added. The cloth was dried in the sun by spreading horizontally on a frame. Test pieces, 5″×5″, having an even shade were chosen. The test piece was shaken in 100 c.c. of 0·3 per cent soap solution for half an hour with distilled water. The test piece was then dried in shade and the extent of soil removed was examined visually. The above test was done in duplicate with each sample of the soap.

The composition of various soap samples together with their lather value, wetting test value and hardness are given in Table I. The detergent qualities of all the samples were found to be almost identical.

## Discussion

From the data given in Table I it is seen that substitution of lauric acid-rich Pisa fat for coconut oil has increased the lather value in samples 2, 4 and 5. Less lather has been obtained in sample 3 due to the partial substitution of a longer chain stearic acid in place of Pisa fat[2]. Again,

TABLE I — COMPOSITION & PROPERTIES OF VARIOUS SAMPLES OF SOAP

| No. | Acid composition of soap | Lather value | | Drave's wetting test values (soap concentration required for 25 sec. wetting time), gm./litre | Hardness, lb. |
|---|---|---|---|---|---|
| | | 5 min., c.c. | 24 hr., c.c. | | |
| 1. | Tallow 75% + coconut oil 25% | 230 | 195 | 0·56 | 52·0 |
| 2. | Tallow 75% + Pisa fat 25% | 250 | 210 | 0·72 | 66·0 |
| 3. | Tallow 75% + Pisa fat 15% + stearic acid 10% | 200 | 160 | 0·88 | 69·5 |
| 4. | Tallow 65% + Pisa fat 25% + castor oil 10% | 300 | 265 | 0·55 | 58·6 |
| 5. | Tallow 65% + Pisa fat 25% + groundnut oil 10% | 280 | 230 | 0·57 | 60·75 |
| 6. | Tallow 60% + castor oil 20% + groundnut oil 20% | 280 | 240 | 0·49 | 48·3 |
| 7. | Tallow 75% + rosin 25% | 210 | 170 | 0·56 | 85·0 |
| 8. | Tallow 75% + hyd. rosin 25% | 240 | 200 | 0·67 | 91·6 |
| 9. | Tallow 65% + Pisa fat 25% + rosin 10% | 240 | 200 | 0·52 | 64·0 |
| 10. | Tallow 65% + Pisa fat 25% + hyd. rosin 10% | 280 | 240 | 0·56 | 76·0 |
| 11. | Tallow 60% + groundnut oil 15% + hyd. rosin 25% | 270 | 200 | 0·56 | 66·5 |
| 12. | Hyd. groundnut oil (I.V. 20-22) 75% + Pisa fat 25% | 290 | Thinned | 0·57 | 58·0 |

substitution of 10 per cent castor oil and groundnut oil in samples 4 and 5 for the same amount of tallow ( sample 2 ) has resulted in a marked increase in the lather value. Drave's wetting test values for these two soaps have also been quite low and are quite close to that of coconut oil soap. They were also found to be less hard than others because castor and groundnut oils are known to give softer soaps than oils containing predominantly saturated acids. The effect of the soap from these two oils is very clearly indicated by the results of the values of sample 6 containing tallow, 60 per cent, castor oil, 20 per cent and groundnut oil, 20 per cent. This soap has given lather value higher and wetting test value lower than coconut oil soap ( sample 1 ) although the hardness has been slightly lower than the latter.

Hydrogenated rosin soap has given a quite good lather value ( samples 8 and 10 ) and has proved better in comparison with ordinary rosin soap ( samples 7 and 9 ). It also retards spotting in soap on storage which usually takes place when ordinary rosin is used. But a combination of lauric acid soap along with that of hydrogenated rosin has definite advantages. Substitution of Pisa fat ( lauric acid ) by groundnut oil and hydrogenated rosin ( sample 11 ), however, lessens the stability of the lather of the soap.

An attempt was also made to substitute tallow by hydrogenated groundnut oil ( I.V. 20-22 ). Although a good amount of lather was obtained, it was very thin and subsided within 24 hr. This may be due to the conversion of oleic acid mostly to stearic acid and partly to iso-oleic acid during hydrogenation. The soaps of these two acids have less solubility and wetting action at low temperatures ( 25°-30°C.). Other soaps ( Nos. 2 to 10 ) have given lathers of nearly equal stability and are almost identical to coconut oil soap.

The hardness of all the samples of soaps with the exception of No. 6 have been found to be more than that of coconut oil soap ( No. 1 ). This may be due to the presence of 15-20 per cent capric and other lower acids present in coconut oil. The existence of these acids in coconut oil is definitely a disadvantage because their sodium salts have very poor lather values and wetting action. However, they are very soluble in water and are removed during the salting out stage. But these acids have not been removed in the present work and were allowed to form a part of the soap. The differences in hardness may not be regarded as a great drawback because by proper formulation of the oils and fats, it may be adjusted to the desired limit. Samples 4, 5, 6 and 10 are quite satisfactory as substitutes for standard coconut oil soap.

## Conclusion

Coconut oil can be substituted in soaps by suitable mixtures of lauric acid-rich fats, castor oil, groundnut oil and hydrogenated rosin.

As castor oil has important industrial uses and groundnut oil is an edible oil, work is being undertaken to employ other non-edible oils in soap manufacture.

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# Studies in the Fermentation of Carbohydrates by Yeasts—Part III

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**The fermentability of 22 carbohydrates by 30 strains of yeasts from the National Collection of Type Cultures has been investigated. Glucose and fructose are easily fermented by all the yeasts examined. Sucrose is not fermented by 2 strains. 10 strains do not ferment galactose, and 8 among these do not ferment maltose also. Raffinose is fermented partially by 18 strains and melizitose by 5. Rhamnose is fermented by only 1 strain. None of the yeasts ferment lactose or starch. Glycogen is partially fermented by 1 strain, inulin by 6 strains and dextrin by 4 strains. 3 yeasts slightly ferment α-methyl-glucoside, and 9 β-methyl-glocoside.**

THE present paper is an extension of the earlier work[1-3] and describes the fermentability of 22 carbohydrates by 30 strains of yeasts from the National Collection of Type Cultures.

In a recent review, Bouthilet[4] points out that it is customary to use yeast extract in the basal media used for fermentation tests. A number of yeasts were observed to ferment the yeast extract and trehalose. From the taxonomic point of view, the use of yeast extract in fermentation tests is open to objection as any positive fermentation observed may be ascribed to the sugars present, even though they may not be fermentable. Mrak and Phaff[5] have observed that 16 strains of yeasts studied by them ferment both yeast extract and trehalose. Yeast extract contains appreciable quantities of trehalose.

The use of dilute yeast autolysates as an additive to the basal medium overcomes the difficulty. During autolysis of yeast trehalose is destroyed. In order to evaluate critically the fermentation reaction of yeasts, we have carried out the tests using yeast extract alone and yeast extract with added carbohydrates. Of the 50 strains studied not one has given any positive fermentation with yeast extract alone.

The procedure adopted by us in these studies has been described earlier[1-3]. The results obtained are recorded in Tables I and II.

## Discussion

1. Among the yeasts studied N.C.T.C. 3084 ferments rhamnose. Other pentoses are not fermented.

2. Observations made after 24 hr. intervals show that the rate of fermentation is the highest in glucose, followed by fructose. A time lag is observed in mannose fermentation.

3. Of the 30 yeasts examined 10 did not ferment galactose. Among the rest, complete gas formation was not observed with 3 strains.

4. Among the disaccharides, lactose is not fermented by any of the yeasts. Sucrose

TABLE I

| N.C.T.C. No. | MONOSACCHARIDES | | | | | | | DISACCHARIDES | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Abrabinose | Rhamnose | Xylose | Glucose | Fructose | Galactose | Mannose | Lactose | Sucrose | Maltose |
| 3003 | — | — | — | ++++ | ++++ | +++ | ++ | — | ++++ | ++++ |
| 3004 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3019 | — | — | — | ++++ | ++++ | +++ | ++++ | — | ++++ | ++++ |
| 3039 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3040 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3041 | — | — | — | +++ | ++++ | — | ++++ | — | — | — |
| 3042 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | +++ | ++++ |
| 3043 | — | — | — | ++++ | ++++ | ++++ | +++ | — | ++++ | ++++ |
| 3044 | — | — | — | ++++ | ++++ | — | ++++ | — | ++++ | — |
| 3045 | — | — | — | ++++ | ++++ | — | ++++ | — | ++++ | — |
| 3046 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3049 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3050 | — | — | — | ++++ | ++++ | — | ++++ | — | ++++ | — |
| 3051 | — | — | — | ++++ | ++++ | — | ++++ | — | ++++ | — |
| 3052 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3053 | — | — | — | ++++ | ++++ | ++ | ++++ | — | ++++ | ++++ |
| 3054 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3072 | — | — | — | ++++ | +++ | — | ++ | — | +++ | — |
| 3073 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3074 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3075 | — | — | — | ++++ | ++++ | — | ++++ | — | ++++ | ++ |
| 3076 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3077 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | — |
| 3078 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | — |
| 3079 | — | — | — | ++++ | ++++ | — | ++++ | — | — | — |
| 3080 | — | — | — | ++++ | ++++ | — | ++++ | — | ++++ | — |
| 3081 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3082 | — | — | — | ++++ | ++++ | — | ++++ | — | + | + |
| 3083 | — | — | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |
| 3084 | — | + | — | ++++ | ++++ | ++++ | ++++ | — | ++++ | ++++ |

—, no fermentation ; +, 0·5 cm. of gas formation ; ++, 1·0 cm. of gas formation ; +++, 1·5 cm. of gas formation ; ++++, 2·0 cm. of gas formation.

TABLE II

| N.C.T.C. No. | POLYSACCHARIDES | | | | | | ALCOHOLS | | GLUCOSIDES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raffinose | Melizitose | Starch | Inulin | Dextrin | Glycogen | Mannitol | Dulcitol | Salicin | Amygdalin | α-methyl-glucoside | β-methyl-glucoside |
| 3003 | + | — | — | + | — | — | — | — | — | — | — | — |
| 3004 | ++ | — | — | — | — | — | — | — | — | — | — | — |
| 3019 | + | — | — | + | — | — | — | — | — | — | + | — |
| 3039 | ++ | — | — | — | — | — | — | — | — | — | — | — |
| 3040 | + | — | — | ++ | — | — | — | — | — | — | — | — |
| 3041 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3042 | + | — | — | — | — | — | — | — | — | — | — | — |
| 3043 | + | +++ | — | +++ | — | — | — | — | — | — | — | ++ |
| 3044 | + | — | — | — | — | — | — | — | — | — | — | — |
| 3045 | + | — | — | — | — | — | — | — | — | — | — | — |
| 3046 | + | — | — | — | — | — | — | — | — | — | — | — |
| 3049 | + | ++ | — | — | — | — | — | — | — | — | — | — |
| 3050 | ++ | — | — | ++ | — | — | — | — | ++++ | — | — | +++ |
| 3051 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3052 | + | — | — | + | — | — | — | — | — | — | — | — |
| 3053 | ++ | — | — | — | — | — | — | — | — | — | — | + |
| 3054 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3072 | ++ | — | — | — | — | — | — | — | — | — | — | — |
| 3073 | ++ | — | — | — | — | — | — | — | — | — | — | — |
| 3074 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3075 | ++ | — | — | — | +++ | — | + | — | ++++ | — | — | +++ |
| 3076 | +++ | — | — | — | — | — | — | — | +++ | — | — | — |
| 3077 | — | — | — | — | — | — | — | + | — | + | — | — |
| 3078 | — | — | — | — | — | — | + | — | + | — | — | + |
| 3079 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3080 | — | — | — | — | — | — | — | — | — | — | — | + |
| 3081 | — | ++++ | — | — | ++++ | — | — | — | — | — | + | + |
| 3082 | — | — | — | — | — | ++ | — | — | — | — | — | — |
| 3083 | — | +++ | — | — | ++++ | — | — | — | — | — | + | ++ |
| 3084 | — | +++ | — | — | ++++ | — | — | — | — | — | — | ++ |

—, no fermentation ; +, 0·5 cm. of gas formation ; ++, 1·0 cm. of gas formation ; +++, 1·5 cm. of gas formation ; ++++, 2·0 cm. of gas formation.

is easily fermented and to the same degree as glucose except in the case of N.C.T.C. 3041 and 3079. Eight yeasts which did not ferment galactose also failed to ferment maltose.

5. Raffinose is partly fermented by 18 yeasts ; the rest do not ferment it.

6. Melizitose is fermented by the following 5 strains, some partially and others fully : N.C.T.C. 3043, 3049, 3081, 3083 and 3084.

7. Starch is not fermented by any of the yeasts. Glycogen is partially fermented by N.C.T.C. 3082.

8. Inulin is partially fermented by 6 yeasts: N.C.T.C. 3003, 3019, 3040, 3043, 3050 and 3052.

9. Dextrin is fermented by 4 strains: N.C.T.C. 3075, 3081, 3083 and 3084, and mannitol, amygdalin and dulcitol are fermented each by 1 strain of yeast.

10. Three yeasts slightly ferment $\alpha$-methyl-glucoside and nine ferment $\beta$-methyl-glucoside.

Our thanks are due to Mr. M. Sreenivasaya for guidance and to the *Council of Scientific & Industrial Research* for financing a scheme of which this work forms a part. We thank the Director, Indian Institute of Science, Bangalore, for his keen interest in this work.

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# Letters to the Editor

## A NEW POLARIZATION EFFECT: REDOXOKINETIC POTENTIAL

WHEN TWO PLATINUM ELECTRODES DIPPED in an aqueous solution containing a reversible redox system are connected to a source of alternating current, it is found that a d.c. potential is developed at each of these electrodes. This d.c. potential can be measured with reference to a third platinum electrode of a large area dipped in the same solution. An electron tube voltmeter was improvised for measuring the same, in order to avoid any large current being drawn by the measuring instrument. The d.c. potential developed is found to be dependent on the magnitude of the a.c. current passing. The general behaviour is reproducible, though the actual values of the potential may not be precisely so, under the present experimental conditions. Two typical results obtained by using a saturated solution of quinhydrone in an acetate buffer of *p*H 4·8 are shown in Table I. The sign of the potential as given in the table indicates the sign of the reference electrode.

The important feature of this new phenomenon is that both the electrodes behave similarly. This shows at once that the phenomenon is not caused by any d.c. component in the a.c. current employed. The phenomenon may be provisionally explained as folllows: Normally when a platinum electrode is dipped in an aqueous solution containing quinhydrone, its potential can be considered as being influenced by a number of redox systems such as (i) hydroquinone-quinone; (ii) hydrogen-hydrogen ion; (iii) hydroxylion-oxygen; etc. But the potential is entirely controlled by the first-named redox system. Since there is sufficient time for interaction, the activities of the components forming the other redox

TABLE I

*Electrode X: dia.: ·0356 cm.; length: ·6 cm.*
*Electrode Y: dia.: ·0356 cm.; length: ·5 cm.*
*Area of the reference electrode: 2·5 sq. cm.*

| A.C. CURRENT, milliamp. | D.C. POTENTIAL OF Y IN VOLTS | | D.C. POTENTIAL OF X IN VOLTS | |
|---|---|---|---|---|
| | after 2 min. | after 15 min. | after 2 min. | after 15 min. |
| **Experiment 1** | | | | |
| 0 | 0 | 0 | 0 | 0 |
| ·512 | −·039 | −·039 | −·044 | −·042 |
| ·768 | −·044 | −·043 | −·047 | −·047 |
| 1·54 | −·046 | −·045 | −·050 | −·048 |
| 2·56 | −·032 | −·028 | −·038 | −·033 |
| 3·074 | −·012 | −·011 | −·023 | −·020 |
| **Experiment 2** | | | | |
| 0 | 0 | 0 | 0 | 0 |
| ·512 | −·037 | −·036 | −·038 | −·037 |
| ·768 | −·041 | −·040 | −·042 | −·041 |
| 1·54 | −·043 | −·042 | −·045 | −·044 |
| 2·56 | −·026 | −·022 | −·036 | −·030 |
| 3·074 | 0 | +·003 | −·14 | −·010 |

systems at the electrode will adjust themselves accordingly so as to conform to the same redox potential. But, when an alternating potential is applied, the relative velocities with which the various redox systems at the electrodes respond to the changing potential will differ. Further, the concentration changes are also influenced by diffusion. The d.c. potential observed appears to be caused by these differential electrode kinetics of the redox systems. These phenomena may also be caused by the differential effect of the two half-waves of the alternating current on the electrode reaction rates. The new effect has accordingly been referred to as "redoxokinetic effect" and the potential produced as "redoxokinetic potential". It is to be noted that the present experiments were done with a well-poised redox system. With a lightly poised system, the effect would be much greater. The effect which appears to be general is being examined with other redox systems. The ferrous-ferric system has already given similar results.

This phenomenon gives a new method of approach for the study of electrode kinetics and is likely to throw light on the velocity of electrode reactions. The details of this work will shortly be published.

The authors wish to thank the U.P. Scientific Research Committee for a grant which made this work possible.

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*September 28, 1950*

## CAMPHOR PRODUCTION FROM *OCIMUM KILIMANDSCHARICUM* GUERKE

*Ocimum kilimandscharicum* GUERKE, A NATIVE of East Africa, grows well in Bombay State, especially in the southern tracts. It grows on all types of soils and in all climates, and yields camphor in 6-7 months after sowing. It can be grown on waste lands, roadsides and along edges of fields, and cattle do not browse on it.

The cultivation of this plant has been undertaken by the Forest Silviculturist in many parts of Bombay. With a view to finding the optimum conditions for the economic exploitation of this plant as a source of camphor, investigations have been undertaken jointly by the Forest Silviculturist and the Forest Chemist, Government of Bombay.

A simple portable distillation plant has been designed and used in these studies. The still (40 gal. capacity) is fitted with a steam coil at the bottom and an exit at the top. The distillate is collected in an open vessel containing cold water which is kept immersed in a larger vessel containing water which is periodically changed. The camphor and oil which collect in the inner vessel are separated by filtration and the camphor present in solution in the oil is removed by refrigeration and filtration. The crude camphor thus obtained is purified by sublimation.

With a view to obtaining data on the effect of storage of leaves on the yield of camphor, fallen and withered leaves collected from the field, fresh leaves gathered from the plants and leaves collected from the plants and dried in the shade for a week, were subjected to steam distillation. The withered leaves had been exposed to sun and rain for over 4 months. The yields of total distillate and camphor are given in Table I.

TABLE I

*(The figures within brackets give the range of values)*

| MATERIAL | AV. WT. OF CHARGE FOR DISTILLATION, lb. | NO. OF DISTILLATIONS CARRIED OUT | TOTAL DISTILLATE, % | CAMPHOR CONTENT, % |
|---|---|---|---|---|
| Withered leaves * | 104 | 7 | 2·64<br>(2·14-2·96) | 1·56<br>(1·12-1·93) |
| Fresh leaves | 52·5 | 7 | 0·4<br>(0·26-0·55) | 0·19<br>(0·12-0·31) |
| Shade-dried leaves † | 128 | 12 | 0·76<br>(0·53-1·06) | 0·32<br>(0·25-0·42) |

* Yield calculated on the weight of dried material.
† Calculated on the weight of fresh leaves. The yield of distillate on dry wt. basis is 4 per cent.

From the results given in Table I it will be seen that the yield of total distillate from leaves exposed for 4 months to adverse weather conditions is 2·64 per cent. This yield compares favourably with the 4 per cent yield obtained from shade-dried leaves. Prolonged storage of leaves does not appear to adversely affect the yield of distillate.

It has been observed that the yield of distillate and the ratio of camphor to oil in leaf material vary according to the locality from which the material is gathered. Further, the yields of camphor and oil from leaves collected from the same locality vary from season to season ; the yields are greater in the dry months and the ratio of oil to camphor in the total distillate is also higher.

A comparison of yields from fresh and shade-dried leaves shows that it is advantageous to employ partially dried leaves for distillation. Weight for weight, a better yield of distillate is secured and there is considerable saving in fuel.

Investigations are in hand to determine the optimum conditions for the cultivation and harvesting of *Ocimum kilimandscharicum*.

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*August* 9, 1950

## OIL FROM THE SEED OF GOKHRU ( *XANTHIUM STRUMARIUM* )

GOKHRU ( *Xanthium strumarium* ) OCCURS abundantly throughout the hotter parts of India. No large-scale use for any product from this plant has been found although Watt[5], Chopra[1] and Nadkarni[4] have described a number of medicinal uses. The seed is known to contain an oil, briefly referred to by Lewkowitsch[3] as a lesser known semi-drying oil. A detailed study of the economic possibilities of the oil from this source has been undertaken in these laboratories.

The seed is enclosed in a tenacious thorny cover which is difficult to remove by mechanical means. It is not rendered brittle for easy crushing by heating, dehydrating and even roasting. It is not softened by soaking in water ; treatments with steam, alkalies and common oxidizing agents are ineffective. By soaking the thorny fruit in 2·5 per cent sulphuric acid for about 12 hr. and then drying in the sun for a day or two, the fruit coat softens and the seed can be obtained easily by lightly pressing between rollers and winnowing. A number of batches can be treated from the same tank of acid solution until the acid strength is reduced to 1·5 per cent.

The seed which is about a third of the weight of air-dry fruit contains 32 per cent oil. The seed yield in the vicinity of Nagpur Agricultural College Farm was about 630 lb. per acre during the year 1948-49 and 480 lb. per acre during 1949-50, the plants being spaced 1′ to 1·5′. This represents an yield of about 175 lb. of oil per acre. Comparing this with yields of oils obtained from the usual cultivated oil seeds, the oil yield from gokhru must be regarded as substantial enough to deserve attention.

The physical and chemical constants of the oil are :

| | 1948-49 *sample* ( *ether extracted* ) | 1949-50 *sample* ( *cold, pressed* ) |
|---|---|---|
| Ref. index at 40°C. | 1·4697 | 1·4665 |
| Sap. val. | 202·5 | 192·0 |
| Iod. val. | 111·9 | 124·0 |
| R.M. val. | 2·5 | 2·0 |

The oxygen absorption values of the oil, according to the method described by Elsden[2], was 6·5 in 2 days, 7·2 in 4 days, 9·3 in 8 days and 11·7 in 12 days.

A sample of oil stored for about a year out of contact with air was found to have developed a thick, tenacious, pale-yellow, transparent film, slightly sticky but otherwise rubberlike. The oil rapidly thickens on heating, and the viscous product thus formed is miscible with mineral oils. The hot oil at the point of jellification has good spreading properties and thin films dry rapidly. Further work on the oil is in progress.

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*August* 14, 1950

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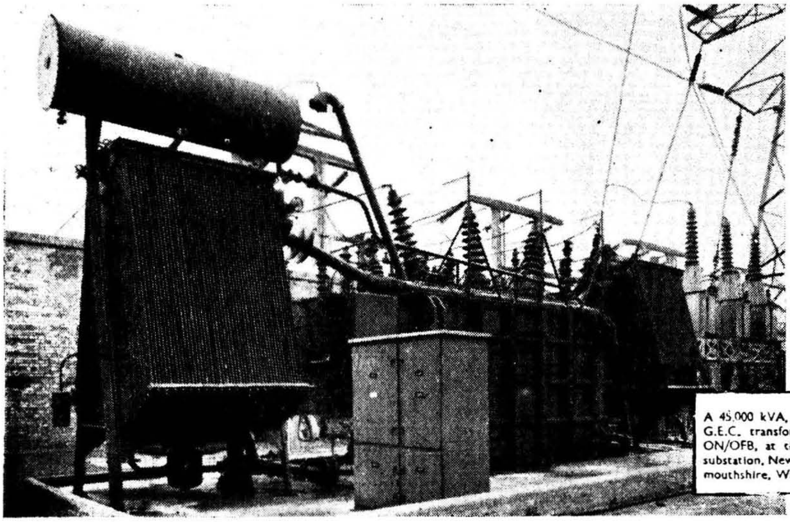

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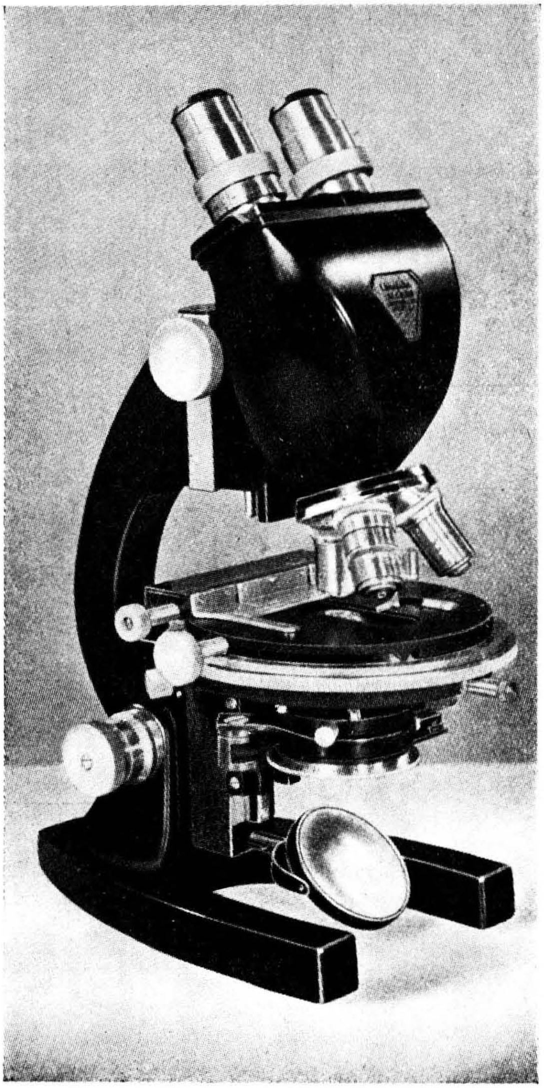

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