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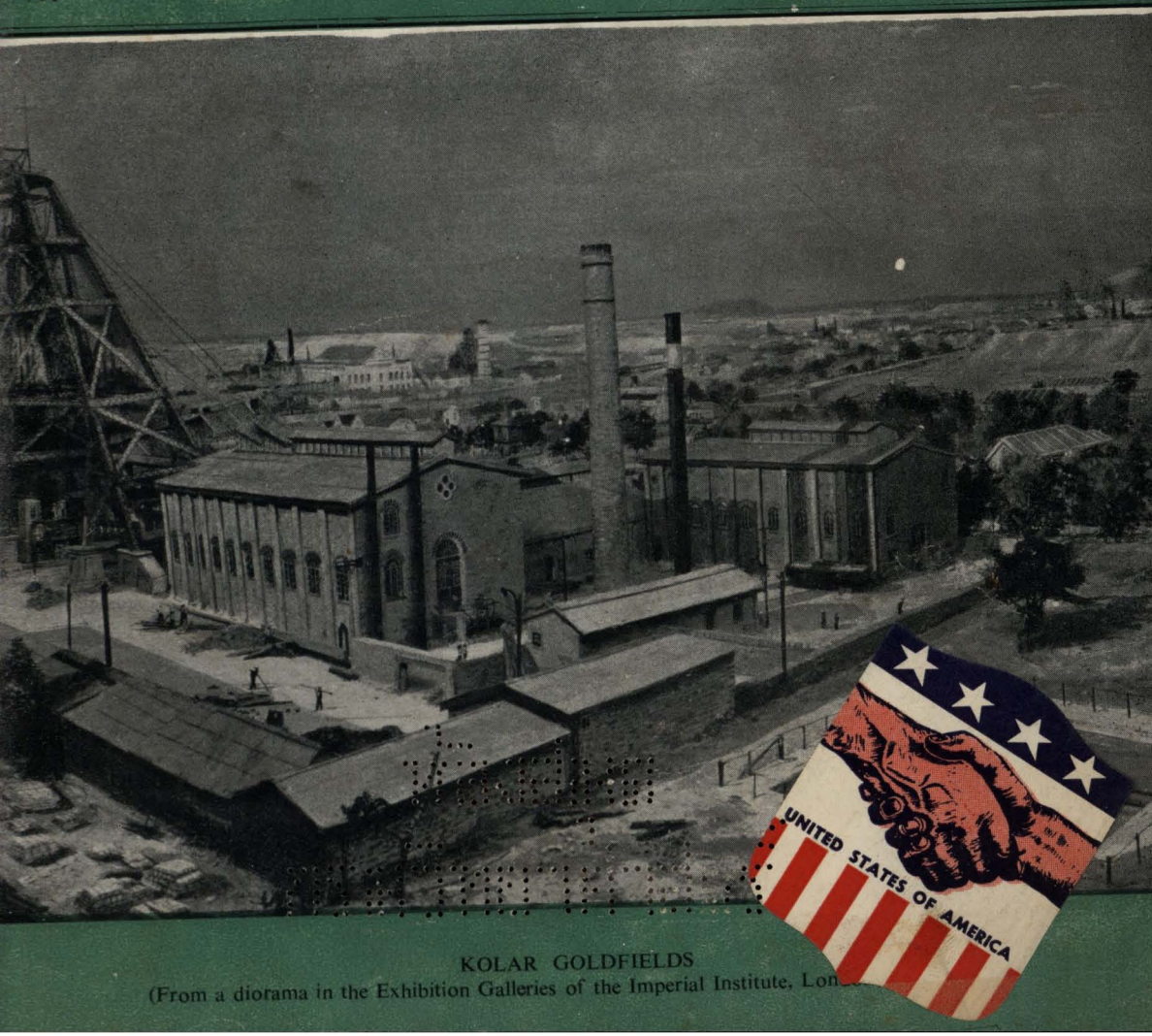
VI] FEBRUARY 1947 [No. 2



KOLAR GOLDFIELDS

(From a diorama in the Exhibition Galleries of the Imperial Institute, Lon

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The Editorial Board in its work of examining papers received for publication will be assisted, in a honorary capacity, by a large number of distinguished scientists working in various parts of India.

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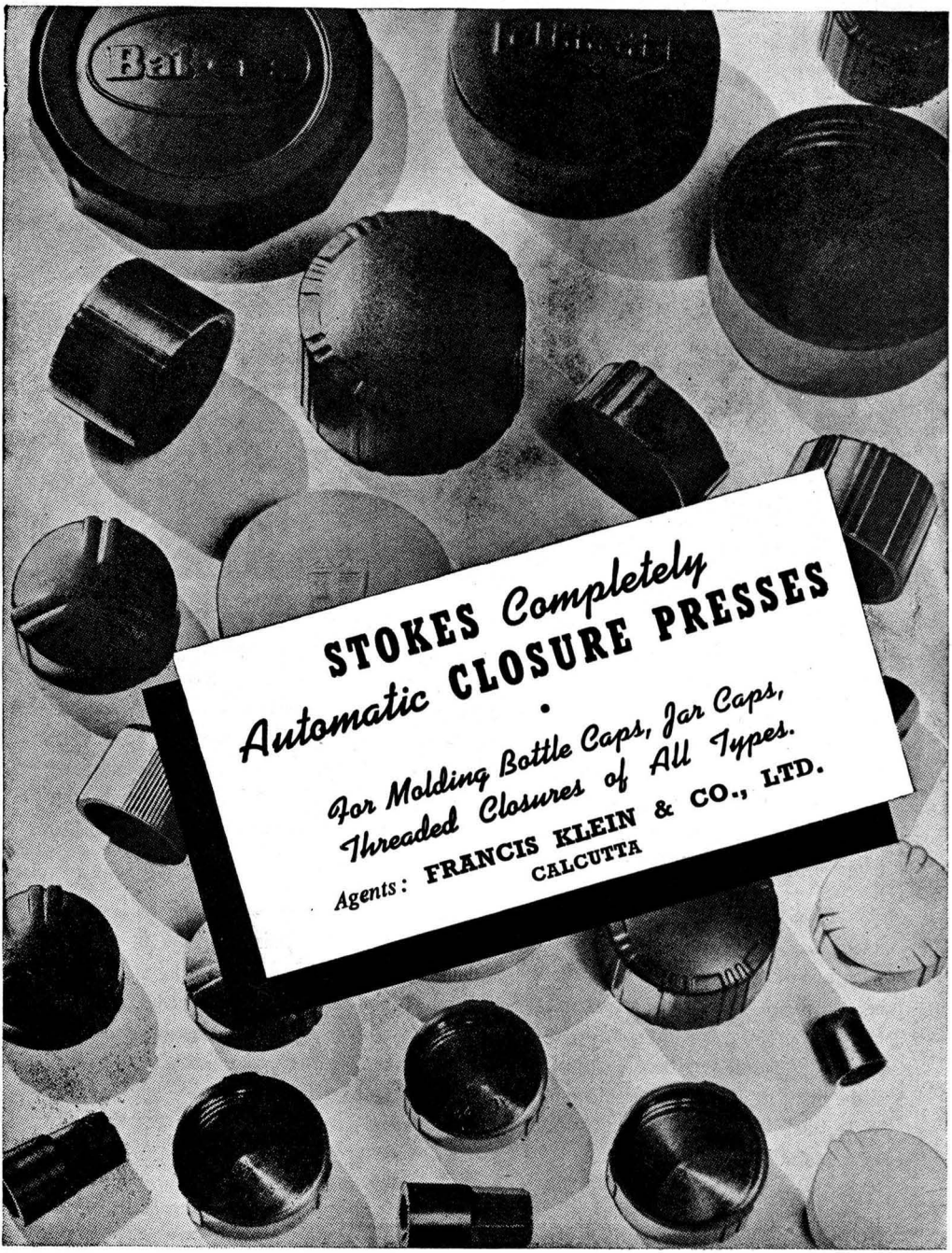
Progress of chemistry... (7)

By about the third century of the Christian era, Indian chemists had reached a stage when, with any luck, they might have anticipated by some hundreds of years the developments in the West which led us to our present understanding of chemical changes. They had a theory of chemical combination based on an atomic system; they had extensive records of specific chemical reactions of which they were making practical use, chiefly in medicine. So far, they had been mainly interested in plant and animal products. They now began to experiment with metal and minerals, from which they prepared a large number of medicines, many of which survive to this day, having real curative powers. Nagarjuna, Buddhist divine and chemist, was the outstanding figure of this age.

From the earliest times, Indian chemistry had been an intimate part of religion. Its intellectual status therefore, and the direction of the efforts of chemists, followed the course of religion itself. After the decline of Buddhism, the various creeds of Aryan Hinduism seem to have absorbed much of the cruder aboriginal worship of magic and sorcery. Inevitably, chemistry followed this downward path and declined into what is commonly known as 'alchemy' which in India was based very largely on the chemistry of mercury, one name for which - "rasa" appears as the first part of the name of most of the alchemical writings in India. Mercury was believed to be the seed of the god Siva, and certain mercuric drugs were reputed to confer immortality upon human beings.

Indian chemistry thus became part and parcel of the various Tantric cults which dominated the scene until the fourteenth century A. D.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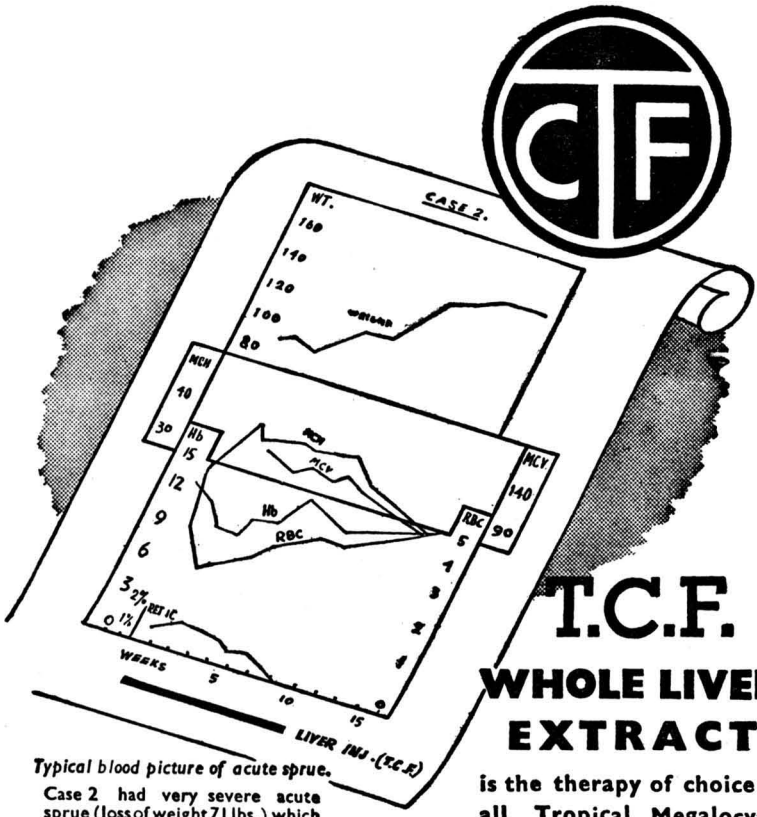

Typical blood picture of acute sprue.

Case 2 had very severe acute sprue (loss of weight 71 lbs.) which responded to parenteral liver therapy (T.C.F.).

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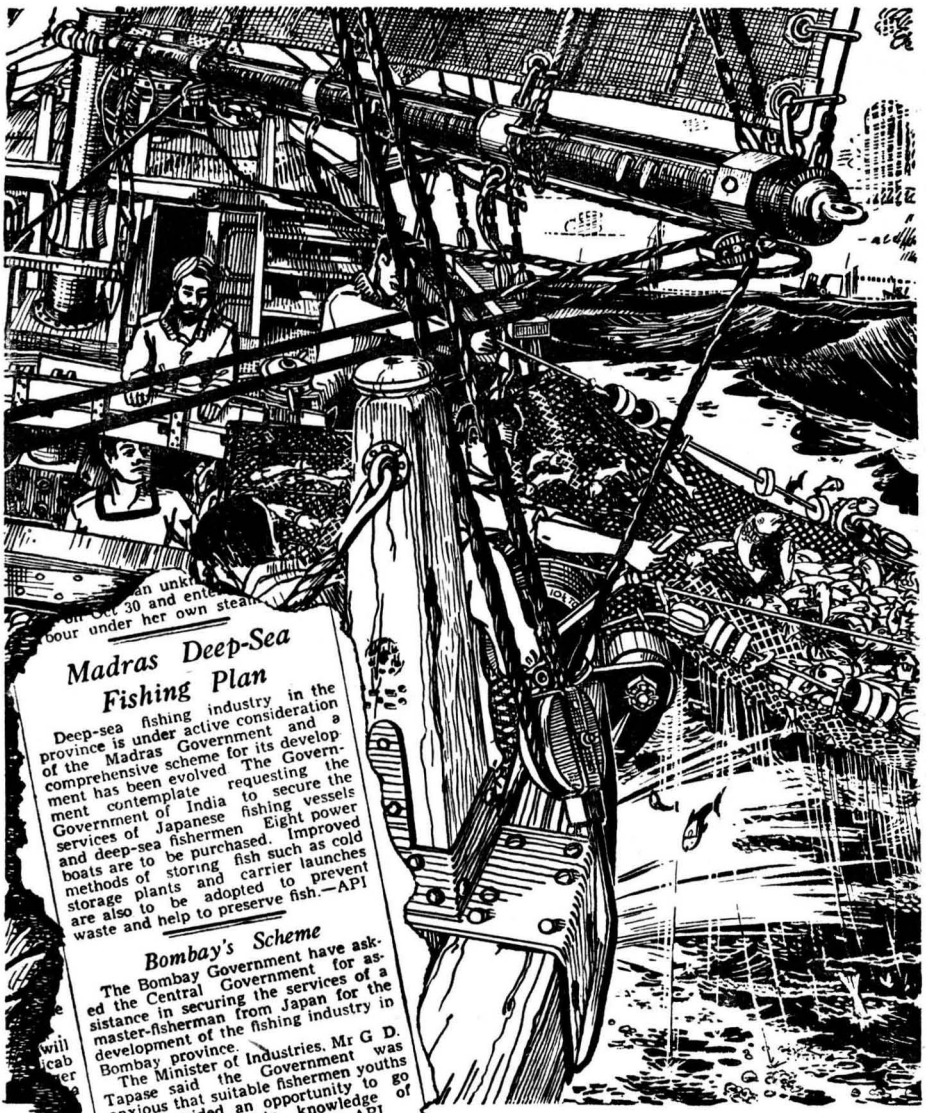

Madras Deep-Sea Fishing Plan

Deep-sea fishing industry in the province is under active consideration of the Madras Government and a comprehensive scheme for its development has been evolved. The Government contemplate requesting the Government of India to secure the services of Japanese fishing vessels and deep-sea fishermen. Eight power boats are to be purchased. Improved methods of storing fish such as cold storage plants and carrier launches are also to be adopted to prevent waste and help to preserve fish.—API

Bombay's Scheme

The Bombay Government have asked the Central Government for assistance in securing the services of a master-fisherman from Japan for the development of the fishing industry in Bombay province.

The Minister of Industries, Mr G D. Tapase said the Government was anxious that suitable fishermen youths were provided an opportunity to go abroad and obtain knowledge of modern methods of fishing.—API

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JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH


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An Institute of Transport for India—a Desideratum

"I THINK that the most useful work of an institution would be to organize and facilitate meetings for the reading of papers and discussion. It is only in this way that any science can be advanced and Transport is, perhaps, the most difficult as it is certainly the most neglected branch of economic science. It contains the most varied, delicate, complicated, elusive interior, under a surface of apparent simplicity.

"An Institute of Transport properly organized and equipped and adequately supported by all the interests, that should be represented on it would bring together in the pursuit of a common purpose large and diverse groups of individuals on whose co-operation and combined knowledge and enterprise, any great developments must depend."

These observations were made by Sir George Gibb, before the *Institute of Transport* was opened in England in 1919, and they apply with singular appropriateness for inaugurating a similar Institute now in this country. The World War advanced the pace of development of this country and the present moment for inaugurating such an Institute is most opportune for more than one reason. Firstly, the fruitless controversy regarding State *versus* Company management of Railways has been finally set at rest and practically all the principal railways are under direct State management. Secondly, the policy as regards the control of the other forms of transport—road, air, etc.—has been defined. Thirdly, plans for rehabilitation of railways and construction of roads for motor transport have been drawn up, involving expenditure "in terms of figures, which would have frightened an older generation". Development of railways and roads, inland waterways and coastal shipping, as part of the same transport system, to render it well-balanced and efficient and integration between air and other forms of transport to ensure harmonious working will, therefore, call for a mighty co-operative effort from the operators as well as the users. The study of these problems concerning the "life-line" of this vast country assumes now a paramount importance. This commendable objective can be achieved by enlisting the co-operation of the *intelligentsia*, concerned directly or indirectly with any of these forms of transport or interested in their development, by means of the Institute.

"To promote, encourage and co-ordinate the study of the science and art of transport in all its branches, to initiate, foster and maintain investigation and research into the best means and methods of, and appliances for, transport, transit and locomotion and the problems that are involved and their most satisfactory solution, to extend, increase and disseminate knowledge, and exchange information and ideas in regard to all questions connected therewith, and to assist and further in all practicable ways the development and improvement of transport, transit and locomotion in the best interests of the community."—(Clause 1 (a) of the Charter of *The Institute of Transport, England.*)

The Institute may, then, function as

(1) Clearing house for exchange of knowledge and experience among the members of the various transport services and as liaison between them and the users of such services for a proper appreciation of the "minutæ" of their working;

(2) Expert organization for setting standards of education for the personnel of the services before recruitment and also promoting efficiency in the higher ranks by holding examinations as in other professional organizations ; and

(3) Research field organization.

These functions may be briefly set down as follows :—

(1) The objectives under the basic plan of the Railway Board, as detailed in the *Second Report on Reconstruction Planning* are many-sided and of far-reaching importance. The Institute will provide a meeting ground for discussion and unofficial contact among the operators of the various forms of transport, which will be helpful in bringing about agreement or compromise between conflicting interests. So far as the Railways are concerned, they can be taken more or less as a compact unit, in view of the State management of all the Class I Railways. The other units, which will be subject to State control—the road, the inland waterways, etc.—are under private ownership with diverse types of organization and management, not to mention the centrifugal tendencies in outlook of Provinces and States, on the schemes sponsored by the Centre. The necessity for a common forum for bringing together all these groups and interests for a free discussion can, therefore, be hardly gainsaid.

Besides engendering such community of interests among the units of transport, in general, there is a wider aspect of no less importance. It will be appreciated, that Railways or any other organized form of transport cannot fulfil its economic functions and responsibilities, without the goodwill and understanding of the users and the public. Instances are not wanting, when leading business men and industrialists in this country have not grasped the minutæ of the railway rates structure and Mr. C. G. W. Cordon drew pointed attention to this lack of understanding in his Presidential Address to the *Indian Railway Conference Association* in 1943, when he said that "our goods rates in the past have received much attention from commercial bodies and public men. This is not surprising, if only for the reason that transportation is an important item in industry costs and in the marketing of produce. To many here, the present rating system is well understood, but outside comment has not always been well informed." Evolution of a new rates structure in keeping with the post-war requirements of the country as a whole is one of the objectives of the basic plan of the Railway Board. The Institute which will be open to all interested in transport will provide the liaison at a high level between the public and the managements, in bringing about a proper understanding of the intricacies, in the evolving of such a structure and its maintenance, for meeting the changing needs of trade and industry. What is more, such a liaison will cover a wider ground of "Public Relations" about which a start has been made recently by some of the Indian Government Railways.

(2) Expert Organization for setting standards of education. It was recently observed by Mr. T. W. Royle, a Vice-President of the L.M.S. Railway in England, as follows:

> "It will be helpful to recall that the *Institute* (in England) was not founded until 1919 and its examinations were not inaugurated till 1926, which is, I think you will agree, rather a curious fact when one reflects that transport has been a vital factor in the life of the people, before many other professions were even thought of and indicates that the industry presents one of the biggest fields in the provision of educational facilities . . . The *Institute* will, without doubt, be called upon to play an increasingly greater part as will the educational establishments which help to prepare students for its examinations. It is worth reporting that Informal Educational Committees are being formed by some of the sections, comprising members of the *Institute* and representatives of local educational authorities and commercial colleges."

Facilities in this country for training in respect of the specialized demands of Trans-

port—rail, road etc.— in their several branches of working are meagre. The report by the Central Advisory Board of Education on *Post-war Educational Development in India* refers to four categories of workers in industrial occupations :—(*a*) Chief executives, as well as research workers ; (*b*) minor executives,—foremen, charge hands, etc ; (*c*) skilled craftsmen ; and (*d*) semi-skilled and unskilled labour. These categories may apply to transport workers as well, and what Mr. Abbott states in regard to large industrial undertakings, reproduced below, applies with equal force to the transport industry.

> "No country can initiate and carry on industries on a large scale, unless it has an adequate supply of men specially trained for the direction and management of large industrial concerns as well as others, qualified for the minor but very important supervisory posts in them."

The existing technological institutions provide courses for specific industries, and the statement made by the Member for Education in the Central Assembly on 4th November, 1946, indicates the action taken or proposed to be taken on the principal recommendations in the *Report*, mentioned above. It is stated that two Central Higher Technological Institutions will provide courses for training of high grade engineers and technologists, to take up positions of trust and responsibility and that the *Indian Institute of Science, Bangalore* and the *Delhi Polytechnic* will also be strengthened considerably. The Provinces will have institutions for training skilled and semi-skilled technicians as also supervisory officials, e.g., chargemen, etc., While these plans have been contemplated, having in view the technical education, in general, it will be a distinct advantage, if a central organization directs and regulates the courses of training to suit the requirements of transport as a whole and the Institute, representing members who can speak from a practical knowledge of the working of rail, road, etc., will give such technical education a "Transport bias", if it may be so termed. Such a bias may be imparted, having in view the fundamentals of transport —*as a service* concerned with operation and management and *as an industry* concerned with manufacture of locomotives, internal combustion engines, etc. To illustrate this further, the courses of study for both these branches may be on the following lines.

(1) Operation and management : (*a*) Engineering.—Civil, mechanical, electrical (including communications, signals and electric traction) having direct bearing on transport, in general ; (*b*) Rail, road, inland waterways air and coastal shipping—economics of operation and principles of management, including prospecting for new railway lines, road routes, etc., and modern port operation; (*c*) Accounts and Auditing.—Rail, road, etc., including Cost and Works accounts ; (*d*) Statistics, with particular reference to transport undertakings ; (*e*) General administration.—Law relating to rail, road, etc. Financing of transport undertakings including Indian railway finance, taxation and public administration, labour legislation, staff welfare organization, etc.

(2) Manufacture of plant and maintenance : (*a*) Mechanical and structural engineering ; (*b*) Manufacture of locomotives, internal combustion engines, other types of engines, carriage trucks, etc., and their maintenance ; (*c*) Costs and Works accounting ; (*d*) Statistics, with special reference to production and maintenance ; (*e*) Labour legislation and welfare organization, etc ; (*f*) Overseas training in manufacture and maintenance of plant—engines, trucks, etc.

An intensive training for five years in each of these branches, as in other professional courses, will provide two groups of personnel, best suited for the Chief executives, etc., contemplated in the *Report of the Central Advisory Board of Education on the Post-war Educational Development*, so far as transport, in general, is concerned. The possible advantages are :

(i) Group I (Operation and management) will have an all-round training suitable for the Departments of Engineering, Transportation (Power, Movement and Commercial), Accounts and Auditing, Stores, Statistics, Personnel and General Management: This basic training, with acquired aptitudes for efficiency in particular branches after gaining experience will give a wide field for selection to the principal executive posts.

(ii) Group II (Manufacture of Plant and Maintenance). The training under this group with greater emphasis on manufacture is conducive to invention and leadership, as in other manufacturing industries, and those which will develop in this country, ancillary to the transport industry.

(iii) The period of training for both these groups after entry into service will be substantially reduced, resulting in saving of expenditure.

(iv) Indianization will, then, mean not only a negative achievement, but a positive advance for making good the opportunities afforded for initiative and responsibility.

Similar courses of study correlated to the standards expected of the supervisory and skilled staff have to be planned for adoption in the Provincial technological institutions.

It may be noted that the courses of study for the Groups I and II above of the higher personnel are suggestive as a working basis to start with and capable of modification ; but it is essential to evolve new types fully trained and equipped (i) to deal with the operating problems, as well as the technique of all forms of transport, when the State has to manage the railways and control the working of other forms; (ii) to manufacture and maintain plant and equipment.

The Higher Technological Institutions may provide these special courses and the cost of doing so cannot stand in their way, when it is realized that over Rs. 800 crores have been invested by the State on the railways alone and what is more, one in every 400 persons in this country is a railwayman and that one in every 100 looks to the railways for living. The Institute, representing the best talent in the country, can direct and regulate, with the changing needs, the education of the administrative and supervisory personnel.

(3) *Research field organization :* Planned economy makes a great demand on human judgment and forethought, setting the wheels of research in "perpetual motion", as it were, to meet its exacting demands. The Member for Transport in opening the 50th session of the *Indian Railway Conference Association* at New Delhi on 25th November 1946, observed:

> "I feel that the time has come when our scientific research organization should be as comprehensive as possible and should embrace a field even wider than the one contemplated by the Railway Board. I can think of no branch of science, pure or applied, barring perhaps astronomy, biology, zoology and the like, which does not come into play in relation to the railway organization at some stage or another.
>
> "The establishment of a Central Scientific Research Institute of Railways appears to be an urgent desideratum."

Transport is a cross-section of industry as well as a service and the results of research, —pure, background or applied—have a direct bearing and application on the former. The *Council of Scientific and Industrial Research* has set up, or proposes to set up, a number of institutions for basic as well as applied research, and the industrial side of transport—locomotive manufacture, etc.— can take advantage of their results, as also those of the research branch of the Railway Board, now concerning itself mainly with standardization of types and designs of vehicles, etc. What is of equal, if not of greater importance, is research in respect of transport as a service, correlated to its role "as one of the key activities" expected to be "rationalized and nationalized in due course". The Institute of Transport, representing the administrative and supervisory personnel of the services with their practical experience, as well as the public who are interested in them, is bound to be a "brain trust" for the Central Research Institute of Railways under contemplation.

The Institute of Transport can serve another important function, viz., the provision of an efficient library and information service to its members. Every industry and trade in the Western countries has a journal recording their progress. The *Railway Gazette*, the *Modern Transport*, etc., in the United Kingdom and the *Railway Age* in the U.S.A. deal with transport, mainly as a service. The publication of such periodical literature has not been attempted so far in this country and the Institute of Transport can give a lead, by issuing periodicals covering all the forms of transport, including the reports of discussions at its meetings.

An Institute of Transport on the lines indicated above, is manifestly important for the efficient and all-round development of transport in this country. It is to be hoped that this question will engage the attention of the Railway Board and leaders of science and industry in India.

G. RUNGA RAJU.

Exhibition of Irrigation Engineering and Research

WITH a view to focus public attention on the importance of projects for the control and conservation of India's vast water resources and their utilization for irrigation, power and navigation, an Exhibition of Irrigation Engineering and Research was organized by the *Central Board of Irrigation* at Delhi. The exhibition was the first of its kind held in India, and much interest was evinced by the public in several of the unique features of the exhibition.

Purpose of the Exhibition

The exhibition was inaugurated by Pandit Jawaharlal Nehru on 28th November 1946. In his welcome address, Rai Bahadur A. N. Khosla, President of the Board, stressed the importance of water resources for national development. Referring to the objects and scope of the exhibition, he pointed out: "The exhibition has been arranged to focus attention on the necessity and importance of projects for the control and conservation of our vast resources in water for purposes of irrigation, flood control, water power and navigation, most of which resources are at present running to waste and doing untold damage in their passage to the sea. The purpose of this exhibition is to give publicity to what is being done for the benefit of the common man, so that instead of remaining a passive spectator of the efforts of others he can understand the significance of such efforts in his everyday life and intelligently participate in them. It is the purpose of this exhibition also to stimulate public interest in the schemes for the control and conservation of water, which are so vital for the building up of the India of to-morrow. Another purpose of the exhibition is to give an intelligent idea of irrigation and allied developments to the laymen who have little time to study these matters otherwise. Still another purpose is to afford facilities for engineers from different parts of India to understand and appreciate the work done in other parts with a view to effect all-round improvement.

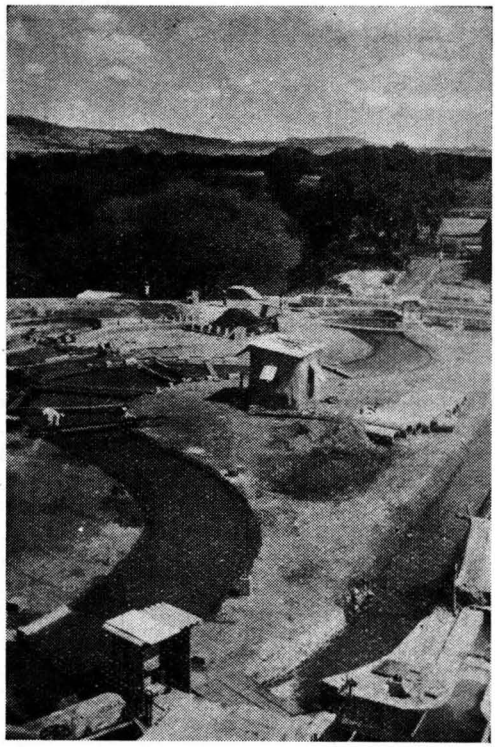
"Our area under irrigation is about 70 million acres which is nearly equal to the areas under irrigation in the rest of the world put together. But the irrigation has brought several fresh problems in its wake such as water logging, soil deterioration with salts, closed drainages and malaria mosquitoes. Remedies had to be found for such adverse factors. For some time reliance was placed on the rule-of-thumb methods and on individual instincts. But the troubles got acute beyond such improved remedies and that led to research being undertaken on scientific lines.

"The researches which started with the idea of mere prevention of adverse features in irrigation areas, soon advanced to the field of investigation and improvements in design of works, in distribution system, in materials of construction and in construction methods.

"Our irrigation research stations now have considerably expanded in scope. They have branches dealing with hydraulics, hydraulic machinery, hydraulic structures, river training, soils, cements, materials of construction, applied physics, physical chemistry, higher mathematics, statistics and agriculture. Already we are reaping the fruits of recent researches carried out in India. We are securing better results at lower costs."

An Instrument of Education

The need of educating the common man regarding irrigation, power, and generally, scientific and industrial research, was emphasized by Pandit Jawaharlal Nehru while inaugurating the exhibition. Pandit Nehru said: "It is really an astonishing fact that this is the first exhibition of its kind in India. Those who are present here are mostly those who do not require many arguments to persuade them about the value of this exhibition. It is those who do not understand what is being done who should come and look at this exhibition. Unless they understand it, it is quite possible that the work of engineers and others will come to a stop. We are dealing here with vast schemes affecting tens of millions of people. You can never have these schemes worked efficiently unless you have the co-operation in some measure of the millions of people affected by them.



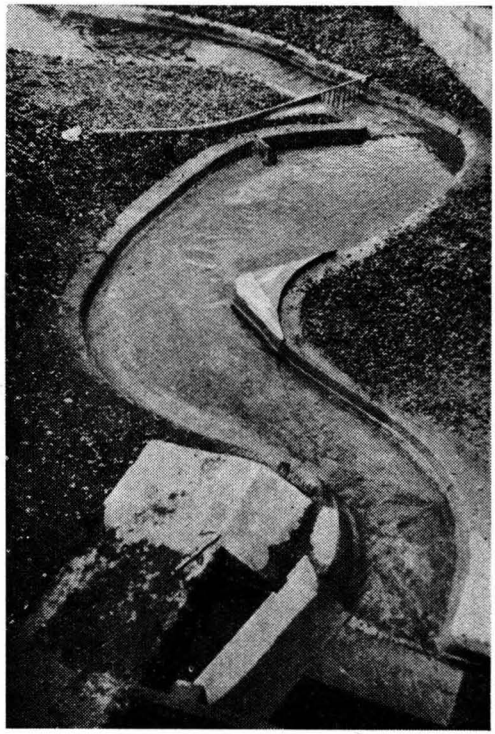
A large-scale model of the Hooghly river, *Indian Waterways Experiment Station, Poona.*

"This education was necessary", Pandit Nehru said, "because often the peasants had a grievance that they were being deprived of their lands and possessions in pursuance of these schemes. Unless it was explained what was going to be done, how it was going to benefit them and the extent to which their incomes and standard of living would rise, it would be difficult to put these schemes into effect."

Pandit Nehru observed that he had been greatly impressed by reading about the Tennessee Valley Authority and what they had done, and about the vast schemes of development which had been carried out in the Soviet Union. It was, however, not only necessary to have a factual knowledge of the potentialities of these schemes, but a real emotional appreciation of what these schemes and projects sought to do. "They are to be understood intellectually, but even more so emotionally. We have to understand what they seek to do in the scheme of things, in the lives of millions of people. If we translate them emotionally in terms of people, they become living, vital things. Otherwise, they are merely charts and maps in the engineer's rooms."

Pandit Nehru urged launching of a widespread propaganda among the people, peasants particularly, who were to be affected by these schemes. Pictures, cinema shows, museums, maps and charts showing the results after a scheme was implemented, should all be utilized in educating people.

"In various places in Europe and America there were magnificent museums showing various scientific devices for the benefit of workers, peasants and students. India had hardly any. A sense of expectation and exaltation had to be produced in the minds of people about the shape of things to come. If work was carried on in this manner, it would be finished faster. Engineers and other experts had to come out of their 'shells' and to consider things from the popular point of view. Peasants were the



Tidal model of Rupnarayan Bridge of the B.N. Railway, *Indian Waterways Experiment Station, Poona.*

most conservative element in a country's population and their isolationism had to be broken. It might not be so now, but ultimately all major decisions would have to be taken with their consent."

Referring to financial resources necessary to put the various development schemes into effect, Pandit Nehru said: "It is obvious that when things have to be done money is not allowed to come in the way. There is no doubt that money will be found, specially when the money required is really in the nature of a tremendous investment which is likely to pay dividends a hundred- or thousand-fold in future."

The Exhibits

Among the many items of interest on exhibition were working models of engineering devices. One of them was a weir showing the scouring action of falling water and the device employed for eliminating it by the provision of specially devised staggard blocks, the size, shape and position of which are determined by model experiments. Another model showed the method employed for the determination of upward pressure at different points under hydraulic structures. A model of rigid module recently evolved in the *Punjab Irrigation Research Institute* was exhibited. A visual test was provided showing that the discharge through it was constant irrespective of an increase of head on the upstream or the distributary side of the module.

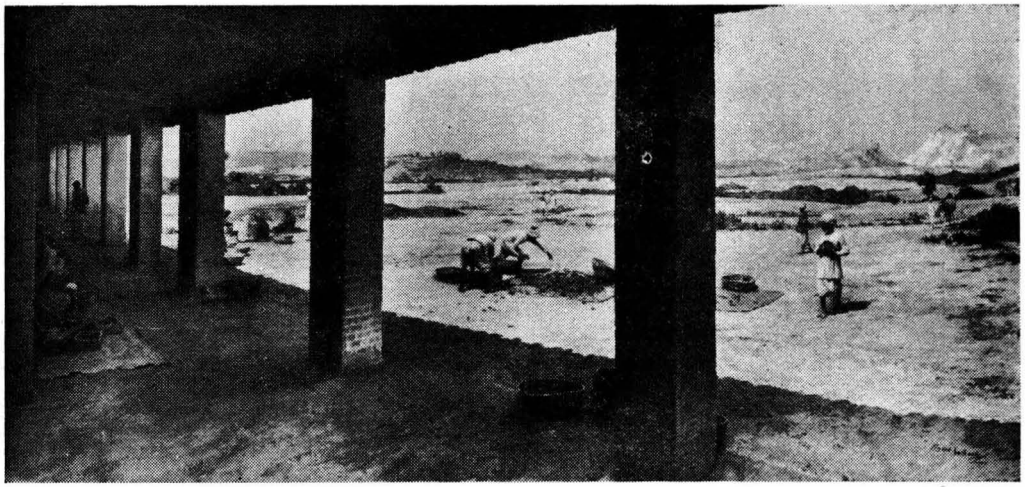
Two models of the Damodar Valley Project showing the dams proposed to be built, two models of Rup Narain River at Kolaghat showing the effect of works built as a result of model experiments, a model of the proposed new barrage over the Indus at Kotri, a cement model of the river Jumna near Delhi, a wooden model of Sarda Type Fall and another of the Mohmadpur Power House showing the arrangement of the Civil Engineering Works at that site were exhibited.

The biggest attraction of the exhibition were two models built to a scale of 2″ to a mile, showing a part of the province of Bihar, and entitled "The Mahanadi Valley as it is" and "The Mahanadi Valley as it will be". The first showed how water from rains in the hills collected and flowed through the Mahanadi serving no useful purpose for mankind but causing erosion of the soil and taking a heavy toll in flood damage, both life and property. As a result, the province of Orissa presents a poor appearance, little habitation, scarce cultivation and no industries. Alongside, the second model presented a contrast. By the construction of three dams, a number of canals and power houses, the entire area was converted into smiling fields. There was visible evidence of prosperity brought about by the utilization of the natural waters for the growing of crops, for the development of industries and all that follows in their train.

Other exhibits of interest were relief maps of India and a map showing all the existing irrigation works in the country. A chart was also displayed showing the development of canal irrigation since 1942. In the Surveys Section were exhibited some of the latest methods and techniques adopted for carrying out surveys which are preliminary to the preparation of every irrigation project. The instruments used in survey work such as topographical stereoscope for determining heights from air photographs, contour maps, etc., were on show.

A wooden model of the proposed Rasul Power House, models of four different kinds of siphons and wooden models of Gibb's Module, Harvey Stoddard Outlets, Standing Wave Flume, Grump's Adjustable Proportionate Module, Kirkpatrich Orifice Semi-module, Standing Wave Pipe Outlet and Indian Waterways Experiment Station type Canal Fall were also displayed. Lastly there was a metallic model of the Boulder Dam showing the dam itself, the power house with tower and penstock pipes.

Other sections of the exhibition were (1) Hydrology in which the Meteorological Department provided a number of instruments such as automatic recording rain gauges, rainfall intensity recorders, evaporimeter, sunshine recorder and two kinds of seismographs, (2) Soil Science, (3) Chemistry, (4) Physics, (5) Reclamation of waste lands, (6) Navigation, and (7) Photographs and Charts.



Mineral Exhibits in the Indian Court of the Imperial Institute, London

IN the Exhibition Galleries of the Imperial Institute an endeavour has been made to afford a balanced representation of the raw materials, industry and life of the whole of the British Empire. It will be evident that, spacious as the Institute's Galleries are, only the rightful amount of space, and that of necessity somewhat limited, can be allotted to India. But the field of India's natural resources and industries is vast in itself; and India's mineral resources, and those industries principally dependent upon them, have in turn to be allotted no more than their due proportion of space. Thus, although the first reaction of the mineral enthusiast on seeing the new Indian mineral exhibits might naturally be a desire for more, he would nevertheless be bound to admit on further consideration that not only has the space been fairly allotted but it has also been utilized to the best advantage.

The Indian Court is the first to be entered from the East Entrance to the Galleries and the mineral exhibits are among the earliest to be encountered.

The centre-piece of a large wall case entitled " Minerals. The Mainstay of Modern Industry " is an extremely clear map showing by means of coloured symbols the main locations of 11 of India's metallic minerals and 21 of her non-metallic minerals. The space surrounding this map is sub-divided to display ore specimens and mining or industrial photographs relating to manganese, coal, iron, mica, salt, petroleum, gypsum, copper, gold, silver, kyanite, ilmenite, talc, felspar, asbestos, sulphur, ochre, barytes, magnesite, chromite, monazite, garnet, zircon, bauxite, alum, beryl, tantalite, tungsten, graphite, gem stones, building stones and cement-making materials. At the top are eleven larger photographs of mining operations and industries based thereon.

Supplementing this admittedly very generalized exhibit are other showcases dealing in more detail with particular branches of India's mineral industry.

A table showcase in the centre of the court is a particularly good example of the story type of exhibit and is devoted to the Travancore beach-sand industry. In the centre is the natural untreated beach sand. Surrounding this and connected with it by radiating ribbons, are the several valuable minerals resulting from electromagnetic separation: ilmenite, monazite, zircon, rutile, sillimanite and garnet. From each of these minerals the system of ribbons radiates further to indicate specimens of the chemical compounds or alloys derived therefrom. Thence the ribbon system, with much bifurcation, continues to indicate further manufactured raw materials, concluding in each instance with selected examples of

well-known industrial applications. Thus a story which, in printed text, might prove a little tedious and difficult for the non-technical person to follow, is presented in a form rapidly intelligible to the average schoolboy.

Immediately opposite these exhibits is a diorama (title illustration) depicting a typical scene in the Kodarma mica field of Bihar and Orissa. In the background on the right can be seen a hill that has been cut right through by quarrying, though a small headgear shows that underground operations are also in progress. Bullock carts and pack animals are seen bringing the crude mica to the splitting and sorting sheds in the foreground. In the centre the trimmed sheets are being sorted and graded for export, while on the left is a dump of mica trimmings and other waste. As in all the Institute's dioramas, realism and perspective are added to the scene by the fact that the foreground and middle distance consist of models and figures, and in this particular instance realism is further enhanced by the use of many small pieces of real mica.

The subject of mica is continued in an adjoining story exhibit, where we are reminded of some of the many valuable applications of this mineral of which India is such an important producer.

Nearby, in a section specially devoted to Mysore, will be found a small collection of the principal economic minerals and building stones of that State. The importance of the Kolar goldfield is acknowledged by the inclusion of a special diorama (*see* cover page illustration). In the foreground is a perspective model of the headgear and surface equipment of one of the principal shafts. This merges into a panoramic background of the surrounding district in which tailings, dumps and the headgear of other shafts are to be seen.

Considerations of space preclude the display of anything more than a bare minimum of essential ore specimens and photographs, but nevertheless this undoubtedly contributes to simplicity of presentation, which is the keynote of the entire Indian mineral exhibit. It is not intended for instruction of the technical man or mineral specialist, though even to him there are doubtless points that may serve as valuable reminders in this compact conspectus of India's vast mineral resources.—(*Contributed*)

Mineral Policy for India

THE National Mineral Policy Conference was held in New Delhi on 10th to 13th January, 1947, under the presidentship of the Hon'ble Mr. C. H. Bhabha, Member for Works, Mines and Power.

Addressing the session, the Member emphasized the need for legislation for the control and regulation of mining on the one hand, and positive guidance and supervision of mineral exploitation on the other. He pointed out that large sectors of our mineral economy must of necessity be left to private exploitation subject to State control and regulation. "It has been a common complaint against Government in this country that it has so far done little to assist private enterprise in mineral development, but I trust if our proposal for a Bureau of Mines is accepted and energetically implemented we shall soon possess an expert organ of executive action in the field of mineral exploitation, which will be in a position to render all necessary assistance to our countrymen anxious to develop our mineral resources. The Bureau will be a complicated structure and before it is fully set up, it may be necessary for us to study very clearly the structure and function of the Bureau of Mines in Canada and U.S.A."

A Mineral Policy for India

Mr. D. N. Wadia, Adviser on Mineral Development, Department of Works, Mines and Power, submitted a memorandum on mineral policy which was considered at the conference. "Up till recent times," says Mr. Wadia, "the subject of mineral development and its exploitation on a national plan has received scant attention. Provincial Governments took very little interest in the development of their mineral resources and did not possess any agency for development, utilization or conservation of their minerals."

The main object of planned economy of a nation's mineral wealth should be not only profit from utilization of the minerals and exploring all the industrial capabilities, but also their conservation and provision

of safeguards against wasteful exploitation. The future must see the initiation and working of a definite plan of mineral development from this point of view in every Province of India. For too long, trade and vested interests have been allowed to perpetuate unscientific and wasteful mining and their uneconomic utilization, paying no regard to conservation of the nation's mineral assets.

During the last 40 years, an unregulated traffic in India's mineral products has grown up, that is, that by far the largest quantity of manganese ore, mica, ilmenite, gold, chromite, refractories and a number of minor minerals are extracted mainly for the purpose of export trade in the raw, and at a rate which will, in future years, deplete the reserves of valuable key minerals.

Individual Provinces which possess full freedom under the present constitution to frame their own mining laws have not been able to check this unregulated traffic in minerals which before the war had reached really harmful proportions.

Minerals are a rapidly depleting asset and the question of ensuring their maximum utility and minimum waste should be the outlook of a central directive of the nation and not of individual provincial or vested interests. It is important, therefore, that the respective roles of the Centre and the Provinces in mines and mine products should be precisely indicated. While Provinces have a right to the income from their mineral deposits and will have compensation for the mineral properties taken over by the Federal Authority for a co-ordinated development in the national interests, there should be no question as to the paramountcy of the nation's interest in particular minerals when public interest so demands. From this point of view, coal, petroleum, iron ores, gold, mica, maganese, salt, monazite (thorium), ilmenite and such other minerals (as uranium ore and rare metal minerals) as may from time to time come to be declared as of key or strategic importance, should be regarded as under public ownership and whose mining and utilization should be under Central regulation. This will yet leave a number of valuable metals, ores, industrial minerals, salts, ornamental and precious stones, etc., under the executive control of the Provinces.

The above considerations suggest the urgency of forming a mineral policy for India directed to secure the following objectives:—

(1) Attainment of mineral and metal self-sufficiency as far as possible.
(2) Bringing under central control minerals of strategic and national defence importance.
(3) Regulation, amounting to stoppage, of export of some key minerals, such as manganese, chromite, ilmenite, sillimanite, beryl, rare earths, etc., without a compensatory return or barter of minerals and metals in which the country is deficient.
(4) Encouragement of local manufacture, especially of non-ferrous metals and products now imported from abroad, e.g., aluminium, various ferro-alloys, alloy steels and alloy metals, heavy chemicals, mica goods, titanium paints, etc.
(5) A better adjustment of mineral tariff in the levying of export and import duties and fixing of quotas.
(6) Revision of mineral taxation, royalty and lease laws.
(7) A progressive change-over to State ownership, where economically feasible, of the coal, petroleum and basic metals mines.

Bureau of Mines to be Set Up

Unanimity prevailed at the Conference on the immediate need on the part of the Central Government to formulate and pursue a planned mineral policy, the representatives present generally approving the policy outlined in the memorandum prepared by the Adviser on Mineral Development, Mr. D. N. Wadia.

There was wide agreement on the need for Central co-ordination and regulation of certain key minerals, such as coal, petroleum, mica, beryl, chromite, ilmenite, sillimanite, manganese ore, monazite, rare earth minerals, all uranium and thorium-bearing minerals and piezo quartz. While the principle of acquisition of mineral rights was generally approved, opinion favoured its immediate application in the case of coal industry.

State control over utilization and development of minerals found unanimous support. The proposal of the Government of India to set up a Bureau of Mines to serve as an executive machinery for the production, conservation and utilization of minerals was commended by all the representatives.

Future of Geophysics in India

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Introduction

INDIA is at present on the brink of an era of great scientific activity, and interest in the science of geophysics is in the fore. The Government of India have appointed a Geophysical Planning Committee to consider fully the existing opportunities for geophysical work under the supervision of the various Government organizations such as the *Meteorological Department*, the *Survey of India* and the *Geological Survey*, and other State organizations and to prepare a plan for future co-ordinated work in this important field.

The science of geophysics or "Earth Physics" deals with the history of the earth, origin of its main features, its physical properties and constitution as well as the properties of the atmosphere and hydrosphere. Being such a comprehensive subject it is inevitable that it draws its data from very widely different sciences such as geodesy, geology, meteorology, astronomy, seismology, terrestrial magnetism, terrestrial and atmospheric electricity, oceanography, volcanology, etc. All these sciences, however, come under the category of Pure Geophysics, which concerns itself mainly with investigations in a broad way of crustal structures right down to the centre of the earth, although naturally the first 100 miles below the earth's surface are the main centre of interest. Right down the scale comes geophysical prospecting, which may be reckoned as Applied Geophysics as related to the lithosphere, concerning itself with investigations of surface layers of the earth within reach of mining operations. While the investigations in pure geophysics are mainly prosecuted in search for fundamental knowledge, those in applied geophysics are carried out primarily, and often exclusively, for utilitarian or commercial purposes. There is rather a wide gap between the two but the difference is only a matter of degree, as in geophysical prospecting instruments used are very similar to those employed in the various other branches of geophysics. A science of such wide scope naturally attracts workers of entirely different outlook and training, and one often finds serious differences in interpretation of the same data by persons apparently qualified to judge. It is not easy to find people acquainted with the whole range of subjects that geophysics comprises. For some of the branches a fine mastery of analysis and a mathematical and physical background is indispensable.

It is not possible in such a short paper to touch even the fringes of this vast subject, and it has, therefore, been confined to presenting in broad outlines only some of the geodetic and geophysical methods used for the determination of the broad features (visible and invisible) of the continents and oceans and for commercial exploitation of small pockets of ores and minerals, and to indicate fruitful lines for further research in some of these problems.

Geodetic and Geophysical Problems and Methods

Geodesy is the science that treats of the size and shape of the earth. The so-called geodetic results are thus of great value in the solution of manifold problems pertaining to the earth.

For geodetic work the irregular earth is replaced by geoid which is a level surface of the earth being a prolongation of sea-level under continents. The topographical features such as mountains and oceans as also the hidden inhomogeneities have attractive effects which distort the geoid from any regular shape. The determination of the best fitting reference spheroid to the geoid and the extent of the departure between the two surfaces have been and still are the major problems of geodesy. The two chief tools which geodesists use for this purpose are the deflections of the plumb-line (derived from combined results of triangulation and astronomical observations) and gravity. If the earth were a true spheroid, then the determination of its elements from observations of plumb-line over a very restricted portion of the earth (say over India alone) could be expected to be reliable or else observations of gravity at three known points would enable us to define it. If it

were a triaxial ellipsoid, knowledge of gravity at four points would be required. In practice, however, to obtain reliable values of constants in the gravity formula appertaining to the geoid it is customary to make use of all observed gravity data on the globe and to apply the methods of least squares.

Gravity observations and arc measurements show that a triaxial ellipsoid fits the geoid better than a spheroid does, but the ellipticity of the geoidal equator is not proved indisputably. This is due to the fact that the data on which the above fit is based are too scanty and consequently unrepresentative. The main desiderata in this respect are the values of gravity at sea and in the southern hemisphere. When these are done it will be possible to introduce and evaluate more harmonic terms in the gravity formula fitting the observed values best. Until then the ellipticity of the geoidal equator will remain an open question and will continue to be one of the foremost unsolved problems of geodesy.

Apart from their use in delineating the figure of the earth, gravity and geoidal observations the whole world over have shown that the larger features of visible topography are compensated in some form or the other. This is known as isostatic compensation. In India, Pratt, as early as 1854, published a paper in the *Philosophical Transactions of the Royal Society* in which he calculated plumb-line deflections due to Himalayas at three stations of the great Arc Series of India and found his computed values to be greater in amount than the observed values. To account for this, he advanced the hypothesis that the irregularities of mountain surfaces have arisen from the vertical expansion of the earth's crust from depths below. Due to this the surface features are underlain by masses of deficient density. He further expressed the view that the attraction of Himalayas was completely compensated by deficient masses below and that all differences between astronomical and geodetic results could be attributed to local pockets of abnormal density round the station. Hayford in 1912 gave a practical shape to Pratt's theory by bringing out tables by which the effect of topography and compensation on the value of gravity at a station could be computed. He assumed the total mass in every surface, called the surface of compensation, to be the same, each column being supposed to be in independent equilibrium. Obviously this hypothesis cannot be mechanically true as it assumes point-to-point compensation which implies that the earth's crust offers no resistance to deformation.

In 1855, Airy propounded an alternative hypothesis that mountains and plateaux have roots below them penetrating into the denser substratum, the whole block floating in hydrostatic equilibrium. For a very long time, all discussions on gravity were based on Hayford anomalies since tables on his hypothesis only were available. But now more general tables on Airy's and other regional types of compensation have been brought out which can be used for various depths of compensation and thicknesses of the crust.

The modern concept of normal structure of the earth's crust as evidenced by study of near earthquakes is completely at variance with the above hypothesis. It has been found to consist of three layers possessing different physical properties. The interfaces of these layers are about 10 km. and 30 km. below sea level, the discontinuity of densities at these layers being about 0.2 and 0.5 gm/cm^3 respectively. Modern theories assume that compensation is confined to the interfaces of these layers. In view of this not much interest attaches to the controversy which has entailed considerable research as to whether Hayford's or Airy's hypothesis accords better with the observed facts.

Observed values of gravity appertain to different level surfaces of the earth and before any use can be made of them, they have to be reduced to the same surface, usually the geoid. In this process, uncertainties are introduced due to various causes, and reductions like the isostatic one which are very suitable for the purpose of the geodesist may actually lead to obscurity for elucidation of small-scale geological features on account of the non-existence of compensation therein. Considerable experience is required for choice of reduction to be used for a particular purpose. Geodesists so far have paid little attention to local geology as in vast areas that they deal with, things get averaged out. What is important from their viewpoint is that the reduction should be rigorously computed. For interpretation of geology of areas such as the Indo-Gangetic trough much greater liberty can be taken and empirical reductions can be resorted to, but a close liason between the geodesist and geologist is indispensable.

In India the Hayford anomalies have generally been employed for the reduction of gravity results and these are computed on the assumption that surface rocks have a normal density, 2.67. This is obviously erroneous as such extensive areas are overlain by dense Deccan Trap and still wider areas by light alluvium. Thick sedimentary series such as occur in areas of Assam, Burma and Indo-Gangetic plain can alter local values of gravity by a considerable amount. Just before the war, the *Burma Oil Company* established 6,000 gravity stations in Eastern Bengal, Shan Plateau and Burma, and for the interpretation of their results they applied the corrections for local geology upto a depth of about 8 miles. This would involve laborious computations if worked from *a priori* principles. To avoid this, short cuts and special templates were devised by the *Survey of India*, under whose direction, all reductions were carried out. The Hayford anomalies on which much of the discussions are based in India can thus only be regarded as preliminary and will be modified considerably in some areas after correction for local geology. While density correction upto sea-level can be made without much difficulty, corrections for density below that surface necessarily involve many doubtful assumptions and much geological information has to be collected to get reasonably accurate knowledge of rock densities down to a considerable depth and to assess the effects of compaction there. The finalizing of the anomalies in India in this light is an important task for the future.

Hayford anomalies, despite the unreal nature of the compensation they postulate, have given very useful information, but opinion is more or less unanimous that the major anomalies mostly arise from variations in depths at the various interfaces. Much research on this has been carried out by the *Survey of India* on a qualitative basis to bring out relation between gravity anomalies and crustal structure lines. A quantitative delineation of the warps at the interfaces is, however, not capable of a unique solution, is rather laborious and is also a task for the future.

A broad framework of gravity and deflection stations observed by the *Survey of India* exists in India proper. Their intensive study has revealed considerable areas in India where isostasy is not fulfilled. There is first the so-called "Hidden Range," a subterranean chain of rocks crossing peninsular India from Baluchistan to Bengal, first inferred by Burrard in 1901 from scanty data and now well delineated by modern work. This extensive region is characterized by a high value of gravity and an elevated geoid and observations in the Bay of Bengal and Arabian Sea are needed to trace its extension.

Associated with the Hidden Range are the Himalayas and the Indo-Gangetic trough both presumably owing their origin to the same tectonic cause. The Gangetic plain is an area of underload, deficiency there being equivalent to a skin density of —500 to —2,000 feet of normal rock condensed on to sea-level surface. As regards the Himalayas, observations have been made by the *Survey of India* in Kashmir area of the Himalayas only upto Deosai plains. Further to the north in the Karakoram, De Fillipi Expedition in 1913-14 observed at 12 gravity stations and still higher up in Pamirs and Ferghana, the Russians have carried out numerous observations. It appears that the outer foot-hills of the Himalayas are under-compensated but that the interior ranges are over-compensated. Ferghana basin is a region of great interest marked by large and rapidly changing gravity anomalies. Dr. Finsterwalder carried out a scientific expedition in the Nanga Parbat area, but his final results are not yet available. Provisional values indicated this area to be a zone of large mass-defect. The inferences drawn about the compensation of the Himalayas up to date are impaired by dearth of data in the Himalayan hills and valleys and much more observations are needed there.

Another very disturbed region is that of South Burma and Malaya which is associated with such a high value of geoidal rise that even the Hidden Range pales into insignificance as compared to it.

A most interesting feature about India, despite its possessing the mighty Himalayas, is that on the whole it is a region of deficient mass. Both geoidal and gravity evidence point to this, the geoidal one in the sense that the geoid in countries to the east and west is more elevated than in India, and the gravity in the sense that gravity anomalies in India are predominantly negative. No geological explanation of this phenomenon has yet been forthcoming.

The present gravity mesh in India consists of stations above 70 miles apart. This has been executed by the *Survey of India* with a cumbersome pendulum apparatus involving a lengthy programme of work at each station. The situation as regards gravity observations has been revolutionized now by the advent of gravimeters which are very convenient and portable robust instruments capable of yielding a greatly increased outturn. The *Survey of India* have on order a Frost Gravimeter, with which it is proposed to establish a 10-mile grid. This would not only result in a fuller and more unified understanding of the anomalies involved, but would also provide bench-marks which will serve as starting points for any detailed exploration of limited areas. The denser mesh would also be of great help from the point of view of pure and utilitarian geodesy. It would enable the deflections at Kalianpur (the origin of the Indian geodetic triangulation) to be determined in terms of a unique earth spheroid and established on an absolute basis instead of their being arbitrarily on a local spheroid (Everest) as at present. It would also be indispensable for the determination of the local humps of the geoid with respect to the spheroid. For this purpose a network of gravity stations all over the globe is required and when in addition to the intensive operations proposed in India, the Indian Ocean, Arabian Sea and the southern hemisphere are also covered by gravity observations, very valuable and revealing information would have accumulated.

When we pass from dry land to the probing of rocky layers under the ocean, we are confronted with a much more difficult situation as everything is hidden from view. The oceans occupy a major portion of the earth and present problems of paramount importance. The investigations concerning them are still in their initial stage and comprise:—

(*a*) Determination of depths and positions to enable maps of the ocean to be made with detail and accuracy comparable with maps of land areas.

(*b*) Structural character of ocean floor composed of marine deposits on the top and the basic underlying rock.

In (*a*), the determination of the position of the ship when sounding is taken is still a major problem. The usual method of dead reckoning becomes uncertain by several miles on account of wind and currents and the astronomical position methods are also not sufficiently precise. Existing methods developed in the U.S.A. giving accuracy of 1 in 1,000 involve laying of a number of buoys and measuring distances between them by running a wire from a drum on the ship, or else by measure of the time taken by sound to reach the various buoys which are equipped with a microphone and a wireless transmitter. These methods are far too elaborate to be used in deep oceans and the problem of accurate position finding in mid-sea is yet to be solved. The impact of war has been very favourable in developing radar technique and this is the hope of the future for work of this kind.

As regards (*b*), the soundings have revealed that the ocean floor is far from being flat. Indeed it can be said to be as irregular as the surface of continents, and there are differences of levels in the oceans comparable to the Himalayas. Ocean ridges have been discovered in all the oceans, but data are not yet sufficient to reveal their character in detail. In the Indian Ocean there is the Murray Ridge commencing in the neighbourhood of Karachi (presumably as a subterranean continuation of Kirthar Range of Sind) and running in the S. W. direction. In mid-Atlantic, there are ranges on a scale comparable with the Himalayas. It is of great interest to discover whether these ridges are folded ranges, or submarine volcanoes. Work of such a nature requires international co-operation. In the Indian Ocean a lot of useful information was collected by the John Murray Expedition in 1933, which worked for about 27 weeks on sea in the trawler "Mabahiss" mapping the ocean bottom and trawling and dredging to secure bottom fauna. Fragments of rock bottom can be brought up in a dredge or grab, but to get an idea of the thickness and composition of sediments and rocks, the help of indirect methods such as the seismic and gravimetric has to be sought.

The seismic method is comparatively of recent origin and has been conspicuously successful in improving our knowledge of the earth's interior. It rests on the property that the velocity of waves generated in an earthquake depends on the elastic properties of the material through which they pass. Seismology by itself cannot decide the type of material at various depths. Difficulties of

investigation increase with depth and tentative conclusions only have to be drawn in several cases as the enormous pressures and temperatures that occur in the earth's interior, are not capable of being reproduced in the laboratories. A study of records of natural earthquakes of sufficient energy to penetrate the entire crust has revealed discontinuities at great depths, which make themselves felt by reflecting and refracting the waves and also has given a good idea of the coarser crustal structure. The core starting from a depth of about 3,000 km. has been found to be unable to transmit distortional waves which points to its being in a molten condition.

In regional geology and applied geophysics, however, interest centres in the main round the fine structures near the top of the crust, say, the first 80 to 100 miles. This part of the crustal structure is very complicated and is very different in different regions. A study of travel-times of waves in near earthquakes (i.e., whose records are within 1,000 miles from the epicentre) has shown that the first 50 miles of continental part of the earth's crust is made up of three layers, starting with the granitic layer and followed by basic and ultra-basic zones. A point of considerable interest naturally is whether crustal structure under the oceans is of the same pattern as that under the continents. The theory of isostasy based on gravity and deflection work on land implies that the relative lack of attracting matter due to the waters of the ocean must be compensated for by relative excess underneath. This in the main has been found to be the case as judged from gravity observations and geodesists believe that differences of density between sub-continental and sub-oceanic rock are almost entirely confined to the top 50-mile layer of earth. In particular, the granitic layer is believed to be absent under most part of the Pacific and Indian Oceans. The shell below the depth of compensation is still believed by many to be in perfect hydrostatic equilibrium but is controverted by the phenomenon of deep focus earthquakes. If materials at depths beyond 50 miles were entirely devoid of strength, it would not be possible for them to accumulate stresses, the release of which is essential for the production of earthquakes. This is confirmed by the widespread gravity anomalies on land and sea which imply loads of such horizontal extent that they would require an impossible strength if they were to be supported by upper layers alone.

Gravity observations play no less a part on oceans than on land, but are much more troublesome as the pendulums have to be swung in a submerged submarine to get over the shaking, and accurate position finding is more difficult. Gravimetric observations in the waters of Dutch East Indies by V. Meinesz have brought out features of unique importance. There is a narrow strip of strong negative anomalies differing by a large amount from the positive anomalies in the neighbouring regions. It runs parallel to W. coast of Sumatra and has been delineated by Meinesz to the parallel of 5° S. Recent observations by the *Survey of India* at one station in the Andaman Islands and at some stations in S. Burma indicate that this negative strip passes through the Nicobar and Andaman Islands, and then links up with the line of negative troughs through W. Burma to the negative trough forming a foredeep of the Himalayas and then possibly continues on to Russian Turkestan. This line is obviously a tectonic line of earth's structure and marks a region of structural instability. It passes over submarine ridges and islands but curiously enough runs to one side of the ocean deeps and not directly over them. By the side of this negative strip there is a line of positive gravity anomalies passing through the line of volcanic activity through Sumatra, Java and Flores. This also appears to continue via the Volcanic Barren Islands to Burma.

In this connection there are interesting gaps in the Bay of Bengal, Indian Ocean and South China Sea which when filled will yield results of capital importance. The indications are that gravity will be in excess in these oceans.

Another major geophysical science which needs special mention is Terrestrial Magnetism. A continuous record of the earth's magnetic field is made at a large number of observatories on the earth and fluctuations at any place are analyzed for various periods such as a day, a year and a lunar day. The study of genesis of these periods is of great interest.

The magnetic declination of a country displayed in the form of generalized charts which give lines of equal magnetic declination (isogonic lines) at a given epoch is what no civilized country can do without.

Such charts are indispensable for land and hydrographic surveys as well as, for nautical and aeronautical purposes. For the initial drawing of isogonal charts an elaborate general magnetic survey is necessary. For India, this survey comprised observations at 1,400 field stations by the *Survey of India* (giving a density of about one station per 1,000 sq. miles), and five permanent magnetic observatories equipped with continuously recording magnetographs. In addition 80 Repeat Stations were chosen which it was the intention to visit quinquennially to keep track of secular variation in the various elements. Due to financial stringency, the various permanent observatories except Alibag have closed down, and for the same reason, the programme of observations at Repeat Stations has not been kept up. Apart from the effect of this break on pure science, its practical drawback was felt during the last war when magnetic declinations had to be put on topographical maps for military purposes. Secular variation had to be extrapolated over a period of 20 years and the situation had deteriorated so far that doubts exceeding 1° about the value of magnetic declination existed in some parts. It is most desirable to reopen the four inactive magnetic observatories (the southernmost being shifted to the Magnetic Equator) and to start regular observations at Repeat Stations and also to initiate systematic earth current registration work.

The magnetic data in the Indian Ocean is based on the last cruise of the non-magnetic ship " Carnegie " in 1919 and are consequently very uncertain now. Considerable discrepancies exist between Admiralty and Australian charts in the area south of latitude 10° N. round about Australia and to the west of it in the Indian Ocean. For any work in these oceans and in the outlying islands international co-operation is necessary.

The general magnetic survey of India has given a picture of magnetic anomalies and revealed some disturbed regions, which need to be studied in detail and a general connection between geological structure and magnetic anomalies has yet to be worked out.

The foregoing discussion is an attempt at giving a broad outline of the gravity, deflection and magnetic programme needed to elucidate deep-seated effects well below the limit of geophysical prospecting. Although considerable progress has been made in India towards completion of these programmes, the situation in oceanic and mountainous regions is still too obscure. Much more detailed work is required for the study of the origin of the mountains and the warpings at the interfaces of the crust. This study assumes considerable importance on account of the possibility, that the tectonic earthquakes that occur from time to time in India may well be a continuation of the process which has created the Himalayan mountains.

Geophysical Exploration

The economic exploitation of minerals constitutes a major current problem in India, and at the Empire Scientific Conference held in London in June 1945, the Indian delegation stressed the need for the geological mapping of known mineral bearing areas and applying geophysical methods of exploration there.

The methods most commonly applied to geophysical prospecting are gravitational, magnetic, seismic and electrical. To a lesser extent, methods based on elastic properties, thermal and radio-active effects have also been utilized. The apparent simplicity of some of the instruments used is unfortunately extremely misleading as the handling of data in practice is fraught with many difficulties, especially as regards reduction and interpretation. Usually one method by itself is incapable of giving a reliable result and has to be supplemented by other methods.

Activities in India in this branch of geophysics have been sadly neglected and no systematic work has been done yet. *The Punjab Irrigation Research Institute* carried out some traverses with the Eotvos torsion balance in the districts of Shahpur and Lyallpur to ascertain depths of previous alluvium.

The Geological Department of Mysore State has carried out several electrical surveys on some ore deposits and for estimating water-table depths.

The *Survey of India* at the request of the *Geological Survey* has carried out the location of a manganese reef in Parsoda area (Nagpur) with the help of a gradiometer and did some preliminary work by electrical methods in connection with prospecting for mica-bearing pegmatites in the Mica belt of Bihar.

By far the largest amount of work has been carried out by the well equipped *Burma Oil Company*, in collaboration with the *Shell Group*, the *Anglo-Iranian Oil Company* and the *Petty Geophysical Engineering Company of America* in search for oil. The results of the work of such companies as also the instruments they use are on the whole kept secret. In 1937-39 alone, they have covered an area of about three and a quarter hundred thousand miles in Assam, Bengal and Burma. The work of this organization was interrupted by the outbreak of war, but now some work seems to be in progress in Western Punjab.

The chief success achieved by geophysical methods is in the domain of oil prospecting. These methods do not locate oil directly but aim at divulging the subsoil structural features most favourable for the accumulation of oil. The last World War has brought forth an important advance by the development of new types of magnetometers which enable the magnetic exploration for oil to be carried out from an aircraft. The method has several attractive features, not the least of which are the speed and the facility with which difficult areas such as swamps, water and jungle can be covered. The aeroplane is fitted with elaborate position reading devices. Other fields for the application of geophysical methods lie in the location of mineral deposits such as gold, aluminium, manganese, nickel, coal, etc. Delineation of geological structures such as faults, anticlines, dykes and ridges below sediments have been made possible by these methods as also the location of salt domes. Their significance in application to engineering problems such as selection of dam sites, foundation conditions, depth to water-table has been well established now. In Canada during the last war a technique was developed for obtaining warnings of imminence of rockbursts in deep mines with the help of geophones.

There is no dearth of important areas in India which need exploratory work. Vast areas are blanketed by alluvial deposits and lavas of old age, the structure of the country below them being entirely hidden. The southern borders of the Indo-Gangetic plain possibly contain buried coal and oil fields and the Deccan Trap is likely to reveal valuable hidden minerals. The structural investigation of the igneous basement rocks under the Indo-Gangetic trough by seismic methods has yet to be tackled and much remains to be done as regards the depth and form of the gangetic trough and details of its flanking rocks and their slopes.

In other parts of the globe, information about top layers of the earth's crust has been made possible by a network of seismic stations on land; the establishment of seismic stations on islands in deep sea is still a desideratum. In India, valuable field work has been done by the *Geological Survey* for investigating earthquakes but a systematic study of the diverse earthquake problems has not yet been started. Proposals are afoot to establish seismological observatories along the earthquake belt under the ægis of the *Meteorological Department*. These are imperative at this time more than ever before as the construction of big dams is being contemplated in earthquake zones.

Yet another problem awaiting solution is the delineation of the buried ridges in the alluvial plains of India which are devoid of any marked topographical features. These have a damming effect on water level and are of great interest to irrigation engineers for the solution of water-logging problems. One such ridge is the Delhi-Shahpur ridge composed of dense rock. Indian gravity stations are not yet sufficiently numerous to show up such buried features in detail and data for the study of these ridges and their effect on water-table is woefully inadequate at present.

The above constitute a very strong plea for the application of geophysical methods on an intensive scale in future. Little has been done so far but it is gratifying to note that in consultation with the Mineral Adviser to the Government of India, the *Geological Survey* in collaboration with the *Survey of India*, is starting on a programme of exploratory work in this connection. The *Survey of India* will provide a gravity and magnetic framework and the geophysics section of the *Geological Survey* will carry out detailed observations. Modern delicate instruments are costly and not easily obtainable in some cases. Trained personnel are another difficulty and for some time to come, a good deal of judgment will have to be exercised to bridge the gap between the desirable and the practicable.

To sum up, we see that quite a lot of the globe is undeveloped geodetically and geophysically. In India there are outstanding geophysical problems awaiting attention for

(*Continued on page* 71)

Board of Scientific and Industrial Research

EIGHTEENTH MEETING — NEW DELHI

A MEETING of the Board of Scientific and Industrial Research was held in New Delhi on 8th February 1947, under the chairmanship of the Hon'ble Sri C. Rajagopalachari.

The Board recommended to the Governing Body of the Council the renewal of 14 departmental schemes and 75 non-departmental schemes. As many as 14 new schemes were recommended by the Board for sanction. The new schemes are:—

1. Prof. F. Adcock (*Bangalore*): Investigation on the development of high purity manganese and the study of its effects as an alloying element with other non-ferrous metals.

2. Dr. R. N. Ghosh (*Allahabad*): Measurement of absorption coefficient for sound waves in air and polyatomic gases.

3. Dr. S. C. Sirkar (*Calcutta*): Investigation of Raman Spectra of organic compounds at low temperature.

4. Dr. G. B. Deodhar (*Allahabad*): Chemical effects in X-ray emission and absorption spectra.

5. Dr. G. P. Kane (*Bombay*): Manufacture of phenol from chlorobenzene.

6. Mr. B. M. Banerjee (*Calcutta*): Development of a new technique of investigating the ionosphere.

7. Dr. H. Rakshit (*Calcutta*): Investigations on microwaves emitted from extra terrestrial sources.

8. Dr. Mata Prasad and Mr. G. C. Mitter (*Bombay*): (i) Further investigations on standardization methods of quantitative estimation of beryllium in the ore; (ii) Investigations on methods of opening up the mineral beryl, and manufacture of the metal with particular reference to the following lines of investigation:

$BaCl_2 + 2\ Na\ (vapour) \rightarrow Be + NaCl$;
$BeO \rightarrow BeCl_2 \rightarrow Be$;

(iii) Methods of preparation of beryllium salts suitable for electrolysis.

(9) Mr. M. Sreenivasaya (*Bangalore*): Study of industrial wastes as supplemental sources of nitrogen and vitamins for the fermentation industries.

10. Mr. Mansa Ram (*Delhi*): Preparation and production on a large scale of pure amino acids from natural sources and by synthetic methods.

11. Prof. P. B. Sirkar (*Calcutta*): Chemical composition of Tipper's collection of rare earth minerals of India.

12. Drs. M. O. Farooq and Abdul Aziz (*Aligarh*): Investigations on Sahar Farsee (*Zataria Multiflora*).

13. Drs. M. O. Farooq and Abdul Aziz (*Aligarh*): Isolation of the gelatinizing principle (pectin) of Bemisal Bel (*Coculusvalusus*).

14. Dr. G. P. Contractor (*Jamshedpur*): Wear of metals.

Cellulose Research.—The Board accepted the recommendations of the Cellulose Research Committee that the scope of work of the Committee be extended to cover research on all aspects of cellulose and related products and the co-ordination of such research in the country. The Board also accepted the recommendation of the Committee to hold a conference of cellulose research workers of India at Delhi.

The Governing Body of the Council decided that, subject to funds being obtained from the Government of India, an equipment capital grant of Rs. 3 lakhs be made to the Research Institute of the *Indian Academy of Sciences*, Bangalore, directed by Sir C. V. Raman.

The Governing Body accepted the donation of Rs. 5,000 from the *Newspaper Association of India* in connection with research to be undertaken in the Council's laboratories on the manufacture of newsprint.

The Council examined carefully the present position arising out of the indiscriminate use of aero-scrap (scrap metal from aeroplane parts available from the *Disposals Directorate*) in the manufacture of cooking utensils and decided that the attention of the Government of India be drawn to the urgent necessity of warning against such use, as aero-scrap has been found injurious to health when used for cooking food. The Council have decided to institute research in the remelting of the scrap and grading of the alloy in order that only such of the alloys as are non-injurious may be utilized for the fabrication of cooking utensils.

Iron Ores*

By F. G. PERCIVAL

(Tata Iron and Steel Co., Ltd., Jamshedpur)

IRON is one of the commonest of the metals, standing fourth amongst the constituents of the earth's crust, of which it comprises 4.44 per cent. The degree of local concentration, that constitutes a workable iron ore deposit varies very considerably in different parts of the world. In Britain, for example, ores with barely 30 per cent. iron are being mined and smelted, though these ores of low iron content usually contain also some lime that assists in fluxing, or are carbonate ores that are calcined before smelting. In India, while ores containing as low as 54 per cent. iron are being fixed with higher grade ores for smelting, an average of about 60 per cent. Fe content is maintained by the major iron and steel companies in Bihar and Bengal. The Mysore Iron and Steel Works are smelting ores of 55 to 60 per cent. iron content. Lower grades than these are not usually considered to be workable ores in India.

It is generally agreed that iron smelting was practised in India at a very early date, but whether as early as 3,000 B.C., as in Egypt, is uncertain, though it is not improbable that the iron blade found in one of the Egyptian pyramids was of Indian iron, in which there was a regular trade throughout the Levant from time immemorial. Unfortunately iron articles usually rust away in the course of centuries, and iron domestic articles and weapons of early ages are rarely preserved for our inspection.

The Iron Pillar now erected beside the Kutab Minar near Delhi is exceptional in this regard. It was wrought during the reign of Samudragupta[1], the second Gupta monarch, whose reign commenced about 330 A.D. The iron for this pillar was presumably made in small blooms of about 10 lbs. each, in primitive furnaces similar to those used by the Agarias still practising their craft over a wide area from the Central Provinces to Bihar and the Orissa States. These blooms were welded into the pillar, 23'-8" high with a diameter of over 16" at the base. Similar blooms were used for the long iron beams employed in the construction of the temple of Konarak, 20 miles north of Puri, but here the welding was not so skilful. The age of the Konarak temple has been variously estimated from the ninth century to 1256 A.D.

The steel exported from India to the Levant was used for the manufacture of Damascus blades. Col. Yule suggests that the name "Ondanique" used for steel anciently supplied to Venice by Persian merchants, was a modification of "Hundwaniy" or "Indian" steel[2].

A comprehensive description of the design and operation of the small furnaces still used by the local Indian smelters has been given by Dr. A. McWilliam[3], and Verrier Elwin's monograph[4] evidences his intimate knowledge of the myths and craft of the present-day Agarias, whose furnaces are becoming fewer in number with the development of India's modern iron and steel industry. Statistics of the numbers of furnaces operating in the Central Provinces only are given in the Quinquennial and Annual reviews of *Mineral Production in India*, published in the *Records of the Geological Survey of India*. The latest published figures are as follows:—

	No. of furnaces		No. of furnaces
1929 ..	174	1934 ..	120
1930 ..	124	1935 ..	127
1931 ..	106	1936 ..	92
1932 ..	118	1937 ..	110
1933 ..	114	1938 ..	136

Description

The chief minerals that are worked as ores of iron are:—

(1) *Magnetite*, Fe_3O_4 (Magnetic iron ore or lodestone) containing 72.3 per cent. of metallic iron and 27.7 per cent. of oxygen. Pure magnetite is the richest of the iron ores.

(2) *Hematite*, Fe_2O_3, known in its various forms as red hematite, specular hematite, oolitic hematite, etc., containing 70 per cent. of metallic iron and 30 per cent. of oxygen.

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor, 20, Pusa Road, New Delhi.

(3) *Limonite.* The limonites, or brown ores are hydrous ferric oxides, to which various names have been given in accordance with increasing percentages of combined water. Of these, *Goethite* (Fe_2O_3, H_2O) appears to be well defined, physically and chemically, and *Lepidocrocite* appears to be of the same composition, but has a lower specific gravity. The other minerals grouped generally as Limonities appear to be mainly amorphous *Goethite* (or *Lepidocrocite*) with absorbed and capillary water.

(4) *Siderite.* Iron carbonate, $FeCO_3$, with, if pure, 48.2 per cent. metallic iron. Frequently in nature the carbonate is a mixed iron-lime carbonate, and sometimes part of the iron is replaced by magnesium or manganese.

Iron silicates and iron sulphides are rarely worked as ores of iron. Laterite, which may be of some importance amongst Indian iron ores, is worked as iron ore in Cuba. Large deposits of laterite occur in the Philippines and Dutch East Indies. It is a residual weathered material, consisting largely of iron and aluminium hydroxides.

Mode of Occurrence

Only a few of the world's iron ore deposits are of direct igneous origin. The bulk are formed by deposition from surface or underground waters, the iron being normally derived by solution from pre-existing rocks under ordinary temperature conditions. In minor cases, the iron minerals are carried in suspension to form iron sands. Certain important lateritic ores in Cuba, Borneo and Philippines are of residual origin.

The deposition of iron carried in solution may be caused by such factors as relative solubility, e.g., iron solutions traversing limestone beds may take the lime carbonate into solution and deposit iron carbonate, the latter replacing the dissolved limestone. Evaporation and consequent saturation may also cause deposition of dissolved iron compounds. Electrolytes occurring in natural waters are effective precipitants of iron. Mixed hydrosols of iron oxide and silica tend to precipitate each other except when stabilized by small amounts of organic matter in solution, and this stability is destroyed by the action of sea water.

The major Indian hematite deposits were originally of sedimentary origin, though much altered after deposition. The Indian lateritic ores are residual or surface deposits, and certain Indian deposits of magnetite are genetically associated with igneous rocks.

Distribution in India

Bihar and the Orissa States.—The most important iron ore field in India is situated in the Singhbhum District of Bihar and the adjoining Indian States of Keonjhar and Bonai, with smaller isolated deposits in Mayurbhanj State. These last were the first to be discovered, in 1904, by Mr. P. N. Bose, State Geologist of Mayurbhanj. Gorumahisani Iron Mine (22° 18′ : 86° 17′) in Mayurbhanj State was opened up in 1910 by the *Tata Iron and Steel Company*. Two more iron mines in Mayurbhanj-Sulaipat (22° 8′ : 86° 13′) and Badampahar (22° 4′ : 86° 7′) commenced despatches to the same *Company* in 1922. In 1907, an independent prospector, Mr. R. Saubolle, had discovered the large deposits of Nota Buru and Pansira Buru near Manharpur (22° 22′ : 85° 12′) in Singhbhum District and these were opened up by the *Bengal Iron and Steel Company*, in 1910. From 1916 onwards extensive exploratory work by the prospectors of various iron mining companies revealed large deposits further south, and commencing in 1918, the *Geological Survey of India* carried out a survey of the whole field[5].

The ores occur in a series of phyllites, banded hematite quartzites, tuffs and lavas of pre-Cambrian age, commonly considered to be Dharwars.

The banded hematite-quartzite, which is the " mother rock " of the ore, is similar to the jaspilites of the Lake Superior region. In fact, the deposits as a whole bear a striking similarity to ores of the same age in the U.S.A., Brazil, South Africa and Australia. The banded hematite-quartzite is generally accepted as of sedimentary origin, though Dunn[6], whilst admitting the sedimentary nature of the banding, considers the cherty silica to be secondary. The banded hematite-quartzite consists of alternating layers of jasper and almost pure hematite (and martite) varying from thin wafers up to an inch or more, but commonly about a quarter-inch thick. The jasper may be white, yellow or rarely green, but most commonly is red, and this last type, when examined in thin sections, is seen to be coloured by fine particles of hematite.

The unaltered banded hematite-quartzite, which contains from 20 to 30 per cent. iron

and 70 to 55 per cent. silica, alumina being less than 2 per cent., is altered to workable iron ore by the leaching out of the silica by meteoric waters[7]. These waters may have introduced some aluminous material, but generally no true replacement has occurred in this process. The removal of the silica bands has merely left open spaces and in consequence the alternating hematite layers have broken up, and have been crushed together by the weight of the overlying beds, producing an easily-worked "slump" textured ore, with an iron content from about 58 to 63 per cent., alumina 4 to 5 per cent., silica 2 to 4 per cent., phosphorus about 0.03 to 0.08 per cent., sulphur 0.01 per cent. and manganese about 0.08 per cent. Leaching is by no means complete and occasional isolated blocks of unaltered banded hematite-quartzite interfere with the mining of the ores.

Another type of ore is massive, almost pure, hematite in beds up to a thickness of 60′. The texture is finely banded and generally does not show a greatly broken "slump" condition. The ore may have been so deposited originally or perhaps the silica layers of the banded hematite-quartzite may have been replaced by hematite through the action of meteoric waters. The iron content of this massive type ranges from about 66 per cent. to practically pure hematite. Silica and alumina are each less than 1 per cent., and phosphorus may be as low as 0.015 per cent.

A third type of ore is an extremely friable hematite powder—"blue dust ore," also rich in iron (65 per cent. and thereabouts). It has presumably been produced by a bleaching process from banded hematite-quartzites, as numerous lateral passages from the one to the other are visible in the mine workings.

Of minor importance as ores are ancient iron-ore conglomerates[8] and comparatively recent consolidated surface ore-debris. In the former the cementing material is hematite; in the latter, laterite.

The chief operating mines are the Noamundi Iron Mine (22° 8′ : 85° 30′) of the *Tata Iron and Steel Company*, the *Gua* (22° 13′ : 85° 23′) and Manharpur Mines of the *Indian Iron and Steel Company*, the mines of *Messrs. Bird and Company* near Barajamada (22° 10′ : 85° 25′) and the three Mayurbhanj mines already mentioned. These, however, are only touching the fringes of the main iron ore beds, which occur in a series of roughly parallel forest-clad ridges and hills running from south-west Singhbhum south-westwards through Keonjhar and Bonai States for a distance of about 40 miles. The beds usually dip to the west-north-west, with considerable overfolding. The stratigraphy of the area is still under discussion. Throughout the field there is little variation in type, though it is possible to despatch special high silica grades, with SiO_2 from, say, 6 per cent. to 8 per cent. and iron about 56 per cent. and special high iron grades (Fe about 68 per cent.), if needed.

Jones estimated the total amount of ore, of 60 per cent. iron content and over, at roughly 3,000 million tons, but said he had little doubt that when the deposits had been opened up, the true figures would be found to be more than double this estimate[9]. The development of the working mines has confirmed this view. Recent re-surveys of Gorumahisani and Badampahar iron mines in Mayurbhanj State have proved new beds increasing their remaining reserves to 52 million tons. The Singhbhum mines are similarly proving richer than at first estimated, and Jones' estimate of 3,000 million tons may be still conservatively increased to 8,000 million tons[10].

Other Deposits in Bihar and the Orissa States.—Vanadium-bearing titaniferous magnetites, genetically associated with basic igneous rocks, occur in Mayurbhanj State and just over its border at Dulabera (22° 30′ : 86° 18′) in the Singhbhum District. The Dulabera deposits are stated to be small[6], and though no published estimates of the reserves available in Mayurbhanj State are available—the iron ore debris at the largest deposit is estimated as one million tons by Dunn[11]—it appears probable that they will be of the order of ten million tons or so. Dunn suggests that these ores should be considered less as iron-ores than as a source of vanadium and possibly titanium. In fact a plant to extract the vanadium has been erected near Rairangpur station on the Bengal Nagpur Railway and this factory has already started the extraction of vanadium as vanadium pentoxide.

Apatite-magnetites of East Singhbhum.—The *Bengal Iron Company* formerly worked certain apatite-magnetite deposits near Kudada (22° 42′ : 86° 12′). The deposits are small and possibly they were worked largely for their phosphorus-content.

Bengal.—Hematitic ores were formerly worked by the *Bengal Iron and Steel Company* in the ironstone shale group of the Raniganj coalfield. The ore occurred as " discontinuous seams or strings of nodules consisting of clay ironstone[12] ". The quality was very variable but iron averaged about 39 per cent. They were rather high in phosphorus and with the depletion of the outcrop workings and the discovery of the Singhbhum hematites, the use of these ores was given up. The reserves have been very variously estimated from as high as 200 million tons in every square mile to only 6.4 million tons per square mile[13]. The distribution of the ore in the shale is given as 1′ in every 10 to 12′ of shale. With so much waste to be disposed of, and with such rich hematite ores at no great distance away, these deposits may be considered unworkable.

Mysore.—Iron ores are widely distributed in the State. The main deposits are banded ferruginous quartzites, associated with crystalline schists considered to be of Older Dharwar age. In the more northern deposits they are hematitic, but in the south, they are more intensely altered and contain a larger proportion of magnetite. They are usually steeply inclined, but in the eastern portion of the Bababudan Hills, they flatten to a nearly horizontal bedding. Leaching of the silica has given residual enriched deposits, which are worked by the *Mysore Iron and Steel Works* at Kemmangundi (13° 33′: 75° 45′) at an elevation of about 4,800′ above sea level, to feed their smelting furnace at Bhadravati, 35 miles distant. The iron content of these leached ores runs up to 64 per cent. but the average of the ore as despatched runs from 55 to 60 per cent., with silica averaging 4.5 per cent. and alumina 7 per cent. These ores and other local deposits are estimated as 5 to 10 million tons of about 64 per cent. iron grade, 25 to 50 million tons running up to 60 per cent. iron and at least a hundred million tons of lower grade down to about 55 per cent. iron.

Massive hematites and limonites of replacement origin are found in the Shimoga and the Chitaldrug Schist belts, but they are far from the railways and have not been closely prospected.

Titaniferous iron ores, probably of magnetic origin, occur associated with ultrabasic rocks in Shimoga and Hassan Districts and further south in some parts of Mysore District. They are generally free from phosphorus and contain some Cr_2O_3. The deposits are small, possibly aggregating to a million tons.

Certain quartz magnetite ores, containing ferromagnesium silicate appear to be a highly metamorphosed facies of the Dharwar banded hematite-quartzites, and are not of commercial importance at present.

Madras.—Iron ore deposits, mainly magnetite, occur chiefly in Salem and Trichinopoly Districts.

The main deposits are reported by Krishnan[14] as occurring in the following hills and areas in these districts.

1. Kanjamalai (11° 37′: 78° 3′).
2. Attur Valley. Godumalai (11° 41′: 78° 20′); area north-east and south of Godumalai; Vellakundam hills including Perumamalai; Singipuram and Puduppalaiyam hills.
3. Attur area—Tammampatti; Singiliyankombai.
4. Tainandamalai and Chitteri hills—Belur and Sittilingi.
5. Tirthamalai.
6. Area between Namakkal and Rasipur.
7. Kollaimalai.
8. Pachchaaimalai and its spurs.

The ores occur in bands of magnetite-quartzites " associated with a series of schistose and gneissic rocks, the most prominent amongst which are chlorite and talc-schists, and amphibole and garnet bearing gneisses. They form a conformable series, though metamorphosed and often severely folded. Much of the succession seems to be of sedimentary origin, but it is probable that some igenous materials have also been involved. The metamorphism has been responsible for the conversion of the ferruginous sediments, deposited perhaps as mixtures of ferric hydroxide and silica, into magnetite quartzites." Some hematite is present, but the average ore contains less than 10 per cent. of the amount of magnetite present. Some of the ores are alternate bands of magnetite and quartz, in layers averaging $\frac{1}{8}$ to $\frac{1}{4}$ inch, and often crumples in a fashion similar to the Singhbhum ores. Local types are irregular or granular.

The iron content of the ordinary ores is about 35 to 40 per cent. with silica about 50 per cent., phosphorus variable (sometimes high) and practically no sulphur. Titania may be up to 1 per cent.

Assuming a workable depth of 100′ from the outcrop, Krishnan makes a conservative estimate of 304,650,000 tons for all the deposits, the chief being Kanjamalai (54.6 millions), the Chitteri hills (55.4 millions), and Kollaimalai (67.4 millions). He considers that three or four times this quantity may be yielded. Concentration by magnetic methods will give ores with over 55 per cent. Fe, the hematite present being lost in the tailings. Sen Gupta[15] states that in the case of Kanjamallai three-sevenths of the iron would be lost owing to the high proportion of hematite present.

Lack of locally available coking coal is an important consideration.

C.P. and neighbouring States.—The ores of the Drug District were noticed by P. N. Bose in 1887 and were prospected and drilled[16] by C. M. Weld of *Messrs. Tata Sons* in 1903-04. The *Tata Iron and Steel Company* afterwards took a lease over the area, but with the discovery of the ores of Mayurbhanj, the Drug ores were left unworked. The iron ores occur in a range of hills rising to about 400′ above the plain. Banded hematite quartzites occur associated with phyllites as is common in the "Dharwar" iron ores. The average analysis of the surface samples of ore was as follows:—

	%		%
Fe	.. 66.35	P	.. 0.058
SiO_2	.. 1.44	S	.. 0.108
Mn	.. 0.151		

The cores from the borings gave even better results with Fe averaging 68.56 per cent. The quantity proved was 7½ million tons but much larger quantities certainly exist here. B. C. Gupta[17] has estimated the reserves at 113 to 175 million tons.

In Chanda District, the Lohara hill mass, which was formerly leased by the *Tata Iron and Steel Company*, and worked for some years, is of even richer grade than the Drug ores. It is estimated to contain over 2 million tons of ore.*

Bastar State.—The iron ores of Bastar State occur in the Bailadila Range[18]. As in the Singhbhum-Orissa belt, the main rocks are banded hematite-quartzites. These pass downwards into ferruginous schists and both are intricately folded, so that vertical schistosity has obliterated the original bedding planes. There are two main high parallel north-south ridges. Crookshank considers the hematite deposits to be formed by replacement of the quartz of the banded hematite-quartzites and in some cases by replacement in the schists. Leaching of silica from the banded hematite-quartzites has formed slump ores here as in Singhbhum. The slump ores are roughly of 60 per cent. iron content and the massive ores, like those of Singhbhum, are almost pure hematite, generally containing over 68 per cent. iron. Phosphorus in the massive ores is about 0.065 per cent. and sulphur 0.05 per cent. though at one locality the phosphorus was higher—0.11 to 0.12 per cent. Crookshank estimated the reserves at 610 million tons, omitting the ferruginous conglomerates and lateritic hematite, and making no allowance for possible concealed beds. The reserves will certainly be found to be much larger when the deposits are worked.

Sandur State.—The central portion of Sandur State forms an oval basin, elongated from north-west to south-east, about 36 miles long, with a maximum width of about 12 miles. The town of Sandur is in the centre of this basin, and is surrounded by hill ranges of the iron ore series, overlying crystalline rocks. The banded hematite-quartzite is similar to that of the Singhbhum-Orissa field, and similarly overlies a series of "shales" and phyllites. There are also associated traps as in Singhbhum. The banded hematite-quartzite forms huge escarpments with an almost vertical dip in places. The hematites (with associated manganese ores) outcrop mainly above 2,600′ above sea level. Some "float" ore occurs below this level. The ore is sometimes covered by laterites, as elsewhere.

The iron ore is mostly hematite, with the same range from soft to hard ore as in Singhbhum. On a conservative estimate, well over 100 million tons of ore are available, with an iron content from about 61 per cent. in the softer ores to over 68 per cent. in the hard massive steel-grey types. Alumina and silica are low, as in the Singhbhum hematites, and phosphorus averages about 0.10 per cent., though selected deposits might be worked with lower phosphorus (about 0.03 per cent.). Occasional deposits of ochre are worked for paint manufacture.

Goa.—The iron ores of Goa and adjoining British district of Ratnagiri are of Dharwar age, mainly hard hematite and limonite with minute magnetite crystals, "At Bicholim, 22 miles from the port of Marmagoa

*Fox's figure of "100 million tons at least[13]" for the Lohara ores appears to be an error.

in Goa, the principal ore band has been traced for a distance of 7 kilometres and is said to vary in width from 30 to 100 metres[19]". At about 50′ below the surface, the ore is found to be largely friable schistose micaceous hematite. The surface hard ore is, however, available in "large quantities," with high iron, low silica and phosphorus below the Bessemer limit. Adequate information on these ores is not available.

Other Indian deposits.—It would swell this article immoderately to record the scores of small deposits of iron ore that occur in all the Indian Provinces. We have only described the major occurrences.

Burma.—The iron ores of Burma[20], while inadequate for the establishment of an iron industry, have been worked on a small scale to provide a flux for the lead smelting operations of the *Burma Corporation* at Namtu. The deposits are mainly residual hematite and limonite in nodules, lying near the base of a red clay capping dolomitic limestone. Five main deposits occur in the neighbourhood of Maymyo and Lashio, but apart from their use as flux they cannot be considered as of much importance. In addition, low grade lateritic ore is of common occurrence, and segregations of magnetite are reported in basic rocks near Mokpalin in Thaton District. The quantity of iron ore raised in Burma from 1926 to 1930 varied between 33,000 and 75,000 tons only per annum.

Ceylon.—Ceylon's deposits of ore are also comparatively small, although it has been suggested that the surface deposits of Ratnapura District would be amenable to electric smelting operations in small-scale ovens. The ores are soft spongy aggregates of hydrated iron oxides. A few million tons are available but phosphorus is rather high (P_2O_5 above 1.5 per cent.). The iron content averages 47 to 50 per cent.[21].

TABLE I

Summary of known reserves of major Indian iron ore deposits

Area	Estimated reserves (In million tons)	Fe content %
Bihar and Orissa States	8,000	60 to 68
Mysore	150	55 to 64
Madras	305	35 to 40
Drug District, C.P.	175	60 to 68
Bastar State	610	60 to 68
Sandur State	100	60 to 68

Mining and treatment.—Iron mining in India is all by open cast workings and up to date mainly by simple hand methods, though mechanical drilling is sometimes used for blast holes. Steam shovels are used for loading at Noamundi, and further mechanization is under active consideration. As the ore occurs in hills, it is lowered to the level of the railway tracks on the plains either by aerial ropeway (Pansira Buru near Manharpur, Gua, and Noamundi in Singhbhum, Badampahar in Mayurbhanj and Kemmangundi in Mysore) or by inclines. Feeder tramlines are commonly of 2′ gauge, but sometimes metre gauge.

Elsewhere iron ores are often concentrated to reduce freight, remove undesirable impurities and increase the iron content of the ores, thus increasing blast furnace output by reducing the amount of slag to be fluxed and removed. Some constituents such as water, sulphur and carbon dioxide, may be removed by heating. Others, interstitial matter or gangue, may be separated by hand picking, simple screening or by plain washing. Where this is not adequate, crushing and separation by jigging or by electro-magnet in the case of magnetic ores may be adopted. (If the magnetite ores of Madras are to be worked, this last process may be used.)

But as the Indian ores now mined are all high grade hematites (with trifling amounts of magnetite), the only treatment now necessary consists of the following: (*a*) Simple screening to remove the fines which may give trouble in the blast furnaces on account of size. (As the fines usually contain much more alumina and silica than the larger lumps, this is also concentration to some extent.) (*b*) Breaking and crushing the larger lumps to give a suitably sized product, commonly by hand, or by gyratory crushers at the loading points. (*c*) Blending the different grades of ores to give a uniform burden to the blast furnaces. This is now done by storing the various grades of ore in separate bins at the furnaces and drawing off skip loads in fixed proportions.

The practice of blending the ore to a regular even feed by storing in layers of varying grades and slicing across the layers is not as yet practised in India, but may shortly be adopted. Washing the ores by water in rotary washers is being tried, and sintering the fines and the blue powdery hematites with blast furnace flue dust is a likely possibility in the near future. In spite of the cost of such sintering and the present availability of vast quantities of high grade

lump ore, this should prove economical, as it will not only make use of a product not now used, but will improve blast furnace operation.

At present only insignificant quantities of the iron ore mined in India are used for any other purpose than smelting in the blast furnace. The possibilities of export have been discussed by Crookshank[18] with special reference to the Bastar State deposits.

Smelting

Although much work of an experimental or semi-commercial nature has been done in recent years on methods for the direct reduction of ore to "sponge iron" or to steel, yet almost all the steel products now in use have been derived from the reduction of iron ores in the blast furnace. Electric smelting of pig iron is in view, however, in Mysore State, limiting the use of charcoal to reducing purposes only, and using electric power for supplying the heat required.

The modern blast furnace is a circular steel casing, wide at the base and somewhat tapering upwards, lined with firebrick, water cooled in the hottest zones. The four constituents required for the production of pig iron are iron ore, fuel, flux and air. The first three are fed into the furnace at the top, normally from skips which draw their supplies in the required proportions from bins alongside the furnace. The air, after being heated, is blown into the furnace through a ring of tuyeres at a level near the base. In addition, scrap iron may be added to the charge, and if a specified manganese content is needed in the pig iron, small additions of manganese ore may be necessary.

The fuel (normally hard coke) burnt with the hot blast, gives temperatures of about 2,000° C. The oxygen of the ore combines with the carbon of the coke, allowing the released iron to melt and work its way down into the hearth at the bottom of the furnace. The silica, alumina and certain other impurities of the ore and of the coke combine with the lime and magnesia of the flux into readily fusible compounds which form a fluid slag. This slag, being lighter than the iron, floats on its surface, and is drawn off at intervals from a "slag notch" at a level above that of the iron. The latter is tapped out at intervals and is either run into ladles lined with firebrick for conveyance to the steel plant or pig casting plant in a molten state or is run off into moulds shaped in sand in an adjoining casting shed. In the latter case, the shape of the moulds is of a long major channel with smaller "pigs taking off at right angles." The main mould casting is, for obvious reasons, called the "Sow."

In addition to the iron and slag drawn off at the base of the furnace, gases and dust pass out at the top of the furnace. These are collected through pipes and dust catchers. Part of the waste gas is burnt in stoves fitted with checker brick. The fuel value of the gas comes from the carbon monoxide and hydrogen content, which amount to about 25 per cent. of the gas. After the bricks of one stove have been heated up, the gas is switched on to another stove, whilst air is blown through the recently heated bricks (or checkers). Thus by burning gas and blowing air in sequence through the stoves, the hot air blast is provided for the furnace. In order that the checker bricks shall not become clogged up with dust carried over beyond the dust catchers, it is now usual for the gas to be cleaned in elaborate electrostatic or other types of gas cleaning equipment. The flue dust collected in the dust catchers naturally contains considerable quantities of iron and carbon, and it can be utilized as a valuable constituent in the sintering of iron ore fines. Blast furnace slags are used in the manufacture of cement slag wool and other products, or may be crushed as ballast.

The pig iron may either be utilized in a foundry for remelting and manufacturing cast iron products or it may be removed in ladles as hot metal, and maintained at a high temperature in a fuel fired mixer, before being removed for conversion into steel. Comparatively small amounts are utilized in electric furnaces. The bulk of the steel now used is made either in the Bessemer Converter, or the Open Hearth furnace or in a combination of these two.

In the manufacture of pig iron in the blast furnace virtually all the phosphorus in the ore and other raw materials remains in the pig, and if too high, it has to be removed in the making of steel. If the phosphorus content is low enough, the iron may be converted to steel either in a Bessemer Convertor, or in an Open Hearth furnace, with a siliceous or acid lining—the acid Bessemer or acid Open Hearth process.

In the Bessemer Convertor, air is blown through the metal combining with certain

impurities, and in this process of oxidation the temperature of the metal is raised. No extra heating is required. In the Open Hearth process, the heat needed is produced by burning gases or liquid fuels with pre-heated air, the heating of the air being effected by utilizing the heat of the waste gases as they pass through checker bricks in a rectangular chamber on their way to stack. This process is reversible. A basic flux (lime) is added to combine with the phosphorus and silica to form a slag. In some cases, the slag is rich enough in soluble phosphate to be ground up for fertilizer (Basic slag), but this is not the case with Indian ores up to date. In the steel furnaces the manganese and carbon content of the metal may be reduced below that desired in the finished steel, and at the time of tapping, this is corrected by the addition of small quantities of ferro-manganese and carbonaceous material (coal, coke or pitch) to the metal. The steel is tapped into ladles, and is teemed into ingot moulds. The ingots after reheating to a suitable temperature in fuel fires, " soaking pits," are shaped between suitable series of rolls to whatever final product is desired.

Iron and steel manufacture in India.— Abortive attempts were made to manufacture iron on an industrial scale at Porto Novo, starting in 1830, Beypur on the Malabar Coast in 1833, South Arcot and Coimbatore Districts in 1853, and in Kumaon from 1857 to 1879, but the first company to work successfully on a large scale was the *Bengal Iron and Steel Company*, which took over the property of the former *Barakar Iron Works Company* in 1889.

The main iron and steel plants now operating in India are:—

(*a*) The *Tata Iron and Steel Company* at Jamshedpur (railway station—Tatanagar, B.N.R.) with five blast furnaces, varying from 500 tons pig iron capacity per day to 1,000 tons capacity per day. In 1941-42, production of finished steel was 824,238 tons with 204,231 tons of surplus pig iron.

(*b*) The *Indian Iron and Steel Company* at Burnpur near Asansol, with two blast furnaces each of 800 tons pig iron capacity per day. In 1940, production was 518,720 tons.

(*c*) The *Steel Corporation of Bengal*, also at Burnpur, which obtains its hot metal from the *Indian Iron and Steel Company* for conversion to steel. In 1942, it produced 241,078 tons of steel.

(*d*) The plant at Kulti, E.I.R., formerly the *Bengal Iron Company*, but now merged with the *Indian Iron and Steel Company*. It has two blast furnaces of 350 and 500 tons per day capacity respectively.

(*e*) The *Mysore Iron and Steel Works*, owned by the Government of Mysore and located at Bhadravati on the left bank of the river Bhadra, in the north-western part of Mysore State. It has one blast furnace with a rated capacity of 80 tons of pig iron per day. The fuel used is charcoal. In the British Empire, this is the only furnace of this capacity which is run on charcoal fuel. The output in 1938-39 was about 27,000 tons of pig iron, of which nearly 50 per cent. was used as surplus pig for sale and castings (mainly cast iron pipes for water supply), and the rest was converted into steel, supplemented with an equal quantity of purchased steel scrap. The average production of finished steel per annum is also about 27,000 tons, mostly merchant sections of bars and rods.

There are, in addition, a number of private and Government steel plants of smaller capacity, and numerous re-rolling mills.

The major iron smelting companies all own their own deposits of iron ore, and the only mines worked on a considerable scale for the sale of iron ore at present are those of *Messrs. Bird and Company* in Kenjhar State. Specifications for sale in India are simple, as the ores naturally occur of high grade. The iron content is usually specified in the neighbourhood of 60 per cent. Alumina, which tends to form a pasty slag in the blast furnaces, is limited. It commonly runs about 4 to 5 per cent., with silica rather less in the Singhbhum-Orissa ores. Phosphorus is rarely high enough to require special mention in Indian ore sales, and the main stress is laid on the size and freedom from fines, so as to give a well-sized product for the furnace.

The production of iron ore in India from 1924 onwards, which we have tabulated, is mainly from Singhbhum District and from Mayurbhanj and Keonjhar States. The figures up to 1938 were obtained from the

Records of the Geological Survey of India, the more recent figures being supplied by the Director of the *Survey*.

The remaining tables of imports and exports, were compiled from the annual statements of the *Sea-borne Trade of British India* up to 1939-40. Figures given after that date were derived from the *Monthly Survey of Business Conditions in India*.

Imports of iron ore were negligible.

Acknowledgments

I am greatly indebted to Mr. B. Rama Rao, Director of Geology, Mysore State, for information on the iron ores of Mysore; to the Director, *Geological Survey of India*, for unpublished statistics on iron ore production; to the *Tata Iron and Steel Company* for unpublished information based on the work of Mr. M. V. Rao in Sandur State, and on the plant at Jamshedpur; and to the *Indian Iron and Steel Company*, and the General Manager, *Mysore Iron and Steel Works*, for information regarding their respective plants.

References

1 Smith, V. A., *Oxford Hist. India*, 1941.
2 Yule, Col., *The Book of Ser Marco Polo*, John Murray, 3rd Ed., 1929, **1**, 93.
3 McWilliam, A., *Journ. Iron and Steel Inst.*, 1920, **52**, 159.
4 Elwin, Verrier, *The Agaria*, Oxford Univ. Press, 1942.
5 Jones, H. C., *Mem. G. S. I.*, 1934, **63**.
6 Dunn, J. A. and Dey, A. K., *Trans. Min. Geol. Inst. Ind.*, 1937, **31**.
7 Percival, F. G., *Trans. Min. Geol. Inst. Ind.*, 1931, **26**, 246.
8 Percival, F. G., *Trans. Min. Geol. Met. Inst. Ind.*, 1940, **35**.
9 Jones, H. C., *Rec. G. S. I.*, 1922, **54**, 212.
10 Percival, F. G., *Trans. Nat. Inst. Sc. Ind.*, 1947, **2**, No. 8.
11 Dunn, J. A., *Mem. G. S. I.*, 1937, **69**.
12 La Touche, *A Bibliography of Indian Geology and Physical Geography*, 1916.
13 Fox, C. S., *Trans. Min. Geol. Inst. Ind.*, 1925, **20**.
14 Krishnan, M. S., *The Iron Ore deposits of parts of Salem and Trichinopoly districts*, Government of Madras, Development Deptt. G. O. No. 4832, dated 11th Nov. 1944.
15 Sen Gupta, K. K., *Q. J. Geol. Min. Met. Soc. Ind.*, 1943, **15**.
16 Quinquennial Review of Mineral Production of India for the years 1929-33; *Rec. G. S. I.*, 1935, **70**.
17 Gupta, B. C., *Records G. S. I.*, 1937, **72**, 52.
18 Crookshank, H., *Trans. Min. Geol. Inst. Ind.*, 1938, **34**.
19 Quinquennial Review of Mineral Production of India for the years 1924-28; *Rec. G. S. I.*, 1930, **64**.
20 Clegg, E. L. G., *The Mineral Deposits of Burma*, 1939.
21 Wadia, D. N., *Administration Report of the Government Mineralogist for* 1939, Ceylon Government Press, 1940.

Location of Rayon Factories in India: A Survey

THERE has been a continuous rise in the consumption of rayon in India during the two decades preceding the war. About the time the last war started, the consumption of rayon goods in this country was about 28,000 tons, and it would have reached 36,000 tons by now but for the war.

An investigation was undertaken at the instance of the Cellulose Research Committee of the Board of Scientific and Industrial Research with the object of selecting suitable sites in this country for erecting rayon factories from various angles, viz., the availability of cellulose, chemicals, fuel, power, water and labour, due importance being given to transport facilities. Certain other factors such as effluent disposal, workshop facilities, vicinity of technical institutions, etc., were also taken into consideration. This investigation is based on two assumptions, viz., that the manufacture of rayon is an economic proposition in this country and that the viscose process is the most suitable one, at least to start with. The basic raw materials required for the manufacture of viscose rayon are cellulose, caustic soda, sulphuric acid and carbon-bisulphide. A brief survey of the available raw materials and factors determining the suitability of sites in several Provinces and States is given below.

Cellulose

Spruce pulp is the generally accepted form of cellulose for viscose manufacture. India possesses little of spruce and that too is not accessible economically. Pine, the next coniferous variety available in this country, is found at relatively higher altitudes and that too in a limited quantity. It appears prudent from the viewpoint of national economy to earmark this variety for its eventual utilization as a raw material for the would-be newsprint industry.

Cotton cellulose is the best raw material. The Indian Central Cotton Committee examined this problem and found that the price the rayon industry could possibly

afford to pay for short-staple cotton as a raw material for its use, would not prove remunerative to the grower. Cotton waste from the textile industry would be just as good for rayon manufacture but the non-uniformity of that waste introduces an unpalatable factor. Linters, however, can, and as a matter of fact should, form the raw material of the rayon industry in India. From the seed of the long-staple variety at present grown in India a potential supply of some 50,000 bales is available annually even to-day. Granting that the potential supply of linters was completely exploited for the manufacture of rayon, it would just give us about 20 tons of rayon per day, i.e., about one-fourth of the pre-war consumption of rayon in this country.

We have, therefore, got to look for some alternative raw material which we find in bamboo. This has been used in India for paper manufacture for years. The choice of this raw material for rayon production presents us with the problem of purifying bamboo pulp to make it suitable as a base for rayon manufacture. This might appear difficult but it is certainly not impossible. The next raw material available in plenty and likely to prove useful for this purpose, after considerable research work, is bagasse, the waste product of the sugar industry. It is no use relying on laboratory experiments, when new and untried materials are to be introduced into a major industry. Nothing short of semi-commercial scale pilot plant experiments will induce the industry to adopt new methods or materials. It is likely that the new material will need new digestion methods, at least substantial alterations in the existing ones. The old myth of sulphite pulp alone being suitable for rayon manufacture is fast dying out and new methods have demonstrably proved successful even on factory scale.

Chemicals

There are only three companies producing any appreciable quantity of caustic soda in this country. They are the Mettur Chemical and Industrial Corporation at Mettur, the I.C.I. at Calcutta and the Tata Chemicals at Mithapur and none of these can individually produce enough caustic soda to meet the requirements of a single rayon manufacturing unit. Sulphuric acid production of this country is also not satisfactory. In both these cases, however, considerable working experience is available and any new expansion can be effected without loss of valuable time. Carbon-bisulphide is not manufactured in India at present but it can be made without danger or difficulty, as the process is almost automatic and needs little supervision. Other chemicals need no mention here, as they are required in small quantities only.

Other Factors

The question of fuel is one that needs careful study. It appeared at the time this report was prepared—early 1942—that the use of wood as fuel might prove economical in Malabar, but the situation has changed since, making this consideration unnecessary. The choice now lies between Indian coal and imported oil and had better be left to the manufacturer.

Water forms an important factor. It is required in large quantity and must also be of good quality. The softer the water, the fewer will be the difficulties to be faced later. A softening plant is essential in any case.

Power requirement of a rayon plant is not great and does not, therefore, need any special consideration, except when caustic soda is proposed to be manufactured at or near the factory site.

Labour is, of course, a major factor in the successful manufacture of rayon. It is a complicated process demanding a certain degree of skill from the worker.

Transport considerations play a fairly decisive role in the location of a rayon factory, especially in this country, where distances are large and the road and rail transport costly. When we look to the fact that the total quantity of goods to be transported is nearly ten times the quantity of rayon produced at the factory, the importance of water transport becomes evident.

Effluent disposal is no doubt an important factor but it certainly does not present an insoluble problem. The acid and alkaline wastes can be mixed together under proper control and run into large rivers subsequent to settling and following æration, if necessary.

The vicinity of academic and technical institutions, of large workshops and also of the investor and the consumer should be regarded as additional advantages while selecting a site for a rayon factory.

Economic Unit

A 5-ton unit is the smallest unit that can be economically operated in India though the modern trend is to use units of 20 tons capacity or over. It may be difficult from practical considerations to put up big plants

in this country. Even a 5-ton plant, complete with buildings and machinery, is likely to cost about 2 crores of rupees. A 5-ton unit would require the services of at least three top-ranking experienced executives, 24 qualified technicians and 500 skilled and unskilled men, the actual number depending upon the scope of textile operations to be performed in the factory. The raw material requirements of such a unit per day would be as follows:

	Tons
Pulp	6
Caustic soda	5
Sulphuric acid	8
Carbon disulphide	2
Coal	20

Baroda, U.P., Bengal, C.P., Hyderabad (Deccan), Madras, Travancore, Cochin, Mysore and Bombay were visited with a view to studying the possibility of establishing the rayon industry in those Provinces or States. The findings are briefly summarized below.

At the time the report* was prepared Travancore was found eminently suitable for pulp manufacture in view of the availability of Eetta bamboo, the best species of bamboo in India. Considerations regarding chemicals and fuel stood in the way of its being recommended for rayon manufacture as well. In the meanwhile, however, the gap in the chemical industry has been filled up very satisfactorily by the Travancore Fertilisers and Chemicals and the water transport facility substantially makes good for the lack of fuel. The result is that the very first rayon factory in this country is at present being built in Travancore.

Bengal appears to be the most favourably situated province for this new industry. There we find coal, chemicals, water transport facilities and even bamboo, once we succeed in making a suitable pulp from the ordinary variety. Some place on the bank of the river Hooghly not far from Calcutta would be the proper site for a rayon factory.

Next we have to choose between Bombay and Baroda, the principal drawback in both these cases being absence of coal. A site somewhere near Kalyan with water transport facility in Bombay and a place somewhere in Navsari District in Baroda also with water transport facility may be tentatively suggested. Very recently the National Rayon Corporation has been formed by a group of Bombay industrialists with a view to locating the plant at the site suggested in this report in 1942.

Madras and Mysore fall in the next group. They are both lacking in coal and their position as regards chemicals is also not very satisfactory. The costly road and rail transport forms the principal obstacle.

Hyderabad (Deccan) and C.P., although having coal, are lacking in chemicals. Transport has got to be by land route and the general industrial development has been rather slow. Information received since writing this report shows considerable industrial progress in Hyderabad and a company has come into being with the object of manufacturing acetate rayon in that State.

U.P. does not offer any special attraction to the viscose rayon manufacturer, at least for the time being.

* Report on the selection of a site for the location of a rayon factory in India, by Dr. Lavji Thoria (Council of Scientific and Industrial Research, India).

Future of Geophysics in India—(*Concluded from page* 59)

which our present knowledge warrants little more than a careful statement of what is involved. Problems of classical geodesy and coarse structure demand research and they are essential for the advancement of science, and though they do not yield any immediate monetary return, they are as important as those of fine structure which are of commercial value. The latter are likely to have a greater appeal in these days due to shortage of every kind of material. While it is not always possible to make a convincing case for spending money on so broad a framework, it should be emphasized that it has its own importance and has advantages from the point of view of application to world-wide problems. Among other things it supplies data for unravelling geological processes within the earth's crust responsible for the tectonic features of large areas. Such investigations should, therefore, form an integral part of any programme of post-war reconstruction and a co-ordinating authority competent to review the broad programmes of the various departments and institutions dealing with these problems is definitely needed on a permanent basis.

REVIEWS

Indian Sugar Industry (1945-46) By M. P. GANDHI. (Gandhi & Co., Jan Mansion, Sir Pherozeshah Mehta Road, Fort, Bombay.) 1946. Pp. iv + 118. Price: Rs. 6-8.

The annual survey covers, as before, a wide field of the past history, the present status and the future prospect of the second biggest industry in our country. This exhaustive review of the sugar industry, at a time when its future cannot be easily discerned, is particularly welcome. A great impetus for the development of this industry was given in 1932 when the Government of India granted protection. This measure was amply justified and the sugar industry played a notable part during the critical period of the war. It is now beyond controversy that the sugar industry should be maintained, no matter how long it takes for the industry to attain a stable position. These conclusions are irresistibly forced on us by this valuable annual publication.

As in the preceding volumes, the publication consists of 35 tables, and a statistical review of the industry from the production and fiscal points of view. A major portion of the book is devoted to an exhaustive discussion of the problems of the industry. The arguments are based on up-to-date data. There is a complete list of the sugar factories in India at the end of the book.

It should be noted with satisfaction that the question of power alcohol has been dealt with at greater length in this Annual than in its predecessors. If the sugar industry has to be maintained, even by having recourse to protective tariffs, it stands to reason that the power alcohol industry, which utilizes molasses, the chief by-product of sugar industry, should, also, be established on a firm basis. Nearly 430,000 tons of molasses are produced annually in India, with a potential capacity for a million gallons of power alcohol. This large quantity of molasses was mostly wasted in the pre-war years. Often they had to be removed at appreciable cost to the producer. The same position will return if a steady outlet for power alcohol is not assured. It is true that molasses have acquired a value for uses other than for power alcohol, and on account of the high prices now obtaining, some producers have been attempting to divert their stocks to other purposes. It should be remembered, however, that the price offered to molasses is due to the high demand from newly established distilleries in the country. These distilleries will have to close down if they do not manufacture power alcohol, because the demands for other industrial spirits are small. With the disappearance of these distilleries, molasses will become a waste product, and the high prices now realized by its sale cannot be maintained. It is futile for the present to think of utilizing molasses for other purposes, because such uses are still in the academic stage, and a uniformly applicable programme cannot be laid down for all provinces in India. It is, therefore, none too early to have a good survey of the problem of power alcohol. It is hoped that the author will sustain the interest of the public in the problems of by-product utilization by devoting more and more attention to them in future Annuals.

G. G. RAO.

UNESCO (Department of Information and Broadcasting, Government of India) 1946. Pp. 52. Price: As. 12.

The Department of Information and Broadcasting, Government of India has brought out a well-got-up and thoroughly informative booklet entitled UNESCO. (United Nations, Educational, Scientific and Cultural Organization) as the first number in their projected Modern India Series. Apart from the meagre and largely disconnected reports in the Press, the man in the street does not get a comprehensive idea of this important organization. The pamphlet issued just before the Paris Conference of the U.N.E.S.C.O. last November, contains a series of informative contributions by some of the outstanding personalities of India and by Professor Julian Huxley. Prominent Indian contributors are Sir S. Radhakrishnan, Rajkumari Amrit Kaur, Professor K. G. Saiyidian, Sir S. S. Bhatnagar, Professor Mohmad Habib and Dr. Syud Hussain.

The get-up of the volume is excellent. In addition to contributions, the pamphlet contains messages from Pandit Nehru and Mrs. Sarojini Naidu, a U.N.O. chart giving a picture of its structure, an article pertaining to the constitution of U.N.E.S.C.O. and reproductions in black and white of paintings by Tagore and Jamini Roy and others which were on exhibition during the U.N.E.S.C.O. Month.

This pamphlet which is primarily intended to disseminate essential information relating to the U.N.E.S.C.O. organization should be distributed widely, if necessary free of cost.

McGraw Hill Book Company

Students and teachers of technical drawing will soon be able to use specially prepared films to supplement and amplify two leading American textbooks on the subject, as a result of a new programme announced by McGraw-Hill Book Company of New York City. Marking its entry into the educational film field, the Company has started distributing two series of McGraw-Hill Text-Films on the principles and techniques of Mechanical and Engineering Drawing, each consisting of seven 16-mm. sound motion pictures and a like number of co-ordinated silent filmstrips.

One series of Text-Films will correlate with French's *Engineering Drawing*, a textbook widely used for three decades in colleges and technical institutes. The other series of Text-Films will correlate with the high school text, French and Svensen's *Mechanical Drawing*. Instructors' manuals will also be provided, with suggestions on making effective, integrated use of these teaching materials.

In the series for college instruction, separate films will explain principles, and demonstrate techniques on (1) orthographic projection, (2) auxiliary views, (3) oblique views, (4) sectioning, and (5) dimensioning.

These subjects were literally selected by the users of the textbook themselves, in answer to a questionnaire which asked them to name those phases of engineering drawing most difficult for the average student to understand. This series will also include an orientation film designed to give the beginning student a real appreciation of the universal importance of engineering drawing in modern production. The final film, entitled " Shop Practices", will show how the finished drawing is actually used in the various productive and maintenance departments of a manufacturing organization, such as pattern shop, foundry, welding shop, machine shop and assembly department.

Each motion picture in each series will be accompanied by a co-ordinated silent filmstrip, or slide film as it is sometimes called. The motion pictures will make extensive use of animated drawing and animated photography of specially made models, all designed to help the student to think in three dimensions and to build up clear mental images of projected shapes and objects.

Each filmstrip is being planned as a follow-up to the corresponding motion picture. Each will present additional factual and diagrammatic material, and practical problems to be solved by students. Also the filmstrip will ask questions, and will re-emphasize key points in both textbook and motion picture. This type of film is valuable for class review, for oral discussion or examination, for lecture illustration or for study by small groups or even by individuals out of class.

These two series of motion pictures and filmstrips are among the first of a number of McGraw-Hill Text-Films being produced to supplement widely used McGraw-Hill textbooks. They are both being produced for McGraw-Hill Book Company, Inc., by the Pathescope Company of America, Inc., well-known motion picture producers of New York City.

On the Theory of Natural Foci of The Human Communicable Diseases*

By PROF. E. R. PAVLOVSKY

ONE of the characteristic features of the activities of the Academy of Sciences in our country is the organization of a great number of expeditions every year to investigate the natural resources and the characteristic peculiarities of the territory of our country. To prove this, I would like to mention that expeditions dealing with only my branch of science (Zoology and Parasitology) amounted to 26 in 1946.

My collaborators and myself have been working for a long time on the problem of communicable diseases whose agents are transmitted by vectors, usually blood-sucking insects or ticks. During these expeditions we attempted to discover if the agent of the disease was a co-member of the natural regions we were investigating, and to ascertain its role in the composition of the biocoenosium of the territories where endemic diseases occur. Our next problem was to find out the circumstances under which men get infected and then discover preventive measures which should be applied to protect people against the diseases.

As a result of 25 years of work in this field, I have formulated the theory of " natural foci of communicable diseases " of man. The natural focus of a communicable disease is that region where the agent of the disease, its vector and animals,—reservoirs of the agent, exist under nature for an indefinitely long time (both at present and during their past evolution) independently from the existence of man. The existence of natural foci is peculiar to many communicable or transmissive diseases such, for instance, as the spring-summer (tick-born) encephalitis, probably the Japanese encephalitis and the sandfly fever; the tick-born spotted fever with its vector-ticks *Dermacentor nuttalli; D. silvarum* and *Hæmaphysalis concinna;* the tick-born relapsing fever with its vectors *Ornithodorus papillipes, Orn. verrucosus, Orn. Tartakovskyi* and *Orn. nerceusis;* cutaneous leishmaniasis in the desert zone of the river Murgab Valley (Turkmenia): tularemia and probably brucellosis. The above list is by no means complete, and many await further investigation.

On the basis of data available, we have to conclude that natural foci exist also in the case of forest yellow fever, the Rocky Mountain spotted fever, the Chagas disease and the like.

A typical feature of the biotic components forming the natural focus of a disease is that the agent, the vector and the animal donor and recipient of the disease are all members of a biocoenosium pertaining to well defined biotops of different geographical landscape zones of our country. The natural foci may be the burrows of rodents, lairs of mammals, caves and grottos in the lower and middle zones of the southern mountains, in the semi-deserts and steppes, etc. In other cases they may be of a diffused character, their vector-ticks being spread over the forest litter or the steppe vegetation.

The natural foci of such diseases may be found in different geographical zones; the tick-born encephalitis is typical of forest zones, some of the tick typhus are characteristic of steppes and bush thickets; the tick-born relapsing fever is often found in the burrows of rodents in the lowlands as well as in the mountain regions up to 2,800 metres over sea level in Pamir; the Turkmenia deserts are characterized by one of the forms of the Oriental Sore.

The existence of natural foci is maintained by the circulation of the causal agent from one organism to another as a result of the food relations which exist between the members of a biocoenosium and can be expressed by the scheme:—

Animal-donor of the agent → vector → recipient of the agent, etc.

When a man, not immune to the disease, appears in the zone of such a focus, he may be attacked by the blood-sucking vectors which will infect him with the disease-producing agent which they have received from a wild donor. This is the explanation for the primary occurrence of infection in unpopulated regions. Instances of such infections are the tick-born encephalitis in

* Translated from a Lecture delivered in Russian by Prof. Pavlovsky during the Indian Science Congress Week at Delhi.

the taiga, the tick-born relapsing fever in the caves, the tick-born spotted fever in the steppes, cutaneous leishmaniasis in the southern deserts, and others.

Directly or indirectly, unconsciously or purposefully, the activity of man may result either in exterminating the natural foci or in transferring them to the zone of domestic or service buildings. In the latter case, the " irradiation of natural focus " may lead to an unexpected outbreak of disease, or it may contribute to the formation of stable, endemic foci. The significance of these foci lies in the possibility and frequency of contact between man and the infected vector.

The possibility of a man being affected by a communicable or transmissive disease from its natural focus depends on three causes: (1) the mobility of the vector (the distance it has to cross, its " domestic " habits, etc.), as, for instance, flying of a sandfly across a distance exceeding 1 km., nocturnal exits of fleas infected with pest bacteria from the Siberian ground-squirrel burrows and their attacks upon sleeping people, (2) direct contact of man with the animal-donor (skinning the captured rodents infected with the pest tularemia or the tick-born relapsing fever), and (3) individual or collective behaviour of man towards the natural foci of infection (factors of anthropological nature).

The natural foci of transmissive diseases are either apparent or concealed. If there is no man in the region of a virulent focus, there can be no disease; but the appearance of man on the scene makes the development of disease possible.

Using the ecologo-parasitological method of investigation we are now able to signalize epidemological danger for any given locality with relation to the existence in it of natural foci of transmissive diseases already known, and to take preventive measures.

The combined efforts of the parasitological expeditions in which my colleagues and myself participated, brought most convincing results leading not only to the understanding of the causes of existence of transmissive disease foci, but also to devise methods for their neutralization and even total elimination. The last possibility was achieved under industrial conditions in the Murgab valley.

For many years the attention of scientists was attracted by the mysterious appearance of Oriental Sore in districts with no population at all, as, for instance, in the desert valley of the Murgab River in Turkmenia. The aim of our expeditions was to investigate the cause of this disease. We discovered firstly, that there exist agents of Oriental Sore in the desert which affect different kinds of rodents. Thus the following types of rodents are affected by the disease: Gerbil, *Rhombomys opimus*, *Meriones Erythrourus*, *Speermophylosis*, *Leptodactylus* and a few others. The percentage of rodents infected by *Rhombomys* in the Murgab valley is exceptionally high—, there are places where about 70 per cent. of all the animals that were examined had the disease. It is worth mentioning that rodents may be repeatedly attacked by this disease, because they do not become immune after the first attack.

Sergent and Sergent, Parrot, Donatien, Begnet and also Adler and Theodor, have shown that sandflies, *Phlebotomus papatasii*, are the vectors of the disease. Our Russian scientists discovered that *Phlebotomus* are found in the burrows of rodents. This accounts for the prevalence of these delicate insects in the desert. The sandflies get infected from the gerbil in the burrows and then pass the infection on to other gerbils. In the night the sandflies leave the burrow and on their way they may get into other burrows and infect other rodents with Oriental Sore.

Latishey has established that Leishmania from gerbil is responsible for the typical wet sore in man; similarly Leishmania tropica from man is infective to the gerbil.

When the infected sandflies fly out of the burrows they may attack men if they happen to be in that part of the desert and infect them with Oriental Sore. This is the cause of Oriental Sore in the desert. The sandflies get leishmania from the gerbil and pass them on to man. The burrows of gerbil and other rodents are typical natural foci of Oriental Sore in the desert.

When people settle down in the desert, the sandflies leave the gerbil burrows and move nearer to the homes of the settlers. In the new conditions created by man the sandflies live, breed and infect people with Oriental Sore. Latishev made a highly interesting experiment with a view to destroy the centres of Oriental Sore in the desert.

About 500,000 burrows of gerbil were destroyed by chloropicrin, about 5 grs.

being used for each burrow. The burrows themselves were tightly filled and covered with earth. This led to three important consequences: the gerbils, agents of Leishmania tropica were destroyed; all the sandflies, the possible vector of Leishmania perished and the burrows, the homes of the gerbil, and the sandflies became isolated. Within one year after all the burrows in the region of 1½ sq. kms. were filled and covered with earth, the number of cases of Oriental Sore fell from 70 per cent. to 0.04 per cent. and the sandflies actually ceased to give trouble to the inhabitants in the neighbouring villages.

These investigations may prove to be of great interest and importance to India. The zone of Oriental Sore in India covers Delhi and stretches as far west as Baluchistan and Afghanistan. There is no doubt that if investigations of the kind we have been making in our country are carried out in India, natural foci of Oriental Sore will be discovered, especially in the desert to the west of Delhi.

At the present time we are working on problems of genesis and spread of diseases which can be traced to natural foci. Prof. Latishev has suggested the following hypothesis for the evolution of Oriental Sore and Kala-azar. Leishmania may have existed on the earth before man appeared. Being reptile parasites, Leishmania were of a mixed type. In the course of further evolution they penetrated into deserts through rodents and formed natural foci. The parasites were then passed on to men and the wet type of the Oriental Sore came into being. Another line of evolution is the passage of Leishmania from rodents to the habitations of man giving rise to the town form (the dry form) of Oriental Sore. A third line of evolution was that kind of Oriental Sore which affects mostly the inner organs of man; that was how kala-azar came into being.

Analogical hypotheses have been formulated concerning the genesis of the tick-born relapsing fever. The essence of these hypothesis is the application of the methods of ecology and blozenology to the analysis of the characteristic features of the epidemiology of communicable diseases of man.

Snow Survey in the Himalayas

THE Snow Survey expedition in the Himalayas planned by the Central Waterways, Irrigation and Navigation Commission and guided by Dr. J. E. French, President of the International Commission, Snow Survey (U.S.A.), has already commenced, now that an advance ground reconnaissance party has left for Siliguri.

Meanwhile Dr. Church is in Delhi conferring with the officers of the C.W.I.N.C., the Indian Metereological Department and the Survey of India and fixing up the preliminaries for the two forthcoming expeditions for snow survey in the Tiesta and the Kosi regions of he Himalayas. He will guide both these expeditions as well as an air reconnaissance party which is to form part of the whole programme.

The purpose of these expeditions is to survey the conditions and the amount of snow accumulated in the various snowfields and to lay out a few observational snowfields for future survey work. It is the aim of C.W.I.N.C. to establish snow surveys all along those Himalayan regions through which the Indian rivers flow and to make the Survey a permanent institution aiding, as in U.S.A., Canada, Europe and the U.S.S.R., in making reasonably accurate forecasts of discharges in the rivers.

The forthcoming expeditions, which will be of an exploratory character, are intended to give the Indian personnel an occasion for having their training in snow survey initiated under the direct guidance of Dr. Church.

Dr. Church, who is now 78 years old, is known all over the world as the father of snow survey. He founded it as a personal hobby nearly 55 years ago, since when he has developed it into an exact science indispensable to the exploitation of snow-fed streams. He has led snow survey expeditions in many countries of the world including his own country (U.S.A.), Canada, Newfoundland and Switzerland ; among the many national groups of the International Commission on Snow Survey he has trained, may be mentioned the Soviet group, which is reported to be playing a vital role in the development of Russian water resources. Dr. Church will remain in India for three months.

NOTES and NEWS

Lactic Acid From Sulphite Waste Liquors

A process for the production of lactic acid from sulphite waste liquor has been worked out at the University of Wisconsin. (*C. T. J.*, 1946, **119**, 649).

It has been found that the sulphite liquor as produced at the pulp works was best prepared for fermentation by steam stripping to remove sulphur dioxide, and subsequent neutralization to a slightly alkaline condition with slaked lime. After filtration to remove the sulphite precipitate and adjustment to the desired acidity by the addition of carbon dioxide the liquor was ready for fermentation. An inoculum was prepared of a lactic acid-producing organism, *Lacto-bacillus pentosus* 124-2, on a rich medium. The inoculum medium was preferably composed of malt sprouts and molasses although other preparations were known to serve equally well. The fermentation required 40 to 48 hours at 30° C. for completion. During this period the lactic acid formed was neutralized by addition of calcium carbonate or slaked lime. Usually 1.8 per cent. lactic acid was formed during fermentation.

The recovery of lactic acid was perhaps of greater difficulty than the fermentation itself. Recovery was best accomplished by first concentrating the fermented liquor from 12.5 per cent. solids and 1.8 per cent. lactic acid to about 40 per cent. solids and 6 per cent. lactic acid. Several solvents were selected which would extract the acid from the waste liquor without extracting the associated impurities. Extractions were made successfully at 90° C. since at this temperature the viscosity of the concentrate was sufficiently low. The acids were washed out of the solvent with water and the final aqueous solution was concentrated. The acetic acid which was naturally present in the liquor was removed by distillation. The purity of the crude concentrate varied with the solvent employed; with amyl alcohols the lactic acid was of 90 per cent. strengtn, 8 per cent. non-volatile impurity and 2 per cent. water. Methods for separating the lactic acid from non-volatile impurities are under investigation.

Assuming 2,000 gallons of waste liquor per ton of pulp and 95 per cent. recovery by the extraction, 285 lbs. of lactic acid and 75 lbs. of acetic acid may be obtained per ton. The yields varied with the wood species and the cooking procedure, but the potential capacity of a single sulphite pulp mill would far exceed the present demand for the product, 9,000,000 lbs. of lactic acid annually from a mill producing 100 tons of pulp daily in a 300-day year. The cost of raw materials and steam was computed on the laboratory data at 3.4 cents per lb. of acid recovered. If the lignin were usable as fuel, the cost might be reduced to 2.5 cents and the process would give a complete utilization of sulphite waste liquor. No estimate has been given for the initial cost of a plant.

Modified Gramicidin

Gramicidin, an antibiotic produced by *Bacillus brevis*, is being produced commercially in the United States. It has powerful antibacterial properties, chiefly against gram-positive bacteria, but it is poisonous to tissues of the body. A lesser disadvantage is that it is sparingly soluble in water. For these reasons its clinical use is limited, though it has been quite widely used in veterinary work, particularly for treating mastitis in cows.

During the past year, however, simple derivatives of gramicidin have been prepared which while retaining the high antibacterial activity of the original gramicidin are devoid of most of its toxicity. The improvement is striking enough to anticipate that the importance of gramicidin in medicine may grow rapidly during the next few months. (*Discovery*, 1946, **7**, 324.)

Research workers at the Western Regional Research Laboratory, California, reported in September 1945 that on treatment with formaldehyde gramicidin was converted quantitatively into methylol gramicidin, which could be easily isolated in the form of a powder. Methylol gramicidin was only about half as active as gramicidin against *Staphylococcus aureus;* on the other hand, it was only one-tenth as destructive to red blood cells as gramicidin. Tests with rats showed that the overall toxicity of methylol gramicidin was strikingly less than that of gramicidin. Finally, methylol gramicidin was found to be four times as soluble as gramicidin.

These results were so promising that the work has been continued with results even more encouraging. If methylol gramicidin is further treated with succinic acid a new derivative is obtained, whose antibacterial activity is reduced fourfold, but at the same time the toxicity is reduced fiftyfold. The derivative is also more soluble, so that the net result is a drug with greatly improved therapeutic properties.

By reversing the order of treatment—using first succinic acid and then formaldehyde—yet another useful derivative is formed. This has three-quarters of the antibacterial activity of gramicidin, four times its solubility and a greatly reduced toxicity. Treatment of gramicidin with succinic acid alone gives another derivative with improved properties.

Carbon Blacks From Tar Products

One of the war-time technical developments in Germany, of some interest relates to the production of rubber-reinforcing blacks from coal-tar products such as anthracene oil and naphthalene, according to a Technical Report of the *B.I.O.S.* Minor quantities of carbon black were produced also as by-products of various processes from natural gas and coke-oven gas; a plant for the production of black from acetylene is also available. (*C.T.J.*, 1946, **119**, 489.)

The German lamp-black plants are based on the old chamber system, and with one exception all are intermittently operated. The CK_4 type reinforcing black made at Dortmund is obtained by enriching coke-oven gas with anthracene oil or anthracene residue and burning the enriched gas in jets, the flames impinging on a cooled rotating drum. Part of the black is scraped from the cylinder, the remainder being recovered from waste combustion gas by bag filters. A high yield of 66 per cent. of fully-reinforcing black on anthracene oil residue is claimed.

In the Karlsruhe plant using naphthalene, the yields are lower. The German technologists hold the view that anthracene nucleus with three benzene rings is intrinsically capable of giving a higher yield of reinforcing-grade black than the two benzene-ring nucleus. Only aromatic molecules give carbon when burned, and methane free from all traces of aromatic hydrocarbons gives no carbon on burning.

The available data prove beyond doubt the possibility of producing a fully reinforced carbon black from coal-tar raw materials and coke-oven gas, and it is possible to design plants superior to the German ones.

Acetone From Acetylene

Acetone is now being manufactured in Canada by direct synthesis from acetylene using a mixture of ferric oxide and zinc oxide as catalyst. The process was developed by *Shwinigan Chemicals Ltd.*, and a plant capable of producing 300 tons of acetone per month has been installed. The process is described in *Canadian Chemistry and Process Industries.* (*C.T.J.*, 1946, **119**, 517.)

Acetylene is purified from traces of phosgene and volatile sulphur compounds by passage through a series of scrubbers where it is washed by sprays of sulphuric acid followed by caustic soda. The catalyst consists of a mixture of ferric oxide and zinc oxide The ferric oxide is prepared by treating a 45 per cent. solution of ferric chloride with ammonia to precipitate the ferric hydroxide. The latter is separated on a centrifuge and washed repeatedly with water. It is then mixed with zinc oxide and ground in a ball mill filled with $\frac{3}{8}''$ iron balls. The contents of the mill including the iron balls are transferred to the reactors.

The reactor comprises a series of vertical tubes 10.5′ long and 2.75′ in diameter grouped into a cylindrical unit. The tubes open at the bottom into the reactor head through which, during the operation, the mixture of steam and acetylene is admitted. A perforated basket fits into the lower end of each reactor tube to support the catalyst. The upper ends of the tubes lead into an outlet chamber which is connected to a condenser. 270 lbs. of the catalyst mixture is charged into each tube and the whole unit is conveyed to an electric dryer where it is kept for eight hours prior to its connection to the processing system.

The processing assembly consists of 22 cylindrical salt baths built to hold a single reactor tube and charged with a eutectic mixture of sodium and potassium nitrates. The baths are lined with electrical heating elements which keep the salt mixture molten.

When properly dried the reactors are transferred to the salt baths where they are immersed in the molten mixture and connected to the steam line. Steam is then forced through the reaction tubes for two hours to effect a thorough hydration of the catalyst. Acetylene is then fed into the steam injector at the rate of 650-800 cu. ft. per hour at N.T.P.—the rate being regulated by an orifice meter. For each volume of acetylene, 10 volumes of steam are passed through the injector.

The reaction being exothermic the success of the process depends on the efficient transfer of heat away from the reaction zone; otherwise rapid deterioration of catalyst results. The iron balls in the reactor are used to help to conduct the sensible heat away from the reaction zone, as also to disperse the catalyst mixture, thereby providing a greater reacting surface. The heat is rapidly conducted away to the walls of the reactor tubes, and dissipated into the molten salt bath.

The total running life of the catalyst is 300 hours although it has to undergo a series of periodical "rejuvenating" processes during the time of operation. When freshly charged, it can be used continuously for a period of 16 hours, whereupon the process is stopped and a mixture of air and steam is forced through the reactor tubes. The acetylene passage is then resumed for another run shorter than the first. The period of processing runs become successively shorter and the time required for "rejuvenation" of the catalyst successively longer until the final run is reduced to a period of 12 hours. The temperature of the salt bath during the catalyst's operational cycle undergoes a similar change. The initial temperature of 420° C. in the first run is gradually raised to 480° C. in the final run.

The vapours containing a mixture largely of acetone, hydrogen, carbon dioxide and excess of steam are passed through a condenser and the condensed liquids diverted to a storage tank. The residual gases containing appreciable quantities of acetone and acetaldehyde are passed through a series of scrubbers to recover the last traces of acetone. The dilute acetone solution after stripping of acetaldehyde is rectified in the conventional manner.

Dehydrated Egg Powders

The effect of decreasing moisture content, gas packing, acidification and acidification + gas packing on the shelf life of dehydrated powders during storage at 36.5° C. have been determined at the Western Regional Laboratory, U.S. Department of Agriculture. (*Ind. & Eng. Chem.*, 1946, **38**, 1071.)

"Shelf life" is defined as the time of storing during which the egg powder remains acceptable for consumption as scrambled eggs. Egg powders of lower moisture content were found to retain their palatability better than those containing more moisture. Packing in nitrogen or carbon dioxide increases the shelf life two and four fold respectively. Acidification of egg emulsion to pH 5.5 before drying results in a two to three fold increase in shelf life. Acidification + carbon dioxide or nitrogen packing brings about the best retention of palatability during store and increases the shelf life five or six fold. Acidified spray-dried powders retain good beating properties in contrast to non-acidified spray dried powders. The acidified spray-dried powders were acceptable during long periods (two to three years) when stored at 20° C.

Sintered Glass—A New Method of Production

A new technique for the production of complex glass-metal structures, such as the bases of thermoionic valves, is described by E. G. Dorgelo in the January 1946 issue of the *Philips Technical Review*, Vol. 8. The process consists in pressing finely powdered glass into a graphite mould in which the metal parts are supported and in sintering it in a mixed nitrogen-hydrogen atmosphere by high-frequency induction heating. The finished product is opalescent because of the large number of gas bubbles, the average diameter of which is about 50μ which are trapped in the fused glass; but these are said not to affect the mechanical properties detrimentally, while in respect of electrical breakdown it is suggested that the powdered-glass product is

likely to be superior to that of ordinary glass in which, by mischance, air bubbles of larger size have become enclosed.

Sterilization of Milk

Sterilization of milk by hydrogen peroxide has been studied for a number of years. All the milk consumed in the Milan area, Italy, is being successfully sterilized with hydrogen peroxide.

Data gathered by investigators show that reputable Italian research laboratories have experimented with 39 per cent. hydrogen peroxide of high purity in milk sterilization and have found it practical. Addition of 2 c.c. per litre, giving 130 volumes of active oxygen per volume of peroxide, ensures sterilization in about eight hours. It is to be noted that such sterilization is effective even at ordinary temperatures. Complete sterilization is effective for three days and will continue to some degree beyond this time. (*Ind. & Eng. Chem., Rpts. on the Chem. World Today*, Oct. 1946, Page 5.)

The simplicity of the method, consisting merely of adding the peroxide to raw milk and stirring, should arouse interest. No problems of handling are involved except that containers must not be hermetically sealed and should be made of tinned iron, aluminium, glass or clay products. Even more appealing from the standpoint of simplicity is the newer development, that of adding the peroxide in powder or tablet form through the formation of solid urea-hydrogen peroxide addition product. Because of the antiseptic characteristics of urea, this is expected to be an even more effective method. Such a process deserves consideration in rural areas where pasteurization cannot be carried out.

A New Water Softening Plant

The new lime and soda ash water softening plant, the "Accelerator," designed by *Paterson Engineering Co., Ltd., London*, has several valuable features. In this plant, the coagulant action and the thorough mixing of the already precipitated sludge with the softening reagent brings about a greatly increased "seed", resulting in accelerated softening. (*Chem. Age*, 1946, **55**, 606.)

The plant consists of a vertical main outer steel plate cylinder containing an inner reaction portion formed also of steel plate. The raw water enters by an inlet pipe at the side of the main cylinder and passes into what is known as the agitator hood, a circular closed chamber of wide diameter in the lower half of the main cylinder with a top hood. The upper portion of the agitator is a vertical jacketed cylinder, known as the secondary mixing zone, down the centre of which is a vertical paddle shaft driven by a small electric motor. The shaft is provided with agitators of the propeller type which give a violent agitation.

The lime and soda enter by a pipe into the top portion of agitator hood where intimate mixing with raw water and slurry is ensured by the propeller agitator. The mixture is forced up and at the top of the secondary mixing zone, alum is added continuously and a gentle agitation provided by simple agitators of paddle or bar type. The whole volume of water travels up from the agitator hood through the secondary zone and flows over at the top of the latter down an outer jacket into the body of water in the main cylinder, the lower half of which constitutes the sludge settlement zone. The pure water passes out continuously from the top of the plant. The sludge is removed continuously from the bottom by a "concentrator discharge trough". The lime cream and soda ash solution are supplied separately to the water; there is no need to mix them first as in the ordinary lime and soda ash plant.

The net result of the accelerator design, according to the designers, is greatly increased efficiency, giving maximum degree of softening, combined with extremely low excess of alkalinity and very effective sludge separation, resulting in a sixtieth saving of chemicals and a great reduction in the wasting of filter material. The total hardness can be reduced to less than 2.5 parts per million, and the alkalinity is as low as 5.5 parts of calcium carbonate per 1,000,000 by the standard phenolphthalein alkalinity test.

Photo-essay

Photo-essay is a new form of photo journalism which is being applied to commercial and industrial use. A carefully planned and scripted sequence of still pictures is used to show the various stages in the manufacture of a product or the departmental structure of an organization. Particularly in overseas marketing is an approach of this type of great value in explaining the large amount of work which goes into the making of manufactured goods. (*Chem. Age*, 1946, **55**, 628.) An article dealing with photo-essay on the production of penicillin by Mr. Jean Straker, one of the foremost exponents of this type of work, appeared recently in a photographic journal. This has been reprinted in leaflet form by *Photo-Union Ltd.*, the industrial and commercial photographers, who would be pleased to send a copy to any reader who writes to their offices at Studio House, 12 Soho Square, London, W.1.

Electronic Depth Recorder

A new and revolutionary electronic "depth recorder" which will help to make coastal navigation safer in fog and at night, and which might be termed the "fisherman's radar" because it can be used to locate fishing banks and schools of fish, has been tested at sea, and is now being put into production at Bendix Marine Division of Bendix Aviation Corporation, Canada. (*Fisheries News Letter*, 1946, **5**, 23.) The device, which reflects a high frequency signal off the bottom of the sea to measure the depth of water, draws a permanent and accurate picture of the ocean floor on a chart.

Discussing details of the depth recorder at a demonstration of the device held on board the "Victor Johnson", the Division's sea-going research and testing laboratory, W. R. Ryan, Chief Engineer of Bendix Marine, stated that the device which represents several years of development work, pointed the way to the development for the first time in history of a small, low-cost depth recorder suitable for small boats and pleasure craft.

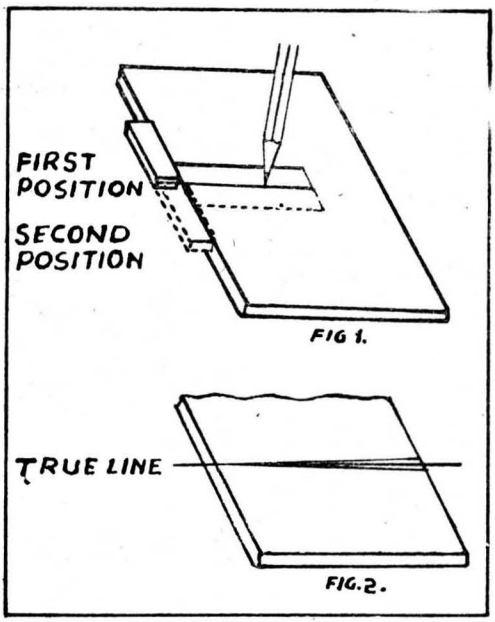
The new depth recorder consists of a signal sender, echo amplifier and graphic recording mechanism. The signal sender sends a high-frequency signal which is caught on the rebound from the ocean floor and amplified by means of electronic tubes, and then recorded on a horizontally moving chart in the graph recorder. The result is a "picture" of the ocean floor over which the ship is passing. "By changing the speed of the graphic recorder, readings can be obtained either in fathoms or in feet. When recording in feet, 288 soundings are taken per minute, or a sounding every 3½ feet when the ship is operating at a speed of 10 knots. When recording in fathoms, 48 soundings per minute are made or one every 21

feet at a speed of 10 knots. These soundings are recorded on the chart to provide an easily read profile of the ocean floor."

The device does not need a trained operator and provides a permanent record of soundings for future reference.

Testing A Steel Square

There are different processes adapted to test the accuracy of a steel square. Mostly test plates fixed with straight edge and like instruments are used. This testing can be simplified by the method as shown below.



The process is simple, gives an accurate result, and no special instrument is required. Another advantage is that the trueness of blade can be checked from inside as well as outside.

Take a plank of wood with one surface planed. Straighten its one edge dead true with a straight edge. First set the square in position as illustrated, (Fig. 1) and draw a line with fine pointed pencil along the blade either inside or outside, which is required to be tested. Than reverse the position of the square as shown in dotted line and keep the same edge of the blade on the line drawn in first position and again mark line.

If the blade is true both the lines will coincide and in case it is not true the lines will lie apart at one end. This difference will be double the actual error as shown in Fig. 2. The true line will fall in the middle of both the drawn lines. (*The Engineer*, 1947, **25**, 42.)

Several angles are checked with a Dihedral Triangle. A dihedral triangle is useful for checking, marking and supporting different angles.

It can be easily manufactured from a steel sheet. The sheet is carefully bent correct at 90° to form a dihedral. One of the two sides is shaped to a triangle having an angle of 45° with either edge and the other to form angles of 30° and 60°.

Scientific Outposts in the Pacific

Plans are virtually completed for a chain of permanent scientific outposts throughout the Pacific Ocean area which will serve as living war memorials for those who perished in these areas in World War II. This constructive project, sponsored by the War Memorial Council of New York City, will provide a fitting medium to keep alive the memory of the 112,003 American soldiers, sailors and marines who died in the Pacific combat. Dr. Dillion Ripley, Professor of Anthropology at Yale University and a member of the Memorial Council's Board of Trustees, who served during the war with the Office of Strategic Services in India and Burma, has surveyed various proposed sites in the area under consideration. The bases, devoted to research for the benefit of mankind, will preserve the memory of names such as Manos, Ponape, Peleliu and Okinawa, famous in the annals of the Pacific war. The project endorsed by the National Research Council, envisages a series of stations for the study of such topics as public health, tropical agriculture, botany, zoology, meteorology, oceanography and anthropology, and also embodies plans for a chain of national parks with conservation areas. Dr. Ripley declares that the Pacific is a fertile field for such research and stressed the fact that conservation of plant and animal life is important if peculiar life forms are not shortly to become extinct. The memorial organization, which will have headquarters in Hawaii and on Guam, will also act as a liaison for scientific expeditions from universities and foundations.

The organization has secured co-operation from the United States Weather Bureau, Coast and Geodetic Survey, War and Navy Departments and other divisions. Negotiations are in progress for fullest co-operation with the United Nations Educational, Scientific and Cultural Organization. As many of the proposed stations will be on islands formerly held under Japanese mandates, exchange of publications with the Japanese is already going forward and a Japanese chief of an experimental station who worked for more than 20 years with tropical plants has been cleared for security and may be enabled to continue his work. To commemorate the names of Hollandia and New Guinea, Dr. Ripley said, it is hoped the Netherlands Government will allow similar projects at these sites. Archibald B. Roosevelt, son of the late President Theodore Roosevelt, and himself a veteran of both World Wars, who is chairman of the Council's Board of Trustees, has announced that a drive to raise the immediate goal of ten million dollars to support the project will be begun shortly.

The idea of living war memorials in the form of permanently valuable scientific projects rather than the kind erected in France after World War I, has been favourably received especially since the war brought out the extent of ignorance concerning Pacific areas and, in particular, concerning former Japanese mandated islands. (*American Newsfile*, Dec. 3, 1946.)

Australia to Grow Linseed

Australia may grow the bulk of its linseed requirements instead of importing as in the past.

A firm using large quantities of linseed in the manufacture of stock feed, plans to provide free seed for farmers on suitable country who are willing to grow linseed. The company will guarantee a price which, it says, will "amply cover normal

costs of production". Its directors decided, after a survey, that the world shortage of linseed was likely to affect Australia for some time, and that the only solution was to grow it locally. They found that apart from the stock feed industry, there was a steady demand for linseed from makers of linoleum, paint, oiled silk and waterproofing. The company has set aside £A.15,000 for the scheme, and will make seed available free. From the first crop the directors do not expect more than enough seed to plant a larger area the following season. Within two years they hope to have ample supplies for their requirements.

Federal and State authorities have already done valuable preliminary work in deciding on the most suitable areas for linseed cultivation. The seed to be distributed is a rust-resistant variety which complies with the requirements of the Federal Agricultural Seeds Act, and was specially bred to suit Australian growing conditions by the New South Wales Department of Agriculture.

British Commonwealth Scientific Official Conference

The establishment of a British Commonwealth Scientific Office in London is one of the main recommendations to Governments disclosed in the Report of Proceedings of the British Commonwealth Scientific Official Conference held during July 1946.

The Official Scientific Conference followed on the Royal Society's Empire Scientific Conference last July. Its primary concern was to discuss scientific collaboration which had grown up in the Commonwealth during the war, and to devise means of ensuring its continuance and improvement.

A large number of resolutions were passed by the Conference and will be considered by the Governments of the United Kingdom, the Dominions and India. Experts in every field from every country represented could not be present to enable authoritative views to be put forward on every subject.

Broadly, the proposal to set up a British Commonwealth Scientific Office (B.O.S.O.) in London is that the various Dominion Scientific Missions and Liaison Officers in London should occupy adjoining offices in the same building. While retaining full autonomy and responsibility to their Governments, they would be able to co-operate more easily in matters of common interest. Thus specialist knowledge which might at any time be available among the staff of one mission would be available to the other missions. The work would be carried out more rapidly and economically by the provision of certain common services such as library, typing, duplicating, abstracting, indexing and microfilming. It is suggested that the Department of Scientific and Industrial Research should be responsible for these common services, and that the B.O.S.O., London, should at first be housed in the same building as D.S.I.R.

It was agreed that permanent machinery for facilitating Commonwealth scientific collaboration and for following up the recommendations of the Conference should be provided by establishing a Standing Committee of the Conference with a Secretary and Working Party in London. The Standing Committee consists of the executive heads for industrial and scientific, agricultural and medical research in the United Kingdom, the Dominions and India, together with three scientific representatives nominated by the Colonial Office.

New World Health Organization

Representatives of 61 countries including India have agreed, subject to ratification by their respective Governments, that a new World Health Organization be set up for "the attainment by all people of the world of the highest possible level of health". The decision to have a single unified health organization was taken by the International Health Conference held in New York in July last under the auspices of the United Nations Economic and Social Council. The new organization embraces the entire field of medicine—both curative and preventive—from the point of view of international control and co-operation. It will also take over the work previously carried on by the Health Section of the League of Nations and other bodies. The World Health Organization will be the directing and co-ordinating authority on all international health work. It will lay down sanitary conventions for preventing spread of epidemic diseases, give advice and technical assistance and stimulate research. It will also work for the improvement of nutrition, housing, sanitation, maternity and child welfare, industrial hygiene, medical education, standardization of food, pharmaceutical and biological products, etc.

The Government of India recently deputed Major C. Mani, Additional Deputy Public Health Commissioner, as their representative on the Interim Commission of the W.H.O. Major Mani has been elected Chairman of the Committee for location of Headquarters and Vice-Chairman of the Standing Quarantine Committee.

Austrian and German Scientists in U.S.A.

Some 280 German and Austrian scientists have been working in the United States for the past one year, according to a War Department announcement.

The announcement points out that the knowledge brought by these scientists has been of inestimable value to American industry and science, and may save two to ten years in American research. It is planned to increase their number to 1,000 as soon as arrangements can be completed to transport them.

All the scientists came to the United States voluntarily and are in the custody of the War Department. Although still working on Government research only, some may be released for employment in private industry and educational institutions. All the Germans were carefully screened for reliability before being brought to the United States. Many of the scientists have displayed interest in becoming U.S. citizens and are studying English.

The work of the foreign technicians covers electronics, supersonics, guided missiles, jet propulsion, fuels, lubricants, optics, synthetics and similar important phases of applied physics and chemistry. (*American Newsfile*, Dec. 6, 1946.)

A "Conversazione" on Fermentation Technology

The Section of Fermentation Technology, Indian Institute of Science, recently organized a conversazione reviewing the work of the section during the past eight years. It covered in a comprehensive and spectacular way, the entire field of Fermentation Biochemistry in its pure and applied aspects. Experiments to illustrate the fundamental reactions in biochemistry and industrial processes in action on a pilot plant scale were on show. Living cultures of bacteria, yeasts and fungi were shown under the microscope; the methods of assaying the vitamins

of the B-complex and of estimating the ten amino acids known to be essential for the nutrition of man were demonstrated. Preparations of vitamin concentrates, essential amino acids, digestive enzymes and physiologically active principles, made in the laboratory were exhibited. Attention was invited to the rich sources of these substances available in the country and the possibilities of taking up their manufacture were indicated. Flow charts describing methods and equipment for the production of fine chemicals and biologicals were exhibited.

The occasion was made use of to portray the entire work against an international background of research in allied fields; this served to bring into striking relief the great advances in experimental technique and technological processes made in Europe and America and to emphasize the urgent need of modernizing our technique and equipment.

Production of citric, lactic and gluconic acids directly from cane juice, was demonstrated on a small scale; so also the manufacture of food and high vitamin yeasts. Of great economic importance to this country was the work on the microbiological formation of sulphur in coastal areas; laboratory work has established the possibility of building up sulphur-producing farms on a twenty-five year rotation, yielding an annual return of about 120,000 tons of sulphur. The production of power alcohol from molasses, employing a new and potent strain of distillery yeast was demonstrated on a pilot plant scale; this process which cuts down the cost of production by 35 per cent. has been successfully adopted at the Daurala Distillery near Meerut. Processes for the manufacture of pharmaceutical and textile diastases and other industrial enzymes were shown. Utilization of shark liver residues and the lac washings as potential sources of vitamins and antirachitic sterols were demonstrated.

The conversazione which lasted for three days commencing from 14th December was the centre of attraction for the Bangalore scientists, technologists, medical practitioners, industrialists and the general public. To the pure scientist, it served to focus his attention on new problems and to indicate refreshingly original approaches to old problems based on recent developments in experimental technique; to the technologist, the exhibition was equally instructive; he was reminded of the latest advances made in America and of the backwardness of the methods of production in this country. The industrialist was impressed by the wealth of potent drugs and active principles which could be manufactured from raw materials and industrial wastes in India.

Indian Institute of Science, Bangalore

The Council of the Indian Institute of Science, Bangalore, has been reconstituted for the triennium 1947-49. The members of the new Council are: Sir Walter Campbell, Resident in Mysore, and Sir S. S. Bhatnagar, Director of the Council of Scientific and Industrial Research (nominees of the Government of India); Dr. T. C. M. Royan and Mr. B. G. Appadorai Mudaliar, Director of Industries and Commerce (nominees of the Mysore Government); Sir Sorab Saklatvala and Prof. R. Cheoksi, Director, Tata Trust, Bombay (representing the Tata family); Diwan Anand Kumar, Dean of University Instruction, Punjab, Prof. N. R. Dhar, Professor of Chemistry, Allahabad University, Dr. Shyama Prasad Mukherjee, ex-Vice-Chancellor, Calcutta University and Sir C. P. Ramaswami Aiyar, Dewan of Travancore and Vice-Chancellor, Travancore University (representing the Universities group); Sir Vithal N. Chandavarkar and Dr. K. P. P. Menon, Industrial Liaison Officer, Trivandrum (nominees of the Court of the Institute); and Sir Jyan Chandra Ghosh, Director of the Institute.

In addition to these thirteen members there is to be a nominee of the Central Legislative Assembly, whose name has not yet been announced.

A Five-Year Food Plan for India

A five-year plan to expand and intensify agriculture in order to wipe out India's annual deficit of a million and a half tons of cereals, was outlined by the Hon'ble Dr. Rajendra Prasad, Member for Agriculture and Food, Government of India, presiding over the *Food Production Conference* held in New Delhi on 15th January. Dr. Rajendra Prasad discussed the short-term projects, which are described as "Grow More Food Plan" and whose results he hoped to see achieved in the shape of 3 to 4 million tons of extra food crops by 1951-52.

The contemplated projects for irrigation, as also of extension, are projects which will not take long to execute and which will begin to give results within a year or two at the most. A greater use of improved seeds and more manure is suggested. It is hoped to increase the use of chemical fertilizers at least threefold after two or three years, by which time the factory at Sindri is expected to be in production. Organic manure can be increased to a very considerable extent by the cultivators themselves. Improved methods and improved implements that are contemplated will be made available within time.

As regards finance, the Government of India have decided that out of every rupee that may have to be spent on "Grow More Food" projects four annas will be contributed by them, four annas by the Provincial Government and the remaining eight annas by the person benefited by it. According to calculations made by the Department of Agriculture the contribution that the Government of India wil have to make to achieve this objective in the nex five years will be between Rs. 50 and Rs. 75 crores. The Provinces will have to make a like contribution and the people will have to find the rest, of which a part will necessarily be in the form of labour.

The Indian Standards Institution—Meeting of the General Council

The General Council of the Indian Standards Institution, set up by the Government of India in September last, held its inaugural meeting in New Delhi on 6th January 1947, under the chairmanship of the Hon'ble Member for Industries and Supplies. The Council, which consists of 64 representatives drawn from the Central Government departments, Provinces, States, Research Institutions and Chambers of Commerce, discussed and ratified the constitution proposed by the Government of India.

That India was one of the first nations to introduce grading of agricultural products and that she did so more than a decade ago was made known at the Commonwealth Standards Conference and the International Standards Conference which were held in London in September and October 1946, respectively. India was represented at both these Conferences by a Delegation, consisting of nine members, led by Mr. M. K. Vellodi, Deputy High Commissioner in the U.K.

At the International Standards Conference, in which 28 nations took part, India was elected to a seat on the Council of the International Organization for Standardization. India was also requested to undertake the technical co-ordination of international standards and methods for grading and testing of mica, shellac and other agricultural products.

India's Water Wealth

An early addition of 25 million acres of irrigation to India's existing 70 millions, and 4 million K.W. of hydro-electric energy to the existing half million, is forecast in a pamphlet on *New Projects for Irrigation and Power* (1947). The pamphlet, brought out by the *Central Board of Irrigation*, is one of the series meant to elucidate to the layman the great potentialities which lie in the water wealth of the nation.

Indian Mercantile Marine

India's mercantile marine, it is expected, will nearly double its tonnage in the first quarter of 1947, according to available information relating to orders for the purchase of ships placed by various Indian shipping companies. A good portion of the new tonnage, it is understood, is being obtained from the U.S.A.

Already seven ships of a total tonnage of nearly 34,000 have arrived in India or will arrive in the near future. More ships bringing the total new tonnage purchased to over one lakh tons are expected later. It is probable that the existing Indian steamer tonnage, which is about 1,30,000, will be nearly doubled in the next few months.

It will be recalled that the Government of India recently agreed to provide exchange facilities to the extent of over 6 million U.S. dollars in one case and the equivalent of Rs. 30 lakhs in U.S. dollars or Norwegian or Swedish currency in another case so as to enable Indian shipping companies to purchase foreign tonnage. The policy of the Government of India, as was announced some time ago, is to consider sympathetically applications from shipping companies for the provision of exchange facilities for the purchase of ships. (*Chem. & Ind.*, Dec. 4, 1946, p. 6.)

Protection For Chemical Industries

The Government of India have granted protection to four chemical industries, namely, calcium chloride, photo chemicals, bichromates, and phosphates and phosphoric acid, and have rejected the claim for protection made by the butter colour industry. The decisions are based on the recommendations of the Indian Tariff Board constituted in November 1945 with Sir Shanmukham Chetty as Chairman and Mr. C. C. Desai, Dr. Nazir Ahmad and Dr. H. L. Dey as members.

On calcium chloride, the existing standard rate of 36 per cent. *ad valorem* and the preferential rates of 24 per cent. on manufactures of the U.K. or of a British colony and 12 per cent. on imports from Burma will be replaced by specific protective duties of Rs. 4-14, Rs. 3-4 and Rs. 1-10 per cwt., respectively.

On the photo chemicals industry, the Government have decided to replace the existing standard duty on sodium thio-sulphate by a specific duty of Rs. 7-8 per cwt. and the preferential revenue duties on imports from the U.K. and Burma by specific protective duties of Rs. 5 and Rs. 2-8 per cwt., respectively. In regard to imports of sodium sulphite and sodium bisulphate, the existing revenue duties will be replaced by specific protective duties of Rs. 12, Rs. 8 and Rs. 4 per cwt., respectively.

On the bichromates industry, the Government have decided to replace the existing revenue duty of 30 per cent. on sodium bichromate, potassium bichromate and all chrome compounds by a protective *ad valorem* duty of 30 per cent. for a period of one year in the first instance.

The Government have decided to levy a specific protective duty of Rs. 23 per cwt. in place of the present 30 per cent. *ad valorem* revenue duty on phosphoric acid, and a specific protective duty at the rate of Rs. 11 per cwt. on all imports of sodium phosphates. They have decided to defer action as regards the acid calcium phosphate industry till such time as it has established to the satisfaction of the Government that it has successfully produced, and is capable of producing, this chemical to the requisite quality and in sufficient quantity. They are also taking steps to ensure supply of sulphuric acid to the industry at a price not exceeding Rs. 160 per ton.

Canadian Market For Indian Manufactured Goods

A list of manufactured products with good sales possibilities in Canada is given by the Government of India Trade Commissioner, Mr. M. R. Ahuja, in a recent report.

" Although price is a major factor in merchandising many of these goods, yet it must always be remembered that the Canadian consumer is accustomed not only to uniformity in standards and quality but to the continuity of supply as well. In some Indian export articles, there is a distinct value in maintaining the old traditional styles, patterns and colours, but in others a certain amount of ' Canadianisation ' in style and colour is absolutely imperative in order to meet with the consumers' requirements.

" India should export goods of a high quality in order to maintain and preserve the proud traditions of the skill of Indian craftsmen. The only way to test market possibilities is by the way of samples, and the best way to study the exact requirements of a market is by trying to counter-sample goods already in the market. The Trade Commissioner's office is willing to co-operate and assist manufacturers in any manner possible."

Among the list of articles which can be sold competitively in Canada by Indian exporters are: bamboo, wicker and cane goods, brushes, ceramics and glassware, cotton goods, cutlery, embroidery and lace, floor coverings, shoes and sandals, leather goods, novelty and gift goods and other consumption goods of a miscellaneous type.

Rural Problems of India

The addresses delivered at the seventh session of the *Indian Society of Agricultural Economics Conference* held at Karachi in December last, deal with a subject about which much has been said and little is being done. Though Provincial Governments and States have been doing a good deal for the rural population, the central problem of the poverty of the villages remains virtually as it ever was. Progress has been sloppy, superficial and often delusive. The effort hitherto put into it has been either inadequate or it has suffered from some fundamental drawback. Sir Manilal B. Nanavati thinks—and this is not the first time he has given expression to his views—that it is both. In his presidential address to the Conference, he maintains that the fundamental issue in the

programme of rural development is how to enlist the co-operation of the people themselves in implementing the plans. Some method should be discovered to place the minimum responsibility for the economic progress of the village on the villager himself. Sir Nanavati argues for a multi-purpose co-operative organization for the villages. These organizations will draw personnel from the villages but can look for financial help in the initial stages from the Government. They are to cover the entire economic life of the areas they represent.

From the Government side, Sir Nanavati wants an elaborate extension of research activities which should be widely decentralized: the central department should be responsible for guidance, supervision and co-ordination. In the field of research, non-official agencies like universities are required to take a more active interest.

Manufacture of Textile Machinery in India

An agreement has been signed between Mr. Krishnaraj Thackersey, on behalf of the Indian Delegation, and Mr. K. Preston, Chairman of *Textile Machinery Makers Limited*, on behalf of the English companies, under which a textile spinning machinery manufacturing plant will be started in India as soon as possible, with the full assistance and co-operation of *Textile Machinery Makers Limited*. The agreement provides, *inter alia*, for the formation of an Indian company with a capital of Rs. 1½ crores. While the majority of shares will be held by Indians, the English companies are to have a financial interest in the company and will be represented on the Board. The principal benefits envisaged are the acceleration of the production of urgently needed new machinery to fulfil the planned extension of India's cotton textile industry, and the hastening of rehabilitation or replacement of machines which, owing to being worked continuously during the war at high pressure without adequate overhaul, need replacement in whole or in part immediately. (*Indian Engineering*, 1946, **120**, 310.)

Quality of Sugar Manufactured in India

An interesting review of the quality of sugar manufactured in India during the year 1945-46 has been published by the Director of the Imperial Institute of Sugar Technology (*Indian Trade Journal*, dated 24th October 1946). The review covers both the crystal and crushed grades of sugar for colour and size of crystals. The quality has been determined for the products from 122 factories as against a total of 142 factories which are reported to have worked during the season. There has been a general improvement in the colour and grade of the sugar produced as compared with those of the sugar produced in 1944-45. The bulk of production is in the superior colour grades, namely, 28, 27, 26 and 25, colours 27 and 26 forming the major part. In the grain size also, a small improvement is noticeable. There is an increase in the production of sugar of grain size *D* and a small increase in the grain size *C*. The production in grain size was of the standards *C*, *D*, *E* and *F*.

The review contains an interesting tabular statement on the different standard qualities for the season based on the production of the 122 factories. The graphical illustrations for colour, grain-size and improvement in colour are instructive.

G. G. RAO.

U.N.E.S.C.O. General Conference

India played a vital part in the U.N.E.S.C.O. General Conference held in Paris and the delegation from the very beginning kept alive before the Conference the idea of the importance of a world organization embracing all races and nations. It was in recognition of his importance as a philosopher and spiritual leader that Sir S. Radhakrishnan was elected by the Conference as one of the eighteen members of the U.N.E.S.C.O. Executive Board. The drawing of lots determined that he would remain in office for the next two years. Professor H. J. Bhabha was made Chairman of the Sub-Commission on Natural Sciences. It was in the Sub-Commission on Education that the Indian delegation made perhaps the most important contribution.

The Sub-Commission on Natural Sciences not only adopted the Indian proposal to institute a group of Nutritional Science Field Teams, but instructed the U.N.E.S.C.O. Secretariat to proceed at once with the organization of such teams in India, China and other countries, each consisting of from two to three scientists of high quality with their assistants, based wherever possible on existing laboratories, but made fully mobile by special transportation aids. The Indian delegation also called attention to the fact that fish forms an extremely valuable food for large sections of the population of India, Ceylon, Malaya and other countries bordering on the Indian Ocean, and, therefore, proposed the establishment of an Oceanographic and Fisheries Institute for the Indian Ocean. For the time being, because of lack of funds, the Secretariat has been instructed to explore the possibilities for the foundation of such and similar institutes and report on the findings to the Conference next year.

Indian Chemical Manufacturers' Association

The seventh annual general meeting of the Association was held in Delhi on 21st November 1946, Dr. K. A. Hamied presiding. In his presidential address, Dr. Hamied reviewed the progress made by some key industries in the country, special mention being made of the progress in the sulphuric acid and pharmaceutical industries.

According to Dr. Hamied, sulphuric acid production before the war was about 70,000 tons with a consumption capacity of 30,000 tons. Several new plants came into existence during the war and the present production capacity is 100,000 tons. It was pointed out that unless other industries which consume sulphuric acid are soon developed in the country, there would be a surplus of this acid.

Reviewing the position of the fertilizer industry, Dr. Hamied stressed the need for the manufacture of superphosphate and ammonium sulphate. The Government of India were contemplating to produce 350,000 tons of ammonium sulphate and as satisfactory results are obtained with a mixture of superphosphate and ammonium sulphate in the proportion of 1½ : 1, there would be need for the production of about 500,000 tons of superphosphate. This would greatly assist the sulphuric acid industry. Dr. Hamied said that the bones available in India would be sufficient to produce about 200,000 tons of superphosphate and the sulphuric acid requirement could be met by the present output.

The idea of a large chemical manufacturing combine with a capital of 50 million rupees was again mooted by the President. The main function of this

concern would be to undertake the production of all necessary chemicals, organic, inorganic, heavy and fine, in co-ordination with the existing manufacturing activities of the members of the Association.

The meeting passed a number of important resolutions uring the Government of India to adopt an effective tariff policy with respect to chemical industries, assistance to chemical industries in the form of subsidized supply of imported raw materials, preferential railway rates, abolition of excise duty on imported scientific equipment and on machinery not manufactured in India, and rail transport facilities by providing more wagons and special ones for transport of corrosive and inflammable articles.

Improved Farming Methods

In reply to a question in the Central Assembly on 6th November 1946 by Sardar Mangal Singh whether Government had considered any scheme for introducing an improved method of farming in the Centrally Administered Areas, Sir P. M. Kharegat, Secretary, Agriculture Department, said that it had been decided recently to take up pilot experiments in co-operative or joint farming in the Delhi Province to determine the type of farm management most suitable for adoption on a large scale under local conditions. The question of preparing a scheme for this purpose was under consideration.

A scheme to introduce mechanical cultivation in selected areas in Baluchistan was also under examination.

Announcements

Electron Jubilee Celebrations. The fiftieth anniversary of the discovery of the electron by the British physicist, Sir Joseph Thomson, O.M., will occur in 1947. To mark this jubilee and to demonstrate the tremendous influence such an advance in pure physics may have on the life of the community, the *Institute of Physics* and the *Physical Society* are jointly arranging a series of meetings and other functions to take place on 25th and 26th September 1947, in London. A special exhibition which will remain open to the public for several weeks, will be held at the Science Museum, South Kensington, and will show the development of the vast range of modern industrial equipment from its earliest experimental origins. (*Chem. Age*, 1946, **55**, 628.)

United Nations Schoarships. The Purdue University, Lafayette, U.S.A., has offered to Indian students two United Nations Scholarships each of the value of $130 per term, tenable at the University for study in Science, Engineering, Agriculture, Pharmacy and Education for the term beginning in September 1947.

The scholarships will be granted for one term in the first instance but can be extended a term at a time till the completion of the course, provided the scholars make satisfactory progress. Candidates must be graduates of Indian Universities and should be able to supplement the scholarship from their own funds in order to meet the high cost of University education in the U.S.A. They should be prepared to spend about 2,500 dollars from their own pockets.

The Government of India have invited universities and other educational institutions of similar rank to recommend names of suitable students. The final selections will be made by the authorities of the Purdue University.

The World Telecommunications Conference. The World Telecommunications Conference will be held during the spring and summer, 1947, in Atlantic City, New Jersey. The first of these conferences, viz., Radio Administrative Conference, will begin on 15th May, 1947 and will be followed by the plenipotentiary Telecommunications Conference and Shortwave Broadcasting Conference.

The 80-member International Telecommunications Union last met in general session at Cairo in 1938, when the radio regulations and the telephone and telegraph regulations of the Madrid Convention of 1932 were revised. Great advances and changes in telecommunication techniques during the war have rendered obsolete the provisions of the Cairo and Madrid conventions. The conference in Atlantic City will try to bring these provisions up-to-date, and revise the legislative machinery of the Union so as to permit such future revision of the agreements as may be necessary to keep them in step with scientific advances.

Twentieth Century Fund, a non-profit organization for research and education on economic problems, has selected Turkey as the first subject for a series of case studies of how American resources and technical skills might be employed to assist other countries in developing their potentialities and achieving higher living standards. Max Weston Thornburg, engineer and business consultant, will direct the inquiry and will visit Turkey in the near future, accompanied by Graham Spry, experienced economic investigator. A local staff will be recruited to assist in the task. At least two other similar studies will be made this year.—*U.S.I.S.*

Central Drugs Laboratory, Calcutta.—The Government of India has decided that with effect from the 1st February, 1947, the *Biochemical Standardisation Laboratory*, 110, Chittaranjan Avenue, Calcutta, shall be known as the **Central Drugs Laboratory** and shall perform the functions of the *Central Drugs Laboratory* under section 6(1) of the Drugs Act, 1940, except in so far as such functions are entrusted to any other Laboratory.

The All-India Manufacturers' Organization.—Sir M. Visvesvarayya has been unanimously re-elected President of the *All-India Manufacturers' Organization* for 1947. He will preside over the 7th Annual Conference to be held in Delhi on 12th and 13th April.

Errata. Vol. 5A, Page 127 L.H. column, line 36: *for* gammexane *read*," Gammexane."

"Gammexane" is a registered trade mark of I.C.I. Ltd., and printing with a small g without inverted commas suggests that it is the generic name of an ordinary compound, which is incorrect.

This Journal, 1946, December, Vol. 5B. Pages 80-81:

The following correction refers to Tables I, II, III and IV in the article "Synergism in Chemotherapy," Part I:—

"The actual concentration of the dye solutions used in all the cases apart from the multiplying factor should be reciprocals of the figures given in the Tables. Thus in Table II, the concentration of the dyes should read $\frac{1}{2} \times 10^{-6}$, $\frac{1}{2.5} \times 10^{-4}$, etc., instead of 2×10^{-6}, 2.5×10^{-4} etc. In Table IV, the concentration of penicillin is expressed as units per c.c. and not μ per c.c. as printed."

REPORTS FROM STATES & PROVINCES

Madras

The Ramapadasagar Reservoir

AN indication of the extent to which the Government of India may be prepared to give financial aid to the Government of Madras towards the realization of the Ramapadasagar Reservoir project on the Godavari, was given by the Hon'ble Mr. C. H. Bhabha, Member for Works, Mines and Power, while replying to a question in the Council of State on 7th November 1946.

He said: The Government of India informed the Government of Madras on 28th February 1946 that, provided the scheme is duly approved with the concurrence of all interested, they will advance all such loans as may be required by the Government of Madras for this scheme. If it is found that the scheme will not be fully self-financing, the Government of India will also be prepared to provide a substantial contribution towards the portion of the capital cost which is not met from loan money. Any such contribution will, however, be taken into account when the aggregate share of Madras in Central grants for post-war development in general is settled.

The scheme has not yet been finalized, pointed out the Hon'ble Member, and the question of assistance which the Government of India may be willing to give towards the realization of the scheme is still under consideration.

The Ramapadasagar project involves the construction of a dam over a mile long and 393 ft. high with a total waterspread of 483 sq. miles and an effective storage capacity of 520,000 million cubic feet of water. It is estimated to cost about Rs. 66 crores and may take 12 years for completion. The area likely to benefit is 23½ lakhs of acres which will yield approximately one million tons of extra rice. The net additional revenue is estimated at Rs. 2.35 crores per annum which will accrue to the Provincial Government. The amount of electrical energy produced will be of the order of 75,000 k.v.a.

Mysore

Trade Problems of Mysore

Mysore is an inland State and the bulk of its external trade is carried on with the adjoining districts of the Bombay and Madras Presidencies and through the ports of Madras, Marmagoa and Mangalore. The distinct feature of Mysore's foreign trade is that it has been exporting largely raw and semi-manufactured articles while importing manufactured articles from abroad. The total value of the merchandise imported into this State has been in excess of the value of merchandise exported. But this excess of import can be, however, set off against the deficit of exports and the balance of trade maintained in favour of the State. To a considerable extent the export of gold from the Gold Mines in the K.G.F. area contributes to this result. The value of gold exported by the Gold Mining Companies in the year 1945-46 was about Rs. 2,61,00,000.

The promotion of the trade and commerce of Mysore has been one of the chief activities of the Department of Industries and Commerce in Mysore from its inception. In addition to collecting and disseminating information relating to trade, the Department is interesting itself in trade problems and in assisting the creation of trade openings by putting in touch trade representatives of other parts of India and foreign countries with the local dealers of Mysore produce and manufactures. The Department also compiles and publishes statistics relating to the business conditions in Mysore and the foreign railborne and roadborne trade of the State.

It is seen from the statistics collected that the preponderating share of Mysore's export trade is held by the Madras and Bombay Presidencies and Madras ports. Out of the total quantity of about 5,700,000 railway maunds exported by rail during the year 1945-46, the exports to the above presidencies and ports amount to about 4,800,000 railway maunds or 84 per cent. of the total exports. Though the bulk of the trade is carried on by rail, there is also considerable traffic passing through the frontier roads of the State, the value of which is estimated at about Rs. 5 crores per year.

Owing to its situation in the interior, Mysore has no seaport of its own with the result that the entire export trade has to pass over long distances through land frontiers before shipments are made to foreign countries through the Indian ports. The question of constructing a harbour at Bhatkal, which is situated at a distance of 30 miles from Mangalore on the west coast and 60 miles from Sagar (Shimoga District in Mysore), has been receiving the active consideration of the Government of Mysore for some years past and it is hoped that this harbour would serve as an entrepot for the trade of Mysore.

Among the more important of the articles of merchandise exported from the State, mention may be made of the following: Coffee, cardamom, cotton, groundnut, coconut and copra, betelnut, tanned hides and skins, woollen druggets and sandalwood oil. Of these, tanned hides and skins and woollen druggets are exported to foreign countries through the Madras port. Marmagoa is a distributing and shipping centre for groundnut and cotton, which are consigned chiefly from Chitaldrug and Davangere railway stations in the State. The total exports of the above commodities in 1945-46 amounted to about 105,000 railway maunds and 70,500 railway maunds, respectively. The bulk of coffee produced in the Kadur and Hassan Districts is consigned to Mangalore port for purposes of shipment abroad. Coffee is chiefly exported to the United Kingdom, France, Germany and other continental countries in Europe. The exports in 1945-46 amounted to 281,803 railway maunds, valued at Rs. 277 lakhs. Cardamoms are exported mostly to the Southern Mahratta Districts of the Bombay Presidency, while coconuts and copra are exported to the Northern Indian markets, viz., Delhi, Lahore, Cawnpore, etc. The quantity of coconuts exported in 1945-46 was 504,115 railway maunds valued at about Rs. 51 lakhs while the quantity of copra exported was 283,841 railway

maunds of the value of Rs. 129 lakhs. The trade in betelnut is carried on chiefly with the Madras Presidency. Sandalwood oil, which is produced in the Government Sandalwood Oil Factories of Mysore, is exported to overseas countries, the United Kingdom and Japan (before the war) being the principal recipients. The quantity exported in 1945-46 was 83,931 lbs. Lacquerware toys, sandalwood articles and rosewood articles inlaid with ivory are some of the other chief products of Mysore which find a market in foreign countries.

Considerable quantities of machinery were imported from the United Kingdom, Germany and several other continental countries in Europe before the war. The annual imports of machinery before the war were valued at about a crore of rupees. During the war period, the imports of machinery suffered a heavy fall. The necessity for the import of machinery from abroad both for replacement and expansion of the industrial concerns in the State is, however, keenly felt. Steps are being taken to import textile, chemical and engineering machinery needed for the post-war expansion scheme of the Government.

Owing to the conditions created by the war, the foreign trade and commerce of the whole of India has been considerably affected. The position of Mysore has been similar. Further, the unfavourable seasonal conditions prevailing in recent years have not only reduced the available surplus for export of most kinds of agricultural produce, but have also brought about a shrinkage in the output of the chief articles of food, which is far below the actual requirements, while the supply position with regard to textiles, consumer goods, drugs and medicines, machinery and mill stores, etc., has been rendered acute owing to the absence of shipping facilities and the imposition of trade restrictions. With the cessation of war in Europe and the Far East in 1945, post-war reconstruction schemes have been taken on hand by the Government and the situation is being brought under control. Vigorous and systematic efforts are being made to obtain increased supplies of food and other essential articles from other countries while augmenting the local output with the available resources. It is hoped that these measures will go a long way in easing the supply position with regard to many articles of merchandise and stabilizing the trade and commerce of Mysore.

The Government of Mysore have appointed a Trade Commissioner in the United Kingdom for the purpose of improving the trade of the State in Europe. Similarly, in the United States of America, an American representative has been appointed.—(*Contributed.*)

Mysore Iron and Steel Works

The sales of the Mysore Iron and Steel Works during the year 1945-46 amounted to Rs. 1.54 crores as compared with Rs. 1.26 crores in the previous year. Trial manufacture of tractor ploughs has been taken up in collaboration with the Implements Factory. Research and investigation on the manufacture of heat-resisting alloys and graphite electrodes, utilization of blast furnace slag for cement, manufacture of special bricks for steel furnaces and manufacture of acetic acid and bakelite moulding powder are being carried on at the works. Trial operations of the rod and strip mills were conducted for nearly a month and regular operation will commence after obtaining additional power supply. The foundation work of the second machine shop has been completed and the creation of steel structures, columns and trusses is under progress. A capital grant of Rs. 25 lakhs has been provided in the budget for putting up an electric pig-iron furnace and for extending the cement plant. Other development schemes under consideration include acetic acid plant (Rs. 10 lakhs), billet and light structural mill and manufacture of bright drawn bars (Rs. 28.50 lakhs), expanded ferro-silicon plant (Rs. 12 lakhs), manufacture of calcium carbide (Rs. 2.5 lakhs), edge tools and files (Rs. 15 lakhs) and wire and wire products (Rs. 25 lakhs). The development of other electro-chemical and electro-metallurgical industries, utilizing Jog power supply, is under consideration.

Mysore Economic Conference

The Co-ordination and Finance Committee has dealt with 208 post-war schemes in all, of which 171 schemes were approved for inclusion in a five-year plan with an estimated expenditure of Rs. 21.83 crores non-recurring and Rs. 6.75 crores recurring. Of these, 34 schemes classified as "remunerative," involve a capital expenditure of Rs. 13.04 crores with an expected return of Rs. 41 lakhs. The number of schemes classified as "partly remunerative" is 23 for which the expenditure in five years is estimated at Rs. 29 lakhs non-recurring and Rs. 35 lakhs recurring; these being expected to yield a return of Rs. 20 lakhs. The remaining 114 schemes are "non-remunerative", the expenditure in the course of five years in respect of these being Rs. 8.44 crores non-recurring and Rs. 6.26 crores recurring. All the 171 approved schemes have been classified in the order of their urgency and importance into first and second priorities.

The more important among the post-war schemes approved by the Committee are: Second stage of the Jog power project; five-year programme of construction of 34 major irrigational works; expansion of primary and middle school education; supply of large quantities of high-yielding seed, manure and improved agricultural implements; establishment of cattle breeding farms and improvement of live-stock; establishment of 150 additional rural health units; development of the Bhadravati Iron and Steel Works and other Government industrial concerns; electrification of the Mysore-Bangalore section of the railways, and extension of the railway line from Talaguppa to Jog and from Kadur to Chikmagalur; and development of communications and road transport.

Board of Scientific and Industrial Research

The eighth meeting of the Board of Scientific and Industrial Research, Mysore, was held on 8th September 1946, Sir J. C. Ghosh presiding.

The Board considered the progress of research schemes in respect of (1) manufacture of furfural, (2) resistance alloy, (3) dyes from saw-dust, and (4) graphite. The Board decided to stop further work on dyes from saw-dust.

Investigations on Sericin. Laboratory investigations relating to the production of sericin have been completed at the Central College, Bangalore. An equipment for large-scale manufacture is now being designed. The work on the purification and utilization of protein and oil from silk-worm pupa has given interesting results. It may be pointed out that silk-worms pupa are largely wasted at present, being either buried or burnt.

INDIAN PATENTS

[The following is a List of Patent Applications notified as accepted in the *Gazette of India*, Part II, section I, for September 1946 to January, 1947. Patents from the *Council of Scientific and Industrial Research* are indicated by an asterisk.*]

33417. RAIL ANCHOR: *Under rail portion of angle bar formation and jaw overlying rail flange of T cross section.*—The P. & M. Co. (Eng.), Limited.

33679. APPARATUS FOR USE IN THE REPAIR OR ALTERATION OF LIQUID-CONTAINING PIPES: *Portable plant for freezing pipe comprises a refrigerating apparatus employing a circulating refrigerant, a device fitting the pipe and including a chamber, and flexible connections between the refrigerating apparatus and the chamber.*—Freez-Seal Equipment Co., Ltd.

33746. APPARATUS FOR DENTING CENTRE-POPS AT THE ENDS OF RODS: *Conical pointed denting tool, and spring-loaded guide-pieces surrounding ring and washer.*—Bysakh.

33960. BUILDING WALLED STRUCTURES AND PREFABRICATED BUILDING UNITS THEREFOR: *Units consisting of panel portions having tubular interlocking enlargements at side edges.*—Porter.

33961. ROOF CONSTRUCTION AND PRE-FABRICATED ROOFING UNITS THEREFOR: *Roofing unit consists of a panel having a middle longitudinal reinforcement, a cover groove at one side edge and a rib at the other.*—Porter.

34047. SHOE-INSEAM SEWING MACHINES: *A curved hooked needle, a channel-guide, a needle support and a channel-guide support capable of moving about an axis common to both to and from a workpiece.*—The British United Shoe Machinery Co., Ltd.

34093. NEW PHTHALOCYANINE DERIVATIVES: *Heating a metal or metal-free phthalocyanine with aluminium chloride and sym dichloro or dibromodimethyl ether.*—I.C.I. Ltd.

34118. CLAMPING DEVICES FOR CONNECTING WIRES TOGETHER ELECTRICALLY: *Comprising a pair of clamping members engaging two threaded portions on a screw.*—W. T. Henley's Telegraph Works Co., Ltd.

34151. JACQUARDS: *The griffer of the jacquard being actuated by a cam.*—Peter Walker (Blackburn), Ltd. and Walker.

34250. DERIVATIVES OF *p*-AMINOBENZENE SULPHONTHIOUREA: *Condensing a dibasic acid or derivative thereof with p-aminobenzenesulphonthiourea.*—Societe Des Usines Chimiques Rhone-Poulenc.

34275. ORNAMENTAL SURFACE PATTERNS ON TIMBER: *Pattern is engraved on a pressure plate which is pressed on timber while heated.*—Schafranek and Schafranek.

34290. MORTISE RACK BOLT LOCK: *A stop is provided to protrude behind the bolt.*—Lt.-Col. Lester.

34293. APPARATUS FOR CONTROLLING THE OPERATION OF WATER GAS PLANT: *Prime mover driving a timing gear through reduction gearing for controlling the operation of valve means of the water gas plant.*—Burns and Gibson.

34368. ELECTRO-MAGNETIC SWITCHES: *Armature pivoted intermediate its length, outside magnetic path and arranged to operate with two air gaps in series; one gap between core and armature, and other between yoke extension and armature.*—J. Stone & Co., Ltd.

34393. COATING OF PAPER: *With dispersion containing pigment, casein, rosin and/or oily or saponifiable medium.*—Montgomerie.

34455. PANELLING: *Interengaging strips of folded sheet material, horizontal strips holding in place upper ends of the strips and skirting members holding in place the lower ends.*—James Howden & Co., Ltd.

34515. TIN OPENER: *Comprising a split spindle and two metal plates serving as guides to prevent distortion of the spindle.*—Caddy.

34887. BED OR LIKE COVERINGS: *Multiple member of pockets in each of which is placed a removable pad of warmth creating material.*—Guest.

30341. STEERING MECHANISM FOR VEHICLES: *Valve mechanism controlling power cylinder actuated through pivoted levers, connected to steering gear of wheels and operated from steering wheel.*—Clayton Dewandre Co., Ltd. and Rodway.

30807. WATERPROOFING HYGROSCOPIC SALTS: *Mixing hygroscopic salts in the form of crystals, granules etc., with a spreading oil and wax.*—I.C.I. Ltd.

31442. WROUGHT METAL ELECTRICAL RESISTANCE MATERIALS: *An alloy containing 1—5 per cent. preferably 2.5 to 4.5 per cent. silicon, 1—7 per cent. aluminium and the balance essentially copper; chromium or titanium or aluminium oxide, magnesium oxide or cerium oxide added to inhibit grain growth.*—I.C.I. Ltd.

31803. VENTS FOR ELECTRIC ACCUMULATORS: *Of the type which permits the escape of gases from the cell when in upright position but prevent escape of liquid when tilted.*—The Chloride Electrical Storage Co., Ltd.

31851. COMPOSITE SHEETS OR BOARDS, PARTICULARLY WATERPROOF AND/OR ROT-PROOF SHEETS OR BOARDS, AND METHOD OF PRODUCING THE SAME: *Depositing fibrous pulp into a fabric base and forming a layer or web of interlaced or entangled fibres.*—Baskin.

31856. LAUNDRY AND OTHER PRESSES: *Head can be brought to operative position over the work for application of pressure and moved clear on a lever arm.*—Gledhill, Gledhill and Gledhill.

31921. ANHYDROUS MAGNESIUM CHLORIDE: *Mixing pulverous material with water and subjecting to treatment in a chlorinating furnace.*—Magnesium Elektron Ltd.

31930. FILTERING DEVICES OF CRIMPED OR PLEATED OR SIMILAR FORM: *Means are provided on the outside of the bends as the inlet side of a screen including deeply pleated soft fibrous material.*—Vokes Ltd.

31965. PRESSURE HEADS FOR LAUNDRY AND OTHER MACHINES: *Pressure head universally mounted and springs controlling universal movement and*

equalising pressure.—Gledhill, Gledhill and Gledhill.

31966. LAUNDRY AND OTHER PRESSES: *Power cylinder with a removable head.*—Gledhill, Gledhill and Gledhill.

32158. COOKERS: *A steam heated cooker in which the steam press remains within safety limit through the provision of a safety valve.*—The Jay Engineering Works Ltd.

32268. MACHINES ADAPTED FOR LASTING SHOES: *Comprising means arranged to apply a frictional drag on the lasting margin and means for laying the tensioned upper on shoe bottom.*—The British United Shoe Machinery Co., Ltd.

32305. CUTTING TOOL FOR SPOT FACING OR COUNTERBORING: *Adjustable cutter blades and removable pilot formed of head detachable from common stem.*—Clark.

32357. COOKING RANGES OR OVENS: *A composite unit comprising a cooker, baker and water heater.*—Kashyap.

32379. REFRACTORY MATERIAL FROM MAGNESIUM SILICATE ROCK: *Calcined magnesium silicate rock, raw or calcined magnesite and high grade chrome ore mixed and recalcined in oxidising atmosphere.*—Dr. Mitra.

32502. TEXTILE BOBBINS: *A tubbur fibrous barrel and a plastic head moulded around the end of the barrel.*—The American Paper Tube Co.

32544. NEW YELLOW AZO DYESTUFFS: *Azo dyestuffs are produced by heating substituted 4: 4—dibenzthiazyl—(2)—azobenzene with dialkyl sulphate or sulphite.*—I.C.I. Ltd.

33120. RECOVERY OF GUANIDINE SALTS: *Spraying a dispersion of a guanidine salt into a closed chamber while supplying heat.*—American Cyanamid Co.

33122. NEW MONOAZO DYESTUFFS: *Coupling diazotised p-nitroaniline with the sulphuric ester of N-hydroxyalkyl-N-phenyl or naphthyl-alkyl-aniline.*—I.C.I. Ltd.

33123. NEW MONOAZO DYESTUFFS: *Coupling diazotised p-nitroaniline with the sulphuric ester of N-hydroxyalkyl-N-phenoxy or naphoxy-alkyl-aniline.*—I.C.I. Ltd.

33124. NEW MONOAZO DYESTUFFS: *Coupling diazotised 2-cyano-4-nitro-aniline or its 6-halogenoderivative with the sulphuric ester of N-hydroxy-alkyl-N (phenyl, naphthyl, phenoxy or naphthoxy)-alkyl aniline.*—I.C.I. Ltd.

33220. UNDER-JET COKE OVENS: *Delivering combustion medium from header pipe into heating flues of the under firing system by regulating flow through pipe connections comprising a ceramic body held in the pipe.*—Koppers Co., Inc.

33324. REFRIGERATION: *Concentration of absorption solution varied by storing refrigerant in a vessel, in proportion to the variation operating conditions.*—Servel, Inc.

33410. MOUNTING OF BUS—CARS FOR USE IN ELECTRIC SWITCHBOARDS AND IN DISTRIBUTION BOARDS AND PILLARS: *Transversely adjustable washers with upturned edges and scalloped slots threaded on clamping bolts passing between two busbar components.*—British Insulated Callender's Cables Ltd.

33476. ALTERNATING ELECTRIC CURRENT RECTIFIERS OF THE SELENIUM TYPE: *Counter electrode composed of an alloy containing 20-30 per cent. thallium applied by spraying.*—Westinghouse Brake & Signal Co., Ltd.

33553. PROCESSES OF PURIFYING CRUDE METAL PHYTATES: *By removing proteinaceous impurities by treating with an aqueous solution of a alkaline reagent.*—Corn Products Refining Co.

33591. FOLDABLE CLOSURE FOR DOORS AND THE LIKE: *Inextensible and collapsible series of hinge plates and foldable covering with trolley means for track engagement.*—New Castle Products.

33595. PHENOXYALKYL-AMMONIUM COMPOUNDS AND THEIR USE AS DISINFECTING AND PRESERVING PREPARATIONS: *Quaternating phenoxy-ethyl amines with agents capable of introducing a hydrocarbon radical with at least 8 carbon atoms.*—Ciba Ltd.

33936. FLAME-PROOFING OF COMBUSTIBLE MATERIALS AND NEW REAGENTS USED IN CONNECTION THEREWITH: *Impregnating cellulosic materials with a polyethyleneimine and then treating this with a solution of pentaerythritol tetraorthophosphate.*—I.C.I. Ltd.

34469. SPRING CATCHES: *The catch comprises a jaw at the entrance of a holding recess, a rocking latch having arms capable of lying across the entrance of the recess and a spring urged plunger having inclined faces at its end co-acting with inclinded faces on the rocking latch.*—English Steel Corpn. Ltd.

34518. INSOLUBILIZATION OF POLYAMIDES: *Incorporating an insolubilization catalyst or a curing agent with an N-alkenoxy methyl polyamide.*—E. I. Du Pont De Nemours and Co.

34565. COLLAPSIBLE UMBRELLAS: *A collapsible umbrella comprising a telescope shaft, a frame formed of inner and outer telescoping rib members and a runner on the shaft carrying struts.*—Mappin.

34587. COSMETIC COMPACTS: *Comprises a body part to contain the cosmetic, a lid carrying a mirror and an electric lamp operated by a battery and a switch* —Glas.

32308. PROCESSES AND COMPOSITIONS OF RUBBER: *Incorporating amine and a terpene mercaptan a metal terpene mercaptide.*—Du Pont de Nemours & Co.

32515. THERMALLY RELIEVING RESIDUAL STRESS IN METAL MEMBERS AND STRUCTURES: *Welded metal structures freed from residual stress by cooling the area of residual tensile stress and heating the complementary area of residual compression stress parallel to the weld by refrigerators and flames or electric means respectively.*—The Linde Air Products Co.

32689. SUBSTITUTED ACRIDINES AND INTERMEDIATES THEREFOR: *Producing acridine derivatives by condensing a substituted diamine with 2-methoxy-6, 9-dichloroacridine.*—Eli Lilly and Co.

32731. SUBSTITUTED ACRIDINES AND INTERMEDIATES THEREFOR: *Producing acridine derivatives by condensing a substituted diamine with 2-methoxy-6, 9-dichloroacridine.*—Eli Lilly and Co.

33141. DRY CELLS: *Consisting of a metal top closure which is insulated from the zinc electrode and which holds the insulating material in proper position.*—Ray-O-Vac Co.

33330. DIAMIDINES: *Reacting 2-halo-4: 4'-dicyanostilbene with dry hydrochloric or hydrobromic acid, and then with ammonia.*—May & Baker Ltd., Ewins, Ashley, Self and Harris.

34113. PISTONS: *Securing of an end part at the crown of the piston by a casting operation to provide a higher thermal resistance to heat flow between*

the body of the piston and the said end part.—Lister & Co., Ltd.

34356. GYROSCOPIC INSTRUMENTS FOR NAVIGATION AND THE LIKE: *Gyroscopic instrument for navigation provides construction of mounting for the instrument mechanism and is arranged to function accurately for long periods without attention.*—Reid.

30234. CONTROLLING CLUTCH AND BRAKE MECHANISM OF ROAD AND LIKE VEHICLES: *Single operating element actuates reaction valve(s) in which pressure or vacuum reacts against applied effort; Series of valves control servo cylinders to disengage clutch and apply brakes.*—Clayton Dewandre Co., Ltd. and Edge.

30559. FIREARMS: *Raised bearing surfaces or lands formed upon breech bolts, are adapted to engage upon their outer surfaces with the inner surface of bolt race; pointed extremities formed on lands to clear a gritless surface.*—Patchett and Sterling Engineering Co., Ltd.

30719. FILTRATION OF LIQUIDS: *Hollow tubes with elongated slots covered by filtering media and arranged in a circle, interior of tubes connected to a circular heater communicating with the outlet.*—Tecalemit Ltd.

30804. SEALING TUBELESS PNEUMATIC TYRES: *Comprising four sided annulers, connected at the outer periphery by a wall, having an air outlet, seating on the rim af the wheel with an air inlet operating.*—Dunlop Rubber Co., Ltd.

31990. HOLLOW RIVETS AND EXPANDING ELEMENTS THEREFOR: *Anvil for expanding part, tubular rivet comprises conical base and a truncated conical portion with a cylindrical extension.*—Blackburn Aircraft Ltd.

32031. PYRIMIDINE COMPOUNDS: *By the interaction of an arylamine, with a 2-cyanimino-4-hydroxy-pyrimidines.*—I.C.I. Ltd.

32197. FORMING CASTINGS: *A shrink bob cavity provided between the feeder and cavity impression, and means interposed between feeder and shrink bob to restrict flow of metal.*—Castings Patent Corpn.

32476. SPLICING OF WEBS: *Use of splicing tab having splicing adhesive on one face and a central actuator on the other, and means responsive to the latter.*—Wood Newspaper Machinery Corpn.

32639. SWITCHES AND SWITCHGEAR: *U shaped lamination assembled to form bridging member and adapted to bridge the gap between insulated fixed contact pieces.*—Brookhirst Switchgear Ltd.

32924. PUMPS, FANS AND LIKE MACHINES FOR TRANSMITTING ENERGY TO FLUIDS: *The boss which carries the rotor blades has a surface conforming to a surface of revolution of "dolphin" shape.*—Gill.

*32970. COMPOSITIONS FOR ELECTRO-DEPOSITION OF RUBBER: *Grinding compounding ingredients, preparing a dispersion bath of each and adding a homogenising mixture to the latex.*—Sir J. C. Ghosh, Verghese and Dr. Govindarau.

33022. VACUUM DRYING CYLINDERS PARTICULARLY FOR GRAIN: *Steam jacketted rotating cylinder having plurality of axially arranged heating conduits forming cruciform filling space and gauge covered vapour exit pipes connected to suction header.*—Huzenlaub and Rogers.

33144. NEW QUINOLINE DERIVATIVES: *4 halogeno-quinolines from an arylamine and a 2:4 dihalogeno-quinoline.*—I.C.I. Ltd.

33228. ADHESIVE COMPOSITIONS FOR BONDING TEXTILE FIBRES TO ELASTOMERIC MATERIALS: *Heating polyisocyanate and an isoprene polymer.*—Du Pont de Nemours and Co.

33412. CONTROL APPARATUS FOR AN ELECTRIC MOTOR: *A complete cycle unit for movement through complete revolutions and a partial cycle unit for movement through partial revolutions.*—Yardeny.

33816. ELECTRIC ACTUATORS: *Reversible electric motor operates drives screw operated ram through gearing and clutch; limit switch reverses motor connections at ends of travel of ram.*—Miles Aircraft Ltd.

33924. HERMETICALLY SEALED CONTAINERS FOR RADIO APPARATUS AND THE LIKE: *Joint made by low melting point alloy and a heating coil attached to the container near the joint.*—Standard Telephones and Cables Ltd.

33927. HYPODERMIC AMPOULE SYRINGES: *Hypodermic syringe with a collapsible tube over which the needle is mounted, the tube being provided with an extension for supporting the needle in the enclosed chamber.*—Jones.

34021. BALL-COCKS: *Ball-cock incorporating rotary valve driven from ball lever through step-up gearing.*—The Walsgrave Engineering Co. (Conventry) Ltd.

34071. PREFABRICATED BUILDING UNITS: *A conveyor for feeding moulds to charging and vibrating stations and a second slowly moving conveyor for feeding the moulds through curing chambers.*—Alltools, Ltd.

34105. MIXTURE FOR JOINING WIRE TO CARBON OR GRAPHITE BRUSHES: *Contains graphite black lead, shellac and methylated spirit.*—Narayan.

34304. DISTRIBUTOR FOR MANURE OR THE LIKE MATERIAL: *Includes a carriage supporting a rotary or other driven spreader and means for transferring the material.*—Thwaites.

34442. LIGHTNING ARRESTERS: *A lightning arrester provided with a pressure release diaphragm, the diaphragm acting as a pressure relief device upon failure of the arrester.*—I.G.E. Co., Inc.

34517. REMOVAL OF COLOUR FROM SHAPED ARTICLES COMPRISING A POLYMER OF ACRYLONITRILE: *Subjecting the polymer of acrylonitrile while in the gel state to a treatment with an aqueous solution of hydrogen peroxide or hypochlorous acid.*—Du Pont de Nemours and Co.

34564. MAINTAINING HUMIDITY IN INCUBATORS: *Tray located within egg chamber connected to source of water outsided incubator through horizontal pipe.*—Capt. Wright and Saigal.

34723. FLY TRAP: *Comprising a base having two concentric inner and outer containers, for carrying sweet and insecticide solution and a cover to fit on to the base.*—Patel and Patel.

34769. HYDRAULIC RAM PUMPS: *Hydraulic ram providing an adjustable hinged type inwardly opening nonreturn flap valve and a cheek valve of similar type opening outwardly.*—Macdonald, Forman and Co., Ltd., and Harris.

34866. EXTRACTION OF LIQUIDS FROM LIQUID-CONTAINING MATERIALS: *Exerting a thrust on the material at spaced point while exerting a contrary thrust in opposite direction.*—Sizer.

28663. LAUNCHING OF TORPEDOES: *Propellant charge comprising a fast burning portion and a slow burning portion.*—The British Power Boat Co., Ltd. and I.C.I. Ltd.

31609. WATER-REPELLENT CONSTRUCTIONAL MATERIALS: *Applying water insoluble polyvalent metal salt of a water insoluble carboxylic acid.*—I.C.I. Ltd.

31922. ANHYDROUS MAGNESIUM CHLORIDE: *Magnesia is added to water and magnesium chloride so as to self harden and then chlorinated with reducing agent.*—Magnesium Elektron Ltd.

31933. SUSPENSION SYSTEMS FOR AUTOMOTIVE VEHICLES: *Spring interposed between axle and frame is distorted at a non-uniform rate by uniform increase of lead.*—Willys-Overland Motors, Inc.

32018. BUILDING BLOCKS AND BUILDINGS FORMED THEREWITH: *Two similar Zed sectioned blocks form a hollow wall.*—Dr. Carbone-Fania.

32334. AROMATIC AMINE N-PENTOSIDES: *Reacting primary aromatic amine with pentose.*—Hoffmann-La Roche, Inc.

32335. PENTOSES: *Heating an aromatic amine pentoside in solution in the presences of water.*—Hoffmann-La Roche, Inc.

32336. TRIACYL PENTOSES: *Heating a primary aromatic amine N-triacyl pentoside in presence of water.*—Hoffmann-La Roche, Inc.

32337. RIBITYLAMINOBENZENES AND TRIACYL DERIVATIVES THEREOF: *Hydrogenating a riboside in the presence of a metal hydrogenation catalyst.*—Hoffmann-La Roche, Inc.

32338. ELECTROLYTIC REDUCTIONS: *Impelling cathalyte through cathodic chamber in contact with liquid alkali amalgam cathode.*—Hoffmann-La Roche, Inc.

32416. BENZENE HEXACHLORIDE ISOMERS: *Extracting crude benzene hexachloride with aliphatic or cycloaliphatic solvent of 6-carbon atom ring.*—I.C.I. Ltd.

32781. CONVERTING RECIPROCATING MOTION OF PISTON OR PISTONS, TO ROTARY MOTION OF DRIVEN SHAFT: *Converting reciprocating motion into rotary motion without using cranks.*—Berry, Berry and Vallentin.

*32971. EXTRACTION OF RUBBER FROM THE LEAVES OF CRYPTOSTEGIA: *Grinding a mixture of the leaves of cryptostegia, water and oleic acid.*—Sir Bhatnagar, Dr. Karimullah and Shanker.

33006. POLYMERISABLE ORGANIC COMPOUNDS AND POLYMERS THEREOF: *Reacting allyl or substituted allyl esters of hydroxy acids with acid chlorides, anhydrides, or dibasic acids. The di-esters formed are polymerised with polymerisation catalyst.*—I.C.I. Ltd.

33090. FABRICS PARTICULARLY OPEN MESH CLOTHS SUCH AS INSECT SCREENING: *Impregnating threads with low amount of plastic material before weaving and subjecting them to heat after weaving for binding.*—Bloch.

33136. AXLEBOXES FOR RAILWAY VEHICLES: *Two complementary halves encircling the axle journal joined in a vertical plane along the axis of the bearing.*—The Federated Engineers Ltd.

34137. AMINO-FORMALDEHYDE RESINS: *Plasticized by an inorganic lactate.*—William Walker and Sons Ltd.

33161. STABILIZERS: *Radius rods secured to axle ends extend diagonally rearwards to be secured to a transverse torsion bar rotatably mounted on the frame.*—Ford Motor Co. of Canada, Ltd.

33229. SYNTHETIC RUBBER-LIKE MATERIALS: *Polymerising fluoroprene butadiene and ethinyl carbinol.*—Du Pont de Nemours and Co.

33230. NEW RUBBER-LIKE POLYMERIC MATERIALS: *Polymerising a halogen-substituted* 1: 3-*butadiene in presence of an ester of alpha unsaturated alpha, beta dicarboxylic acid and a monohydric unsaturated alcohol.*—Du Pont de Nemours and Co.

33267. FOUNTAIN PENS: *Clamping the nib to the barrel by endless metallic ring. Engagement of inturned flanges of that nib with the longitudinal grooves in the barrel.*—Bernier.

33382. GASOLINE ECONOMIZERS FOR ADMITTING AIR INTO THE INTAKE MANIFOLD OF AN INTERNAL COMBUSTION ENGINE: *Suction operated valve having tapered grooves constituting an air passage-way varied in size increasingly by the moving valve in proportion to its movement effected by increasing suction pressure.*—Autac, Inc.

33384. COKE-OVEN DOORS: *Self sealing door comprising a clamping sheet, an inner plug member, a flexible sealing member and an outer metallic member, the said members are fixedly secured at one point of clamping sheet and compressively non-fixedly secured at another point of the sheet.*—Koppers Co., Inc.

34416. PROFILE TURNING ROLLER BOXES OR STEADIES FOR LATHES: *Frame with steady rollers and a profile bar moving endwise of the frame, causes tool to turn required contour.*—Manchester Repetition Engineers Ltd.

33449. INCINERATOR: *Opening in bottom of curtain wall connects downdraft flue and chimney flue and opening below arched roof connects combustion chamber with top of downdraft flue.*—Sharpe.

33479. ETHERS AND ESTERS OF CARBOHYDRATES: *Heating a mixture of carbohydrate and a small proportion of water during or after esterification or etherification, suddenly for a short time, then drying by pressure.*—Scholten's Chemische Fabrieken.

33643. BETA-MERCAPTOVALINE AND METAL SALTS THEREOF: *Removing β-benzyl group from β-benzyl mercaptovaline by treatment of the latter with metallic sodium in an anhydrous liquid.*—American Cyanamid Co.

33656. TREATING MECHANICAL GROUND WOOD PULP: *Treating pulp with acids and peroxides.*—Buffalo Electro-Chemical Co. Inc.

33762. FOLDABLE CLOSURE: *Horizontally collapsible and extensible linkage combined with vertically collapsible and extensible linkage, the latter being extensible away from and collapsible towards the former.*—New Castle Products.

33788. INDICATING MEANS: *Indicating apparatus with a reduction gear and a friction clutch mechanisms.*—Indications Ltd.

33996. DEVELOPER FOR BROMIDE PAPER: *Soda carbonate more than soda sulphite and hydroquinine more than double of metal.*—Anand.

33997. DEVELOPER FOR FILMS: *Consisting a reducing agent, a preservative, alkali and hypo.*—Anand.

33998. AERATION OF LIQUIDS: *Liquid to be aerated passed over one or more conical surface bodies.*—B. N. Roy.

34049. WHISKS FOR CONCRETE AERATING MACHINES AND CONCRETE AERATING MACHINES INCORPORATING THE SAME: *Whisk for concrete aerating machine comprising cage-like structure of blades and tubes for leading air into.*—Cheecol Processes Ltd.

34649. GENERATING HEAT: *Jackets air container having a metallic disc above the top and a pump for compressing air into the container.*—Chadray.

34688. CONTACT ARRANGEMENTS FOR CONTINUOUS CARBON ELECTRODES: *Contact members pressed against electrode by movement of a water cooled pressure ring.*—Det Norske Aktielskab for Elektrockemisk Industri.

34712. TWO-PENTODE TUBE AMPLIFIER: *Comprises two pentode tubes, one of high dynamic amplification coefficient and other of low direct current and high alternating current resistances.*—Standard Telephones and Cables Ltd.

34721. WIPER ASSEMBLIES FOR AUTOMATIC SWITCHES AS USED IN TELEPHONE SYSTEMS: *Wiper blades are separate from and pivotally mounted on the wiper assembly a spring connection after pressure to wiper tips.*—Automatic Telephone & Electric Co., Ltd.

33755. SLIDING CLASP FASTENERS: *A disc or wheel with teeth or notches speed around its periphery is provided between delivery end of an inclined rail and upper inlet end of a storage magazine.*—Aero Zipp Fasteners Ltd.

34774. LIGHTERS: *Pivoted pressure element bears on a cam lever with an arm connected to wick cap.*—Phillips.

34835. IMIDAZOLINES: *Reacting a nitrite with a* 1: 2-*diamine in the presence of hydrogen sulphide.*—Ciba Ltd.

34839. SAFETY RAZORS: *At least for part of the handle length is arranged at an oblique angle to the protective plate a screw-tap on the clamping plate and a rotatable spindle journalled in the tabular handle screw threaded part on the clamping plate.*—Rakbladsaktiebolaget Svenskt Stal.

34971. ORGANIC AMIDE COMPOUNDS: *Reacting an organic phosphazo compound with a carboxylic acid compound.*—General Aniline & Film Corpn.

35311. NEW POLYMERISABLE ORGANIC MATERIALS AND POLYMERS AND COPOLYMERS THEREOF. (Divided OUT OF No. 3306): *Polymerising a compound of the formula* $CH_2 = CH^1.\ CX^2X^3.\ O.CO.R^1.\ O.Z.R''.\ CO\ O.CX^4.\ X^5CX^6.\ CH_2$ *where Z is dibasic acid radical.*—I.C.I. Ltd.

28379. PURIFYING AND CRYSTALLISING NITROGUANIDINE: *Maintaining at a temperature not exceeding* 100° *C. a slurry comprising nitroguanidine and water and atomising the resulting stream of solution.*—I.C.I. Ltd.

30331. APPARATUS FOR TUNING AN ELECTRICAL OSCILLATOR: *Comprising an electrical generator providing a set of standard frequencies to one of which variable oscillator is tuned, means for comparing this frequency to any one of the set.*—G.E.C. Ltd.

30663. RADIATORS: *Airways disposed at right angles to waterways width of waterways* 1/16 *in., pitch of waterways and airways* ½ *in. and* 1/10 *in.*—I.C.I. Ltd.

30907. COOLING OR ATTEMPERATING OIL OR OTHER VISCOUS LIQUIDS: *Oil cooling device with a thermostatic device.*—I.C.I. Ltd.

30982. FIBRES, THREADS AND YARN MADE FROM POLYMERS AND INTERPOLYMERS OF ETHYLENE: *Heat-treatment of previously oriented polythene threads.*—Du Pont de Nemours and Co.

32020. MIXING LIQUID WITH FIBROUS MATERIAL: *Apparatus comprising an inclined trough with grid-like bottom, mixing effected by screw conveyor.*—Cellulose Development Corpn., Ltd.

32069. N-ALKOXYMETHYL POLYAMIDES: *Acid treatment of N-alkoxymethyl polyamide to improve its properties.*—Du Pont de Nemours and Co.

32118. SPRING-OPERATED DRIVING MECHANISM FOR ELECTRIC SWITCH GEAR: *Spring operated driving mechanisms for circuit breakers and the like.*—A. Reyrolle & Co., Ltd.

32315. KNIVES OR LIKE TOOLS: *A knife in which the knife blade comes out and in of a cylinder through the operation of a rotary propelling device.*—Vernons Industries Ltd. and Kennerley.

32358. PENS: *Pen nib comprising two metal strips or wire pressed together to form ink feed, slits, one end serving as writing tip.*—Gowland.

32365. WEB SPLICING: *Accelerating new rolls with adhesive layer at leading end, and effecting pressing and serving of webs respectively by control actuators.*—Wood Newspaper Machinery Corpn.

32449. COMPACT COMBUSTIBLE EXPLOSIVE CHARGES: *Fusing ammonium nitrate with ammonium bichromate, wax and magnesium nitrate and casting at* 110° *C.*—I.C.I. Ltd.

32466. EDGE SCRAPPERS FOR ELECTROLYTIC TINNING LINES AND THE LIKE: *Processed strip formed tinned plates contact a scrape wheel for scraping away the granular crystalline treed formation of strip edges.*—Carnegie-Illinois Steel Corpn.

32579. SEPARATORS FOR SEPARATING GASEOUS FLUID AND LIQUID: *A bank of corrugated plates forming sinnous channels, one set of plates for fluid flow channels at inlet end and second set inter-leaved with first.*—Bernier.

32707. WEFT-FORK FOR CIRCULAR WEAVING LOOMS: *A number pivoted on shuttle which under the action of centrifugal force closes an electric circuit to stop the loom.*—Saint Freres Societe Anonyme.

33203. INHALERS FOR ANALGESIC OR ANAESTHETIC PURPOSES: *An inhaler for analgesic, and like purposes.*—Hayward-Butt.

33222. INTERPOLYMERS OF STYRENE WITH FROSTING DRYING OILS AND OF COATING COMPOSITIONS OBTAINED THEREFROM: *The reaction between the styrene and the oil is carried out in the presence of a solvent consisting of or comprising a monocyclic alpha terpene.*—Lewis Berger and Sons Ltd., Wakeford, Hewitt and Davidson.

33270. CERAMIC MATERIALS OF HIGH PERMITIVITY: 1 *per cent. to* 70 *per cent. of wet milled barium titanate and* 99 *per cent. to* 30 *per cent. of dry milled barium titanate are mixed together prior to fabrication and firing operations.*—Philips Lamps Ltd.

33304. RAISING WATER: *A rotary suction pipe connected to short lengths of delivery pipes which are also adapted to revolve.*—Lawrence.

33316. CHLORAL: *Adding chloral alcoholate to strong sulphuric acid.*—I.C.I. Ltd.

33389. AUTOMATIC ELECTRIC ALARM SIGNALLING SYSTEMS: *A vibrating relay in a selector unit responds to impulses and closes an alarm circuit.*—Standard Telephones and Cables Ltd.

33396. RUBBER-LIKE MATERIALS: *Polymerising a mixture of* 2-*fluoro*-1: 3-*butadiene, another polymerisable unsaturated compound and* 0.5 *to* 5.0 *per cent.* 2: 2′-*difluorobutene*-3.—Du Pont de Nemours and Co.

33397. RUBBER-LIKE MATERIALS: *Polymerising* 90-60 *per cent. of fluoroprede or its methyl, ethyl or propyl homologue with* 10-40 *per cent. of styrene.*—Du Pont de Nemours and Co.

33421. POLYSTYRENE AND/OR FILM FORMING COMPOSITIONS OBTAINED THEREFROM: *Effecting the polymerisation of monomeric styrene in a solvent consisting of terpenes.*—Lewis Berger and Sons Ltd., Wakeford, Hewitt and Armitage.

33451. DISCRIMINATOR CIRCUITS FOR FREQUENCY MODULATED WAVES: *Includes a cathode follower valve stage with a tuned cathode circuit connected to two diodes.*—Marconi's Wireless Telegraph Co., Ltd.

33505. FIRE-EXTINGUISHING APPARATUS: *Hand operated fire extinguisher having pick up device.*—The Pyrene Co., Ltd.

33685. RADIO DIRECTION FINDERS: *Maintains output signal waves at constant phase relationship by means of a phase advance network.*—Standard Telephones and Cables Ltd.

33709. OUT-OF-STEP RELAY ARRANGEMENTS FOR ALTERNATING CURRENT POWER SYSTEMS: *Effects control operation at a point where an open relay is connected to the system.*—I.G.E. Co., Inc.

33838. ELECTRIC COILS AND THE LIKE: (Addition to No. 29996): *Electrical instrument wound with wire having terminal tags to which lead-out wires are fuse-welded.*—Standard Telephones and Cables Ltd.

33843. ELECTRIC WAVE FILTERS: *Terminated by a resistance at one end, by-path means associated therewith.*—Standard Telephones and Cables Ltd.

33982. Walmsleys (Bury) Weirs and like liquid level control means: *Lip of one plate contacts with tail of another forming continuous beffle.*—Walmsleys (Bury) Ltd.

34025. MACHINES FOR MAKING POTTERY WARE: *Have jigger heads, shaping arms, a mould carrier, the latter two operating simultaneously.*—John Maddock and Sons Ltd. and Maddock.

34320. FRAMES FOR USE IN HOSPITAL BEDS: *Cross bar carrying pulley secured to vertical member at the foot end.*—Hall.

34456. ELECTRIC TORCHES. (Addition to No. 33779): *Underside of rim of plug has projections which when the plug is turned, rides on two inclined surfaces at the lower ends of the torch casing.*—Yashanoff.

34584. ISOPRENE BY DISTILLATION OF RUBBER: *Rubber or synthetic hydrocarbon gases are produced by heat, cracked and condensed and then isoprene is obtained by distillation.*—Rubber-Stitching.

34628. AQUEOUS EMULSIONS OF WAXES: *In wax emulsions, the colloid is treated with a salt of dinaphthyl-methane-disulphonic acids.*—Du Pont de Nemours and Co.

34676. FUNNELS OR TRUMPETS FOR CONDENSING THE SLIVERS FROM DRAWING FRAMES AND SIMILAR TEXTILE MACHINES: *Having a hardened steel pressure washer interposed between the upper surface of the semi-conical segments and the bottom of the upper part.*—Schofield.

34992. DEVICE ON SEWING-MACHINES FOR DRIVING THE FEEDER: *Connecting the feedrack to a carrier engaged by two oscillating levers, one imparting a horizontal movement and the other a vertical movement.*—Brutsch and Brutsch.

34994. ILLUMINATING DEVICE FOR SEWING MACHINES: *Shade containing the lamp is a case-part, detachably secured to the front face of the sewing head.*—Brutsch and Brutsch.

35097. CARTON: *Comprising two tray-like parts with a common edge, one part adapted to cuter within the other and secured by binding means.*—Rumsey.

29432. PROJECTILES AND DRIVING BANDS THEREFOR: *Projectile having a cylindrical rear portion engraved and in advance of said portion one or more deformable fins, a groove in rear of said fin and a lubricant in said groove.*—Johnson.

31081. WELDING RODS: *Sintering a mixture of meta powders in which that metal liable to form a layer of refractory oxide is employed in the form of an alloy or compound.*—Murex Welding Processes Ltd.

32251. DRIVING OF SPINDLE-ASSEMBLIES OR FLYER-ASSEMBLIES IN SPINNING AND LIKE FRAMES, AND PARTICULARLY TO THE DRIVING OF WHARF-FLYER ASSEMBLIES IN FLYER-SPINNING FRAMES: *Having a nodal point in the said assembly where driving force is applied to minimise vibrations.*—Morrison and McGregor Gunn.

32459. LOW CARBON FERRO-ALLOY: *Primary low carbon alloy of high silicon content is first made, silicon content is then reduced by intermixing with an oxidising slag in two stages of the process to obtain low carbon ferro-alloy of the desired composition, iron being added during the process.*—Societe D'Electro-Chimie, D'Electro-metallurqui et des Acieries Electroques D'Ugine.

32535. B B' B"-TRICHLOR-A Á BIS 4 CHLORPHENYL-ETHANE OR DICHLORDIPHENYLTRICHLORETHANE: *Treating chloral hydrate with 25 per cent.—75 per cent. excess of monochlorbenzene.*—Gladden and Cocker.

32659. GRAPHITIC ALLOY STEELS AND NITRIDED PRODUCTS MADE THEREFROM: *Graphitizable steel heated to graphitising range, thereafter cooled, reheated to nitriding temperature in contact with nitrogen liberating agent ammonia.*—The Nitralloy Corporation.

32665. GLASS MELTING TANK FURNACES: *A melting chamber and an associated working chamber at a lower level.*—Smith.

32668. INSECTICIDAL COMPOSITIONS: *Preparation of cyclopropane derivative by heating pyrazoline compounds containing at least one isocyclic ring and incorporating the same in an inert solid diluent.*—Geigy A.-G.

32743. HEAVY MEDIA SEPARATION PROCESS: *Treating mixture with fluid containing magnetically suspectable material and separating it after demagnetisation.*—American Cyanamid Co.

32994. ANTIBIOTIC AGENT EXTRACTION PROCESS: *Extracting with organic solvent after acidification.*—Shell Development Co.

33594. FURFURAL: *Producing furfural by subjecting vegetable raw material to heat and pressure in a stationary reaction vessel, together with an aqueous liquid.*—I.C.I. Ltd.

33699. HEAVY GRINDING MILLS: *Means lubricating reduction gear surfaces before and trunnion bearings before starting; laminated seal assembly between trunnion at discharge end and gear casing.*—Kennedy.

33733. PURIFICATION OF IRON OXIDE-CONTAINING ORES: *Ores melted, impurities slagged off with or without use of flux.*—Societe D'Etudes et de Brevets.

34048. DRYING OF TEA DURING MANUFACTURE: *Drying with mixture of air and products of combustion in apparatus having combustion chamber, burner nozzles, a mixing chamber.*—Walshaw.

34114. DIPOLE ANTENNA SYSTEMS: *Comprises two rigid conducting members each electrically unbalanced with respect to earth about a feed point located intermediate their ends.*—Standard Telephones and Cables Ltd.

34346. PLASTIC COMPOSITIONS: *Shellac is mixed with Buna N a copolymer of a conjugated diolifin and an acrylic nitrile.*—The Firestone Tire & Rubber Co.

34630. PERCUSSIVE TOOLS: *A rotatable eccentric member arranged within the striker in the form of a ring, so as to reciprocate it.*—Stutz.

34893. CUPBOARD DOOR AND THE LIKE CATCH FITTINGS: *A body portion for securement to door has a finger hole in front thereof into which projects or depressing plate forming a portion of a bolt which is pivotally mounted to the body.* Somerfield.

34913. WRINGING MACHINES, MANGLES, CALLENDERING PRESSES AND THE LIKE: *Rollers supported in separate frames, pivoted to one another and provided with spring means one side, other side being free.*—Parnall Aircraft Ltd.

34983. RESPONDING TO MAGNETIC FIELDS: *Separate magnetic cores having hysteresis loops with sharp knee at saturation periodically energized to reach saturation abruptly, phases of energizing cycles shifted by ambient field and sharp voltage pulses produced thereby received by selective transducer.*—Gulf Research & Development Co.

34995. PROJECTING PULVERISED MATERIAL: *Comprises a casing which can be oscillated by means of a handle.*—Lee.

35007. AIR-CONDITIONING DEVICES: *Comprises a coil and a fan for circulating air over it.*—Braun.

35090. CATALYTIC CRACKING OF HYDROCARBONS: *Reacting a hydrocarbon fraction in the presence of a catalyst comprising essentially hydrogen flouride and boron triflouride.*—Jennings.

35121. LOCKING MEANS FOR USE WITH FISH PLATES: *Spring formed by resilient wire fastened to thin plate secured to fish plate bears eccentrically against sides of nuts on bolts.*—Curtis.

36086. NEW ALLOY STEEL: *Containing carbon, aluminium, chromium, molybdenum, manganese and substantially all iron.*—Nitralloy Corpn.

27308. SUPPLEMENTARY PROPULSION OF CYCLES BY THE OSCILLATION OF THE HANDLEBARS: *A chain fixed to each side of handlebars passes over a guide pinion and directed round a driving pinion gives forward movement for each oscillation of handlebars, tension of chain assured by a spring.*—Genin.

30256. SURFACES FOR AIRCRAFT STRUCTURES: *Sheet incorporating strands of material of high tensile strength and elasticity, stretched longitudinally over rails on basal structure in a tensioned condition by clamping battens screwed down to the rails.*—Vickers-Armstrongs Ltd.

30623. LUBRICATING COMPOSITION: *An organic compound consisting of a phosphite or thio-phosphite ester is added to a lubricating oil.*—C. C. Wakefield & Co., Ltd.

31361. BINDING AND/OR WATER PROOFING AND/OR COMPACTING AND STRENGTHENING OF SAND, SOIL, EARTH, CLAY AND LIKE MATERIALS: *Applying to sand, soil, earth, clay and the like a pectous and or mucilaginous material.*—The President, Forest Research Institute and College.

32035. BINDING WATER-PROOFING, COMPACTING AND/OR STRENGTHENING OF SAND, SOIL, EARTH, CLAY, AND LIKE MATERIALS: *Treating with pectous and/or mucilaginous material containing a hydroxide.*—S. Krishna.

32127. SPARKING PLUGS FOR INTERNAL COMBUSTION ENGINES: *Sparking plug having metal body provided with an external copper face.*—Dorman & Smith, Ltd. and Atherton.

32202. ADVERTISING OR DISPLAY DEVICE: *Plates provided with upstanding flanges and so mounted each has one end positioned in the intermediate of adjacent plate.*—Smith.

32203. WHEEL RIMS FOR PNEUMATIC OR OTHER TYRES: *Oneside edge of medial depression the wheel rim is constructed to be detachable and replaceable from or upon the rest of the wheel rim.*—McKenzie.

32248. PRINTING BODIES MADE OF CELLULOSE, SUCH AS TEXTILE FABRICS, PAPER AND THE LIKE, WITH CHROMIUM MORDANT DYESTUFFS AND BODIES PRINTED ACCORDING TO THIS PROCESS: *Cellulosic bodies are printed with pastes containing beside dyestuff an amide, an alkali chromate, a salt of an acid deriving from an oxygen compound of sulphur and an aromotic compound and allowed to dry without steaming.*—Durand & Huguenin A. G.

32469. HEELING OF SHOES OR MEANS FOR USE THEREIN: *Devices for supporting shoe and heel, fastener inserting arrangement and hole turning means for heel.*—The British United Shoe Machinery Co., Ltd.

32622. PUMPING SYSTEMS, AND PARTICULARLY TO CENTRAL LUBRICATION SYSTEMS FOR VEHICLES AND MACHINES: *One or more pumps actuated by a piston operated by fluid, depending on the period for which the machine is in operation.*—Tecalemit Ltd.

32632. DESHELLING PADDY, DAL AND THE LIKE CEREALS: *Rotating blades causing cereals to impinge under centrifugal force against hard stationary surface of housing.*—Roy.

32772. CONCRETE PIPE JUNCTIONS: *Stepped shoulder of passage way formed in the main pipe is curved and concentric with the internal circumference of that pipe.*—Hume Pipe Co. (Australia) Ltd.

32776. TRANSMISSION GEARING FOR USE ON DRIVING SHAFTS: *A spur-wheel peripherally grooved through its teeth to provide opposed cone surfaces to receive a bell drive of V-type, the spur-wheel being rotatably mounted in a frame floatably mounted on the driving shaft.*—Wearn's Patents Ltd.

32837. AUTOMATIC INFLATING ARRANGEMENTS FOR PNEUMATICALLY-TYPED VEHICLE WHEELS: *Annular piston with stud engaged by groove on cam on spindle, and housed in hub bernel, unloading valve between outlet and wheel to prevent over humping.*—Saxby, Stabback and Collins.

33898. ELECTRIC CONTROL APPARATUS FOR EDDY CURRENT CLUTCHES: *Comprising means for avoiding the effects or supply line voltage charges on the speed of the eddy current clutch.*—Heenan & Froude Limited.

33958. ASCERTAINING THE ANGLE OF AN INCLINED SURFACE AND/OR THE LENGTH OF SUCH SURFACE AND/OR FOR DELINEATING ANGLES: *A base incorporating slidable scale with zero mark thereon juxtaposed graduations on the base, a rotable cursor with points thereon juxtaposed graduations on said base and on scale and a level bulb in said cursor.*—Hunt and Woodward.

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Chemical Examination of Nim Blossoms (*Melia Azadirachta* Flora)

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(Chemical Laboratories, Council of Scientific and Industrial Research, Delhi)

THE therapeutic properties ascribed to the various parts of the nim tree (*Melia azadirachta, Melia indica*) in the indigenous systems of medicine, have been referred to in some detail in recent publications[1] dealing with the isolation and study of the bitter constituents of the nim oil and their utilization in the pharmaceutical industry. As an extension of the work so far carried out on the nim seed (*loc cit.*) to the other parts of the tree, the nim blossoms which are reputed as a tonic after fevers and are also used in the treatment of atonic dyspepsia, were taken up for investigation. It is important to note in this connection that while extensive work has been carried out by a number of authors on the nim oil and by some also on the bark, no attention appears to have so far been given to the blossoms. As a result of the present investigation, the following products have been obtained from the cold alcoholic percolate of the powdered, air-dried blossoms:

1. Nimbo-sterol, $C_{20}H_{34}O$, m.p. 137° C., colourless needles and leaflets (yield, 0.03 per cent. on the weight of the dry flowers).
2. Nimbo-sterin (the sterol-glucoside), m.p. 294° C., clusters of needles (yield, 0.005 per cent.).
3. Nimbicetin, $C_{15}H_{10}O_6$, $C_{15}H_6O_2(OH)_4$, m.p. 272° C., fine yellow needles (yield, 0.05 per cent.).
4. Essential oil, consisting of sesquiterpene derivatives, the lowest boiling fraction analysing for $C_{15}H_{24}O_2$ (yield, 0.5 per cent.).
5. Saturated hydrocarbon (Nonakosane), $C_{29}H_{60}$ m.p. 64-66° C., flakes (yield, 0.01 per cent.).
6. Fatty acids—Behenic, arachitic, stearic, palmitic, oleic and linolic.

In the course of these investigations, it has been noted that the extraction of flowers with ether is better suited for the isolation of the essential oil in the form in which it appears to be present in the plant body, but that it fails to extract the sterol-glucoside and the colouring matter which are obtained from the alcoholic extract of the flowers.

The isolation of the various constituents from the alcoholic extract is primarily based on its separation into (1) water soluble, ether insoluble and (2) water insoluble and ether soluble fractions, of which the former yields the flavone, nimbicetin. On partitioning the ether soluble portion between petroleum-ether and dilute alcohol, the alcoholic layer yields the nimbosterin (the sterolglucoside). The total essential oil is obtained by steam distillation of the combined residues left on removal of the solvents from the petrol-ether layer and the mother liquors of nimbosterin. The fatty residue left after steam distillation, gives nimbosterol and the hydrocarbon from its unsaponifiable fraction and a mixture of saturated and unsaturated fatty acids consisting mainly of behenic, arachitic, stearic,

plamitic, oleic and linolic acids from the fatty component.

It may be noted here that no bitter constituent could be isolated from the blossoms and that the water soluble portion of the alcoholic extractive yielded a crystallizate of inorganic salts consisting mainly of potassium chloride. A qualitative analysis of the ash (6.3 per cent.) of the blossoms indicated the presence of sodium, potassium, calcium iron, chloride, carbonate, sulphate, phosphate and silica.

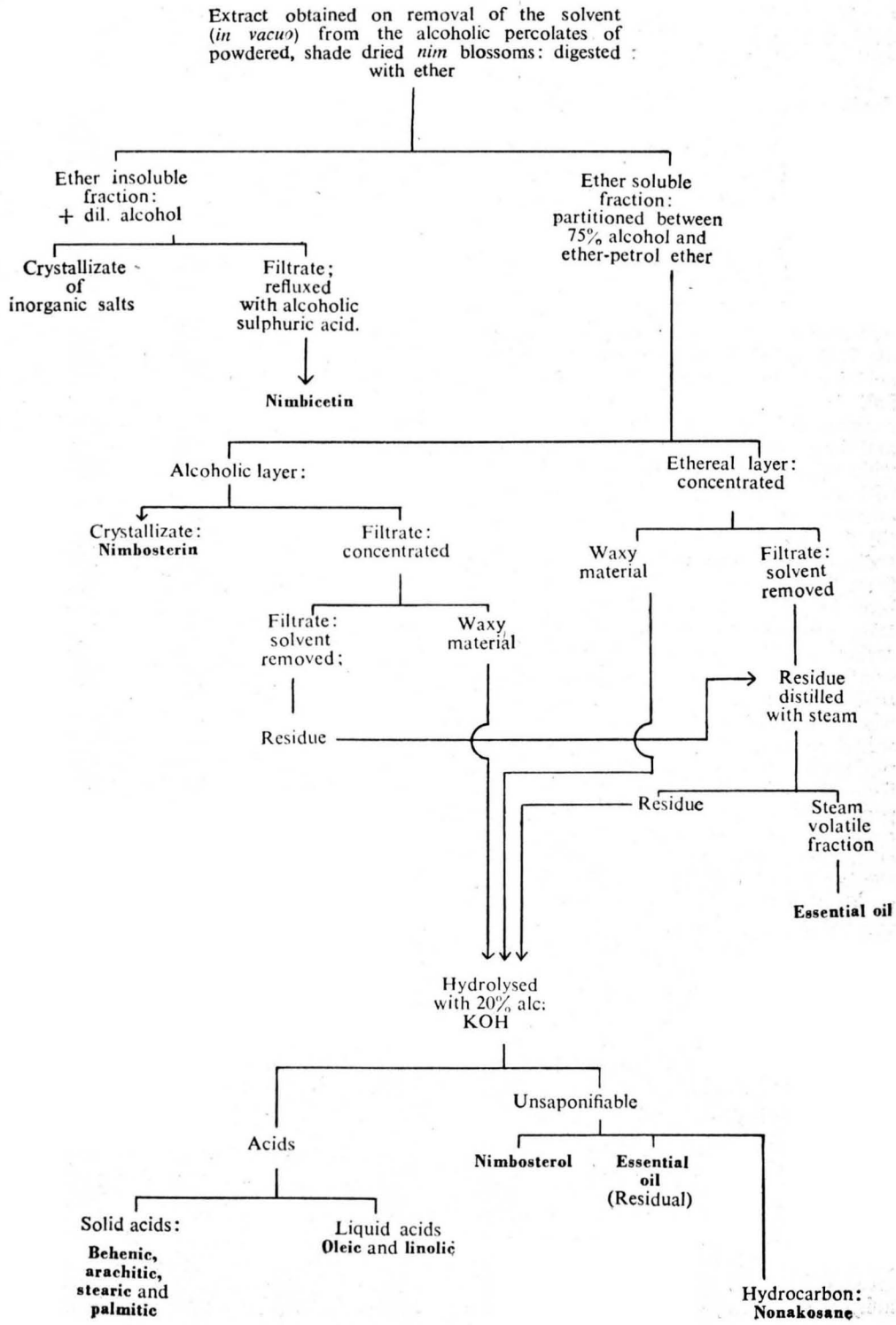
Experimental

The nim blossoms used for the present investigation were collected locally during the flowering season in April-May. After a preliminary examination of the powdered material for ascertaining the most suitable procedure for the extraction of its more significant chemical constituents, a larger quantity of the blossoms was worked up in the following manner (Chart I).

8 kg. of air-dried, powdered nim blossoms were percolated five times with alcohol at room temperature. The total percolate (20 litres) was concentrated under reduced pressure to about 4 litres of a thick, syrupy, greenish-brown, pleasant-smelling liquid which set to a semi-solid mass on keeping in the cold. The total extractive was digested with ether. From the greenish ethereal extract the solvent was removed partially and petrol-ether added to the concentrate when a quantity of brownish mass was precipitated out. This was again digested with ether and the ethereal extract added on to the ether—petrolether solution. A repetition of these operations ultimately led to the separation of the alcoholic extract into two clear-cut fractions, one of which (A) was soluble in ether and insoluble in water, while the other (B) was soluble in water and insoluble in ether.

The ether—petrol ether solution was concentrated on the water bath to about 1.5 litres and the concentrate, which now consisted mainly of petrol ether as solvent, was repeatedly partitioned with dilute alcohol (75 per cent.). On keeping for a few days in the cold, the dilute alcoholic solution yielded a small quantity of a micro-crystalline substance (0.4 gm.) which on repeated crystallization from pyridine yielded a sterol-glucoside, m.p. 294° C., which has been provisionally named nimbo-sterin. The alcoholic filtrate was then concentrated under reduced pressure and the concentrate kept in the cold, when a white, flocculent, semi-solid mass separated out which was filtered and washed with cold alcohol. On purification through alcohol, ether—petrol ether and acetone, it yielded a white semi-crystalline, waxy substance melting at 60-65° C. The petroleum ether layer from the foregoing partitioning operations was washed with water, dried over anhydrous sodium sulphate and concentrated after filtration. On keeping the concentrate in the cold, a waxy material similar to that obtained from the dilute alcoholic layer, separated out and was worked up in the same manner. The odorescent residues left after removal of the solvent from the filtrate and the combined alcoholic washings of the waxy matter were subjected to steam distillation. The turbid distillate (7 litres) was saturated with common salt and repeatedly extracted with ether. The total ethereal extract was washed with water, dried over anhydrous sodium sulphate, filtered and freed from the solvent when a sulphur-free essential oil (*ca.* 40 gms.) was obtained in a yield of 0.5 per cent. on the weight of the air-dried material.

The greenish, waxy residue (*ca.* 35 gms.) left after steam distillation was saponified with 20 per cent. alcoholic potash under reflux on the water bath for about 10 hours and the major portion of the solvent distilled off under reduced pressure. The greyish pasty residue was diluted with water and repeatedly extracted with ether. The combined ethereal extract was then washed with water, dried over anhydrous sodium sulphate and filtered. On removal of the solvent from the filtrate, the unsaponifiable fraction (*ca.* 3.5 gms.) was obtained as a brownish semi-crystalline solid mass. On fractional crystallization of this product from a mixture of ether and ethyl acetate, the less soluble fractions yielded through acetone and alcohol, a hydrocarbon (*ca.* 0.8 gms.) melting at 64-66° C., while the tail fractions gave a sterol (*ca.* 2.5 gms.) which after repeated crystallization from alcohol finally melted at 137° C. and has been provisionally named nimbosterol. The residue from the combined mother liquors of the hydrocarbon and sterol yielded a sweet smelling essential oil on steam distillation. The aqueous alkaline solution from the saponified wax was acidified with dilute (10 per cent.) hydrochloric acid and the liberated acids repeatedly extracted with ether and finally with ethyl acetate. The


Extract obtained on removal of the solvent (*in vacuo*) from the alcoholic percolates of powdered, shade dried *nim* blossoms: digested with ether
Ether insoluble fraction: + dil. alcohol
Ether soluble fraction: partitioned between 75% alcohol and ether-petrol ether
Crystallizate of inorganic salts
Filtrate; refluxed with alcoholic sulphuric acid.
Nimbicetin
Alcoholic layer:
Ethereal layer: concentrated
Crystallizate: Nimbosterin
Filtrate: concentrated
Waxy material
Filtrate: solvent removed
Filtrate: solvent removed;
Waxy material
Residue distilled with steam
Residue
Residue
Steam volatile fraction
Essential oil
Hydrolysed with 20% alc: KOH
Unsaponifiable
Acids
Nimbosterol
Essential oil (Residual)
Solid acids: Behenic, arachitic, stearic and palmitic
Liquid acids Oleic and linolic
Hydrocarbon: Nonakosane

combined ethereal extracts were thoroughly washed with water, dried over anhydrous sodium sulphate, filtered and freed from the solvent finally *in vacuo*, when a greenish liquid mass was obtained as residue (*ca.* 30 gms.).

The ether insoluble portion of the alcoholic extract which formed a semi-solid pasty mass, fraction (B), failed to yield any crystalline constituent through alcohol, acetone-water, pyridine or varying mixtures of these solvents. The lead method also proved ineffective for the isolation of any crystalline substance from this fraction. Ultimately it was subjected to hydrolysis by refluxing in alcoholic solution with 4 per cent. sulphuric acid for 12 hours on the water bath. Nearly half the solvent was then removed from the reaction mixture under reduced pressure and the concentrate was repeatedly extracted with ether and ether-acetic after dilution with excess of cold water. The combined ethereal extracts were washed with water till free from acid, dried over anhydrous sodium sulphate and the solvent removed from the filtrate finally in *vacuo*. The dark brown semi-solid residue (*ca.* 5.5 gms.) was taken up in a 5 per cent. solution of sodium carbonate, the yellowish-brown, alkaline solution was acidified with hydrochloric acid and repeatedly extracted with ether, when a blackish sticky mass was left undissolved as a middle layer. This process of purification was repeated with the residue from the ethereal solution. The yellowish product eventually obtained through these operations was digested with hot petroleum ether to remove a tenaciously adhering sulphur containing impurity. After a further purification through ether—petrol ether, it was taken up in glacial acetic acid, when bright yellow needles crystallized out on keeping the solution in the cold. On repeated crystallization of this product from glacial acetic acid and then from methyl alcohol, a flavone which melted at 272° C. with decomposition was finaly obtained. It has been provisionally named nimbicetin.

Characterization of the Constituents

Nimbosterol, $C_{20}H_{34}O$, crystallizes as colourless clusters of flakes and needles melting at 137° C. and is soluble in alcohol, acetone, ether, ethyl acetate, chloroform, and insoluble in petrol ether and water. It yields a crystalline digitonide, gives a bluish green coloration in chloroform with acetic anhydride and sulphuric acid and a negative Tortelli-Jaffe colour reaction. It is leavo-rotatory and shows an optical activity $[\alpha]_D^{27°.5} = -74°$ in chloroform (Found: C, 82.66; 82.60 per cent.; H: 11.80, 11.96 per cent.; $C_{20}H_{34}O$ requires: C, 82.75 per cent.; H, 11.72 per cent.). Nimbosterol thus appears to be a new sterol differing from the common sitosterols which have an optical rotation below —45° and molecular formulæ of the order of C_{29}.

Nimbosterol-Acetate, $C_{22}H_{36}O_2$.—0.2 gm. of nimbosterol was taken up in 5 cc. of acetic anhydride together with 1 gm. of freshly fused sodium acetate and the mixture was refluxed on a sand-bath (150-160° C.) for 4 hours. The reaction mixture was then poured into ice-water and the solid acetyl derivative collected, washed with water and crystallized from alcohol, when it was obtained as colourless needles, which on recrystallization from the same solvent finally melted at 128° C. It is soluble in ether, ethyl acetate, chloroform, acetone and insoluble in light petroleum. (Found: C, 79.63 per cent.; H, 11.10 per cent.; $C_{22}H_{36}O_2$ requires: C, 79.51 per cent.; H, 10.84 per cent.).

Nimbosterin crystallizes in clusters of short needles, melting at 294° C., and is very sparingly soluble in moist acetone, soluble in pyridine, insoluble in other common organic solvents. It responds to the colour reactions of a sterol. On hydrolysis with 5 per cent. hydrochloric acid it gave an aglucone which melted at 137° C. and showed no depression in its melting point on admixture with nimbosterol. The acidic aqueous portion responded to the tests for reducing sugars with Fehling's and Benedict's solutions, but as the substance was not sufficient in quantity, the sugar component of the glucoside could not be identified.

Nonakosane, $C_{29}H_{60}$, crystallized as flakes and leaflets melting at 64-66° C. It is soluble in ether, light petroleum, ethyl acetate, benzene, chloroform and hot alcohol. It does not take up bromine in glacial acetic acid or chloroform solution at room temperature. It is leavo-rotatory and shows $[\alpha]_D^{26} = -9°$ in chloroform solution. (Found: C, 85.60 per cent.; H, 14.73 per cent.; Mol. weight, 390; $C_{29}H_{60}$ requires C, 85.29 per cent.; H, 14.7 per cent.; mol. wt. 408). The Nonakosanes ($C_{29}H_{60}$) recorded in literature

have a melting range of 62-66° C, but no optical activity has been noted for them.

Nimbicetin, $C_{15}H_{10}O_6$, $\frac{1}{2}H_2O$ crystallizes in fine, light yellowish needles, melting at 272° C. (softening earlier). It is sparingly soluble in water, moderately soluble in ether, benzene, acetone, chloroform alcohol, methanol, ether acetic and insoluble in petroleum ether. On exposure to air it slowly turns greenish brown and on aerial oxidation in alkaline solution, it turns dark red and ultimately brown. With alkalies it develops a bright greenish yellow colour, and in concentrated sulphuric acid it dissolves, giving a bright yellow solution with a greenish fluorescence. On reduction with magnesium and hydrochloric acid it gives a bright pink coloration. (Found: *micro*, C, 60.84 per cent.; H, 3.87 per cent. $C_{15}H_{10}O_6$, $\frac{1}{2}H_2O$ requires C, 61.01 per cent.; H, 3.73 per cent. After drying at 100° C. over P_2O_5 *in vacuo*, found: (*micro*) C, 62.9 per cent.; H, 3.7 per cent., loss in weight, 3.25 per cent.; $C_{15}H_{10}O_6$ requires C, 62.9 per cent.; H, 3.4 per cent., loss in weight for $\frac{1}{2}H_2O$, 3.5 per cent.).

Ethereal Extract

1 kg. of the powdered nim blossoms was extracted with ether in a modified Soxhlet apparatus. The total ethereal extract (2 litres) was partially freed from the solvent, when a softish semi-crystalline product separated out at room temperature which was washed thoroughly with acetone and alcohol, in which the substance is insoluble in the cold. On purification of the residue through ether, ethyl acetate and acetone, a nearly colourless substance melting at 65-71° C. was obtained which was similar in character to the waxy product referred to in the working of the alcoholic extractive.

The greenish semi-solid pasty residue (*ca.* 15 gms.) from the ethereal filtrate and washings of the waxy matter was subjected to steam distillation and 3.5 litres of distillate collected, which yielded *ca.* 5 gms. of the essential oil after being worked up in the usual way.

Neither nimbosterin nor nimbicetin could be isolated from the ethereal extract of the blossoms.

10.5 gms. of the essential oil yielded the following fractions when distilled *in vacuo*.

No.	Boiling range/pressure	Yield gms.	Colour	Density at 27° C.	Refrective index n 25
I.	120-150° C./40 mm.	5	Light yellow	0.9473	1.255
II.	150-200° C./10 mm.	3	Brownish yellow	0.9569	1.505
III.	210-220° C./3 mm.	1	Dark brown	—	1.511
IV.	230-250° C./2 mm.	0.5	Darker	—	—
V.	Residue	—	Black	—	—

The essential oil is soluble in alcohol upto 3:1 dilution. It is highly pungent in smell and taste, but in dilutions of the order of 1:2000 to 1:5000 with deodorized alcohol, it gives a pleasant scent similar to the fragrance of the fresh nim blossoms. Fraction (I) noted below gave the following analytical data (Found: C, 75.11, 75.39 per cent.; H, 9.92, 9.06 per cent.; $C_{15}H_{24}O_2$ requires: C, 76.2 per cent.; H, 10.1 per cent.):

Acid value: 24.6; 24.8

Ester value: 121.6; 119.5

Saponification equivalent: 146.2; 144.3.

Acetylation of Fr. I of the essential oil could not be effected by refluxing it with acetic anhydride and fused sodium acetate. Hydrolysis of the essential oil with 20 per cent. alcoholic potash under reflux for 8 hours yielded a sweet smelling neutral component (yield 60 per cent.) and a pungent smelling acidic fraction, which was obtained from the alkali soluble fraction of the hydrolyzate on acidification with dilute hydrochloric acid, extraction of the liberated acid with ether and removal of the ethereal solvent after washing and drying over anhydrous sodium sulphate. From the above findings, it appears that the essential oil is a mixture of an ester and an acid.

Composition of the Fatty Acids

On crystallization from alcohol and methanol, the total acidic component referred to in the working of the alcoholic extractive, yielded a mixture (*ca.* 5.5 gms.) of solid fatty acids melting at 72-85° C. On repeated fractional crystallization from alcohol and methanol, behenic acid (*ca.* 0.2 gms.) melting at 81-84° C., arachitic acid (*ca.* 0.2 gms.) melting at 76-77° C. stearic acid (*ca.* 0.15 gms.) melting at 69° C. were obtained. The iodine value of the total acidic component was found to be 99.2 after Hanus' method. The acids from the combined mother liquors were subjected to lead treatment (Twitchell's method). The ether insoluble lead salt yielded *ca.* 6.5 gms. of solid fatty acids, which on repeated fractional crystallization from alcohol yielded stearic acid melting at 69° C. (mixed

Fractions	Boiling range	Yield gms.	Mean mol. wt.	Comparison of mol. wt.
'A'	170-180° C./6 mm.	4	309.9	310 (Ethyloleate)
'B'	180-190° C./6 mm.	11	307.5	308 (Ethyllinolate)

melting point with authentic sample, 68-69°) from the less soluble fractions, while the tail fractions gave palmitic acid melting at 59-61° C. (mixed melting point with an authentic sample, 59-60° C.). The mean molecular weight of the ethyl ester (293.4) indicates the presence of *ca.* 35 per cent. of stearic (2.3 gms.) and *ca.* 65 per cent. of palmitic acid (4.1 gm.) in the solid acid mixture. The ether soluble lead salt yielded a mixture of liquid acids (*ca.* 22 gms.) having an iodine value of 99.8 (Hanus' method). This mixture of liquid acids (19 gms.) was esterified with 100 c.c. of absolute alcohol and 2.5 c.c. of concentrated sulphuric acid under reflux on a water bath for 8 hours. The reaction mixture was diluted with ice cold water and repeatedly extracted with ether after addition of common salt. The combined ethereal extract was thoroughly washed with 1 per cent. sodium hydroxide solution until free from the unreacted acids and finally with water and dried over anhydrous sodium sulphate. The residue after removal of the solvent, yielded a brownish yellow oily liquid (16 gms.) which when distilled *in vacuo*, gave the above fractions.

From the above data and the preceding findings the following percentage composition of the fatty acids of the waxy component is obtained:

	%
Behenic acid	0.66
Arachitic acid	0.66
Stearic acid	8.16
Palmitic acid	13.60
Oleic acid	65.30
Linolic acid	8.00
Loss	3.62

Acknowledgment

The authors take this opportunity to express their thanks to Mr. R. C. Tewari and Dr. Weiler for the analytical data incorporated in this publication.

Reference

1 Siddiqui, *Curr. Sci.*, 1942, **11**, 278; Siddiqui and Mitra, *Jour. Sci. & Ind. Res.*, 1945, **4**. 5.

Action of Light on some Direct and Vat Dyes, Dyed on Nylon

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IN 1932, Carothers and Hill[1] produced "strong, pliable, transparent permanently oriented fibres" which simulate natural silk, from entirely synthetic material. These authors[2] also described the production of "super polymers" having molecular weights above 10,000. Among them, super polyesters which had low melting points and super polyanhydrides which were easily hydrolizable on standing in the atmosphere, were not considered to be of much practical value, but the super polyamides and their mixtures found many industrial applications.

According to various patents, nylon is produced through the condensation of one or more amino carboxylic acids or certain of their ester derivatives, in the presence of inert high boiling mixed cresols, xylenols or similar compounds, by heating for a few hours at 220° C. By varying the composition of the constituents many different nylons could be produced.

Through such reaction high molecular compounds of polyamino methylene carboxyl type, e.g., — NH — $(CH_2)x$ — NH — CO — $(CH_2)y$ — CO, are produced. The reaction

mass on cooling sets to a hard stable solid, but the material in the molten state can be spun into filaments at about 200° C. in a non-oxidizing atmosphere like nitrogen. The molten mass is forced under pressure of three pounds of nitrogen, through fine orifices, and the filaments so produced are rolled on a motor drum at the rate of 27 yards per minute. These filaments are immediately drawn out in the cold condition by winding on another drum which rotates at double the speed of the previous one, thereby giving hundred per cent. extension and by this process the fineness of the filaments is adjusted to the required value[3].

The physical characteristics of nylon fibres have attracted the attention of textile manufacturers. Their high tensile strength (about 5 grms/den in dry condition and 4.4 grms/den in wet condition) with a 91 per cent. elastic recovery when stretched to 16 per cent. of their length, coupled with their wear resistance have rendered them very valuable for hosiery, knitted goods, bathing costume, sewing threads, shirting, pyjamas and such other goods[4].

Once the usefulness of nylon was recognized it was necessary to study its dyeing property and this has been done by White[5], Stott[6], Whittaker[7], Saville[8] and Boulton[9] and it has been thus ascertained that nylon can be easily dyed with acid, mordant, direct cotton, acetate rayon, vat and soledon dyes. In general, it has been found that the adsorption of dyes by nylon is similar to that by wool or silk; dyes commonly employed for acetate rayon also have a good affinity for the new fibre.

In the absence of acids and salts the rate of dyeing is low with the direct cotton dyes, but they have better fastness to washing on nylon than on viscose. These dyes are again of about the same light fastness both on nylon and viscose. They do not do damage to the fibre on exposure to light. Vat dyes, on the other hand, particularly the reds, oranges and yellows are more fugitive on nylon and in ordinary atmosphere accelerate the damage caused to the fibre by light.

The nylon fabric which has found its way only recently into the Indian market under the misleading name of 'glass cloth' has been included in our studies on the photochemistry of the dyes in substance and on various fabrics. The observations recorded here are made with three direct cotton dyes and two Soledon dyes on nylon, cotton, wool and viscose. Experiments with potassium dichromate as a mineral dye have been also described.

Experimental

Nylon.—The nylon fabric which was purchased locally was found to have a texture of 115 ends and 105 picks per square inch. The fibre diameter was very uniform with an average value of 19 microns and coefficient of variation of 15 per cent. Before dyeing it was thoroughly scoured in 3 gms. per litre Lux soap solution at 60° C. for fifteen minutes.

Cotton.—Cotton cloth used was a bleached variety of medium count longcloth, which was scoured by soaping at boil for half an hour before use.

Wool.—White gabardine was used after cleaning by treatment with 0.25 per cent. Igepon T solution at 60° C. for half an hour.

Viscose.—White viscose cloth obtained was further cleaned by giving soaping treatment in Lux soap solution.

Dyes.—Three direct cotton dyes, namely, (1) Chlorazol orange RNS (CI 415), (ii) Chlorazol Brown MS (CI 420), (iii) Chlorazol Azurine GS (CI 502) and two solubilized vat dyes, (i) Soledon Pink FF and (ii) Soledon Blue 2RCS were used in the experiments.

Light sources.—Sunlight and a "Medisun" mercury vapour lamp were used as light sources for the exposure tests, the latter for the effect of the ultraviolet light. The relative intensities of these in the visible region as measured by a Weston light meter were 7,000 footcandles for sunlight and 220 footcandles for mercury lamp (at a distance of 8").

Tintometer, viscometer and tensile strength apparatus.—The tintometer used to follow the fading process with each of the dyed patterns, was a B.D.H. pattern apparatus, giving the colour values in Lovibond units. The tendering action of light on the plain and dyed nylon fabric was studied by means of fluidity measurements of nylon dissolved in *m*-cresol and by an O'Neil type of single fibre testing tensile strength apparatus. The viscometer for fluidity measurements was of the type described by Boulton and Jackson[10].

Nylon was dyed in the usual way at boil with three direct colours in the absence of acid or salt. The percentage of dye in the dyebath was 2 per cent. on the weight of material and exhaustion obtained was about

50 per cent. in all the three cases. The dyeings in the case of cotton and wool were also carried out in the same way using 1 per cent. of the dye instead of 2 used for nylon.

The two Soledon colours were dyed by padding with solutions containing the colour and sodium nitrite, which were then developed by treatment with sulphuric acid.

All the dyed patterns together with blanks were exposed to sunlight and to the mercury vapour lamp, and their fading course was recorded in terms of their dominant colour on the Lovibond tintometer. All the dyeings which were to be compared, were dyed in the respective colours so as to obtain shade values for each pattern which did not differ from one another by more than 0.3 Lovibond units for the dominant colour. Thus the colour loss with each dye on different fabrics was comparable.

For the fluidity measurements of light-degraded nylon dissolved in *m*-cresol, a concentration of 0.8384/10 c.c. was employed. This gave an 8 per cent. solution of nylon (on dry wt.) at 72 per cent. relative humidity. The time of flow was noted in case of each sample before and after 50 hours' exposure to sunlight and to the mercury vapour lamp.

The tensile strength of the fibres from each of the exposed as well as unexposed nylon patterns was measured on the O'Neil apparatus by removing an amount of water just enough to snap 1 cm. length of the fibre attached to the float of the instrument. According to a calibration of this instrument every cubic centimetre of water withdrawn represented 0.077 grm. of breaking load.

Results.—Details regarding the light exposure tests carried out with all the three types of fabrics dyed with each of the five dyes are shown in Table I. Table II shows the relevant figures for the fluidity and tensile strength of nylon, exposed and unexposed in the dyed and undyed condition to both the light sources.

TABLE I

Relative colour losses on dyed nylon, cotton, wool and viscose under exposure to sunlight and mercury vapour lamp

Dye pattern	Exposure in sun light	Fall in Lovibond	Exposure to mercury light	Fall in Lovibond
	Hrs.	Units	Hrs.	Units
Chlorazol orange RNS on				
Nylon	100	6.2	125	3.0
Cotton	100	10.9	125	4.3
Wool	100	5.2		
Chlorazol Brown MS on				
Nylon	100	4.2	100	3.0
Cotton	100	5.0	100	3.0
Wool	100	4.0		
Chlorazol Azurine GS on				
Nylon	50	6.4	100	3.2
Cotton	50	6.6	100	5.0
Wool	50	5.8		
Soledon Pink FF on				
Nylon	125	1.5	125	0.9
Cotton	125	2.1	125	1.1
Viscose	125	1.5	125	0.9
Soledon Blue 2RCS on				
Nylon	125	1.2	125	1.4
Cotton	125	0.4	125	0.4
Viscose	125	0.3	125	0.5

Discussion

It will be observed from Table I that the fastness of the two direct colours Chlorazol Orange RNS and Chlorazol Brown MS is greater on nylon than on cotton, while Chlorazol Azurine GS appears to be equally fast both on nylon and on cotton. On wool, however, all the three dyes are slightly faster than on nylon. In the case of Soledon colours the pink dye shows little better fastness on nylon and viscose while the blue dye has a better light fastness on cotton and viscose. The direct dyes are far more fugitive than the vat dyes, as would be observed from the figures for the colour loss, yet amongst the three direct colours, the brown colour Chlorazol Brown MS is superior to the other two. The shade card values of the light fastness as supplied by the manufacturers is in general agreement with the observed values. The brown colour is stabilized to a greater extent against light, by the presence of an NH_2 group in the 2 position of the naphthalene nucleus. Increased stability on nylon fibres for the direct dyes may be considered as due to much lower rate of light reduction, which for cotton is accelerated by the formation of oxycellulose and hydrocellulose in light. Vat dyes, on the other hand, are generally more fugitive on nylon than on cotton and on viscose though in the present case, Soledon Pink FF seem to be faster on nylon than on cotton and of about equal fastness on viscose and nylon.

Boulton and Jackson[10] and Boulton[9] have determined the damage done to nylon by exposure to light of carbon arc in a fadeometer and in sunlight, respectively. Their values of tensile strength of yarns show a loss of 30 per cent. and 22 per cent. respectively, after 100 and 149 hours exposure. The yarns in the fabric used in the present

TABLE II—*Tensile strength and fluidity measurements on dyed and exposed nylon fibres*

Dye pattern	Exposure time in sunlight	Breaking load	Loss	Time of flow at 32° C.	Time of exposure to mercury lamp	Breaking load	Loss	Time of flow at 32° C.
	Hrs.	Gms.	%	Secs.	Hrs.	Gms.	%	Secs.
Undyed	0	13.92	—	226	0	13.92	—	226
	50	8.67	38.8	160	50	10.37	25.5	184
	100	5.42	61.06	—	100	5.8	58.3	—
Chlorazol Orange RNS	0	13.54	—	224	0	13.54	—	224
	50	10.21	24.5	180	50	8.898	34.28	164
	100	8.36	38.2	—	125	4.56	66.3	—
Chlorazol Brown MS	0	13.46	—	223	0	13.46	—	223
	50	9.98	25.8	174	50	10.14	24.6	179
	100	7.66	43.1	—	100	5.73	57.6	
Chlorazol Azurine GS	0	13.54	—	223	0	13.54	—	223
	50	8.67	35.96	161	50	9.28	31.5	168
					100	5.8	57.1	—
Soledon Pink FF	0	13.62	—		0	13.62	—	
	125	5.26	61.3		125	6.03	55.7	
Soledon Blue 2RCS	0	13.46	—		0	13.46	—	
	125	5.8	56.9		125	4.33	67.8	
Potassium dichromate 2%	0	13.92	—					
	5	13.15	5.5					
Potassium dichromate 4%	0	13.92	—					
	5	12.07	13.29					
Potassium dichromate 2% with 0.5% H_2SO_4	0	11.2	—					
	50	4.64	58.5					
Potassium dichromate 1% with 0.5% H_2SO_4	0	11.2	—					
	50	5.64	49.6					

work, however, seem to suffer a much greater loss as shown by the fluidity increase in *m*-cresol and by loss in the tensile strength. Thus it would seem from Table II that the breaking load falls from 14 gms. to 5.4 gms. during hundred hours exposure to sunlight giving a loss of 61 per cent. In the presence of two of the direct colours Chlorazol Orange RNS and Chlorazol Brown MS, this loss in the tensile strength is reduced to about 2/3 the original value while for the vat dyes and azurine colour, no appreciable gain over the undyed material is obtained. Similar results have been obtained by Boulton[9] with direct dyes, while with the vat dyes used by him results show a somewhat greater tendering effect as compared with the untreated fibre. The reason for this difference is that in the present case the vat dyes were the soluble Soledon colours, which due to their different mode of application probably do not affect the fibre in any adverse way during its photochemical degradation.

Observation records of the colour fading and tendering action on nylon, of ultraviolet light from the mercury vapour lamp, are also shown in Tables I and II respectively. It would be observed here that although the intensity of the visible light from this source was less than 1/30th of that of the sunlight, the light fading action of the two sources were comparable, while the tendering action on the fibre is much more pronounced in the ultraviolet light than in the sunlight, particularly with the dyed material. No protecting action of the dyestuff, like the Orange RNS, is found to be exerted under ultraviolet irradiation.

That nylon loses much of its tensile strength on exposure to light has been recognized by the manufacturers and they have very recently (B.P. 568688) prepared polyamides of improved light stability.

The potassium dichromate dyeings in the neutral and acid bath are interesting. A good lemon yellow tint was obtained by boiling nylon with a 2 per cent. solution of potassium dichromate for 15 minutes. Subsequent dyeings with 1 per cent. of the salt gave slightly a lighter shade but deeper shades were not obtained by concentrations much higher than 2 per cent. There was no loss in the tensile strength but the colour was very unstable towards light. The fabrics were completely bleached within 5 hours of exposure to sunlight. Better results could, however, be obtained with an acid dichromate bath containing 0.5 per cent. sulphuric acid. Deeper shades of orange appearance were obtained by this method. The dyeings at boil caused considerable tendering but at

50° C. it was comparatively little. On exposure to sunlight the orange colour obtained with the acid bath changed to brown-khaki and finally to olive green in 50 hours. The photochemical change which thus takes place is obviously the reduction to chromium oxide of some amino chromic acid complex formed on the nylon fabric. Similar changes were noted on silk and wool treated with acid dichromate solutions.

Summary

1. Lightfastness of three direct colours, namely, Chlorazol Orange RNS, (C.I. 415), Chlorazol Brown MS (C.I. 420) and Chlorazol Azurine GS (C.I. 502), and two vat dyes, Soledon Pink FF and Soledon Blue 2RCS, has been studied on nylon, cotton and wool. The stability of the first two direct dyes is greater on nylon than on cotton, while on wool it is slightly greater than on nylon. With the vat dye Soledon Pink FF, the colour loss is about the same on nylon and on viscose but it is more on cotton. The blue vat colour Soledon Blue 2RCS, however, shows greater stability on cotton and on viscose as compared with nylon.

2. The tendering action of light on nylon is quite pronounced, the undyed fibre losing about 61 per cent. of its strength after 100 hours' exposure to sunlight. In the presence of the three direct colours however, this loss is reduced to nearly two-thirds of its value, but the vat dyes on nylon are not helpful in retarding the photochemical degration of the fibre.

3. Acid dichromate dyeings on nylon are about as much fugitive to light as on wool and silk.

References

1 Carothers and Hill, *J. Amer. Chem. Soc.*, 1932, **54**, 1579.
2 Carothers and Hill, *Ibid.*, 1932, **54**, 1559, 1560, 1569.
3 E. Clayton, *Amer. Dyestuff Reptr.*, 1939, **28**, 196.
4 *Textile Chemistry and Dyeing* by Louis A. Olney. Lowell Mass., 1945.
5 White, *J. Soc. Dyers and Col.*, 1939, **55**, 409.
6 Stott, *Am. Dyestuff Reptr.*, 1939, **28**, 582; 1940, **29**, 646; 1941, **30**, 710.
7 Whittaker, *J. Soc. Dyers and Col.*, 1943, **59**, 69.
8 A. K. Saville, *Am. Dyestuff Reptr.*, 1946, **35**, 51.
9 J. Boulton, *J. Soc. Dyers and Col.*, 1946, **62**, 65.
10 J. Boulton and Jackson, *J. Soc. Dyers and Col.*, 1943, **59**, 21.

Enzyme Bates from the Pancreas of Cow, Sheep and Pig

By B. M. DAS and S. K. MITRA
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THIS work was undertaken with a view to find substitutes from indigenous sources for bating materials which were being imported from the U.K. and the U.S.A. before the war. These materials were in great demand by the Indian leather industry for the manufacture of finer varieties of leather, especially box sides and glace kid.

Experimental

A number of bating compositions were prepared from the pancreas of cow, sheep and pig. The glands were collected immediately after the slaughter of the animals and left in an ice box overnight. They were then partially degreased, mechanically, by removing adhering lumps of fat, freed from muscle fibres and minced.

Cow pancreas: Sample A.—The minced pancreas was dehydrated with 75 per cent. alcohol, dried in a desiccator, powdered and mixed with equal quantity of ammonium chloride. The yield of the powder was 20.25 per cent. The proportion of the dehydrant to the minced material was 3 : 1.

Sample B.—The minced gland was extracted with ice cold water (1 litre of water for 250 gms. of minced material) for 3-4 hours and the enzymes in the extract precipitated by adding an equal volume of 90 per cent. alcohol. The precipitate was dried in a desiccator and the dry material mixed

with fine wood flour and ammonium chloride in the proportion of 1 gm. dry powder, 16 gm. ammonium chloride and 8 gm. wood flour. The yield of the dry powder was 12.8 per cent. The extraction was not exhaustive. The supernatant liquor after the addition of alcohol was not tested for proteolytic activity.

Sample X.—The minced pancreas was extracted with four times its weight of ice cold water. The extract was mixed with wood flour, using ¼ lb. wood flour for every lb. of extract and air dried. The dried material was finally mixed with 66 per cent. ammonium chloride. Toluene was added to the final extract as an antiseptic before mixing with wood flour.

Pig pancreas: Sample C.—The method adopted was the same as that used for B.

Sample D.—Same as X.

Sheep pancreas: Sample E.—The procedure was the same as that adopted for X. The yield from the pancreas of pig and sheep were also similar to that of the cow.

Sample F was a non-enzyme preparation containing wood flour and ammonium chloride only. It was used as a control. The relative proportion of wood flour to ammonium chloride was 1 : 2. The different preparations are stable and can be stored long if kept in dry cool place.

Sample G was an imported standard bate, and was used for comparison.

TABLE I—*Gelatine liquefying capacity of different preparations*

Sample	Volume of 1 Per cent. Enzyme Extract.				
	1 c.c.	2 c.c.	3 c.c.	4 c.c.	5 c.c.
A	1	2	3	3	3
B	0	1	2	2	3
X	0	0	0	1	1
C	1	2	2	3	3
D	0	1	1	2	3
E	0	0	1	2	2
F	0	0	0	0	0
G	0	0	1	2	3

0—No apparent softening. 1—Slight softening.
2—Considerable softening. 3—Liquefaction.

The purpose of adding ammonium chloride is twofold. Firstly, it removes the lime present in the pelt under bating by converting it to soluble calcium chloride which can be washed away from the pelt. As a result of this treatment, the pelt shrinks in volume. The ammonium chloride lowers the pH from about 12 to 8, and the pelt becomes fallen and flaccid. Secondly, the ammonia generated by the reaction of calcium hydroxide with ammonium chloride activates the pancreatic enzyme, and enables it to digest elastin and keratose which are present in the pelt. The action of ammonia in this respect is similar to that of enterokinase.

The purpose of adding wood flour is to increase the bulk of the enzyme preparation and make its weighment for use in the tannery more convenient and practical. Adsorbents like kieselguhr can be used in place of wood flour.

The activity of the samples was determined using 6 per cent. gelatine as substrate, at pH 8.3 and 37° C. The method employed was that recommended by Atkin and Thompson[1]. The results are given in Table I. Practical bating tests were carried out with all the samples excepting Sample X, which had very poor proteolytic activity. Pieces of limed cow hides were bated for one hour with the bating compositions at 37° C. and the bated pelts were then finished as box side by the usual process. The observations are tabulated in Tables II and III.

For testing, the enzyme extracts were prepared by leaching 1 gm. of the material in 100 c.c. water for about an hour at a temperature of 37° C. In Table I, 1 c.c., 2 c.c., 3 c.c., etc., refer to volume of enzyme extract used in the test.

Conclusion

From a comparison of leather pieces bated with the bating compositions A, B, C, D and E, it appears that sample E (a preparation of sheep pancreas) is more suitable as a bate for box and willow sides than the

TABLE II—*Condition of the pelt after bating*

Sample No.	Deliming	Flaccidity (Fallenness)	Retention of finger impression	Surface feel
A	Complete.	Most flaccid in the series.	Less than B, E and G.	A little more slippery than the others.
B	Slightly alkaline inside.	Next to A.	Longest in the series.	Fairly smooth.
C	Complete.	Next to B.	Less than B, E, G and A.	Do.
D	Do.	Next to C.	Equal to C.	Do.
E	Do.	Next to F.	Equal to G.	Do.
F	Do.	Next to D.	Least in the series.	Do.
G	Do.	Least flaccid in the series.	Next in order to B.	Do.

TABLE III—*Nature of the leather pieces after finishing*

Sample No.	Thickness	Surface feel	Handle	Grain	Tearing strength	Fibres	Crack	Microscopical appearance of the fibres
A	Appreciably reduced.	Much smoother than F and G. No dryness in the feel.	Softest of all the samples without much firmness; leather porous with an empty feel; water soaks in much quicker than F and G.	Fairly tight but much less than F and slightly less than G.	Equal to G.	Longer and more separated than G.	No crack at double fold and key test.	Separated fibre bundles. Slightly irregular weave pattern. Very large amount of splitting.
B	Same as F., i.e., no falling of the pelt.	Same as F.	Somewhat softer and more pliable than F.	Looser and the break of the grain definitely larger than all the samples, showing that the surface bating was drastic.	Very good.	Somewhat shorter and less separated than A.	Do.	Fairly compact fibre bundles but irregular weave pattern. Practically no splitting at the centre of the corium.
C	More reduced than E, showing more falling of the pelt; bating greater than E.	Same as E.	A little softer than E.	Slightly looser and the break of the grain larger than E.	Same as E.	Somewhat longer and more separated than E.	Do.	Separated fibre bundles. Slightly loose and irregular weave pattern. Large amount of splitting.
D	Thinner than E; same as C.	A little smoother than E.	Somewhat softer than E; same as C.	Tighter and break of grain finer than E and C.	Good. Same as E and C.	Slightly shorter and less separated than C.	Do.	Fairly compact fibre bundles with a fairly regular weave pattern. Medium splitting.
E	Not much reduced, almost like F and G, and appreciably more than A.	Smoother and less dry than F; smoother than G, showing appreciable surface bating.	More pliable than F and G, but firmer than A. (The leather is of appropriate softness for box and willow sides.)	Tight and break of the grain small like F. The tightness and break are appreciably better than those of A and G.	Better than A.	Longer and more separated than G and A.	Do.	Compact fibre bundles with a regular weave pattern. Fair amount of splitting near flesh and grain layers but only slight amount of splitting at the centre of the corium.
F	Not much reduced.	Not harsh. Somewhat dry.	Pliable and firm.	Tight having fine break.	Fair.	Short.	Do.	Slightly shorter but compact bundles. Fairly regular weave pattern without any appreciable amount of splitting.
G	Similar to F.	Smoother and less dry than F.	Same as F.	Looser and break of the grain larger than F.	Better than F.	Longer and more separated than F.	Do.	Slightly shorter but compact fibre bundles. Fairly regular weave pattern. Slight splitting near the grain and flesh layers.

others. Sample D (a preparation of pig pancreas) is also suitable for the same but as its action is more penetrating it may be more suitable for softer leathers such as glace kid, glove kid, etc. Sample C prepared from pig pancreas appears to be inferior to sample D as it makes the grain rather loose and the break of the grain large. Sample B prepared from cow pancreas is not suitable as a bate because its action on the surface of the skin is drastic and there is no falling of the pelt as the bate does not probably penetrate. Sample A (another preparation of the cow pancreas) is the strongest of all the bating compositions tried in this experiment. This sample appears to be suitable as a bate for the production of finer varieties of leather where flaccidity and softness are major factors. It is not recommended as a bate for the manufacture of box and willow sides as it produces a somewhat porous leather with an empty feel. The results corroborate the findings of Woodhead[2] that sheep pancreas effects surface bating and is suitable for somewhat firm leather like box and willow sides.

References

1 Atkin, W. R. and Thompson, F. C., Procter's Leather Chemists' Pocket Book, p. 132.

2 Woodhead, T.: *J. Int. Soc. Leather Trades Chemists, Abstracts*, 1943, **27**, 220; 1944, **28**, 49.

Effect of Sunlight on T.N.T. and Tetryl

By B. N. MITRA and M. SRINIVASAN

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THE present investigation arose out of an observation that certain compounded explosives containing tetryl underwent a marked change in colour from yellow to deep red on the surface when exposed to sunlight for a few days. It was thought that this change might be due to the decomposition of tetryl, analogous to T.N.T. which is known to decompose under the influence of sunlight. A study was, therefore, made of the effect of sunlight on pure tetryl about which no reference was available to us. Parallel experiments with T.N.T. were also carried out. These gave certain results which were not in accord with the published data, thus warranting further study of the effect of sunlight on T.N.T. The investigations on tetryl, however, which had been our primary object, became restricted in scope on account of the slow rate of photo-decomposition of tetryl. The few preliminary observations made with tetryl are dealt with in Part II of the paper.

Part I—Effect of Sunlight on α-T.N.T. (2 : 4 : 6)

The decomposition of T.N.T. on exposure to sunlight has been the object of study by a number of workers since the beginning of the present century. Kast[1] exposed T.N.T. to sunlight for 14 days and observed a lowering in setting point from 80° to 79°.5 C. Vasques[2] recorded that sunlight induces a brown colour in T.N.T. but does not otherwise alter its properties. Molinare and Quartier[3] reported a lowering in m.p, from 80°.4 to 76°.6 and an increase in the acetone-insoluble matter from 0.03 per cent. to 0.1 per cent. Molinare and Giua[4] found that after exposure of T.N.T. in a glass tube to daylight for three months, the S.P. (setting point) was lowered to 76°. In an evacuated sealed tube the effect was not so pronounced, the S.P. falling only by 0.6°. Curtis[5] mentioned that sunlight prompts the oxidation of T.N.T. Oddo[6] observed that T.N.T. exposed to sunlight gives an acid reaction. The first attempt at identifying the decomposition products was by Krauz and Turek[7]. They claimed to have identified picric acid and trinitrobenzoic acid among the decomposition products and held that exposed T.N.T. was more sensitive. These conclusions were questioned by Wichert and Thansau[8]. Sensitivity tests carried out by us also indicated that the exposed T.N.T. was less sensitive. Lodati[9] too criticised the conclusions of Krauz and Turek, especially that relating to increased sensitiveness. He was of the opinion that

T.N.T. exposed to diffuse sunlight undergoes decomposition, developing nitrous fumes. Schultz and Ganguly[10] examined T.N.T. after exposure to direct sunlight for two summers in Germany. The material, which had become dark brown in colour, no longer possessed a sharp m.p., the range being 76-130°. They extracted from it a small quantity (0.8 per cent.) of a red substance reported to be a mixture of:—

(*a*) 4 -nitro-2-nitroso-l-hydroxymethyl-5 : 6-benzoquinone-6-oxime.

and (*b*) 4 -nitro-2-nitroso-l-hydroxymethyl-3 : 6-benzoquinone-6-oxime.

According to them, the products have a m.p. > 280°, are water soluble, the *o*-quinone derivative (*a*) being less easily soluble than the *p*-derivative (*b*); (*b*) is soluble, while (*a*) is almost insoluble in acetone.

In view of the different conclusions reached by Krauz and Turek on the one hand, and by Schultz and Ganguly on the other, Sucharewsky[11] repeated the investigation of the effect of sunlight on crude T.N.T. and crystallized T.N.T. in powder form and in pressed pellets. He found that these materials showed a tendency to exude as a result of exposure, while the prolonged action of sunlight produced a darkening in its colour and a lowering of its setting point.

The above review of the literature together with our own results has shown that a lowering in S.P. of T.N.T. on prolonged exposure to sunlight is an established fact. In the present investigation the experiments were rather directed towards some understanding of the nature of the decomposition products.

Experimental

(*a*) *Decomposition of α-T.N.T. in the solid state.*—T.N.T. Grade I (S.P., 80°.6) crystalline, was spread in a thin layer on enamelled trays and exposed to sunlight, a fresh surface being turned over about every 2 hours (months of March, April and May). The exposure was continued for a known number of days and the product then examined.

The exposed material was extracted with hot benzene. The benzene solution was coloured red, unlike the yellow solution which unexposed, high quality T.N.T. usually gives. The benzene insolubles were collected on a filter, washed with benzene and dried. A rough idea of the benzene insolubles may be obtained from Table I.

TABLE I.

Weight of T.N.T. (gms.)	Time of exposure (hours)	Benzene insolubles %
1	40	2.0
1	112	6.0
10	24	1.0
10	48	2.6
30	64	0.1
790	136	1.3

Evolution of nitrous fumes.—A 3-litre flask was fitted with an absorption train, the first absorption tube containing dilute alkali (N/10) for the absorption of fumes from the flask and the second tube containing strong alkali to keep out atmospheric carbon dioxide. A thin smear of T.N.T. was uniformly deposited on the walls of the flask from benzene solution. After removing all the solvent, the flask was closed with the absorption train, and then exposed to sunlight for 32 hours. The decomposition, as judged from a change in colour, started at the end of 1 hour. At the end of the experiment, the alkali solution was tested for nitrate with diphenylamine, and for nitrite with sulphanilic acid and α-naphthylamine. Nitrate was found in traces, while the test for nitrite was very distinct. Starch-iodide paper was affected within an hour after exposure (separate experiment).

Congeners of α-T.N.T., Effect of Light on.—As judged by the colour change, *p*-nitrotoluene (B.D.H.) did not appear to decompose during 64 hours' exposure, while 2 : 4-D.N.T. S.P. 70°.0 (B.D.H.) and α-T.N.T. (crystalline, S.P., 80°.5) started decomposing in about 14 hours and 1 hour respectively. The reaction in presence of water followed the same order.

(*b*) *Decomposition of α-T.N.T. in Solution.*—(i) Water: It has been found that an aqueous solution of T.N.T. (solubility about 0.05 per cent.), or, T.N.T. suspended in water, on exposure to sunlight, changes in colour. The reaction takes place quickly (in about 10 mins.) and even at that low concentration there is a pronounced pink colour. It would seem that this change is not initiated or promoted by any associated impurities in T.N.T., since the same effect

is produced with T.N.T. "grade 1, crystalline for exploders" further purified as under:

(*a*) T.N.T. grade I dissolved in toluene and solution passed through acid-washed talc, which retained some red impurities and T.N.T. recovered from the pale yellow filtrate.

(*b*) T.N.T. grade I recrystallized from hot water—quite colourless.

That the decomposition of T.N.T. in water exposed to sunlight is not due to alkali contamination is further clear from the fact that:—

(*a*) the control (unexposed to sunlight) shows no change,

(*b*) the irradiated solution is acid to methyl red,

(*c*) the decomposition, as judged by the appearance of red colour, takes place even in dil. sulphuric acid (at about pH 3); and is negligible in more acid range.

(ii) Other Solvents: The photo-decomposition of T.N.T. proceeds in the following solvents also and in each case the red colour appears: glycerol, methyl-, ethyl-, butyl- and amyl alcohols and acetone.

There is hardly any effect in benzene, toluene, amyl acetate, ether or carbon tetrachloride.

Properties of the Photo-decomposition product.—(i) Physical appearance: Chocolate coloured, amorphous solid. The colour somewhat varies with the time of exposure, deepening through orange—red, dark—brown to chocolate.

(ii) Solubility: Insoluble in benzene; easily and highly soluble in acetone; soluble in pyridine; slightly soluble in hot water and in alcohol; soluble in alkalies including alkali carbonates; fairly soluble in glacial acetic acid; on boiling with 40 per cent. alkali, an odour resembling pyridine bases is evolved; soluble in cold conc. sulphuric acid without decomposition; no precipitate on dilution with water (freedom from T.N.T.).

(iii) M.P.- $>200°$ C. Intumesces on a flame giving a bulky carbon residue.

(iv) Alkaline acetone solution has a pink colour as with nitrobodies. On oxidation with alkaline permanganate, resulting solution contains nitrate; so, a nitrobody, and not T.N.T., is present.

(v) Picric acid or other nitrophenols could not be detected.

(vi) No diazotizable groups could be detected. On the other hand, it couples with diazotized aniline.

Discussion

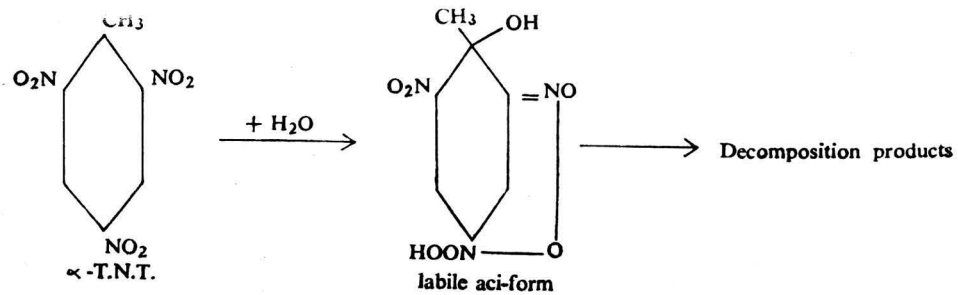
The solubility of the decomposition product first calls for comment, as divergent reports have been made on it. Molinare and Quartier observed an increase in acetone-insolubles of 0.07 per cent. It is not clear that this increase includes all the decomposition products. Schultz and Ganguly were able to obtain a total of 0.8 per cent. of decomposition products; most of the material was soluble in water and some of it soluble in acetone. The benzene insoluble portion, now isolated by us, and so to be reckoned as the decomposition products, varies from 0.1 to 6 per cent. on the weight of T.N.T. exposed. The quantity of the benzene insoluble portion is related to the surface of substrate exposed and the time of exposure. This fraction is wholly soluble in acetone and insoluble in water. There would, however, appear to be, in addition, a fraction soluble in benzene, since while isolating the insoluble part, the resulting benzene filtrate was red, in contrast to unexposed solutions of T.N.T. which are yellow. The benzene-soluble fraction, which is incomparably smaller than the insoluble fraction of the decomposition products, has yet to be examined.

The conflicting results obtained for the solubility of the decomposition product, and the more conflicting views held regarding its nature (compare Schultz and Ganguly with Krauz and Turek) lead to the suggestion that the products vary according to the time of exposure and the intensity of the incident radiation.

We were unable, however, to detect any marked difference in the general characteristics of the decomposition products obtained through different intervals of exposure. The properties described above were repeatable with the different lots exposed to different times. Of course, the time of exposure by some previous workers far exceeds the maximum exposure time in our experiments. In its general behaviour, viz., insolubility in benzene and solubility in acetone, its amorphous and generally inert nature, the photo-decomposition product of T.N.T. as obtained in the present experiments, bears a strong resemblance to the product obtained

by the action of alkali on T.N.T. and the mode of decomposition would appear to follow the same course. Besides the common properties just enumerated, the parallelism is kept up in other reactions also. In both cases the colour changes are similar. Oxides of nitrogen are among the decomposition products in either case. It has been reported that on acidifying a strongly alkaline solution of T.N.T., a black amorphous body is obtained which does not deflagrate on heating, but slowly burns away, a behaviour almost identical with that now observed with the photo-decomposition product.

Hantzsch and Picton[12] explain the coloured alkali salts of T.N.T. and its congeners on the basis of the aci-form of the nitro-bodies. It seems probable, therefore, that T.N.T. equally, in the presence of traces of moisture (or other dissociating solvents) and actinic energy assumes this active aci-form which then decomposes:



Further evidence in favour of the change-over to the aci-form prior to decomposition is the noteworthy observation that the reaction (appearance of red colour on exposure to sunlight) has been observed to take place in solvents consistently all of the dissociating type and hardly at all in non-dissociating solvents. It has been previously suggested that in dissociating solvents T.N.T. forms salts with them, reacting in the aci-form (Beilstein[13]). Again, in the deeply coloured molecular compounds, which T.N.T. is known to form with other aromatic bodies, the formation of colour has been attributed to the aci-form assumed by T.N.T. in these compounds (Sudborough and Beard[14]).

It has been observed that the rose-pink colour, i.e., the initial change, which an aqueous solution of T.N.T. on short exposure to sunlight registers, fades in the dark, although the rate of this 'dark' reaction is slow. Whether the loss of the pink colour is due to a reversal of the " light " reaction (i.e., an instance of ' phototropism ') or, due to further chemical changes, is not yet clear.

Evidence has now been adduced in favour of a rather strong analogy between the effect of alkali and that of sunlight on T.N.T. On this analogy, the decomposition subsequent to " acimerisation " may be assumed to proceed also on parallel lines. This assumption derives support from the characteristics which the photo-decomposition product now isolated possesses, somewhat in common, with those of the alkali decomposition product described elsewhere. The photo-decomposition product which has proved rather refractory to analysis, would thus appear to be similar to the alkali product, a complex body. The alkali product has been assumed to be a complex azoxy compound.

Summary

1. Previous work has established that prolonged exposure of ∝-T.N.T. to sunlight results in a lowering of the setting point. No definite conclusions are, however, recorded regarding the nature of the decomposition products.

2. It has been shown: (*a*) that the quantity of decomposition product (benzene insolubles) in T.N.T. solution or in solid T.N.T. depends upon the extent of exposure, (*b*) that the change proceeds with great facility in dissociating solvents and very little in non-dissociating solvents; presumably a transformation of T.N.T. to the aci-form, prior to decomposition, takes place, (*c*) that the photo-decomposition products bear a strong resemblance in their general behaviour to the products obtained by the action of alkali on T.N.T. An analogous mechanism of decomposition is suggested.

Part II—Effect of Sunlight on Tetryl

Tetryl exposed to sunlight for 112 hours (sun temp. about 130° F.) exhibits the following characteristics:

M.P.—Lowered by about 1°.5. C.

Stability—Gases evolved in 24 hrs. in V.S. test at 120° C., > 10 c.c.

Sensitivity to impact—same as C.E. unexposed.

Nature of Decomposition Products.—(*a*) Nitrous fumes are evolved within about an hour after exposure, and the exposed surface starts becoming brown; the change in colour, however, is far slower and much smaller than with T.N.T.

(*b*) Unlike the corresponding product from T.N.T., the decomposition product from C.E. cannot be separated from the parent substance by preferential dissolution, since the product equally dissolves in the solvents for C.E. On the other hand, the benzene solution of the exposed C.E. is resolvable by a continuum of talc, the impurities being held on top and C.E. solution passing through. The quantity, however, of the decomposition product left on the chromatogram was too small for any examination.

Acknowledgment

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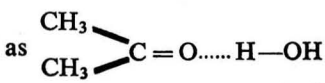
References

1 Kast, *Jahrber. mil. Vers. Amta.*, 1907, **12**, 17.
2 Vasques, *Z. ges. S. & S.* 1911, **6**, 301.
3 Molinare and Quartier, *Notices sur les Explosives en Italic, Mailand*, 1913, **8**. 167.
4 Molinare and Giua, *ibid.*
5 Curtis, *Studies in Actino-Chemistry*, 1917, **184**, 489.
6 Oddo, *Ann. Chim. Appl.*, 1919,.**11**, 186.
7 Krauz and Turek, *Z. ges S & S.*, 1925, **20**, 49.
8 Wichert and Thansau, *ibid.*, 1925, **20**, 69.
9 Lodati, *Giorn. Chim. Ind. Appl.*, 1927, **7**, 572.
10 Schultz and Ganguly, *Ber.*, 1925, **58**, 702.
11 Sucharewsky, *Z. ges. S & S.*, 1927, **22**, 293.
12 Hantzch and Picton, *Ber.*, 1909, **42**, 2119.
13 Beilstein, *Handbuch der Organichen Chemie*, 4th edn., **5**, 348.
14 Sudborough and Beard, *J. C. S.*, 1910, **97**, 773.

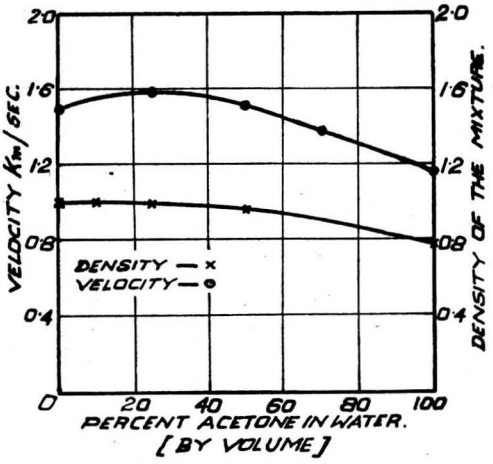
Letters to the Editor

Ultrasonic Velocity in Liquid Mixtures and Compound Formation

IT has been observed earlier[1] and also in the course of our study of ultrasonic velocity in liquids and liquid mixtures that there is an anomalous variation in the ultrasonic velocity in mixtures of acetone and water, which cannot be explained by density variation and its relation to velocity as $V = \sqrt{\frac{1}{\rho \cdot \beta ad.}}$. The possibility of a compound formation in such mixtures through hydrogen bond as



is suggested to explain the anomalous variation in velocity. This is supported by work on the Raman Spectra[2], where it was observed that in mixtures of acetone and water the carbonyl frequency at 1712 of acetone progressively shifts with increasing concentrations of water, the maximum shift occurring at 25 per cent. acetone. The



peak in the variation of ultrasonic velocity also occurs at about the same concentration, as can be seen in Fig. 1.

Further work is in progress.

Our thanks are due to Dr. S. Parthasarathy for his kind interest in the work.

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Council of Scientific and Industrial Research, Delhi, 21st October 1946.

References

1 Willard, *Jour. Acous. Soc. America*, 1941, **12**, 438.

2 Koteswaram, *Ind. Jour. Phys.*, 1940, **14**, 341.

Supplement

AROMATIC PLANTS OF INDIA

PART I

BY

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FAMILIES

1. Ranunculaceae
2. Magnoliaceae
3. Annonaceae
4. Menispermaceae
5. Nymphaeaceae

with a Foreword

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Aromatic Plants of India

Foreword

NATURAL perfume is one of the most remarkable phenomenon of plant metabolism, and no wonder the history of aromatics is perhaps the most romantic story of any vegetable product. The primitive man must have been struck not only by the elegance and vivid colouring of the flowers, but also by the fragrance of the vegetation around him. It is almost certain that this must have aroused his curiosity as much as did the utilization of plants for his food and clothing. History does not throw light on the uses made of these by the primitive man, but this much is certain that spices were eagerly sought for in all parts of the world from the earliest known eras of civilization. Indeed, the universal appreciation of spices and aromatics of the Asiatic tropics constituted the first foundations of international trade, and were among the earliest articles of barter and commerce. Up to this day they have retained their original value in spite of all changes in the world's history, and are being used in the humble abode of the poorest of the poor right up to the palaces of the mighty kings, either in their original state or, in modified and sophisticated forms, produced by the giant stills of modern industry.

Whatever be the significance of the existence of the aromas in plants, and there is a good deal of speculation about this, it is evident that man has always been trying to increasingly utilize these for his happiness and well-being. During the past, spices and aromatics have been used for flavouring foods and drinks, as offerings to deities, in medicine, for aesthetic purposes, as incense, as the principal agent for embalming the dead, and for the prevention of insects from damaging fabrics and grains. These are still their principal uses, except that the *modus operandi* have changed or are changing to a greater or less degree. Modern advances in science, especially since the closing decades of the nineteenth century, have considerably added to our knowledge of the aromatics. These have led to the separation of odoriferous principles from plant materials by a variety of processes involving distillation, expression, enfleurage, etc. Large industries have come into being which not only isolate these fleeting and subtle principles, the aromas, from various plants, but also blend them in varying proportions into bouquets or *melanges*. Side by side with this has also grown up an industry for the manufacture of synthetic perfumes and essences, but in this too, natural perfumes or their ingredients play an important part. As a natural outcome of the development of the perfumery industry a great and increasing diversity of scented articles, for toilet and other uses, are now being manufactured in large quantities. Whereas our ancestors had only a few with which to contend, modern industry has provided for the satisfaction of our aesthetic sense a great variety of perfumes and perfumed preparations, such as hair oils, soaps, skin creams and lotions, toilet powders, tooth pastes, bath salts, smelling salts, sachets, etc.

Hitherto, women have had a predominant share in the use of perfumery and perfumed articles for the enhancement of their charms, but there are signs which indicate that in the world of to-morrow there may be an ever-increasing demand from men too for these articles of aesthetic pleasure. Every advancement of science which may contribute towards prosperity and leisure for mankind is likely to witness a corresponding increase in the desire to satisfy the primary urges, viz., improvement of food and sex appeal. Men and women will vie with each other not only to feel a sense of pleasure, but also to be more attractive to the opposite sex. It would be no great exaggeration to say that in such a world the standard of advancement of a particular country may perhaps be directly judged by the amount of perfumes and essences consumed *per capita* of its inhabitants. Different and changing tastes of peoples of different countries will be a source of inspiration to the perfumery industry to produce and blend an infinite variety of fragrances for every conceivable article and occasion.

With large prospects for the aromatics, and their direct relation to the industry and happiness of mankind it is, indeed, surprising that no serious attempt has, hitherto, been made in any country to survey and record the aromatic plants growing within its

bounds, not to say about their fuller utilization. If an average person in India were asked to name the aromatic plants of the country he may be able to enumerate a dozen, perhaps two or three dozens, of such plants. He is perhaps unaware that India which was the home of spices and aromatics in the Middle Ages, and which was the chief centre for their trade and distribution, is perhaps the richest country of a similar size in the world for these. No information is available with regard to the number of aromatic plants found in any other country, but a recent survey by the authors has shown that there are no less than 1,300 odoriferous plants found in India; this is about 10 per cent. of the total species of flowering plants recorded from this country.

It is not the intention to argue that all aromatic plants found in India could be harnessed for their perfumes, which will be acceptable to the trade, at least at present. The fact has, however, to be remembered that, in the modern perfumery industry, even those natural essential oils which are harsh or distinctly repulsive by themselves can be converted into marketable perfumes by suitable sophistication and blending. Besides, with changing tastes and advancement of science he would be a bold man, indeed, who could say that such and such an essential oil will be useless in perfumery for all times to come. In fact, newer perfumes are coming into fashion and the newest additions to the list are the tobacco, cognac, and Russian leather perfumes which are being prescribed for smart young men in America. Modern perfumery is mostly based on skilful blending and requires a great variety of aromas for the preparation of new and newer notes. In all this, natural perfumes still play an important role, even though synthetics are becoming increasingly valuable. In fact, the two are supplementary and must go hand in hand. It can be stated with confidence that very few synthetic perfumes of repute are known in which a generous proportion of natural essential oil has not been added even though it may be for purposes of rounding off. Any step taken to develop natural perfumes should, therefore, be welcome.

Besides the study of aromatic plants growing wild in the country many an exotic of recognized perfume value should also be introduced and cultivated in India. In fact, many of the indigenous plants of promise may also have to be brought under scientific cultivation, since it is well known that perfume constituents of plants increase and develop better with cultivation. The perfumery industry cannot in all cases depend upon plant materials growing wild and scattered, since the odoriferous principles are delicately balanced and the deterioration sets in almost as soon as the material has been collected for distillation. The rose is a classical example. In order to obtain the best otto of rose, the rose petals must be collected before the sun is up, and distilled immediately. This, of course, would not be feasible if collection of flowers from plants growing wild and scattered were to be depended upon, since by the time they arrive at the factory they may have lost much of their value from the perfumery point of view. There are other advantages too in cultivation, the cost and facility of collection being the main ones.

It has been said that, as a general rule, fragrant flowers flourish in warm climates, but the more delicate perfumes are derived from plants having a colder habitat. Be it so, but this is still a debatable point. India is endowed with all conceivable climates, seasons and soils, and there is no reason why most, if not all, of the commercial perfumes could not be cultivated in this country. A note of warning is, however, necessary in this connection. The cultivation of aromatic plants requires special attention wherein the raising of plants or extraction of perfumes is not the end in itself; it is further necessary to enhance the particular aroma for which it is valued, for example, lavender and peppermint which flourish at Mitcham and Hitchin in England are unsurpassed so far.

As compared to the attention which has been paid to the enhancement of ornamental appearance of some of the common garden plants, only meagre efforts have so far been made to improve the aromatic value of odoriferous plants. The graceful floral beauty of the present-day varieties of some of the favourite garden plants, such as carnations, dahlias and geraniums, is the result of careful and scientific cultivation of their shabby-looking wild ancestors (Svenson, 1946. *Nat. Hist.*, **55**: 120). With modern advances in the science of breeding and selection, the development of exquisite aromas and the greater yield of essential oils are matters which deserve careful attention.

Apart from their use in perfumery, some essential oils, such as the citronella oil, form important ingredients of insect-repellent preparations which are widely used as a protection against insect pests. A good deal of investigation has been made in connection with the insect-repellent properties of essential oils, but comparatively much less work appears to have been done on their insect-attractant properties. It is well known that certain insects are attracted by floral odours. Boll weevil of cotton, for instance, is said to be attracted by the ammoniacal smell emitted by the cotton plant, and the adult Japanese beetles are attracted by the odour of geraniol and eugenol. As an example of what is possible in this direction the work of van Leeuwen and Metzger (1930. *Circ. U.S. Dep. Agric.*, 130) may be cited. They were able to devise a trap by means of which nine million beetles were destroyed by 500 traps on an area of 150 acres. Apart from their properties of being able to attract or repel insects, the floral odours in some cases are able to excite the females to oviposition. A case is cited where Richardson (1916. *Bull. New Jersey Agric. Exp. Sta.*, 292) observed the house flies to oviposit upon substances near which ammoniacal odour was present. The oviposition response could be augmented by butyric and valerianic acids, both of which are products of decomposition. Geraniol, eugenol, citral, phellandrene, linalool, saffrol, and pinenes are some of the important constituents of essential oils which are known to attract insects; of these geraniol is stated to far surpass others in attractive value. The employment of essential oils in the control of human, animal, agricultural and forest pests, by attracting them into properly devised snares where they could be destroyed easily, deserves special attention of research workers.

Closely connected with the use of essential oils in the perfumery industry are various resins and balsams, many of which are widely employed as fixatives or " hold-ups " for evanescent perfumes. Some of them may even be valuable as perfume-spreading agents in the manufacture of soap. Great quantities of these are daily used all over the world, particularly in the Orient, as an incense, either alone or mixed with aromatics. No statistics are available of the quantity and value of incenses used in the world, but they must be enormous. In India, even a poor man uses some of these on auspicious days to perfume the air in his hut. Not only are these of everyday use but also in cremating the dead.

Aromatics enjoy a considerable trade in the world markets. The latest available figures show that in 1935 total imports of essential oils and synthetic odorants to 19 principal countries amounted in value to about 100 million rupees (Schimmel & Co., 1938. *Ann. Rep.*, p. 138):—

	Rs.
Great Britain	2,36,00,000
United States	1,72,00,000
Scandinavian countries ..	30,00,000
British India	14,00,000
Spain	22,00,000
France	83,00,000
Holland	45,00,000
Germany	1,35,00,000
China	17,00,000
Argentina	22,00,000
Italy	47,00,000
Japan	23,00,000
Belgium	29,00,000
Switzerland	37,00,000
Commonwealth of Australia	23,00,000
Czechoslovakia	18,00,000
Brazil (1934)	31,00,000
Egypt	5,00,000
Union of South Africa ..	8,00,000

India's share in the world trade of essential oils is significant, but hardly commensurate with her resources or potentialities. During the two years preceding the war she imported essential oils worth about Rs. 17,00,000 annually, and her average annual exports amounted to about Rs. 25,00,000. During the same period the average annual exports of essential-oil-bearing raw materials (mostly spices) amounted to about 17,000 tons valued at about Rs. 78,00,000 (Narielwala & Rakshit, 1942. *Rep. Essent. Oil Committee—Exploratory*). A vast improvement in the existing state of affairs is not only possible, but also can be easily effected.

France is one of the most important countries where cultivation of aromatic plants and the distillation of essential oils for perfumery has been highly developed. The manufacture of essential oils in Grasse,

her most important centre of perfumery, bought and worked up for odorants on an average about 62,50,000 lbs. of flowers and leaves costing 1,91,53,000 francs annually during the years 1936 and 1937.

Whatever the above figures may indicate, the fact remains that there are no reliable data with regard to the amount and value of aromatic plants which are used in the world for the manufacture of perfumes, cosmetics, soaps, medicines, and as spices, but these must be many times more than what is indicated. Only a few of the essential oils are used in their primary form, but a much larger number are at first blended and then sold as costly perfumes to suit the various requirements. Taken all together they support trade and industry of colossal money value.

The number of aromatic plants or their products which enjoy an international trade at present is comparatively a small one. The following is a list of some of the more important ones of these:—

Agar
Ajwain
Almond, bitter
Allspice
Ambrette
Angelica
Anise
Basil, sweet
Bergamot
Bois de rose
Cajeput
Calamus
Camphor
Cananga
Cardamom
Cassia
Cassie
Cedarwood
Celery seed
Cinnamon
Citronella
Clove
Coriander
Costus
Cubeb
Dill
Eucalyptus
Fennel
Geranium
Ginger
Gingergrass
Ho (Shiu)
Jasmine
Juniper
Lavender
Lemon
Lemongrass
Lime
Linaloe
Mace
Myrrh
Neroli
Nutmeg
Orange
Orris root
Palmarosa
Patchouli
Pennyroyal
Peppermint
Petitgrain
Pine
Rose
Rosemary
Rue
Sandalwood
Spearmint
Spike lavender
Star anise
Thyme
Valerian
Vetivert
Violet
Wintergreen (chenopodium)
Wormseed
Ylang-ylang

The authors have ventured to issue a series of articles which they believe may help to stimulate interest in the vast but, hitherto, little explored field of aromatic plants of this country.

The aroma of a plant or its part may be due to the essential oil which sometimes exists in a free state, as in rose, or occasionally in the form of a glucoside which, under certain conditions, is decomposed by an enzyme present along with it, as in bitter almonds. For the purpose of these series it is immaterial whether the aroma is pleasant or otherwise; the word pleasant itself is only a relative term. The fact that the plant or any of its parts has an essential oil in it in some form or the other, or it is odoriferous, whether in a crushed or intact state, is enough to justify its inclusion in these series. In some cases the whole of the plant may be odoriferous; in others one or more of its parts, viz., flower, leaf, bark, wood, root or rhizome, fruit, seed, or even gum or oleoresin, may be aromatic. Most edible fruits have a pleasant flavour. Although attention has been drawn to these in a number of cases, it is not the intention to include them in these series. The chlorophyllous smell emitted by almost every plant on crushing is not an aroma in the true sense of the word. Aromatics of animal origin, such as musk, have also been omitted for the simple reason that they are not produced by plants. Some of the foreign lichens, such as *Evernia prunastri* Ach., especially when collected from oak trees, form one of the indispensable raw materials of the perfumer. They are known as oakmoss or *mousse de chêne*, and, when extracted with volatile solvents, yield a product consisting largely of chlorophyll together with resin and volatile oil. The colourless absolute obtained from this is the most esteemed in perfumery. No work has, however, been done on Indian lichens. The characteristic violet odour of the foreign alga *Trentepohlia iolithus* (Linn.) Wallr. (violet moss) is due to the presence of ionone (Schimmel & Co., 1937. *Ann. Rep.*, p. 91). None of the Indian algae have, however, been investigated. A few foreign liverworts are known to contain essential oils, but the information is meagre, and none of the Indian plants has so far been investigated. Nothing is known about the mosses. Lower plants have, therefore, been entirely omitted and the series deal with only the flowering plants.

The aromatic plants in these series have been arranged in families according to Bentham and Hooker's system of classification, although the limitations of certain families do not correspond with that system. The genera and species under each family are arranged alphabetically. In the accounts of families and genera a survey has been attempted of all the commercially important aromatic plants of the world and also of those which have been investigated chemically. In these accounts all aromatic plants found in India have been mentioned, irrespective of the fact whether they are of present commercial use or not or whether the chemical constitution of the essential oils present in them is known or not. Such an arrangement, it is hoped, will be helpful in assessing to a degree the value and probable chemical constitution of a large number of Indian aromatic plants, about which very little is known at present, since it is common knowledge that allied plants often have similar chemical constituents or properties. These surveys also include a large number of plants of commercial importance and also those with which the reader is familiar, such as garden plants. The object is to enable the reader to appreciate the relationship of aromatic plants to other plants of economic interest of a particular family or genus. This will also enable a non-botanist to understand and appreciate something about a family or a genus in order to take an intelligent interest in the accounts.

Only those species found in India, whether cultivated or wild, which have been investigated chemically either in India or abroad, have been dealt with in detail. In such cases English and important vernacular names have been given, followed by their habitat, methods of cultivation, importance in perfumery, chemical constituents, etc. Many other uses of such plants have also been included since in the complete economy of a plant its use in perfumery cannot be divorced from other uses. Although the principles responsible for the smell have been dealt with in detail, no attempt has been made in giving complete chemical constituents of the plant, and only those principles, such as alkaloids, glucosides, etc., which are considered important are included. It is well known that the same species will have more or less identical constituents in different countries, climates and soils. For the purpose of giving chemical information, therefore, it has been considered immaterial whether Indian or foreign specimens of a particular plant have been investigated. Wherever Indian material has not been investigated, chemical information on the same plant investigated elsewhere has been given. It must, however, be understood that in the case of aromatic plants it does not necessarily follow that the same species from different areas will have exactly the same aroma. Chemical information about essential oils in these series should, therefore, be taken only as a guide.

A complete list of vernacular names of plants dealt with in detail will be given at the end of the series.

No botanical descriptions of families, genera or species have been included. These are of use only to experts in the identification of a plant, and are of little interest to others. A comparatively small number of plants described in detail are spread over the whole of the vast country and are intermixed with a much larger number of other plants. Even the experts in such cases often require, for correct identification, not only the description of plants but also the characters in which they differ from closely allied species growing in the same area. In order that these botanical descriptions may be of practical use in the identification of plants, they should be supplemented by information for distinguishing them from other allied plants. Such a course would obviously be outside the scope of this work, besides making it unnecessarily bulky. No doubt complete and detailed botanical descriptions would in many cases be useful for the identification of plants by experts, but such descriptions are, in many cases, neither available nor easy to draw up without unduly withholding the publication for a long time. References to descriptions in the *Flora of British India* by Hooker have, however, been given for the benefit of those readers who are interested in the identification of aromatic plants. They are also referred to various local floras which have been published. They will find the identification much easier from these books than from descriptions even if they were included in this work. The large number of illustrations given in the present series should not only make up for the omission of botanical descriptions, but also will serve a very useful purpose in the identification of plants.

Special attention has been paid to the nomenclature of Indian plants, and adherence to the International Rules of Botanical Nomenclature has caused many departures from the names used in the *Flora of British India*. A large number of plants, as described in that work, are differently understood or are differently named or spelt by modern botanists. In some cases the validity of new names has been checked by the present authors; in others, these changes have been verified from the works of well-known botanists. Wherever the name adopted in these series differs from that of the *Flora of British India*, the latter name is given as a synonym for the benefit of those who have become accustomed to the old names. Care has also been taken to cite correct names of foreign plants, but access to foreign literature has been limited in many cases.

References to literature have been given in cases where statements made refer to the work done on aromatics.

The following books have been freely drawn upon:—

1. Chopra, R. N., Badhwar, R. L. & Ghosh, S., *Poisonous Plants of India* (in press).
2. Finnemore, H., 1926. *Essential Oils*.
3. Gildemeister, E. & Hoffmann, F., 1913–16. *Volatile Oils*, Vols. 1–2.
4. Hooker, J. D., 1875–97. *Flora of British India*, Vols. 1–7.
5. Klein, G., 1932. *Handbuch der Pflanzenanalyse*, Vol. 111/1.
6. Martin, G., 1921. *Perfumes, Essential Oils, and Fruit Essences*.
7. Parry, E. J., 1921–22. *Chemistry of Essential Oils and Artificial Perfumes*, Vols. 1–2.
8. ————, 1925. *Parry's Cyclopaedia of Perfumery*, Vols. 1–2.
9. Poucher, W. A., 1936. *Perfumes, Cosmetics and Soaps, with special reference to Synthetics*, Vols. 1–3.
10. Simonsen, J. L., 1931–32. *Terpenes*, Vols. 1–2.
11. Walter, E., 1916. *Manual for the Essence Industry*.
12. Watt, G., 1889–96. *Dictionary of the Economic Products of India*, Vols. 1–6.
13. Wehmer, C., 1929–31. *Die Pflanzenstoffe*, Bd. 1–2.
14. ————, 1935. *Ibid., Supplement*.

This is only a pioneer work in which the authors have attempted to bring together all the known information on Indian aromatic plants, together with a survey of the important aromatic plants of the world. Their object is to stimulate interest in these interesting plants which have been appreciated since time immemorial. The advancing civilization will be more and more in need of perfumes emitted by an infinite variety of vegetation on earth. Few industries have such a future before them as the perfumery and allied industries. It is, therefore, hoped that soon special efforts will be made in making a detailed survey of the natural resources of the country, and augmenting them, where necessary and desirable, by cultivation. The country is in urgent need of a special herbarium and a museum wherein all the aromatic plants of India are housed and all the natural aromas "bottled up" for the industry to select and choose and blend the choicest perfumes for the diverse and changing tastes.

When all the series are published they will be compiled and presented in the form of a monograph, wherein a suitable introduction dealing in detail with the history, industrial and economic uses, cultivation, properties, etc., of aromatic plants will be given.

The authors are thankful to the Essential Oil Advisory Committee of the Board of Scientific and Industrial Research for financing the inquiry which has enabled them to produce these series, and for granting a liberal sum for illustrating these. They are particularly grateful to its Chairman, Mr. P. A. Narielwala of the Tatas, for the keen interest he has taken throughout, and to Dr. Sitarama Rao, lately Economic Botanist of the Committee, for placing at their disposal the collection of notes on aromatic plants prepared by him. These notes have been of much help in checking up references to literature.

Family I—RANUNCULACEAE

(Buttercup or Crowfoot Family)

This family comprises about 40 genera and 1,000 species of herbs, rarely shrubs, of little economic importance, even though some species, such as those belonging to the genera *Aconitum*, *Hydrastis*, *Helleborus*, *Delphinium*, and *Coptis*, are used in medicine. Many of its members are poisonous owing to the presence of potent alkaloids, glucosides, etc. A number of species belonging to the genera *Anemone*, *Caltha*, *Clematis*, *Ranunculus*, etc., possess acrid and vesicant properties; this is said to be due to the presence of a volatile oil called protoanemonin, which soon changes into anemonin (pulsatilla camphor or anemone camphor) having similar properties. The seeds of *Nigella sativa* Linn. (*kalonji*) are used as a condiment; they contain an essential oil. Some plants, e.g., larkspur (delphinium), columbine (aquilegia) and virgin's-bower (clematis), are cultivated for ornamental purposes.

The constituents of essential oils present in the family do not appear to have been investigated except in a few cases. Besides the plants dealt with hereafter, the foreign *Ranunculus ficaria* Linn. yields a dark-brown oil having a tobacco-like odour.

1. ANEMONE Linn.

(From the Greek *anemos*—wind; so named from being easily stripped of its petaloid sepals by the wind.)

The genus comprises about 120 species of perennial herbs which are found in the cold and temperate regions. In India it is represented by 15 species, all of which are found in the Himalayas.

Some of the species are stated to possess toxic properties owing to the presence of anemonin, which is obtained from the essential oil by steam distillation of the fresh plant. The best known plant is *Anemone pulsatilla* Linn., a European species, which was formerly largely used for the treatment of dysmenorrhoea and amenorrhoea, and as a remedy for asthma, hemicrania, etc., but is obsolete now. It is, however, still largely used in homoeopathic medicine. The active principle of this plant is stated to be anemonin (pulsatilla camphor).

No information of value is available about the Indian species, but the root of the Himalayan *Anemone obtusiloba* D. Don (*ratanjog*) contains a small quantity of a substance resembling anemonin. It is stated to be used as a blistering agent in Bushahr.

2. CALTHA (Rupp.) Linn.

(From the Greek *calathos*—a cup; referring to the shape of the flower in the common species.)

Of the 20 herbaceous species belonging to this genus only two are represented in India. Indian specimens of *Caltha palustris* Linn. (water buttercup, marsh marigold) have not been investigated, but foreign plants are stated to contain anemonin (anemone camphor). This plant is found in the marshes of the temperate W. Himalayas from Kashmir to Nepal.

3. CIMICIFUGA Linn.

(From the Latin *cimex*—a bug; and *fugare*—to drive away.)

This genus contains 12 herbaceous species of which only one, *C. foetida* Linn. (bugbane, *jiunti*), is represented in the Himalayan regions of India. This is used in Siberia to drive away bugs and fleas. The flowers and unripe fruits of this plant have an extremely foetid smell, but no essential oil has so far been isolated.

The rhizomes and rootlets of *C. racemosa* (Linn.) Nutt. (black snakeroot, black cohosh) of N. America, which differs from the Indian species very slightly, are official in the United States Pharmacopoeia; they are employed in rheumatism and uterine troubles, and as a remedy against St. Vitus's dance. This plant is stated to be distasteful to bugs.

4. CLEMATIS Dill. *ex* Linn.

(From the Greek *klema*—a vine branch; most species are climbers.)

The genus comprises about 220 species of shrubs of which 20 are found in India. They usually climb by means of their twisted petioles and have opposite leaves.

A number of species are acrid and poisonous. The leaves and fresh stems, if crushed and applied to the skin, produce vesication,

probably due to the presence of anemonin. This has been actually found in the case of two foreign plants *C. angustifolia* Jacq. and *C. integrifolia* Linn. (Beckurts, 1892. *Arch. Pharm., Berl.*, **230**: 182). The leaves of the S. African *C. brachiata* Thunb., when chewed, produce a burning feeling in the mouth, and bruised stems, if sniffed, induce sneezing. Of the Indian species, *C. gouriana* Roxb. (Indian traveller's-joy), *C. graveolens* Lindl., *C. napaulensis* DC. and *C. triloba* Heyne *ex* Roth are acrid, poisonous and/or vesicant.

5. DELPHINIUM Tourn.

(From the Greek *delphinos*—a dolphin; referring to the form of flower.)

Of the 150 species of herbs, the larkspurs, belonging to this genus only 13 are represented in India. They have large, handsome, and spurred flowers. A number of species have often been the cause of poisoning in children and in cattle and horses, due to the presence in them of alkaloids of the aconitine type. The flowers have generally acrid properties.

The Himalayan and Tibetan species *D. brunonianum* Royle (*kasturi*), *D. cashmirianum* Royle (*amlin*), and *D. glaciale* Hook. *f.* & Thoms. all possess strong smell of musk. *D. brunonianum* is especially prized as a substitute for musk and is offered to the presiding deity of hill temples. No essential oil, however, appears to have been isolated either from this or any other species of this genus.

There is a perfume known as " delphinium bouquet " in the market, but this is prepared synthetically.

3. HELLEBORUS (Tourn.) Linn.

(From the Greek *helein*—to cause death, and *bora*—food; referring to the poisonous properties of plants of this genus.)

Except perhaps *H. niger* Linn. (Christmas rose) which may be in cultivation in gardens at high altitudes, none of the fifteen species belonging to this genus is found in India. The roots of *H. niger* are, however, available at druggists' shops in India, since they are imported for use in medicine as a hydragogue cathartic. They contain a small quantity of an essential oil (Wehmer) together with the glucosides helleborin, helleborein, and another.

4. NIGELLA (Tourn.) Linn.

(From the Latin *nigellus*—dark; probably referring to the dark colour of seeds.)

This genus comprises 16 herbaceous species, some of which are cultivated as ornamental plants in foreign countries. *N. damascena* Linn. is the love-in-a-mist of gardens. The seeds of this plant, according to Wehmer, yield an essential oil known as nigella oil. *N. sativa* Linn. (*kalonji*) is cultivated and has run wild in India. Its seeds, which contain an essential oil, are carminative and are used as a condiment in Turkey, Egypt, India, and elsewhere.

Nigella sativa Linn.

(Black Cumin, Small Fennel, *Kala-jira*, *Kalonji*)

This is a pretty herb 1 to 2 ft. high with pale-blue flowers. It is extensively cultivated in many parts of India for its seeds, and has also run wild in some areas.

Fig. 1.—*Nigella sativa* Linn.

The seeds have a strong, pungent, aromatic taste, and are much used in India and elsewhere in curries and pickles. In medicine they are used as an aromatic and carminative, and as an emmenagogue. They are also used as a moth preventive.

The seeds are said to contain 0.5 to 1.4 per cent. of an essential oil, known as black-cumin oil, up to 40 per cent. of a fatty oil, and a saponine-like glucoside, melanthin (Wehmer).

Schimmel & Co. (1913, Oct. *Semi-Ann. Rep.*, p. 19–111) have reported 0.5 per cent. of a brown oil (some record yellow) having the following constants: sp. gr. 15° 0.8855, [∝] + 2.52°, $n^{20°}$ 1.48378, acid val. 1.9, ester val. 31.6, ester val. after acetylation 73.0, and soluble in 2 or more volumes of 90 per cent. alcohol.

5. PAEONIA (Tourn.) Linn.

(After Paeon, the physician of the gods, who is said to have first used peony medicinally.)

Of the 15 species of herbs or undershrubs belonging to this genus only *Paeonia emodi* Wall. (peony rose, *udsalap*, *mamekh*) is found in India, in the temperate W. Himalayas. The tuberous roots of this plant, like those of the foreign *P. officinalis* Linn., are highly prized in medicine for uterine diseases, colic, dropsy, epilepsy, etc. Although no essential oil has been distilled from the roots of the Indian species, it is said to contain one (Nadkarni, 1927. *Indian Materia Medica*, p. 631).

The root-bark of *Paeonia moutan* Sims, a drug that is extensively used in Japan and China, contains on its inner surface as well as on fracture surfaces small white crystals of paenol (peonol) which can be extracted on steam distillation to the extent of 3 to 4 per cent. (Will, 1886. *Ber. dtsch. chem. Ges.*, **19** : 1776). The oil obtained consists of a yellowish, solid mass saturated with a brown liquid. It melts at about 40° C., sp. gr. 15° 1.1502, [∝] inactive, $n^{20°}$ 1.5646, acid val. 12.6, ester val. 24.5, ester val. after acetylation 220.7, and soluble in 1 volume and more of 80 per cent. alcohol. According to Nagai (1891, *Ber. dtsch. chem. Ges.*, **24**: 2847) paenol (peonol) possesses an aromatic odour, melts at 50° C., and has the composition $C_9H_{10}O_3$, *p*-methoxy-*o*-hydroxyphenyl-methyl ketone.

Another foreign plant, *P. officinalis* Linn., is reported to contain an essential oil and an alkaloid (Wehmer).

6. RANUNCULUS (Tourn.) Linn.

(A diminutive of the Latin *rana*—a frog; referring to the damp situation in which some species grow.)

This genus comprises about 300 species of cosmopolitan herbs, known as buttercups or crowfoots. Of these about 20 species are represented in India. A number of plants are poisonous, acrid and corrosive, and some of the species, particularly *R. sceleratus* Linn., are known to cause severe symptoms in sheep and goats. Applied to the skin they raise blisters. The toxic properties are stated to be destroyed on drying or on boiling.

The sharp burning taste and irritant action of fresh ranunculuses is due to a colourless, exceedingly vesicant, and lachrymating volatile oil which has been obtained from some species by steam distillation and subsequent extraction of the distillate with ether or chloroform. This is called protoanemonin which is the lactone of ϒ-hydroxyvinyl-acrylic acid. Protoanemonin readily changes into anemonin, which has similar vesicant properties (Asahina, 1914. *Ber. dtsch. chem. Ges.*, **47**: 914; Asahina & Fujita, 1920. *J. pharm. Soc. Japan*, **455**: 1; Kipping, 1935. *J. chem. Soc.*, p. 1145).

Among the Indian plants, *R. sceleratus* Linn. (celery-leaved buttercup, marsh crowfoot) has been found to contain anemonin (Wehmer), and is known to possess acrid and poisonous properties. Some other Indian species, such as *R. falcatus* Linn., *R. lingua* Linn., and *R. pensylvanicus* Linn. *f.*, also possess more or less similar properties, but have not so far been chemically investigated

Family II—MAGNOLIACEAE

(Magnolia and Champa Family)

This family consists of about 13 genera and nearly 100 species of trees and shrubs of great interest, both from the point of view of essential oils contained in various parts of the plants and as well as timber. The Indian species are chiefly found in more or less inaccessible places in the N.-E. Himalayas and Assam. The most important representative is the American tulip tree or lyre tree (*Liriodendron tulipifera* Linn.), with greenish flowers; this is cultivated in some Indian hill stations. It yields a valuable commercial timber known as canary whitewood or yellow poplar of the trade. Various species of *Michelia, Talauma, Magnolia* and *Manglietia* also contain timber species of local importance and produce woods comparable in general appearance and physical properties to canary whitewood. Some of the plants are cultivated ornamentally for their showy and fragrant flowers, and are among the most beautiful of trees. Among these may be mentioned: magnolia (*Magnolia grandiflora* Linn.) with large, white, scented flowers and lustrous dark-green foliage, and *champa* (*Michelia champaca* Linn.) with yellow flowers having a strong, pleasant fragrance. The magnolia perfume of commerce is distilled from some Japanese species, especially from the twigs of *Magnolia kobus* DC., and is known as kabushi oil; it is also prepared synthetically. The flowers of *Michelia champaca* Linn. and *M. alba* DC. (*M. longifolia* Blume) are the sources of champaca oil of perfumers. The fruit of star anise of China (*Illicium verum* Hook. *f.*) is largely imported into India for use as a condiment in cookery and for flavouring liqueurs and spirits. An oil is also distilled from the fruit and is a valuable article of commerce. The fruit is sometimes adulterated with that of the Japanese sacred anise tree or skimmi of Japan (*I. religiosum* Sieb. & Zucc., syn. *I. anisatum* Linn. ?) which contains a toxic essential oil with disagreeable odour, together with a poison of the picrotoxin class.

A large number of species belonging to the genera *Illicium, Drimys, Magnolia, Manglietia, Michelia, Pachylarnax, Schizandra* and *Talauma* contain aromatic substances in their flowers, leaves and barks. Out of these *Drimys* is not represented in India. In addition to the plants dealt with hereafter, *Pachylarnax pleiocarpa* Dandy of Assam also bears fragrant flowers.

Amongst the constituents of essential oils reported from members of the family may be mentioned the following; these have been isolated from species belonging to the genera *Magnolia, Michelia, Illicium* and *Drimys :* Anethole, *p*-cymol, β-phellandrene, dipentene, farnesol, terpineol and *p*-methoxyphenyl acetone from illicium fruit; γ-phellanderene, geraniol and nerol from michelia flowers; linalool from magnolia, michelia and illicium flowers or fruits; borneol from illicium fruits; citral from magnolia flowers; cineole from magnolia, michelia and illicium fruits or flowers; palmitic, stearic, anisic and anthranilic acids from some of the above and others.

1. ILLICIUM Linn.

(From the Latin *illicium*—an allurement; referring to its aroma.)

Of the 20 shrubby and arboreous species belonging to this genus only 2 are represented in India. The most important plant is the star anise (*I. verum* Hook. *f.*) of China, the anise-scented fruit of which is used as a condiment, in the manufacture of liqueurs, in perfumery, and as a source of star-anise oil. It is, however, occasionally adulterated with or substituted by the Japanese sacred anise or poison bay (*I. religiosum* Sieb. & Zucc., syn. *I. anisatum* Linn. ?), which is poisonous. Not much is known about the two Indian species *I. griffithii* Hook. *f.* & Thoms. and *I. manipurense* Watt *ex* King except that the fruit of *I. griffithii* of Bhutan and Khasi Hills (4,000 to 5,000 ft.) is tasteless at first, but soon afterwards develops a flavour between that of cubebs and bay leaves. The fruit, like that of the true star anise, is said to yield, on distillation, an essential oil somewhat resembling that of aniseed and fennel.

Illicium verum Hook. *f.*

(Star Anise of China)

This is a small evergreen tree reaching about thirty feet in height. The plant is cultivated from its hard shiny seed in S.

Fig. 2.—*Illicium grifithii* Hook. *f.* & Thoms.

China and Indo-China, and is prized for its star-shaped reddish-brown fruit consisting of eight carpels, each with a seed. It is extensively grown in the Chinese provinces of Kwang-si, Kwang-tung, Hai-nan and extensively in the prefecture of Langson in Tonkin. Both the seed and the fruit are highly aromatic, having a flavour of anise. The tree requires special climatic conditions and its development is rather slow and hazardous. It yields fruit at from six to hundred years of age, but a full crop is obtainable only after sixteen to seventeen years. The fruit can be harvested twice or even three times a year, but there is a full crop only once in three years. This is probably due to the bad treatment which the trees receive while the fruit is picked. On an average, a tree is said to yield nearly hundred pounds of fruit annually. The fruits are collected before they are ripe and are dried or immediately distilled for the oil.

Star anise has long been in use in China and Japan, although it has come into use in India only recently. In Europe it is chiefly employed to flavour certain spirits and liqueurs (such as *Anisette de Bordeux*), Germany, France and Italy being the largest consumers. In India, like in China and Japan, it is used as a condiment, and also in medicine as a stomachic, carminative and flavouring agent. It is also used in perfumery.

Large quantities of star anise are exported from China and even larger amounts are utilized in the districts of production for the distillation of the star-anise oil. In 1909 over 1.50,000 lbs. of the oil was exported, but in 1936 Hongkong alone exported 4,65,485 lbs. (Schimmel & Co., 1937. *Ann. Rep.*: p. 82). The chief producing centre for this oil lies at the boundary of the Chinese province of Kwang-si, and probably furnishes 75 per cent. of the total imports of various countries, while the balance 25 per cent. is distilled in Tonkin (Schimmel & Co., 1938. *Ann. Rep.*, p. 99). The volatile oil from the fruits is scarcely distinguishable from dill oil, and may be substituted for it. The leaves also yield an oil, but the quantity is about one-tenth as small as is obtainable from the fruits. For this reason the fruit is usually preferred, but when the supply of fruit fails the leaves are used instead.There is a slight difference between the two oils, but they are indifferently substituted for each other in commerce.

The fresh carpels of star anise of China yield up to 3 to 3.5 per cent. of the oil and sometimes even more. It is a colourless or yellowish, strongly refractive liquid which congeals in the cold because of its anethole content. Its odour is anise-like and its taste intensely sweet. Its physical constants are: sp. gr. 0.98 to 0.99, $[\alpha]$—2° to + 1.5°, m.p. 19.5° to 20° C., congealing point 15.5° C., and soluble in 1.5 to 3 vols. and more of 90 per cent. alcohol (Chib-Hsin Wang, 1934. *Chem. Ind. ustr.* (*China*), 9 (2): 27).

Anethole is the most important and valuable constituent of star-anise oil. Inasmuch as 85 to 90 per cent. of pure anethole can be obtained from good oil by freezing, the actual content is somewhat higher. The non-anethole constituents of the oil (10 to 15 per cent.) consists of *d*-α-pinene, phellandrene, *p*-cymene, cineole, dipentene, *l*-limonene, α-terpineol, methylchavicol (*p*-methoxyallyl benzene), hydroquinone ethyl ether, safrol and anise ketone ($C_6H_4 \begin{matrix} OCH_3 \\ CH_2 \end{matrix}$.$CO.CH_3$, b. p. 263, sp. gr. 1.095). Jackson & Short (1937. *J. Chem. Soc.*, p. 513) have reported the presence of anise oxide.

India imports large quantities of the star-anise fruit from China. Unfortunately, however, this is sometimes adulterated with or substituted by the fruit of the Japanese sacred anise tree or poison bay (*I. religiosum* Sieb. & Zucc., syn. *I. anisatum* Linn.?) which is poisonous. Although this species too contains an essential oil it has no commercial use, inasmuch as the essential oil has a disagreeable odour and taste and the fruit also contains a poison of the picrotoxin class. Cases of poisoning among children due to this have been reported both in Japan and in India and it is desirable, therefore, to have means of distinguishing them. This is not very easy. Greenish (1909. *Materia Medica*, p. 105) gives the following: "The Japanese star-anise fruits are less regularly developed, the carpels usually more wrinkled and provided with a more acute beak, which is commonly directed upwards, the ventral suture is usually more open and the peduncle, to which the carpels seldom remain attached, is straight. Moreover, the taste and odour are quite distinct, for the Japanese fruits have a balsamic, but not anise-like odour, and a disagreeable bitterish taste; the taste and odour are indeed the best characters by which to distinguish the genuine from the false, as they can be applied to fragments of the fruits." According to Wagenaar (1936. *Pharm. Weekbl.*, **73**: 1490, *vide Brit. Chem. Abstr. B.*, 1936: 1233), the fruits of the genuine star anise (*I. verum*) can also be distinguished from those of the poisonous species (*I. religiosum*) by the colour reactions of the alcoholic extract with concentrated hydrochloric acid and β-naphthol, ferric chloride, aniline dyestuffs, and especially with concentrated sulphuric acid.

2. MAGNOLIA Linn.

(Named after Pierre *Magnol*, Professor of Medicine and Botany at Montpellier, France, in the seventeenth century.)

Of about 20 species of trees and shrubs belonging to this genus, five are found in India. They have highly ornamental, large, white, pink or purple flowers, and several are commonly cultivated in gardens. The barks, which are usually aromatic, and fruits of some species are used in medicine as a tonic and, like other bitters, sometimes for malaria. They also furnish some timber of value.

The delightful fragrance of magnolia flowers has led to the preparation of artificial

Fig. 3.—*Magnolia grandiflora* Linn.

oils of this name, which usually consist of oils of jasmin (*Jasminum grandiflorum* Linn.), neroli (from the blossoms of bitter orange tree) and rose (*Rosa centifolia* Linn. and other species of rose), with traces of ionone and benzaldehyde. The most important species is *M. grandiflora* Linn. with flowers six to eight inch across, whitish, highly odoriferous having a predominating note suggestive of ylang-ylang [*Cananga odorata* (Lam.) Hook. *f.* & Thoms.] backed up with orange blossom (*Citrus sp*). This is commonly cultivated in Indian gardens. Kabushi (or kobuschi) oil of commerce is derived from the twigs of the Japanese *M. kobus* DC., and contains anethole and citral as the main constituents. The bark of this tree has a camphoraceous odour and the fragrance of flowers is suggestive of verbena (*Lippia citriodora* H. B. & K.; syn. *Verbena triphylla* L'Hérit., *Aloysia citriodora* Orteg *ex* Pers.). The leaves and flowers of *Magnolia glauca* Linn. of E. United States are fragrant; the former yield 0.05 per cent. of a pale-yellow aromatic oil, and the latter 0.04 per cent.

The fragrance of the oil of flowers from most of the species resembles that of ylang-ylang backed up with narcissus and jonquille (species of *Narcissus*) and orange blossom. The commercial oils have been obtained from Japan, but the species from which they are derived are not very clear. The following are the constituents identified from the Japanese oil, but they cannot be taken as a guide for compounding the synthetic perfume: cineole, citral, anethole, eugenol, methylchavicol, phellandrene, linalool, terpineol, caprinic acid, oleic acid, and possibly pinene [Schimmel & Co., 1909 (April). *Ann. Rep.*, p. 59].

Fig. 4.—*Michelia champaca* Linn.

The leaves, bark, and flowers of *M. pterocarpa* Roxb. (erroneously spelt as *M. sphenocarpa* in *Fl. Brit. Ind.*) of E. Himalayas are aromatic, and *M. globosa* Hook. *f.* & Thoms. of Sikkim and *M. griffithii* Hook. *f.* & Thoms. of Assam and Nepal bear scented flowers. No essential oil has, however, been distilled from these. The barks of the foreign species *M. obovata* Thunb. and *M. officinalis* Rend. contain an oil (Sugii & Schindo, 1930. *J. pharm. Soc. Japan*, **50:** 709; *Ibid.*, **50:** 183).

Magnolia grandiflora Linn.

(Great-flowered Magnolia, Great Laurel-magnolia)

This is an evergreen tree 80 to 100 ft. high, with firm laurel-like leaves and large (6 to 8 in. across) whitish, highly fragrant, cup-like flowers. It is a native of the S. United States and several varieties are being cultivated for ornamental purposes in gardens all over the world, including India. The tree likes moist situations and flowers freely in May.

No oil is reported to have been distilled from plants grown in India although, like those grown in America, both the leaves and flowers appear to have essential oils. The perfume of the flowers is said sometimes to vary in different countries, but that grown in its native country has a predominating note suggestive of ylang-ylang or ilang-ilang [*Cananga odorata* (Lam.) Hook. *f.* & Thoms.] backed up with orange blossom. The oils described below are from the American tree:—

(*a*) The flowers give 0.04 per cent. of a slightly yellow oil of rather unpleasant odour, having sp. gr. 20° 0.902,

$n^{20°}$ 1.5250, $[\alpha]^{20°}$ + 3.12°, $[\alpha]$ after acetylation + 6.50°, b.p. 155° to 260° C., acid val. 1.20, ester val. 54.20, ester val. after saponification 75.5, slightly soluble in 90 per cent. alcohol. The constituents of the oil are not recorded but, like other oils from this genus, it is likely to contain cineole, citral, anethole, and phellandrene.

(*b*) The leaves contain 0.12 per cent. of a slightly greenish oil of unpleasant odour and, on being left in air, thickens and becomes sticky. The oil has sp. gr. 15° 0.915 to 0.916, $n^{20°}$ 1.5004 to 1.5014, $[\alpha]$ + 1.20° to 1.30°, b.p. 170° to 265° C., completely soluble in 95 per cent. alcohol, ester val. 26.9 to 28.14, ester val. after acetylation 51.0. Total ethers 9.8 per cent., total alcohols ($C_{10}H_{18}O$) 13.5 per cent., and free alcohols 5.7 per cent. (Ginseppe Tommasi, 1928. *Ann. Staz. chim.-agr. Roma*, **10**: 29, 53, 63).

3. MANGLIETIA Blume.

The genus comprises 4 species, out of which three are represented in India. All these, viz., *M. caveana* Hook. *f.* & Thoms., *M. insignis* Blume, and *M. hookeri* Cubitt & Smith, are found in Assam and have scented flowers, but no essential oil has been distilled from these.

4. MICHELIA Linn.

(Named in honour of Piero Antonio *Micheli*, a botanist of Florence.)

This genus consists of 16 species of trees, all of which grow in the tropical hills of India, Malaya, the Philippines, and China. Eleven species are found in India, and of these three are timber trees. They are used in medicine on account of the bitter substance they contain. Some species are cultivated in gardens for their fragrant, magnolia-like flowers. The most important representatives are *M. champaca* Linn. of India and *M. alba* DC. (*M. longifolia* Blume) of Java. The fresh flowers of these yield the commercial champaca oil. At present the supply of genuine oil is limited to only a few kilos per annum, and almost all of this is employed in fine jasmin-flower perfumes. The oils from these two species are quite distinct in odour and constituents; that from *M. champaca* is very fragrant and fluorescent, while the one from *M. alba* is more fruity. It appears doubtful whether commercial oils are distilled from *M. champaca* alone or from a mixture of the two species with a possible addition of ylang-ylang [*Cananga odorata* (Lam.) Hook. *f.* & Thoms.] blossom. According to Brooks (1911. *Philipp. J. Sci.*, **6A**: 333; *J. Amer. chem. Soc.*, **33**: 1763), the oil from *M. champaca* contains cineole, *p*-cresol methyl ether (?), benzaldehyde, benzyl alcohol, benzoic acid and phenylethyl alcohol, while that from *M. alba* contains linalool, methyl-eugenol esters of methylethyl-acetic acid and a phenol having an odour of thymol. Others have shown the presence of *iso*eugenol, geraniol, and methyl anthranilate. Most of the champaca perfumes are prepared artificially from these bodies, and these are fixed by suitable fixatives.

An oil from the leaves of champaca is also said to be prepared on a large scale in Java. The odour of the oil recalls that of basil (*Ocimum bacilicum* Linn.)

Besides *M. champaca* a few other Indian species contain essential oils, but these have not been investigated. *M. nilagirica* Zenker (*pila-champa*), with white flowers somewhat tinged with yellow, is commonly met with in the shola forests of the Nilgiris and Pulneys; its bark is stated to contain an essential oil, that of the branches and younger stems being more aromatic (Dymock, Warden, & Hooper, 1890. *Pharmacographia Indica*, **1**: 43–44). The large, white flowers of *M. excelsa* Blume* (white magnolia, *seto-chanp*, *dieng-rai*) are faintly sweet scented. This tree has been extensively grown in Bengal plantations and is also found in Khasi hills. Its timber is highly prized in the hills. When freshly cut the wood has a strong undescribed smell. The pale-yellow flowers of *M. kisopa* Buch.-Ham. *ex* DC. of temperate Himalayas, which is cultivated in Shillong, are delightfully scented. The inner bark of *M. punduana* Hook. *f.* & Thoms. of Khasi hills and of N. Bengal is aromatic. The white flowers of *M. oblonga* Wall. of Assam are scarcely scented, but the bark is aromatic. *M. montana* Blume (*pan-sopa*) of Assam has fragrant, white flowers, and its bark is

* This species, together with *M. manipurensis* Watt *ex* Brandis, has been reduced to *M. doltsopa* Buch.-Ham. *ex.* DC. (Dandy, 1927. *J. Bot. Lond.*, **65**: 277–79).

also aromatic; the fresh wood of this plant smells like fresh ginger.

Michelia champaca Linn.

Fl. Brit. Ind., 1, 42.

(Champaca, Champak, *Champ, Champa*)

This is a tall, evergreen tree with a long clean cylindrical bole, attaining a height of 110 ft. or more, and bears very fragrant yellow flowers 2 inches in diameter. It is found wild in the evergreen forests of W. Ghats from Kanara southwards and in the Himalayas from Nepal eastwards; also rarely in Bihar, Orissa and Central Provinces. It is much cultivated all over India, especially about the Hindu temples, and has run wild from these places. It is, therefore, difficult to determine the exact limit of this species in a wild state. In ordinary forest conditions it attains a girth of 8 to 12 ft. or more, but it is said that there is an old tree in Biligiirirangan Hills of Mysore, which is over 50 ft. in circumference.

In its natural habitat the tree is ordinarily found in regions where the maximum shade temperature varies from 95° to 105° F., the absolute minimum from 38° to 62° F., and the normal rainfall from 90 to 200 in. or more. It is a moderate light-demander and thrives best in damp climate with a moist deep soil. The seeds are oily and quickly lose their germination power. They should, therefore, be sown as soon after collection as possible. The seedlings may be transplanted from the nursery in the second year after sowing. They are very sensitive to frost and seedlings require protection.

All parts of this plant are useful. The timber is durable and is used in India for planking, door panels, furniture, house-building, canoes and tea-boxes. It is suggested that its durability is connected with the protection given by an intensely bitter substance present in it. It is described as suitable for making furniture and mouldings and for decorative work and veneer. The wood is made into beads which are strung into necklaces for sale to pilgrims in holy places. The bark is used as a febrifuge in indigenous medicine, and the seed, leaves, roots, and leaves are also used locally for many other diseases.

The leaves when distilled produce a sweetly scented water (Watt).

The delightfully fragrant flowers are often tucked in the hair, especially by women, for ornamental purposes. They are often used in the Hindu religious ceremonies, hence the plantation of trees in the vicinity of the temples. A few flowers, if placed in a room, impart a sweet fragrance to the atmosphere. The people of Malaya place dried flowers among their clothes for the sake of their perfume, and in Siam a cosmetic for use after bath is prepared from infused flowers.

It is stated that cultivation improves the perfume of flowers. The flowers yield on distillation a fragrant oil. For this purpose only freshly picked flowers are used since decay sets in rapidly, and even before it is evident a certain amount of aromatic substances present in the flowers are lost while some less agreeable substances appear. Steam distillation ruins the oil, consequently the oil is obtained either (*a*) by maceration of the flowers with paraffin oil, in which the flowers are allowed to remain for 24 hours and the residual oil used nine times over for the extraction of fresh flowers. Subsequent extraction of the oil with alcohol yields an essential oil of a fine and strong odour; or (*b*) by means of petroleum ether.

Essential oil is hardly ever recovered from champaca flowers in India. Fatty oils which have acquired the odour, on steeping the *champa* flowers in them, are largely used as hair oils.

Champaca odour is heavy and persistent, of the same type as ylang-ylang and the larger varieties of perfumed lilies. The oil examined in the Philippines is said to have been obtained in yields varying from 0.11 to 0.2 per cent. (Worsley, 1934. *Bull. imp. Inst. Lond.*, **32**: 268; Bacon, 1910. *Philipp. J. Sci.*, **5A**: 262). The constants are sp. gr. 0.883 to 1.020, n 1.4640 to 1.4880, $[\alpha]$ — 13°, ester val. 34.5 to 146 (usually 124 to 146), ester val. after acetylation 199, sap. val. 160 to 168 (Brooks, 1910. *Philipp. J. Sci.*, **5A**: 262; Worsley, *loc. cit.*; Cerbeleand, 1927. *Parfum. mod.* **20**: 98).

5. SCHIZANDRA Michx.

This genus is represented by 7 species of climbing shrubs, five of which are found in India. They bear white, yellow or red flowers. *S. grandiflora* Hook. *f.* & Thoms. of the temperate Himalayas has waxy white fragrant flowers which are often tinged with

pink. The yellow or orange flowers of *S. propinqua* Hook. *f.* & Thoms. of the temperate Himalayas are also slightly scented. No essential oil appears to have been distilled from these species, but the Japanese *S. nigra* Maxim. (*matsubasa*), which is used there as a bath perfume, is reported to yield on steam distillation 1.3 per cent. of oil from the " shredded drug " (presumably stem or root bark). The constants of this oil are: sp. gr. 15° C. 0.8763, $[\alpha]^{12°}$—5.78, acid val. 3.5, sap. val. 31.7, sap. val. after acetylation 54. It contains an acid and phenolic constituents and about 8 per cent. of methyl undecyl ketone $C_{13}H_{26}O$, m.p. 28°. (Sengoku, 1933. *J. Pharm. Soc. Japan*, **53**: 947). Another foreign species of *Schizandra*, *S. chinensis* C. Koch, is known as " Chinese lemon " in Russia because of the odour of its bark, young leaves, and fruit (Pereslegin, 1944. *Vide Chem. Abstr.*, 1945, **39**: 3591).

6. TALAUMA Juss.

(Etymology obscure.)

This genus consists of about 40 species of trees and shrubs of which three are found in India. Hard timber is more or less a characteristic of the genus. The timber from *T. hodgsoni* Hook. *f.* & Thoms. (*hare*, *bhalukhat*, *siffu-kung*), a lofty timber tree of Sikkim and Assam, is used for making *kukri* and knife handles, and *T. plumierii* DC. of West Indies has ebony-like wood. Aromatic substances occur in the tissues and are distributed in different parts of plants. In *T. hodgsoni* the flowers are fragrant; in *T. phellocarpa* King it is the bark, whereas in *T. plumierii* all parts are odorous. The chemistry of volatile oils of species belonging to this genus has not been worked out, but the leaves of S. American *T. ovata* A. St. Hil. have been found to contain coumarin and tannin; these leaves are used for making a herbal tea.

Family III—ANNONACEAE

(Custard-apple Family)

This family consists of trees or shrubs which are found in tropical regions. The timbers of the family are relatively unimportant. Many of the succulent fruits of its representatives are delicious, but, owing to the rapid rate at which they ripen, are of poor keeping quality and do not lend themselves to transport; this feature, coupled with the ornamental value of these plants, makes them prized species for cultivation round about residences and habitations throughout the Orient. The flowers, leaves, barks, roots and seeds of a number of plants are aromatic and are used in the tropics as spices and drugs. The famous ylang-ylang or ilang-ilang perfume, which is much used in high-class perfumery, is prepared from the yellow, fragrant flowers of *Cananga odorata* (Lam.) Hook. *f.* & Thoms., a large evergreen tree cultivated in many parts of India for ornamental purposes. The globose, areolate fruit of *Annona squamosa* Linn. (custard apple), and also of some other species of *Annona*, is commonly eaten for its sweet and aromatic pulp. The leaves of this plant are slightly scented, and its seeds possess poisonous and insecticidal properties. The fruit of *Miliusa velutina* Hook. *f.* & Thoms., found wild in India, is edible. *Polyalthia longifolia* Benth. & Hook. *f. ex* Hook. *f.* (Indian fir, mast tree) is an evergreen avenue tree grown throughout the hotter parts of India; its leaves are somewhat aromatic. *Polyalthia fragrans* Benth. & Hook. *f. ex* Hook. *f.* of the evergreen forests of S. Kanara, Annamalais, and Travancore bears fragrant flowers. The roots of *Uvaria narum* Wall. of W. Ghats yield a sweet-scented greenish oil; its bruised leaves are said to smell like cinnamon (Watt.). According to Gamble (1922. *Manual of Indian Timbers*: 20), " the bark, especially of the root, the flowers and the fruit " of *Xylopia parvifolia* Hook. *f.* & Thoms. of Travancore " are all very sweet-scented and aromatic, and are chewed with betel ". The leaves of *Saccopetalum tomentosum* Hook. *f.* & Thoms. of Nepal, the United Provinces, Bihar, and W. and S. India possess a faint cinnamon-like odour.

Some species of *Artabotrys*, a genus of scandent shrubs, have fragrant flowers; of these *A. uncinatus* (Lam.) Merr. (*A. odoratissimus* R. Br.) is indigenous to S. India, and is often cultivated for its strong-scented flowers which are at first green and later yellow. The odour of the flowers resembles closely that of ylang-ylang. This plant presents an ornamental appearance when it bears copious, small, globose, pear-like, odorous fruits. *A. suaveolens* (Blume) is another tall climber of Assam and Bengal having creamy white, fragrant flowers. Its seeds and leaves are also odoriferous. No essential oil has been distilled from these or any other species of *Artabotrys*. *Unona praecox* Hook. *f.* & Thoms. of Assam has sweet-scented light-green flowers and *U. desmos* Dun. from the same area bears odorous, yellow flowers; the former is a tree while the latter is a straggling or climbing shrub. The dull-yellow flowers of *Sageraea laurina* Dalz. (*Bocagea dalzellii* Hook. *f.* & Thoms.) are sweet-scented, and the leaves when bruised give resinous, mango-like smell. Three Indian species from Bengal and Assam of *Melodorum*, a genus of climbing shrubs, have delightfully fragrant flowers; these are *M. verrucosum* Hook. *f.* & Thoms., *M. polyanthum* Hook. *f.* & Thoms., and *M. rubiginosum* (DC.) Hook. *f.* & Thoms. No essential oil from any of the above, except from *Cananga odorata*, has been isolated.

Members of this family which have been examined possess in their oils the following constituents: cymene and β-phellandrene and camphene in the seeds of the African plant *Monodora grandiflora* Benth.; *l*-limonene, β-phellandrene and cineole in the seeds (owere seeds) of the foreign *Monodora myristica* Dun.; and cadinene, geraniol, *d*-*l*-pinene, nerol, farnesol, cineole, and methyl anthranilate in *Cananga odorata* (Lam.) Hook. *f.* & Thoms. flowers (ylang-ylang oil and/or cananga oil).

CANANGA Rumph. *ex* Hook. *f.* & Thoms.

(From the Malayan name *kenanga*.)

This genus comprises 3 tropical species. The flowers of *C. odorata* (Lam.) Hook. *f.* & Thoms. (and possibly another species *C. latifolia* (Finet & Gagnep.) are the source of the famous and most important perfume ylang-ylang and also of the widely used cananga oil. *C. odorata* is cultivated in Indian gardens and is described below in detail.

Cananga odorata (Lam.) Hook. *f.* & Thoms.

Fl. Brit. Ind., **1**, 56.

(Cananga, Ilang-ilang, Ylang-ylang*)

A native of Burma, Java and the Philippines, this fast-growing tree, which may grow to a height of 120 ft. with a long clear bole, is occasionally planted in gardens throughout India on account of its sweet-scented flowers. These flowers, which have an exceedingly delicate and evanescent fragrance, are about 3 inches long, drooping, and are usually arranged in threes. When they begin to expand they are green and scentless. The scent develops as they grow larger, and turn yellowish to yellow. They are the source of the most important and famous perfume ylang-ylang, and also of the cheaper cananga oil. A volatile oil can also be distilled from the leaves, but it has little commercial value. Large plantations for the distillation of ylang-ylang and cananga oils exist in the Philippines, Java, and the French possessions in the Indian Ocean, Réunion, Nossi-Bé, the Comoro Islands, and Madagascar. This plant was first introduced into India in 1797 and, although the climate is suitable for its cultivation, no attempt appears to have been made for its large-scale plantation and extraction of the oils.

The tree in its natural habitat flourishes in damp localities. It delights in light, or even " stony " soils. It is usually raised from its small seeds which weigh 500 to 600 to an ounce. The seeds should be grown in lots of twos or threes, each group being 15 to 20 feet apart, where the trees are to grow. The seedling soon develops a taproot and, therefore, does not transplant well. A few seeds may be sown in pots or in baskets to replace or supply any that may fail in the field. If more than one seed germinates at each spot, the most vigorous one should be allowed to grow; the others should be discarded (Poucher; Reed, 1936. *Perfum. essent Oil Rec.*, **27**: 211). Reed (*loc. cit.*) considers it advisable to grow other plants—so-called " covering plants "—between the single, little cananga plants, the leaves of the former shading the ground from the strong rays of the sun, and keeping it moist. According to him, *Carica papaya* Linn. has been found to be very useful for the purpose, and, in

* Ylang-ylang in Philippines means 'flower of flowers', also something which flutters; it refers to the flowers which hang down loosely and are readily moved by the wind.

Fig. 5.—*Artabotrys uncinatus* (Lam.) Merr.

addition, is the source of papain, an albumin-splitting ferment.

The tree has a brittle and fragile trunk, and consequently it is very hazardous to climb it for the collection of flowers. Various devices are, therefore, adopted in different countries to overcome this difficulty. According to Hischmann (1936. *Perfum. essent. Oil Rec.*, **27**: 385), the tree is allowed to grow to its full height of 120 ft. in Java, and a thick, slotted bamboo tube is firmly fastened to its brittle and fragile trunk. This bamboo acts as an ingenious, cheap, permanent ladder and the flower gatherer uses the bamboo instead of the trunk for climbing up the tree. For plucking the flowers from the extraordinary fragile and brittle branches and twigs, the gatherer uses another ingenious device. This consists of a long bamboo at the end of which is fixed a strange little knife. This knife is made from the bone of buffalo and is so fashioned that by pulling with one half or pushing with the other the flowers can be broken off. The flowers are ultimately picked off from the ground. At some places (Poucher) the tree attains a height of about 7 feet after three years, and at this stage terminal buds are removed. By repeatedly topping the trees the branches spread horizontally and collection of flowers becomes easier. In this way the difficulty and risk of climbing the brittle branches for plucking flowers are avoided. According to Reed (*loc. cit.*), the trees reach a height of about 20 feet in the third year in Samoa. He suggests topping the tree at this height. In the French colonies, according to Trabaud (1937. *Perfum. essent. Oil Rec.*, **28**: 406), the upward growth of the trees is restricted by bending the branches; this gives the ylang-ylang plantations the appearance of countless crosses.

The tree starts flowering when only $1\frac{1}{2}$ to 2 years old. In the French colonies the

Fig. 6.—*Cananga odorata* (Lam.) Hook. *f.* & Thoms.

flowers can be collected throughout the year, but their greatest yield is from November to March. In Manila the trees blossom all the year round, but the best flowers are generally plucked during May and June. When the flower buds open, they have little or no fragrance. At this stage the petals are green and covered with white hair. As they mature the green colour diminishes and the hair disappear. After two or three weeks it is first of a pale colour and then becomes yellow, emitting a strong and agreeable fragrance. Those yellow flowers, having a red tinge in the centre, which are withering, are plucked; this being the proper stage of maturity. They are harvested at or about the dawn, during warm and sunny weather. This is done because the scent in the flowers is said to dissipate largely by the heat during day-time and is strongest in the early morning. According to Trabaud (*loc. cit.*), the flowers must be gathered with care, avoiding any crushing or bruising, and transferred at once to the stills. If they are bruised or blackened, there will be a diminution in the yield of oil and an impairment of quality. According to Reed (*loc. cit.*), however, the flowers after gathering will keep in good condition for distillation purposes over several days when in shade.

Very wide variation of the yield of flowers and of oil has been recorded. Burkill (1935. *Dict. Econom. Prod. Malay Peninsula*, **1**: 423) mentions that a four-year old tree may give 10 to 11 lbs. of flowers per annum; that aged ten years, 20 to 24 lbs., while mature trees have been recorded to yield about 130 lbs. In the French colonies, 11 to 22 lbs. of flowers are stated to be obtainable from a single tree, according to its age and richness of soil (Trabaud, *loc. cit.*). Finnemore records 80 lbs. per tree per annum. Reed (*loc. cit.*), however, obtained 200 lbs. of

flowers per tree in the sixth year, yielding on distillation 14 ozs. of essential oil; this means a yield of 0.44 per cent. of the oil on fresh flowers. Others have recorded a yield of up to 2.5 per cent. on fresh flowers.

The flowers from wild trees are stated to be almost odourless. Commercial oils are, therefore, exclusively distilled from cultivated trees. It is, however, well known that flowers grown in certain localities possess better aroma than in others. The essential oil from Manila is considered to be the best, while that from Java is of a lower quality. Hischmann (*loc. cit.*) simultaneously planted seeds of ylang-ylang obtained from Manila and seeds of cananga from Bantam (in the north-west of Java). The trees from Bantam seed had, under the same conditions, attained an enormous size, while those from Manila seed reached half the size. The leaves and the seeds, too, of Manila seed were smaller than those of the Bantam cananga. There was also a big difference in the fragrance of the flowers. How far the physiological varieties or the climatic and edaphic conditions are responsible for the wide differences in the growth of the plants, the yield of flowers and oil, and in the quality of fragrance produced from different localities, is not so far known, but great differences in the quality of oil are undoubtedly produced during the process of distillation.

As stated above, the flowers are said to contain up to 2.5 per cent. of the essential oil on weight of fresh flowers, but if all of this is extracted the oil obtained is of a poor quality. According to some only 1 lb. of the finest oil is obtainable from 350 to 400 lbs. of flowers. When this has been distilled, the rest is collected in a separate receiver. The first distillate is called the ylang-ylang oil, and consists principally of the more readily volatile oxygenated and ester constituents and of traces of terpenes; these are the bearers of fragrance. The second distillate, which is inferior, is known as the cananga oil, and consists largely of sesquiterpenes. According to Trabaud (*loc. cit.*), the best oil is that which is recovered at the commencement of distillation, and represents about 50 to 60 per cent. of the total quantity of oil recovered. In the French colonies the ylang-ylang oils are classified into four categories, viz., *Extra*, *First*, *Second*, and *Third*. The best quality of oil is the *Extra*, which has the highest specific gravity corresponding to the highest ester content. It is also the one which has the finest odour. Trabaud gives the following constants of the various grades of the ylang-ylang oils (*see* table below).

Best results are obtained if the flowers are distilled as soon as they are plucked. Slow distillation with steam from fresh water gives better results than the water which has been condensed from previous distillations, since the latter contains acetic acid and probably formic acid which tend to decompose the esters present in the oil. Only badly conducted factories immerse the flowers in water. A still of 1 hectolitre capacity containing 15 kilos of flowers yields 150 gms. of oil in nine hours by steam distillation. This works out at 1 per cent. According to some the oil obtained during the first two hours is the best, while that produced by continuing the distillation after that is less fine. The line demarcating the ylang-ylang and cananga oil is, therefore, arbitrary.

Both the ylang-ylang and cananga oils are sensitive to light and air, and must be kept in well-filled, dark bottles with airtight corks (Atkins, 1935. *Perfum. essent. Oil Rec.*, **26**: 253).

The tables on the next page give information on ylang-ylang and cananga oils of various origins:—

Glichitch & Naves (1932. *Parfums de Fr.*, **10**: 7–13, 36–41) have carried out considerable researches on the composition of ylang-ylang. According to them the following constituents are present in the oil: Alcohols

	Extra	First	Second	Third	Total
Specific gravity at 15° C.	0.9686	0.9556	0.9396	0.9191	0.9406
Optical rotation	—31°	—33°	—54°	—61°	—48°
Acid value	3.9	3.9	3.9	3.0	2.25
Esters, per cent. (as acetate of $C_{10}H_{18}O$)	55.5	50.3	37.3	21.0	37.4
Solubility in:					
Alcohol 90%	1:0.5 then insoluble	1:0.5	insoluble	insoluble	insoluble
Alcohol 95%	1:0.5	1:0.5 then insoluble	1:0.5	1:1	1:0.5

Ylang-ylang and cananga oils—constants

Source	Specific gravity	Refractive index	Optical rotation	Ester value	Acid value	Solubility
Commercial ylang-ylang oil[1]	0.911 to 0.958 at 30° C.	1.4747 to 1.4940 at 30° C.	—27° to —49.7°	90 to 138	—	0.5 to 2 vols. of 90% alcohol
Commercial cananga oil[1]	0.896 to 0.942 at 30° C.	1.4788 to 1.5082 at 30° C.	—27° to —87°	42 to 94	—	——
Manila[2]	0.9396 to 0.9659	1.4957 to 1.5070	—25° to —51°	89 to 158	—	Insoluble to .1 in 1 of 80% alcohol
Bourbon (fine quality)[2]	0.9595 at 15° C.	1.4922 at 25° C.	—23°	74.6 (as linalyl-benzoate)	—	1 in 1 of 80% alcohol (opalescent on dilution)
Samoa[3]	0.940 at 15° C.	1.4863 at 20° C.	—8.10°	89.25 (31.2% esters)	2.80	2 vols. of 70% alcohol (turbid above 8 vols.) soluble in all proportions of 80% alcohol
New Zealand[4]						
Fraction I	0.9441 at 15° C.	1.4929 at 19° C.	—8.26° (?)	96. 1 (after acetyn. 179.8)	1.8	2 or more parts of 70% alcohol; ½ vol. of 80% alcohol.
Fraction II (collected 4 hrs. after I)	0.9499 at 20° C.	1.5002	—5.50° (?)	96.3 (after acetyn. 226.1)	—	1.5 vol. and more of 70%; 0.75 and more of 80% alcohol
French Islands in Indian Ocean[5]						
1. Terpeneless oil	0.970 to 0.997 at 15° C.	1.4985 to 1.5085	—12° to —18°	—	—	1 or more parts of 80% alcohol
2. Extracted oil	1.024 to 1.0317 at 15° C.	1.5200 at 20° C.	—	148.4 to 177.45	10.08 to 17.68	75% of the oil soluble in 95% alcohol

Ylang-ylang and cananga oils—constituents

Source	Constituents
Commercial ylang-ylang oil[1] Commercial cananga oil[1]	*p*-cresol methyl ether, *l*-linalool, geraniol, eugenol, *iso*eugenol (the last three perhaps as esters), benzyl alcohol, esters, formates, acetates (as benzyl), valerates (as benzyl and methyl), salicylates (as benzyl and methyl). Sesquiterpenes are absent in extracted oil.
Manila[2] Bourbon (fine quality)[2]	*p*-cresol, *l*-linalool, geraniol, methyl esters, benzyl alcohol, eugenol, *iso*eugenol, methyl eugenol, formates, acetates, valerates, benzoates and salicylates, particularly benzyl acetate and benzoate, methyl and benzyl salicylates, and sesquiterpenes.
Samoa[3]	This resembles the Philippine oil rather than Java oil of cananga.
French Islands in Indian Ocean[5]	
1. Terpeneless oil 2. Extracted oil	Sesquiterpenes absent in the extracted oil, phenols 4 to 10%.

References

1. Fourman, 1936. *Amer. Perfum.*, **31** (6): 59–60.
2. Atkins, 1935. *Perfum. essent. Oil Rec.*, **26**: 251–53.
3. ————1932. *Parfums de Fr.*, **10**: 146.
4. Hosking, 1933. *Perfum. essent. Oil Rec.*, **24**: 2.
5. Glichitch & Naves, 1932. *Chim. et Industr.*, Mar., Spl. No.: 556–62.

and esters 52 to 64 per cent. (methyl benzoate, and the following in both free and combined states: *l*-linalool, ∝-terpineol, benzyl alcohol, phenethyl alcohol, geraniol, nerol, farnesol, nerolidol, *l*-cadinol, a monocyclic sesquiterpene alcohol m. p. 138°); sesquiterpenes 33 to 38 per cent. (a bicyclic slightly *l*-rotatory sesquiterpene, *d*-caryophyllene, an aliphatic sesquiterpene, a sesquiterpene yielding cadinene dihydrochloride) phenols and phenol esters 3 per cent. (*p*-cresol, methyl ester of *p*-cresol, a phenol of m. p. 116° to 118°, eugenol, *iso*eugenol, methyl salicylate, benzyl salicylate (?), higher phenols); terpenes 0.3 to 0.6 per cent. (*d*-∝-pinene); aldehydes and ketones 0.1 to 0.2 per cent., etc.

Cananga oil obtained from the leaves has no commercial value in perfumery. According to Koolhaas and Rowaan (1937. *Indische Mercuur*, Aug. 11; *vide* Schimmel & Co., 1938. *Ann. Rep.*, p. 12), who distilled Java leaves, it has a yellow to bright yellow colour, and has the following constants: sp. gr. 15° 0.908 to 0.925, [∝] —15° to —40°, $n^{20°}$ 1.495 to 1.506, soluble in 1 to 3 volumes of 95 per cent. alcohol, opalescence to cloudiness on further addition, acid val. 0.5 to 2, ester val. 15 to 35, residue after distilling 5 per cent. at the highest.

The cananga-oil industry in Java has been expanding. In 1933 it exported 25,903 lbs. but this gradually increased to 41,584 lbs. in 1936. In 1937, the export of the cananga oil from Java amounted to 50,133 lbs. which constituted a record for the last 50 years (Schimmel & Co., 1938. *Ann. Rep.*, p. 11).

According to Trabaud (1937. *Perfum. essent. Oil Rec.*, **28**: 406), the distillation of ylang-ylang oil was originally a monopoly

of the Philippine Islands, with Manila as the centre of production. In consequence of the acute competition from the French possessions in the Indian Ocean, Réunion, Nossi-Bé, the Comoro Islands, and Madagascar, the industry in the Philippines gradually declined, until it is now practically insignificant. The export of ylang-ylang from Manila fell from 1,364 lbs. in 1929 to 1,170 lbs. in 1930, and amounted to no more than 22 lbs. for the first fix months of 1931.

As against this, the three French islands exported about 77,000 lbs. of ylang-ylang oil in 1930, which represents approximately the world consumption. Nossi-Bé alone supplies three-fourths of the total quantity of oil distilled in the French colonies. Thus, in spite of the high esteem in which Manila ylang-ylang was held at one time, it has been almost completely superseded by the oils produced in the French colonies. The ylang-ylang oils distilled in the Philippines and in the islands of the Indian Ocean have, according to Trabaud, the same characteristics.

It is said that cananga oil is sometimes adulterated with coconut oil. This may be detected by the fact that its saponification value is much increased, and its solubility in 95 per cent. alcohol is destroyed, drops of oil separating out at the bottom of the container from the turbid mixture on standing.

Ylang-ylang oil is the queen of perfumes. It is much used in high-class perfumery, and blends well with bois de rose oil, amyl salicylate, phenylethyl cinnamate, and vetivert oil as the basis of perfumes for face powder. It is largely employed as a modifier in artificial violets and lilacs. It is often used in the fixation of floral odours in general, and with excellent results in the fixation of violet along with orris root and sandalwood. It may be fixed with any of the crystalline synthetics or plant gums and resins, and will supply the dominating odour note in many Oriental perfumes. A number of delightful bouquets are prepared by using ylang-ylang in conjunction with neroli, jasmin, and iris. It is used in proportion of 2 to 10 per cent. in a long series of floral odours, so that it well deserves the name "flower of flowers." Artificial ylang-ylang oil can also be prepared, on the basis of its known composition, at the price at which the cheaper cananga oil is produced, with many times more its strength. Modern good-quality perfumes, however, almost invariably contain only the finest ylang-ylang, even though their cost is about twice as much as that of the ordinary Manila quality.

Cananga oil is used in cheap perfumery and in perfuming soaps.

Although the tree is occasionally planted in gardens throughout India, it is surprising that no attempts have, hitherto, been made to raise large-scale plantations for the extraction of the valuable oil from its flowers. An establishment of this industry has every prospect of a success.

Family IV—MENISPERMACEAE

(Moonseed Family)

This family comprises climbing or twining, rarely erect shrubs. Many species contain poisonous, narcotic and bitter principles, especially in their fruits and seeds, but only a few are used in medicine. From the point of view of essential oils the family is of little significance. The small flowers of *Anamirta cocculus* (Linn.) Wight & Arn. (Cocculus indicus of pharmacy, poison berry, fish killer), a large climber of Western Ghats, Orissa, Oudh, Eastern Bengal and Assam, are scented, but no essential oil has been distilled from these. Its berries are, however, an article of commerce, and contain picrotoxin, a highly poisonous substance; they are used for poisoning fish and crows and in the preparation of an insecticidal ointment. *Tinospora cordifolia* (DC.) Miers (*gilo, gulancha*) of tropical India is largely used in Hindu medicine as an alterative, tonic, and aphrodisiac. The leaves of *Cocculus hirsutus* (Linn.) Diels (C. *villosus* DC.), a slender climber of tropical and subtropical India, when triturated with water swells into a thick mucilage; the juice of its ripe fruit makes a durable bluish-purple ink. The roots of *Jateorhiza palmata* (Lam.) Miers (calumba) and *Cissampelos pareira* Linn. (false pereira brava, *akanadi*) are aromatic. *J. palmata* is a large scandent undershrub

of S.-E. Africa and is cultivated in some parts of India. The dried roots of this plant, which are used as a simple bitter in Western medicine, contain, besides the alkaloids columbine, jatrorrhizine, etc., and bitter principles, a small quantity (0.005 per cent.) of an essential oil (Haensel, 1904. *Apothekerztg., Berl.*, **19**: 46). No essential oil has been extracted from the aromatic roots of *Cissampelos pareira*, a large climber of tropical and subtropical India, but the Brazilian C. *ovalifolia* DC. is reported to contain 0.08 to 0.135 per cent. of an oil in the roots. The oil is pale yellow and viscous having sp. gr. 25° 1.055 and $n^{25°}$ 1.4528. About 20 per cent. of the oil is thymol (Freise, 1931. *Perfum. essent. Oil Rec.* **22**: 370). This oil is said to be used as an anthelmintic, and does not produce the ugly symptoms which sometimes appear after the use of chenopodium oil from *Chenopodium ambrosioides* Linn., var. *anthelminticum* (Linn.) Gray, a foreign plant.

Family V—NYMPHAEACEAE

(Water-lily or Lotus Family)

This is a family of aquatic herbs, the water lilies, most of which are prized for their large, ornamental flowers. Many species have been cultivated, from very remote times, both as food plants and on account of the beauty of their flowers which are usually odorous. The seeds are usually rich, in starch and are eaten; in some cases such as in Chinese lotus (*Nymphaea tetragona* Georgi) which is also found in the Himalayas, they are also rich in phosphorus. The roots and rhizomes of a number of species are eaten, and are rich in starch. The giant water lily (*Victoria regia* Lindl.) of Amazon is a most magnificent plant with immense, rose-white, delightfully fragrant flowers 12 to 18 inches across and with large leaves up to 4 feet in diameter. This plant has been introduced into the Royal Botanic Garden, Sibpur, and Eden Garden, Calcutta, and is an attraction when in flower. The slightly odorous, white or rose-coloured, 4 to 10 inches across flowers of the sacred lotus or *kanwal* (*Nelumbo nucifera* Gaertn., syn. *Nelumbium speciosum* Willd.) are sacred to the Hindus; they are also used in the preparation of a syrup for coughs, menorrhagia, and dysentery. The petals are made into a cosmetic application for the face in China. In Indo-China the stamens are used for flavouring tea; they are also used as a cosmetic in China. The seeds of this plant are valued in indigenous medicine as a diuretic and as a refrigerant. An alkaloid, nelumbine, has been isolated from its leaves. The blue, white, rose or purple flowers of lotus (*Nymphaea stellata* Willd.) are slightly odorous, and its roots and seeds are frequently eaten. The farinaceous roasted seeds of *Euryale ferox* Salisb. (*makhana*) of sweet-water lakes of Bengal, Assam, Oudh and Kashmir are extensively eaten all over India, and are specially valued as an easily digestible food for invalids.

Lotus is an ancient Egyptian name for the water lily growing in the Nile; this was not worshipped but was an emblem. Thus the blue water-lily (*Nymphaea caerulea* Savign.) and, to a lesser extent, the Egyptian water-lily (*N. lotus* Linn.*) are figured in Egyptian tombs and the flowers are found in funeral wreaths of nearly 2,000 B.C. (Conard, 1905. *Waterlilies*, p. 6). These appear to be the plants of Egypt before *Nelumbo nucifera* Gaertn., the sacred lotus, was introduced as a result of Persian contact about 708 B.C. In India the sacred lotus occurs in ancient frescoes, and is the *padma mani* of the Buddhists. It is believed that Brahma and Buddha (the supreme intelligence) were born of this heavenly lotus.

The so-called lotus perfumes in the market are not extracted from any of the above or allied plants which have been appreciated since antiquity, but are all of synthetic origin. According to Parry, "the so-called lotus perfume to-day is any heavy 'Oriental' odour compounded, according to the taste of the individual, from such natural perfumes as patchouli, benzoin, storax, etc., with the assistance of artificial perfumes, such as phenyl-ethyl alcohol, cinnamic alcohol and similar bodies." The lotus perfumes are always creations of phantasy, and are frequently of the heavy lily-ylang type.

* Contrary to the Flora of British India and many other Indian books, this species is not found in India. The plant referred to in these books as *N. lotus* Linn. is *N. rubra* Roxb. *ex* Salisb.

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