

Journal of Scientific & Industrial Research



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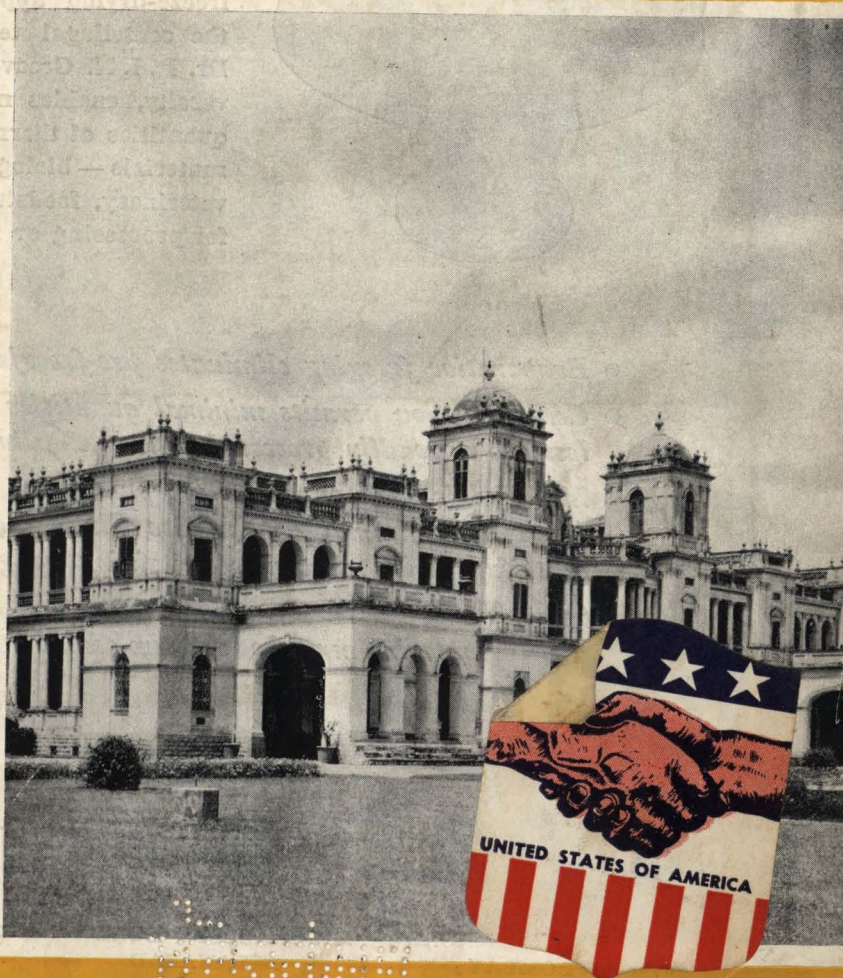
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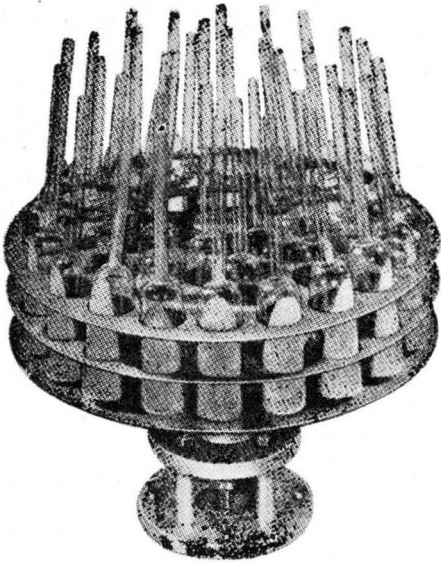
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COVER PICTURE

The cover shows the picturesque Cheluvamba Mansion in Mysore, which houses the Central Food Technological Research Institute of the Council of Scientific & Industrial Research. The Mansion was formally taken over by Pandit Jawaharlal Nehru on behalf of the Government of India on December 29, 1948.

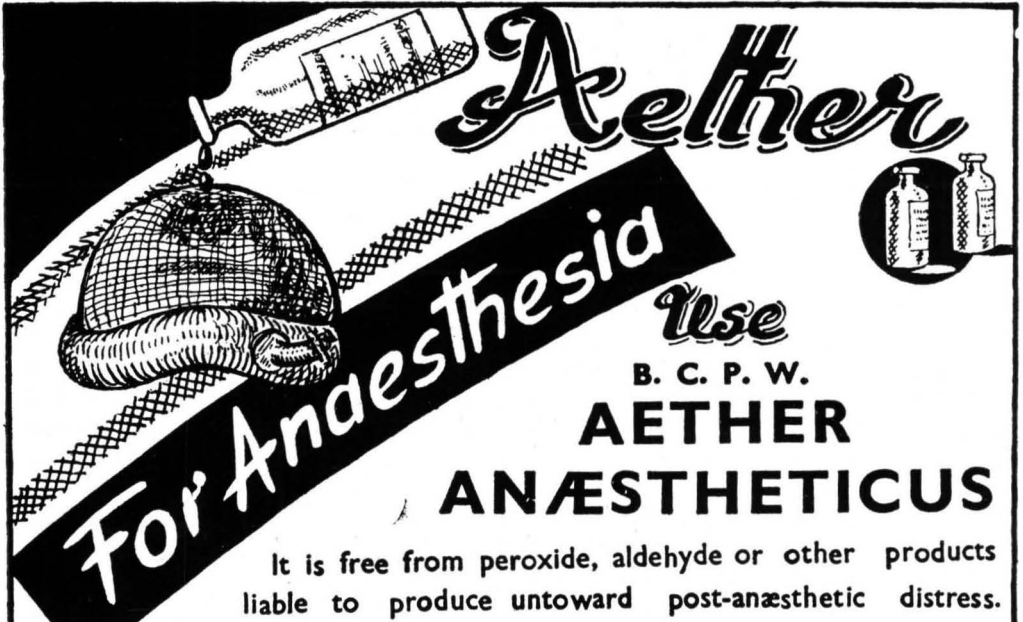
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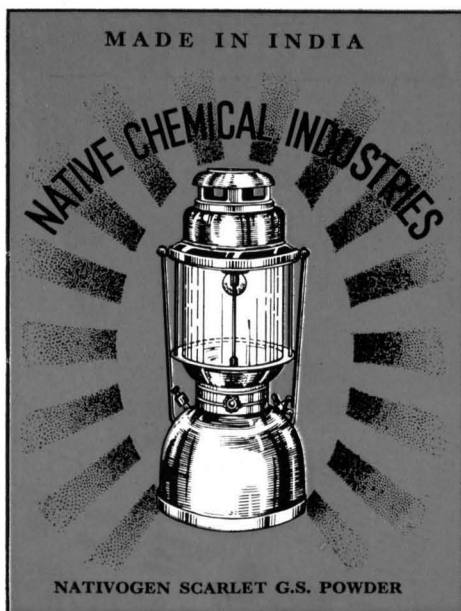
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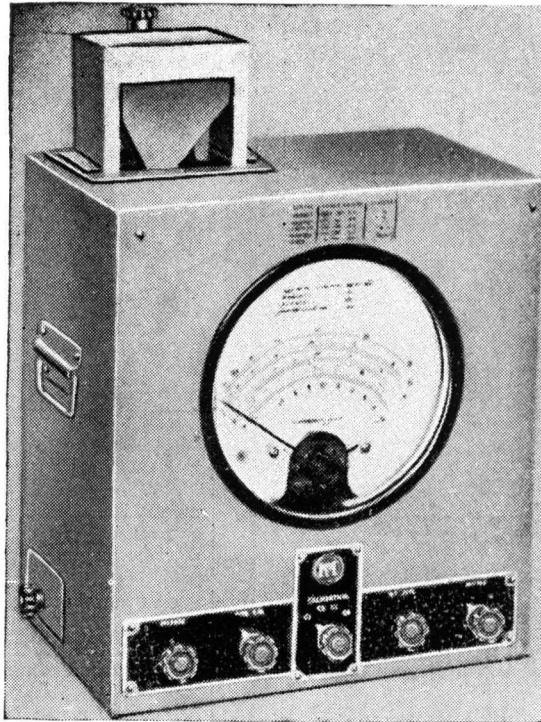
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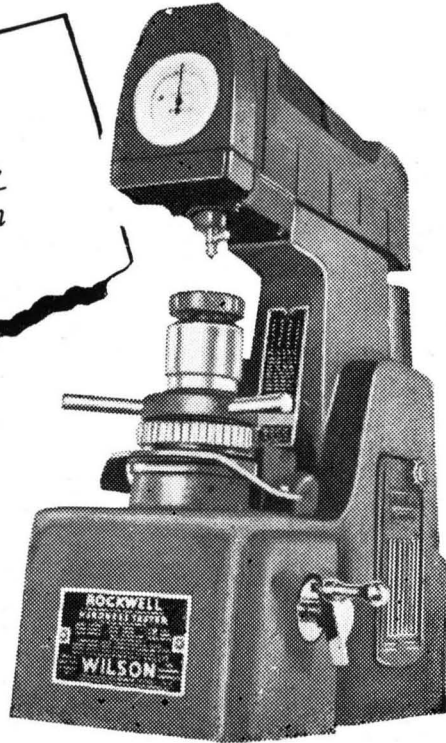
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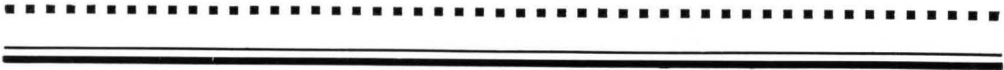
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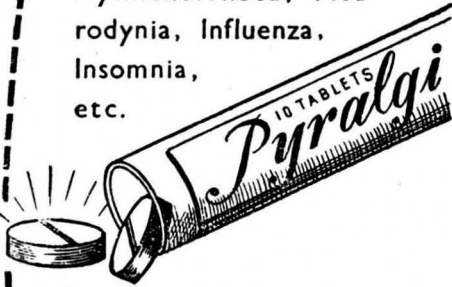


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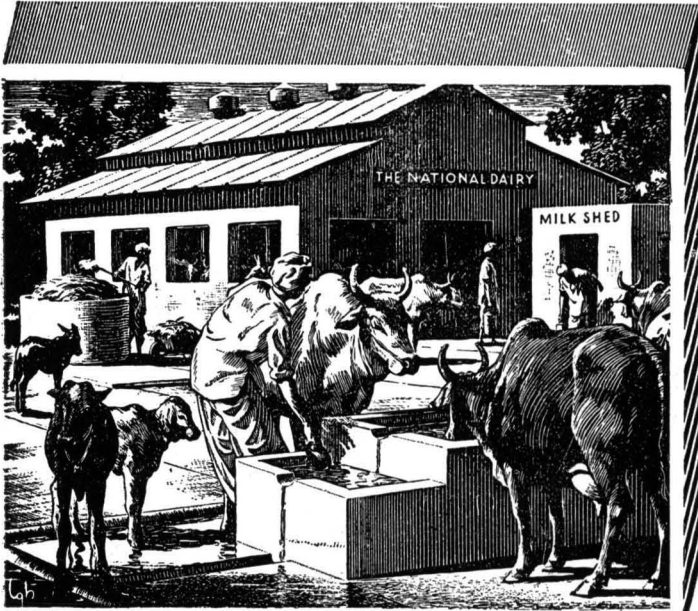
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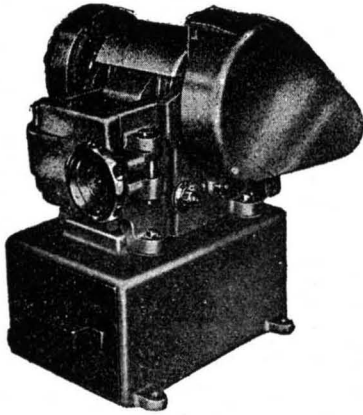
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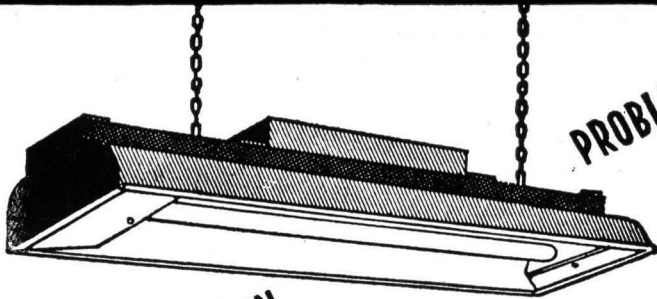
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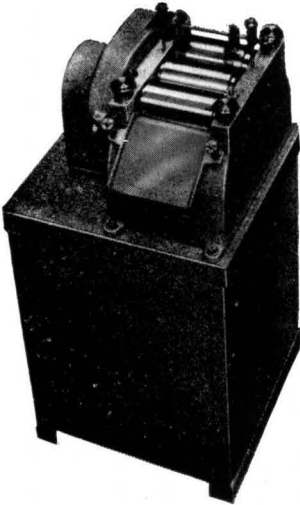
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Study of the History of Science

THE decision to form a Society for the promotion of study and research in History of Science in India, reached at a meeting of Indian scientists at Allahabad on January 3, is to be welcomed. Such an organization co-operating with the International Union of History of Science would give a much-needed fillip to the promotion of knowledge on a subject of the utmost interest and importance to this country.

It must be admitted that the attention given so far to the study of history of sciences in India is very meagre, but then the recognition of history of science as an independent discipline and the realization of its importance as a subject for study and research are comparatively recent. It is true that both history and science are ancient, but their combination, "the application of the well-known methods of history to the well-known facts of science" is relatively new. It is only since the close of World War I that the subject gained a place in the curriculum of studies in American universities, and at a somewhat later date in British universities. The first journal devoted to history of science—the *Isis*, was started in Belgium in 1913, and the History of Science Society, an international organization with its centre in America, was founded later. In India, while individual scientists have made valuable contributions to this subject, its study at the university level was initiated only 5 years ago in the Delhi University, thanks to the foresight of the members of the Faculty of Science who were seized of the importance of its study, particularly in India, which shares with Egypt and early Asian civilizations the distinction of being the ancient home of science.

It is of interest to examine briefly the value of this comparatively new discipline in order to appreciate the significance of the decision taken at Allahabad to establish the new Society. History of science, as we

have stated before, is both history and science. Science is systematized positive knowledge—or what has been taken as such in different ages and in different places. In the words of Dr. George Sarton*, the accumulation and systematization of positive knowledge are the only human activities which are truly cumulative and progressive, and history of science is the only history which can illustrate the progress of mankind. In fact, according to Sarton, *progress has no meaning in other fields than in the field of science*. The *understanding* of this progress is greatly assisted if we penetrate into its genesis and evolution. "Knowledge is not something dead and static, but something fluid, alive and moving. The latest results are like the new fruits of a tree; the fruits serve our immediate practical purposes, but for all that it is the tree that matters. The scientist of philosophic mind is not interested so much in the latest results of science as he is in its eternal tendencies, in the living and exuberant and immortal tree. The fruits of today may be tempting enough, but they are not more precious, to his way of thinking, than those of yesterday or tomorrow." Early science was once alive, even as our own will soon be dead, and to understand the life of science we must observe it as it grows around us.

And why should there be so much emphasis on the *understanding* of science? Science represents the greatest triumph of the human mind. Its positive achievements are many, and it has provided the means to advance our material welfare. Even more important than its achievements are its methods and techniques. It is of fundamental importance that every man and woman should understand the methods and spirit of science and should be educated to consider everyday problems and social and

**The Study of the History of Science*, 1936, Harvard University Press, Cambridge, Massachusetts.

political controversies objectively and disinterestedly. It is this objective, disinterested struggle for the discovery of truth that forms the theme of history of science. The great men and women to whom we owe our heritage of knowledge and culture are the heroes of this history. Their biographies, which are of intense human interest and provide material for the study of man, fill its pages. They are the actors in the great and noble struggle for knowledge, and it is they that fashioned the tools which mankind employed in raising itself from one cultural level to another. The method of history is the method which leads to the understanding of science — the method which leads people to appreciate the tasks and social implications of science.

The promotion of the study of history of science is in effect the promotion of a wider understanding of science and scientific method, and it is for this reason that we welcome the inauguration of the Society. Many schemes have been formulated and implemented for the development of scientific research in this country. These are of the utmost value for the promotion of national welfare. But the

problem of educating the people at large to appreciate the objects and methods of science so that they may enthusiastically support scientific research and development has yet to be tackled. History is an instrument of public education, and we look upon the formation of the new Society as a landmark in the progress of science in the country. Professor Govind Behari Lal, Science Editor of the Hearst group of papers in the United States, during his recent visit to India, urged the need for a scientific movement in this country. "We have got to infuse the masses with the scientific spirit;" he said, "they should have a scientifically trained mind. In the past our conditions taught us to think in terms of politics. We have now to learn to think in terms of science." The scientific movement to which Professor Lal has referred has been, in our opinion, well and truly initiated by the formation of the Society of History of Science, and we have every confidence that the new Society would help in a wider understanding of the tasks of science and lead the people of this ancient land with its rich scientific traditions "to think in terms of science".

Central Food Technological Research Institute

THE Cheluvamba Mansion, a beautiful and spacious building situated on 160 acres of land in the capital city of Mysore, has been placed at the disposal of the Government of India for the location of the Central Food Technological Research Institute. The mansion was formally taken over by Pandit Jawaharlal Nehru on behalf of the Government of India on December 29 at a special function organized for this purpose and attended by a large gathering of scientists and prominent State officials.

The Cheluvamba Mansion is situated on elevated ground in close proximity to the Mysore Railway Station and commands an impressive view of the Chamundi Hill on one side and the main part of the city on the other. The mansion is a 2-storeyed building measuring 210' by 445'. There are over 100 halls and rooms covering a floor area of about 130,000 sq. ft. The halls are ideally suited for lecture halls, library, machine rooms and

workshops, while the rooms are spacious, well ventilated and can be readily converted into laboratories. The gardens and roads are well laid out. The surrounding ground is suitable for construction of additional laboratories and staff quarters. It is proposed to make immediate arrangements for converting a part of the mansion into laboratories and to start work in the summer of 1949.

The Food Technological Research Institute is one in the chain of eleven national institutions sponsored by the *Council of Scientific & Industrial Research*. The Institute will have divisions for research and investigation on storage and reclamation of food grains, composite and emergency foods, food engineering and dietetics, adulteration, etc. Steps would be taken to stimulate food industries in the country, and the Institute would collect food statistics and issue bulletins on food and food products for the information of the public.

Characteristics of the Ionosphere at Calcutta (November 1948)

S. S. BARAL, S. N. GHOSH, R. K. MITRA,
D. C. CHOUDHURY & (Miss) T. K. PAL

Wireless Laboratory, University College of Science, Calcutta

THE following are the ionospheric data for the month of November 1948. The observations were made at each hour of the day for 5 days a week.

Fig. 1 presents the mean hourly values of the virtual heights and critical frequencies of the F_2 layer and the critical frequency of the E layer in graphical form during the month of November 1948. Fig. 2 gives the predictions of maximum usable frequencies which can be used for different distances of transmissions during February 1949 by reflection at the F region over Calcutta. Table I gives the list of occasions when the E region was found to be abnormal and the corresponding penetration frequencies and heights. It is found that in this month the abnormal E ionization is most prominent during the early morning hours.

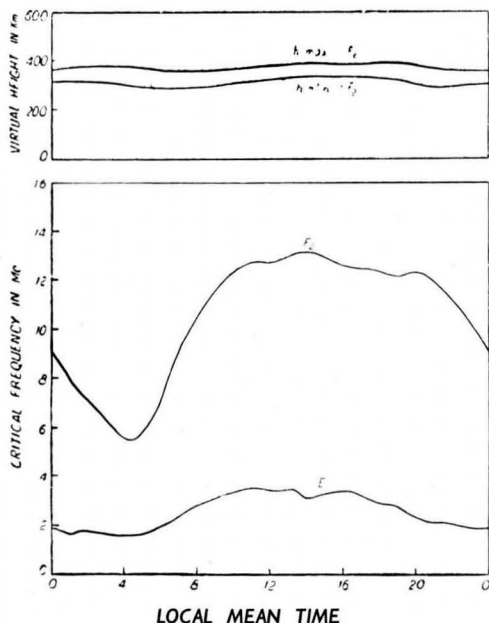
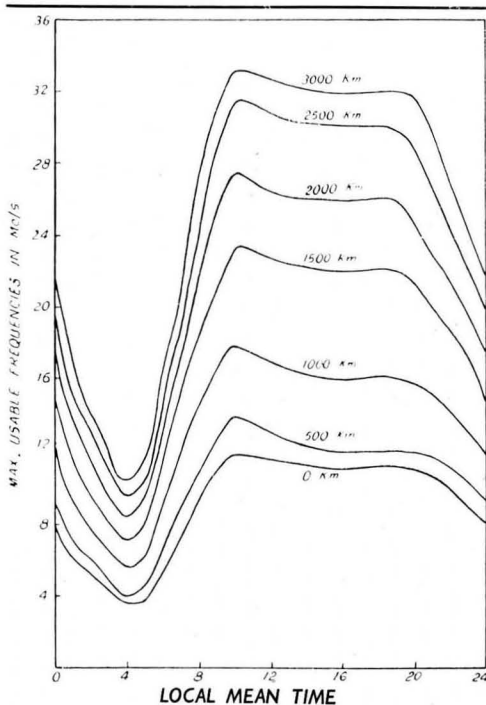


FIG. 1 — NOVEMBER 1948. 5 HR. 54 MIN. AHEAD OF G.M.T.

TABLE I

MONTH & YEAR	DATE	HOURS	$f_o E_s$	$h' E_s$
			Mc.	Km.
Nov. 1948	5	21.00	3.00	90
		22.00	2.00	90
		23.00	2.00	90
	6	00.00	2.00	90
		01.00	1.90	90
		02.00	2.00	90
	9	03.00	2.00	90
		01.00	1.80	90
		02.00	1.85	90
	23	02.00	2.40	90
		03.00	2.35	90
		04.00	2.10	90
	26	02.00	1.80	90
		03.00	2.00	90
		04.00	2.50	90
	27	22.00	2.50	105
		00.00	2.00	105
		02.00	2.50	90
	28	01.00	3.10	105
		02.00	3.35	105
03.00		3.50	90	
04.00		3.30	90	
		05.00	3.00	90



AT POINT OF REFLECTION
FIG. 2 — PREDICTED M.U.F. FOR TRANSMISSION VIA F_2 LAYER, FEBRUARY 1949.

Characteristics of Photoflash Lamps

MOHINDER PARKASH MURGAI

Department of Physics, Delhi University, Delhi

PHOTOFLASH lamps first appeared in the market in 1930. The bulb was filled with oxygen and contained a quantity of aluminium foil which was flashed by igniting a chemical covering a thin wire through which a current was passed¹. As the total duration of the flash was only a small fraction of a second, it was immediately accepted as a suitable source of illumination for indoor, instantaneous photography. The bulb was naturally a great improvement over the magnesium powder whose open firing often caused accidents, apart from the uncertainty of the flash itself^{2,3}. The photoflash lamp, on the other hand, provided a completely controlled source of illumination.

To begin with, a certain amount of judgement was necessary in taking a photograph. The shutter was opened just before the flash and closed immediately afterwards. This naturally entailed some practice before successful photographs could be taken, and to get over this difficulty "synchronizers" were introduced. These were small mechanisms which permitted simultaneous and automatic opening and closing of the shutter at the time of the peak intensity of the flash. This maximum intensity was standardized to occur after about 20 milliseconds of the switching on of the current in the filament. Under such conditions the total duration of the flash after reaching half peak intensity was slightly less than 10 milliseconds. As it was found difficult to synchronize the opening of the shutter with the flash during such a short interval, attempts were made to increase the duration of maximum brilliancy of the lamp. This was achieved by replacing the foil with shredded foil or filaments. The duration of the peak intensity was, in this way, doubled and led to an easier manipulation of the shutter⁴. Curves in Fig. 1 show the chief characteristics of the foil-filled and filament-filled lamps. It will be seen that both types reach the maximum peak intensity about the same time. But whereas the foil-filled lamp reaches a higher peak intensity than the filament-filled lamp, the

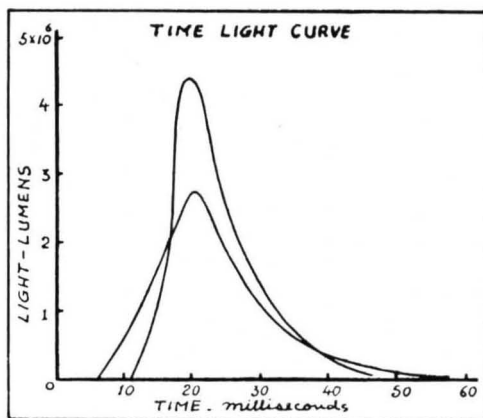


FIG. 1

duration of the flash is larger in the latter. Also the flash starts more quickly in a wire-filled lamp.

The suitability of the radiant energy emitted by the photoflash lamp for photographic purposes⁵ can be ascertained by a comparison of colour-temperatures (temperature for black body giving the same colour) of various sources (TABLE I). The photoflash lamp is the nearest approach to sunlight.

An interesting recent development of the flash bulb is the *GEC* (speed, midget) flash bulb. This does not contain any wire or foil-filling. The sole illuminant is an extra large dose of primer compound on the heating wire. The special advantage of this is the elimination of time lag.

The foil-filled lamps investigated by us were made in the laboratory, for the first time in India, with materials available here.

TABLE I

SOURCE	COLOUR TEMPERATURE °C.
Nernst filament	2,400
Tungsten temperature	2,780-3,000
Flash powder	3,800
Carbon arc	4,000
Photoflash lamp	5,000
Sun	5,400

Our studies have shown that the bulbs compare quite favourably with the imported ones.

Construction

The essential constituents of the lamp are: (a) hollow bulb of known capacity; (b) hair-thin filament connected to electrical leads; (c) primer compound coating for the filament; (d) aluminium foil-fillings; and (e) oxygen at suitable pressure.

The bulbs were supplied by *Kaycee & Co., Ltd.*, Lahore, and were those ordinarily used for lighting purposes. To avoid accidents, particularly while dealing with high-pressure oxygen flash lamps, it is desirable to give them an inner coating of transparent lacquer. This, however, was not necessary in the present work since the pressure of oxygen was always kept much below that of the atmosphere. The glass should be of uniform texture to minimize chances of cracking.

As regards the filament for coating the primer compound, nichrome was selected as the most suitable. It has high electrical resistance combined with a high melting point (1400°C.). Since only a few millimeters of the wire are employed, the gauge number should be so selected that even one or two volts from a cell could provide sufficient current to raise the temperature of the wire to a degree sufficient to cause the ignition of the primer compound. SWG No. 40 (resistance 94 ohms/meter) was used. Half a centimeter of this wire has a resistance slightly less than half an ohm. Since the fusing current is 1 amp., one to two volts should be enough to cause fusion.

Primer Compound—A mixture of sulphur, charcoal and nitre was used in the proportion 2:1:1. This was coated on the filament with a paste of shellac in methylated spirit. The mixture burns with a fountain effect, producing sparks and aids in the complete combustion of the foil contents of the bulb.

Aluminium Foil—The thickness of the foil in the imported bulbs is of the order of 0.00004 cm. The foils used in the present work varied in thickness from 0.000056 to 0.00012 cm. as measured by weighing foils of known areas. These foils were locally produced by hammering in gold-beaters skin and were found quite satisfactory.

Oxygen—The actual quantity of oxygen required depends upon the weight of the aluminium foil used. For complete combustion the bulbs are filled with dry oxygen at a pressure of about 30 cm. of mercury for 65 mg. of aluminium charge. Oxygen

was obtained from commercial suppliers and dried by storing over calcium chloride. The jar containing calcium chloride is first evacuated and then filled with oxygen at atmospheric pressure. It gets sufficiently dry after 24 hours. The reservoir is connected to the bulb and sufficient oxygen admitted to give the desired pressure as indicated by a mercury manometer.

Characteristics of the Lamp

The following characteristics of the bulb must be known: (a) total quantity of light in lumen-seconds; (b) maximum intensity of the radiation in lumens; (c) time from the application of the filament current to the start of the flash, in milliseconds; (d) Time from the application of the filament current to the peak intensity of the flash, in milliseconds; (e) total duration of the flash above a certain specified minimum intensity; and (f) spectral distribution of the flash light.

The bulbs are manufactured in different sizes. A determination of the characteristics of the bulb fixes the exact use to which a bulb of any particular size can be put to the best advantage⁵. For example, the total quantity of light of commercial bulbs manufactured by the *General Electric Company* and numbered 10, 20 and 75, are suitable for portrait photography, small groups and large groups respectively. (c), (d) and (e) characteristics are used to regulate the speed of the camera shutter in order to avail of the maximum light in the flash. Since the opening of the shutter is not instantaneous, the actual quantity of light across will vary with time and may be represented by a graph of the type shown in Fig. 2. The shutter opens fully only for a part of the time and, consequently, the shutter and the flash should be so synchronized that the flash reaches the peak at the point A, when the shutter is fully open.

The determination of the spectral distribution of the flash is useful for colour photography⁶. Slight variations in the distribution do not matter for ordinary photography, but as the distribution plays an important rôle in the colour photography, due consideration should be given to it.

Rotary Flashometer

For determining the characteristics mentioned above a flashometer is employed. Various forms of this have been used by previous workers⁷⁻⁹. The rotating flashometer

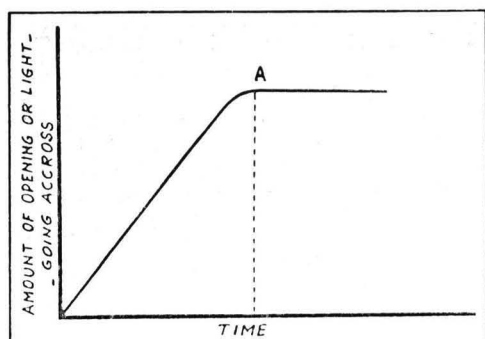


FIG. 2

used in the present experiments was designed and constructed in the laboratory and has proved completely satisfactory. This consists of a rotating drum on which a photographic film is wrapped. The light from the flash bulb, after passing through a slit, is made to fall on the film and traces out a band of graded intensity. Starting with low intensity it reaches a maximum and then again falls to zero. As the drum rotates at a previously determined speed, the total duration and time for which the lamp flashes at its peak value can be ascertained. Absolute intensity can be measured by comparing with a standard source. A special feature of the arrangement was the commutator by means of which it was possible to arrange the opening of the slit just before the closing of the electric circuit for the flash, and the closing of the slit automatically when the bulb ceased to glow. Details of the assembly are as follows.

Camera—This consists of two parts: a wooden box of special construction and a metallic drum capable of rotating round its axis, held inside the box. The box is 14" × 6" × 6" with about a dozen circular holes, each 0.25" diameter, in a line on one of its sides. Attached to this side of the box is a metallic cover which is worked by an electromagnet for opening and closing the holes, and which can be put in the front of any one of the openings. The drum is 4" in diameter and 12" long, and is positioned at the centre of the box by an iron rod running along the axis of the drum. A part of the rod projects outside the box and supports a pulley for a belt drive for rotation. The surface of the drum on which the photographic film is wrapped is about an inch away from the holes in front of the box. In order to get a sharp impression on the photographic record a small metallic cylinder with a sharp slit

attached to the side is inserted in each one of the small openings on the side of the box, and the slit brought as close to the drum surface as possible.

The electromagnetic arrangement for opening and closing the holes is shown in Fig. 3. E is the electromagnet which actuates the rod MN about the fulcrum L. H is the hole in the metallic strip. The hole normally remains closed, and opens only when the magnet is actuated. By a spring action the slit closes again as soon as the current is stopped.

Commutator—To operate the flashometer it is necessary to have some mechanical contrivance by which the following operations could be automatically carried out successively: Opening of the shutter at predetermined intervals, flashing the lamp and finally closing of the shutter. This was arranged by a commutator of special design shown in Fig. 4.

This consists of a cylinder 3" in diameter and 4" in length, partly brass and partly ebonite as indicated. A V-shaped spiral groove of 5 or 6 turns is cut over the whole length, the last turn being a continuous circular groove. The commutator is suitably supported and made to rotate by means of

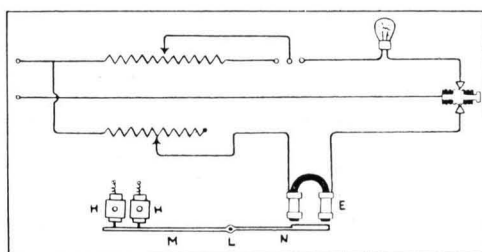


FIG. 3

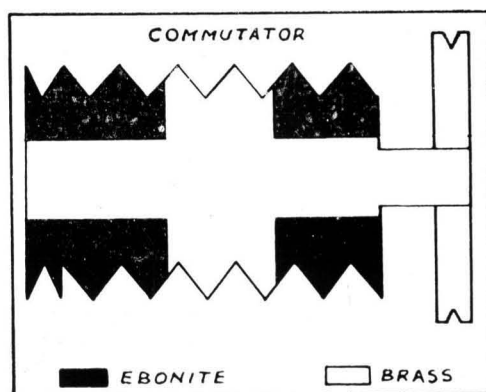


FIG. 4

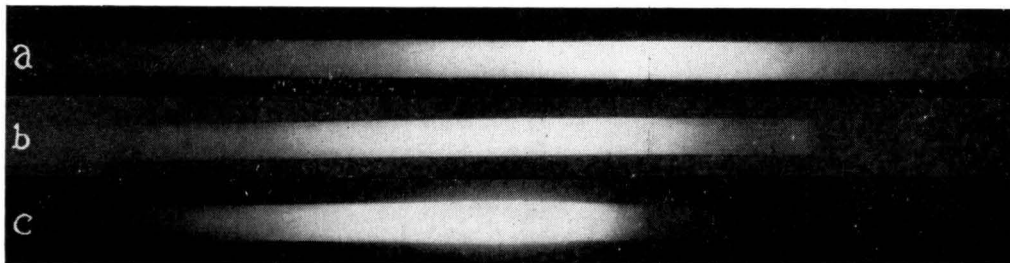


FIG. 5 — PHOTOFLASH TRACES : (a) OXYGEN, PRESSURE 25 CM. ; (b) OXYGEN, PRESSURE 30 CM., ALUMINIUM, 60 MG. ; (c) OXYGEN, PRESSURE 35 CM., ALUMINIUM, 60 MG.

a belt drive at a regulated speed. Two elastic metallic brushes press against the grooves and move laterally as the commutator is rotated. This lateral movement stops as soon as they reach the circular groove. As the brushes move in the spiral groove, one of the brushes leading the other by a fraction of a revolution, electrical connections are made by the metallic portions of the groove. The leading one opens the shutter by actuating a current in the electromagnet, and the other closes the circuit for flashing the lamp. The circuit is broken after one and a half revolutions as soon as the brushes come over the ebonite portion. The circuits are shown in Fig. 3.

Some of the photographic records made with different weights of aluminium foil at various pressures of oxygen are shown in Fig. 5. The total duration of the flash can be estimated from those with a fair degree of accuracy if the speed of the drum is known.

For the determination of the interval of time between the contact and the peak of the flash, a 2-volt torch-bulb is put in series with the flash bulb. The metallic brush used for operating the electromagnet was permanently connected to the metallic part of the commutator through a key. Also two slits are provided instead of one, one for the flash bulb and the other for the 2-volt bulb, both worked by the same electromagnet.

In starting the observations the motor was allowed to run for a time till it acquired a constant speed. The key was then closed and the brush allowed to fall on the commutator. Two flashes are traced out on the film, one through each slit. Assuming that the time required for lighting up the 2-volt bulb is negligibly small, it is easy to determine the interval between the contact

and the peak of the flash. Fig. 6 is a record of one of these observations.

Measurement of Light Intensity — For measuring the illuminating power a 500-watt lamp was selected for comparison. Traces on the film with this lamp at different distances were obtained and microphotographed along with that of the flash bulb. For cutting down light from the bulbs by a known fraction, screens for transmitting a definite fraction of the light were used. These screens were prepared by stretching metallic strips of about 2 mm. width at suitable distances across a frame and placing them between the bulb and the slit at the time of taking the trace. No special advantage is obtained by rotating the frame as the duration of the flash is too short.

Lumens & Lumen Seconds

The illuminating power of the flash lamp at its peak value is given by the relation

$$4\pi W \frac{D^2}{d^2} \times f \times \frac{100}{T}$$

where

W = wattage of the standard lamp whose intensity at a distance d (in feet) equals the intensity of the flash lamp placed at a distance D .

T = percentage of light transmitted through the screen.

f = conversion factor for expressing wattage in candle powers.

The photomicrogram gives the variation of the intensity of the flash bulb with time. For determining the total output of light in lumen seconds, a time-intensity curve is plotted for the flash bulb. The distances on the trace are convertible into time scale and the deflections of the microphotometer are expressible in terms of intensity; since the response of the microphotometer, as that of the photographing film, is not linearly

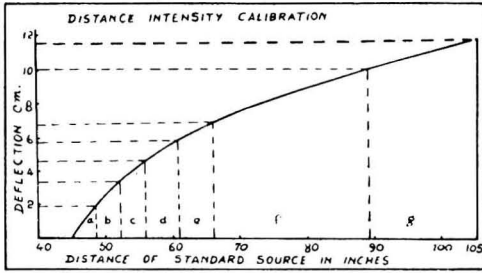


FIG. 6 — DEFLECTION OF THE MICROPHOTOMETER FOR THE STANDARD SOURCE TRACE.

related to the intensity, the curve is divided up into a number of smaller parts where this relation may be considered sensibly linear. The mean percentage of the intensity of light for each one of these parts is then calculated by first obtaining the point by extrapolation where the intensity may be considered 100 per cent and then applying the inverse square law for calculating the average intensity for various deflections. Conversion factors are obtained for time-axis and intensity-axis. The total area in the time-intensity graph being divided into a number of smaller areas, the actual energy output of the flash lamp is given in lumen seconds by multiplying each area with its corresponding conversion factor and adding all the products together (Fig. 6).

The following observations recorded in a typical set are given as an illustration.

TABLE II

DISTANCE IN INCHES	DEFLECTION IN CM.
52	3.5
58	5.2
70	7.5
90	9.5

Illuminating power of the flash bulb at its peak value being

$$I\phi = 4\pi W \frac{D^2}{d^2} \times f \times \frac{100}{T}$$

where

- $W = 500$ watts
- $f = 2$ c.p./watt
- $d = 45/12 = 3.7'$
- $T = 25\%$
- $I\phi = 78 \times 10^3$ lumens

The curve is divided up in seven lengths, as shown in Figs. 6 and 9. The intensity is 100% at 45".

- Total length of the flash = 12 cm.
- Total duration of the flash = 120 milliseccs.
- Most effective duration of the flash = 40 milliseccs.
- Lapse of time between contact and peak of flash = 100 milliseccs.
- Total energy output = 172×10^2 lumen seconds.
- Energy output at the peak = 8,500 lumen seconds.

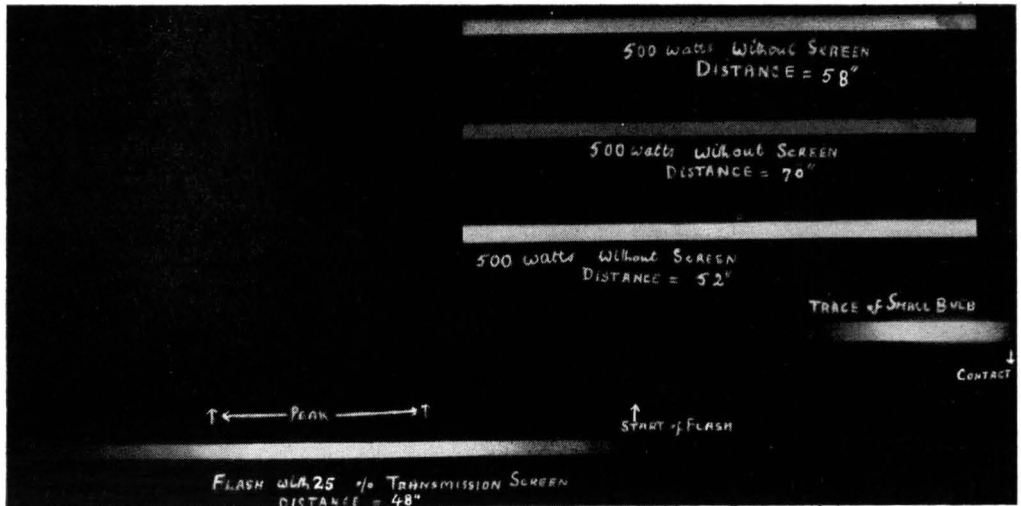


FIG. 7 — TRACE OF THE FLASH BULB.

TABLE III

HORIZONTAL DISTANCE ALONG X-AXIS GIVING TIME CM.	VERTICAL DEFLECTION ALONG INTENSITY CM.
0-0	11-6
1-4	10-1
3-7	4-3
5-2	5-9
7-2	4-0
9-0	3-2
12-5	0-7
12-9	0-6
16-8	0-1
21-8	0-1
25-1	0-3
26-3	0-7
27-0	1-4
28-9	2-5
32-7	5-0
35-7	7-0
38-8	9-9

TABLE IV

No.	DEFLECTION IN CM.	MEAN DISTANCE IN INCHES	% INTENSITY
a	0-0 to 2-0	47-0	91-8
b	2-0 to 3-5	50-5	79-0
c	3-5 to 4-4	53-0	72-0
d	4-5 to 6-0	56-0	60-5
e	6-0 to 7-0	61-5	50-3
f	7-0 to 10-0	78-5	32-9
g	10-0 to 11-5	105	19-8

Spectral Distribution

To examine the character of light in the flash, its spectrum was photographed with a quartz spectrometer. For this purpose a side tube was attached to the bulb and a quartz window provided. This was placed quite close to the slit of the spectrometer. The spectrum of the flash was very diffuse containing arc lines of copper and alu-

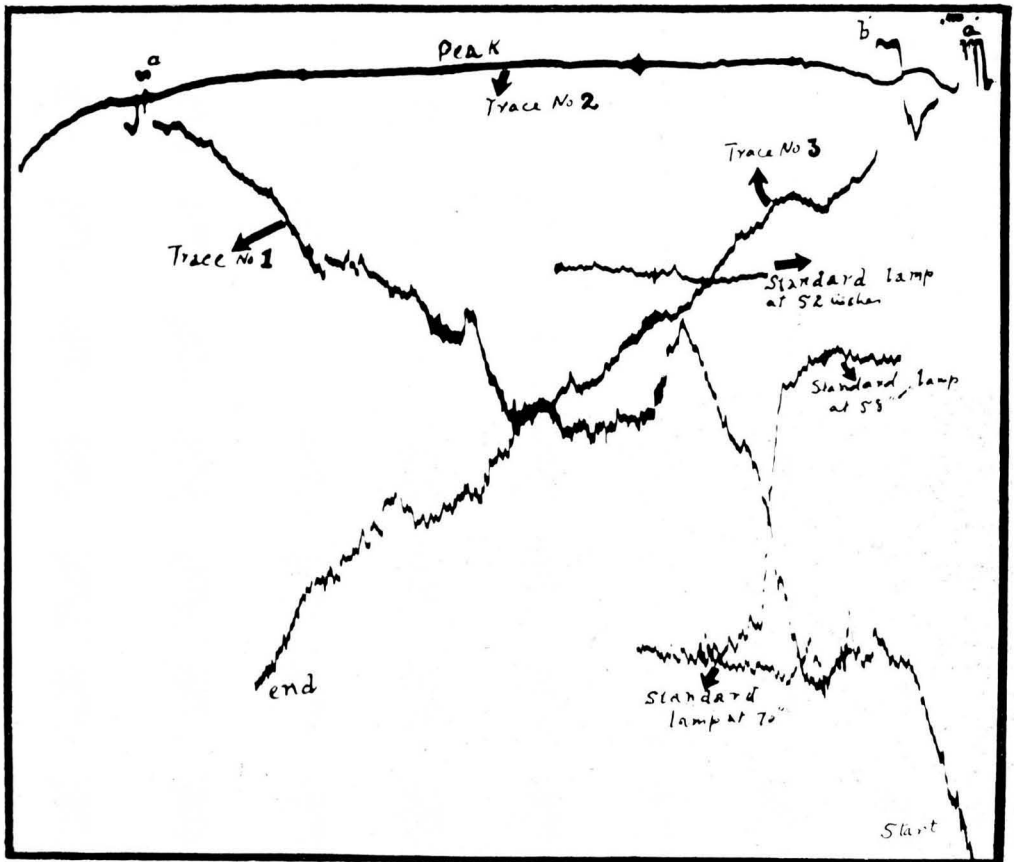


FIG. 8 — MICROPHOTOMETER RECORD (TAKEN IN THREE PARTS) DEFLECTION OF THE MICROPHOTOGAM. PHOTOMICROGRAPHS 1, 2 AND 3 ARE FOR THE THREE PARTS OF THE PHOTOFLASH TRACES. REMAINING THREE TRACES ARE FOR THE STANDARD LAMP AT DIFFERENT DISTANCES.

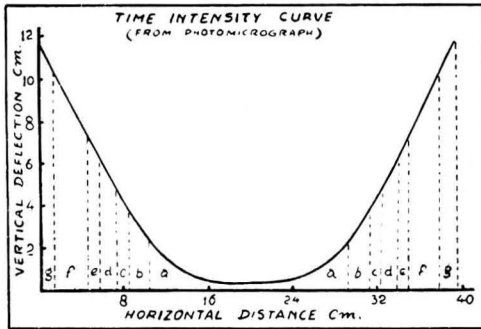


FIG. 9 — DEFLECTION OF THE MICROPHOTOMETER FOR THE FLASH BULB TRACE.

minium superimposed on a continuous background.

In order to see how different wave-lengths in the spectrum change with time, the slit of the spectrometer was reduced to a small square of $\frac{1}{2}$ mm. side. The telescope of the spectrometer was removed, and the light coming out of the spectrometer prism was focussed by a lens on the drum of the rotating flashometer. The drum was then set rotating and the lamp flashed. The resulting spectrum gave the wave-lengths emitted at different times. It was found that these

were not very different from those observed in the previous photographs.

These observations are, however, only of a preliminary nature and the work is being continued.

The work described in this paper was carried out under the direction and supervision of Dr. P. K. Kichlu, and the writer wishes to express his best thanks to him for his interest in the work and for his encouragement during the investigation.

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REVIEWS

Race, Language and Culture, by Franz Boas (Macmillan & Co. Ltd., London), 1948, pp. xx+647, 90 illustrations. Price 27s. 6d. net.

THE LATE PROF. FRANZ BOAS'S CONTRIBUTION to anthropology is well known both in India and abroad. His work in the fields of physical and cultural anthropology had been prolific, thought provoking and competent. He founded a school, and his students are spread over the Americas and many from Europe and Asia have learnt at his feet. He was one of those who have given status and reorientation to the science of man. To him anthropology had never been merely antiquarian research, mere curiosity, "regarding the early history of mankind". "Knowledge of the life processes", wrote Prof. Boas, "and behaviour of man under conditions of life fundamentally different from our own can help us to obtain a freer view of our own lives and of our life problems." He was more interested in the dynamics of life than in the material of cultural life though the relation between the two was never ignored by him.

In this volume Prof. Boas has thrown light on many problems of anthropology, physical and cultural, and his treatment of the two branches shows his synoptic attitude to culture which finds culmination in the *gestalt* approach to culture by the most articulate of his disciples, Dr. Ruth Benedict. The book is divided into three major sections, Race, Language and Culture, with a small tail of miscellaneous writings on aims and advances in anthropological methodology. The problems mooted and the arguments advanced have the freshness of field and first-hand research; the academic approach, where it has become necessary, is not allowed to be dogmatic, though the egalitarianism in him runs through the whole narrative. It is difficult to swim against the tide and Boas's task has been complicated by the emotional reaction of peoples of his country, and his thesis on the sociology of racism has had to be administered in doses mild and innocuous. Whether his attitude to racism is deliberate or not, his approach has the merit of objectivity which seldom has

inspired the "so-called" literature on race and "racialism". Prof. Boas recognizes the influence of the environment on the body form. "I think", he writes on page 59, "the evidence showing that the form of the head is susceptible to environmental influences is incontrovertible." "I also believe that adequate proof has been given for modification in the width of the face under changed conditions of life." Yet Prof. Boas avows that the causes of these changes are still entirely obscure. If chemical changes occur under new environmental conditions and unequally influence growth in different directions, he advocates investigations of the instability of the body under varying environmental conditions as one of the most fundamental subjects to be considered in an anthropometric study of human population. This is the scientific attitude and this is Boasian in the fullest sense of the term.

Boas has been a most difficult personality in ethnology for his achievement, in the words of Prof. Lowie, is full of paradoxes. Boas has been accused of a lack of synthesis though his is a method probably more totalitarian than the functional approach of Malinowski. Says Lowie, "It is still more paradoxical that this indefatigable collector who has consistently preached the totalitarian view of culture, has produced not a single full length monograph of any one tribe." But Boas's training and his interests never compromised with the study of closed groups, while his "totalitarianism" finds expression in the sweep of studies he made his own. His failure to write a monograph is probably due to the recognition of the gaps that every ethnologist has to fill up with cement and plaster, but Boas was too puritanical to attempt the same. Other strong points in Boas's discipline are his historical sense, his relevant arguments on the phenomenon of cultural parallelism which he weighed cautiously with mythological evidences, his analysis of the factors leading to Eskimo migration, his insistence on the comparative method with regard to the display of museum specimens and his substitution of phenomenism for "an arid conceptual realism based on premature

classification", exemplified by the literature on Totemism.

In his approach to cultural evolution, Boas has an enigmatic rôle. While Lowie thinks Boas was not anti-evolutionary but merely attacked Morgan's and others' evolutionary schemes, Leslie White thinks it otherwise. Boas and his students are said to have shown little hospitality to the theory of cultural evolution. It is also true that Boas and his school, even if they did not object to the theory of cultural evolution *in toto*, did not develop an adequate form of evolutionist theory. Goldenweiser and Radin also have characterized Boas's philosophy as anti-evolutionist, a contention which has formed the subject of an animated controversy in the pages of the *American Anthropologist*, more particularly between Lowie and Leslie White. Even if Prof. Boas has not been an anti-evolutionist, his approach to problems of race and culture in effect gives the impression that his first-hand investigations and laboratory experiments did not encourage him to support the evolutionary point of view but the departure probably was the result of a scientific scepticism. Cultural evolution, however, stands on a different footing than that of racial evolution, and as Ellwood has shown, a parabolic development from pre-control to rational decontrol may replace an unilinear evolution which Boas and his school have rightly contested. Whether Boas believed in evolution or not, the march of culture is a process in which evolution does have its rôle and as Leslie White (*Am. Anth.*, 1947, 49, No. 3) affirms, evolution is not losing ground in American anthropology though the Boas school has probably done much to undermine it.

The sweep, the contents, and the methodology that Boas condenses in this volume will benefit students of anthropology in all parts of the world, and although from a cursory perusal the chapters may appear to be "bites", there is a vast store of knowledge at the back of the information doled out. "Boas is a man lacking and scorning any artifice that might attract students. Yet he has trained and influenced the greatest number of professional anthropologists." The book as presented will equip the students of man with multiple starting-points for both field study and academic research without Prof. Boas's claiming the same. We recommend the book to all anthropologists and also to laymen, for

both are likely to profit in obviously diverse ways. The absence of an index is a desideratum for which we can blame the publishers alone.

D. N. MAJUMDAR

A Human Relations Casebook for Executives and Supervisors, by Frances S. Drake & Charles A. Drake (McGraw-Hill Book Co. Inc., New York, London), 1947, pp. xiv+187. Price \$2.50.

THIS IS A BOOK WHICH SHOULD BE CAREFULLY read by all persons charged with the responsibilities of running an industry or a business house or any other organization employing a number of persons. In my opinion our industrialists have been too much preoccupied with technical improvements of the plant and have somewhat ignored the men who ultimately have to run the plants and who must be in a right frame of mind if maximum advantage is to be secured from the available physical resources and plant. *The McGraw-Hill* publishing house has brought out a series of useful books,—“the Industrial Organization and Management Series”, dealing with this aspect of industry.

The approach to this subject in the present book is practical. It deals section by section with topics like: “Adjusting the Human Resources”, “Developing Attitudes and Sentiments”, “Using and Abusing Incentives”, “Bargaining with Individuals and Groups”, “Mobilizing the Brainpower of an Organization” and “the Ways of Executives and Supervisors”. In each section a number of practical cases are taken up and topics for discussion arising therefrom are suggested and certain principles are derived. It may be that conditions in the Western countries are different and, therefore, the psychological background may have but a remote bearing to the conditions existing in our country. An intelligent person will, however, by studying particular cases, easily grasp the principles underlying their studies and apply the principles *mutatis mutandis* to conditions existing in our own country. When one considers the loss of industrial resources as a result of strikes, slackness of workers, disorganization, lack of co-ordination of work in a factory and other human elements, one cannot under-estimate the importance of a concerted effort to grasp the principles that should determine the relations between the

executive and the worker in an industrial organization and the principles that make for maximum output by a harmonious working of the labour force. But understanding of principles is not enough. The executive should be trained to apply these principles in actual life. I feel that books like the present are helpful in achieving both the objectives.

K. R. F. KHILANI

Heat, by Archie G. Worthing & David Halliday (John Wiley & Sons Inc., New York ; Asia Publishing House, Bombay), 1948, pp. xii+522. Price \$6.00.

THE BOOK OPENS WITH A CHAPTER ON SOME laboratory procedures — methods of observation ; record and treatment of data ; presentation of a report ; etc., etc., — and sets the pattern on which the whole book is cast. It is specially written for the benefit of those who are taking up a serious study of heat for the first time, and the authors have, therefore, been at pains to emphasize the physical and the experimental sides. The whole book abounds with neatly drawn diagrams, sketches, charts, graphs and tables of constants. Numerous applications of the principles to industry and every-day life are discussed and will be greatly appreciated by young readers as aids to a clear understanding of the subject.

Each chapter is preceded by an introduction giving the relative importance of the topics discussed. After every discussion examples have been worked out to elucidate the manner of calculating the results from the data provided ; in many cases alternative methods for the determination of a quantity are given. Wherever possible methods and results of recent developments have been incorporated. As an exercise to the student, a large number of carefully selected problems are added at the conclusion of each chapter. In general the treatment is elementary but complete within limits, and the derivation of formulae which require the use of advanced mathematics or understanding of complicated physical processes is left out. For the benefit of the diligent student who might like to go deeper, the derivation of Maxwell law of distribution of velocities is given in the appendix. Short biographies of great personalities in physics mentioned in the text form a most interesting feature of the book.

The topics covered in the book are generally those prescribed for pass B.Sc. course

in Heat of Indian universities and the book will be greatly welcomed by a large body of undergraduate students. The treatment is in some ways different from what the Indian students have been accustomed to, but the departure is all to be desired and will be found most refreshing and stimulating. It is a modern text-book in every way. Considering the scope of the book the authors, as experienced teachers, have done a service to the student world by presenting the material in such an attractive form. There is perhaps nothing the reviewer would like to say by way of criticism, but he feels that the chapter on " Kinetic Theory " might have been written in slightly greater detail. Also, a knowledge of the properties of substances at low temperatures has become important both in science and in industry. A discussion of the liquefaction of gases and other methods of producing low temperatures could have been included with profit.

The get-up is excellent and the book is strongly recommended for adoption by Indian universities.

P. K. K.

Chemical and Electro-plated Finishes : The Protective Treatment of Metals, by H. Silman (Chapman & Hall Ltd., London), 1948, pp. xiii+414. Price 30s. net.

INTENSIVE AND EXTENSIVE SCIENTIFIC INVESTIGATIONS into the principles underlying the processes of electrochemical and purely chemical methods of supplying protective and decorative coatings on metals have led to vast advances in the industrial techniques employed in these fields. Mr. Silman has presented in this book a very readable account of the subject which will be welcomed at once by those interested in the underlying scientific fundamentals, and those who are mainly interested in the technical applications.

Chapters I to IV deal with the preparation of the metal surfaces for the various finishing processes. All the methods are dealt with in sufficient detail, and the data on the plants and machinery supported by choice illustrations enable the interested readers to benefit greatly by the information given. The recent developments in electrolytic pickling are included and also the electrolytic methods of polishing of metals. The latter subject has roused considerable

interest in recent years both on account of the reduction in cost and in labour, and also because of the fact that in some instances, as in the case of aluminium, it is possible to produce a higher degree of finish than is obtainable by mechanical methods of polishing. There can be little doubt that electrolytic methods of polishing have a considerable future. The electro-polished surface is usually free from strain while the technique enables a variety of surface finishes ranging from a full bright to satin or matt finishes.

Chapter V gives a very helpful account of the various methods of metal colouring that are now successfully adopted on a large scale, processes such as phosphatizing, in which metal surfaces are suitably treated with solutions of chemicals to develop a coating which has a good degree of rust resistance and other desirable properties. The recipes commonly used are given in fair number, with the compositions in the oz.-gal. or gr.-lit. system according, perhaps, to the available data.

Chapters VI to XII covering nearly 160 pages of the book are devoted to the details of the modern electro-plating methods and plants. The hardness, uniformity, and the durability of even thin coatings are the chief merits of this important finishing process which has now been developed into an art well based on a growing science. The modern methods of bright nickel plating have received special attention over nearly 12 pages.

Chapter XIII deals with the important subject of finishing of light alloys of aluminium and magnesium. Here a good account is given of the industrial methods of anodizing and subsequent finishing.

The last chapter, XIV, bespeaks the scientific character of this apparently professional book, and gives the various standard testing methods for quality control.

The book cannot claim to be a complete guide to the processes described and does not claim to be so. It should, however, meet adequately the requirements of designers and engineers and the processing technologists. There are also select references to original literature at the end of each chapter. The book is well printed with many clear photo reproductions and neatly arranged with an appendix of useful reference tables and indexes. The book is highly commended.

M. A. GOVINDA RAU

Standard Design of Reinforced Concrete Road Bridges, by L. E. Hunter (Chapman & Hall Ltd., London), 1948, pp. xv+176. Price 25s. net.

STANDARDIZATION IN DESIGN AND CONSTRUCTION of reinforced concrete road bridges is of the highest importance, especially in the present "post-war" period when damaged communication systems have to be set right without much delay to bolster up the shattered economy of many countries. The stereotyped methods of design adopted in the pre-war period were uneconomical and caused considerable loss of time in the execution of much-needed bridge projects. This book has been published at the most appropriate time, and it is certain to be of invaluable assistance to students, bridge designers and practising engineers. The author has to be congratulated on his fine effort in publishing so useful a book on an extremely difficult subject.

The author has aptly stated in the preface that it would take normally a life-time or more to deal adequately with the subject. It is indeed remarkable that he has so dexterously compressed a vast amount of useful information in a single volume of 176 pages.

The book deals with simplified designs on reinforced concrete road bridges of the various types generally used. It includes also one chapter on steel bridges. It abounds in a large number of valuable sketches, design tables and diagrams which, along with the formulae and calculations used to arrive at the dimensions of various members comprising a bridge, will definitely simplify the work of bridge engineers in the evolution of sound and economical designs.

This book should prove particularly valuable for students in engineering colleges of Indian universities.

R. K. N. IYENGAR

The Indian Cotton Textile Industry — 1947-48 Annual, by M. P. Gandhi (Gandhi & Co., Bombay), 1948, Vol. XI, pp. xiv+184+xxvii. Price Rs. 6.

MR. M. P. GANDHI DESERVES TO BE COMPLEMENTED for bringing his 1947-48 annual of the Indian Cotton Textile Industry which, in a comprehensive and well-arranged manner, brings to light all the important developments of the cotton textile industry in India during 1947-48. The statistical

information which was not available in earlier annuals have been mostly made good and it is hoped that in future annuals more complete statistical data would be included.

The contents of the annual have been very ably classified and should serve as a very valuable ready reference book worthy of the library of all those interested in the textile industry, — students, economists, industrialists and business men. While chronologically detailing the various developments that lead to the discontinuance and reintroduction of the cotton control measures regarding output, price and distribution, he has analysed and given certain very valuable suggestions. So long as the Government of India depend for their advice and guidance mostly on those engaged and actively interested directly in the profits of the industry, and as long as they do not have on their staff specially qualified and able men in the Textile Directorate, no continued and useful policy regarding the textile industry can be evolved. In the case of such an important national industry like the cotton textile industry a policy of make-shift just to meet the exigencies of times is adopted which, in my opinion, gravely affects the future of the textile industry. There are quite competent men well able to determine and advise the Government but may not be able to do so as long as their loyalties remain divided between his employer on the one hand and the Government who seek his advice from time to time without a chance to put such advice to practise on the other. Both on account of its natural importance and on account of the varied and several most complicated problems involved at each phase of the cotton textile industry, the Government of India should examine the advisability of having a textile directorate manned with competent and well-qualified staff specially trained for the purpose on a permanent basis.

The several important problems that face the Indian cotton industry both now and in future have been ably discussed by Mr. Gandhi and deserve careful reflection by all concerned in the development of the industry in India.

B. K. MURTHY

Microwave Transmission Circuits, edited by G. L. Ragan (McGraw-Hill Book Co. Inc., New York), 1948, pp. xvii+725. Price \$8.50.

THIS VOLUME, WHICH IS NO. 9 OF THE "Radiation Laboratory Series", deals with the theory and practice of coaxial cables and wave-guides used in the propagation of microwaves. Seven authors who worked in the M.I.T. Radiation Laboratory have contributed to it under the heads: Elementary Line Theory, Materials and Constructional Techniques, Rigid Transmission Lines, Flexible Coupling Units and Lines, Transition Units. (between coaxials and wave-guides), Motional Joints, Tuners, Power Dividers and Switches, Theory of Microwave Filters, and Design of Microwave Filters.

Although the earlier volume, No. 8, of the Series entitled "Principles of Microwave Circuits" covers the theoretical aspect of the subject, a certain amount of repetition has become inevitable in the present volume for the sake of completeness. The chapter on Theory of Microwave Filters covers aspects applicable to low frequency waves also and it is followed by a chapter dealing comprehensively with the design of microwave filters. "The theory and techniques described in these two chapters", it has been stated, "came too late to play a significant rôle in the war, but they should prove extremely useful in peace-time applications."

The term "microwave" is as vague as ever. For example, Vol. 11 on Microwave Measurements defines microwaves as extending from 1 mc./sec. to 30,000 mc./sec. In Vol. 8 the word microwave does not necessarily imply a particular range of frequencies, but "a characteristic technique and aperture field". In the present volume the term "microwave" may be assumed to include all frequencies greater than 1,000 mc./sec., but it has been specifically stated that the circuits described operate in the range from 2,500 to 25,000 mc./sec. In conformity with other volumes of the series *mks* units are used throughout the book; the text matter is well illustrated. The volume is beautifully got up, and it is a monumental contribution to the rapidly growing literature on microwaves.

B. N. SINGH

NOTES & NEWS

Precision Graduation of Scientific Glassware

MR. H. DUTTA, CHIEF GLASS Technologist, *Ganga Glass Works Ltd.*, Bulwali, writes as follows:

"Students of science and technology and research workers, all concerned with measurements of volume, demand accurately graduated and properly standardized measuring vessels for their work. There are a few firms in India turning out graduated glassware, but the bulk of the articles turned out have not attained the accuracy of the *N.P.L. (National Physical Laboratory, Teddington)* 'A' or 'B' grade. It would be realized that the expense and labour spent on accurate or faulty graduation are nearly the same, and with a little extra care it should not be difficult to turn out graduated ware of dependable accuracy in India."

The writer of this note recently visited U.K. to study the methods of graduation and calibration employed by manufacturers of scientific glassware in that country. The following notes based on his experience and study may be of interest to Indian manufacturers:

1. *Chemical Composition of Glass* — No definite composition of glass has been prescribed for scientific ware. The coefficient of cubical expansion determines the choice of glass employed for volumetric vessels. As the coefficient of cubical expansion of water is much higher than that of glass, it would be sufficient for most purposes to use low-alkali high-lime silica glass for making measuring vessels. Pyrex glass is generally employed wherever high accuracy is demanded.

2. *Method of Graduation* — The methods for marking vessels which are required to be accurate for contents, e.g. cylinders, flasks, and those which are required to be accurate for delivery, e.g. burettes, pipettes, are too well known. These methods which have been practised for some decades still prevail for precision jobs and for small production. For mass production of items, e.g. measuring glasses, the method is to employ pre-graduated paper transfer

papers, the articles are passed through a furnace when the graduation is permanently transferred to the glass.

The major difficulty in adopting this method in India is that the transfer scales have to be imported and they can be employed only if the sizes of the articles conform accurately in every respect to the standard. Any variation, however slight, would render their use out of question. More recently an ingenious printing machine and a new technique, "Silk Screen Printing", have been developed in Britain, which will render possible the precision graduation of syringes, ampoules, measuring glasses, etc. Although not directly applicable to all types of scientific glassware, these developments have great possibilities in India, and their adoption demands close consideration.

The scientific associations in India have to examine the position connected with the development of precision instruments required for research, education and professional work, and co-operate with manufacturers in their production. Standards have to be evolved and prescribed for adoption in India. It should be made incumbent on manufacturers to stamp their names on articles, and a certifying agency as in the U.K. should be established to issue certificates of accuracy for scientific glassware.

Synthetic Glycerol

THE FIRST SYNTHETIC GLYCEROL plant, constructed by the *Shell Chemical Corporation* at Houston, Texas, went into operation last September. Commercial success has been attained for the first time since the discovery by Scheele, 170 years ago, that glycerol can be produced synthetically (*Chem. Age*, 1948, 59, 584). Employed in the manufacture of high explosives, surface coatings, and some 1,500 other applications, glycerol has become a heavy chemical in its own right, whose availability as a by-product of soap manufacture is no longer looked upon as a satisfactory sole source of supply.

The starting material is propylene produced from petroleum

hydrocarbons. Chlorination of propylene yields allyl chloride and hydrolysis of the chloride to allyl alcohol which in turn is chlorohydrinated are the principal stages in the process. The resulting glycerol dichlorohydrin is hydrolysed to glycerol.

98 per cent pure propylene is employed in the process. A suitable excess of propylene is maintained, the mole ratio of propylene to chlorine being about 7:1. A temperature of 500° to 580°C. is maintained during the reaction and yields of allyl chloride as high as 85 per cent are reported. The reaction products are first freed of hydrogen chloride by water scrubbing. The organic chlorides are removed by a kerosene wash and are then separated by fractionation. The residual propylene is recycled to the chlorination reactors, which it enters preheated to 400°C. by the outgoing products of reaction.

The hydrolysis of allyl chloride to allyl alcohol is carried out continuously at 150°-160°C. A pressure of about 200 lb./sq. in. is necessary to maintain a liquid phase. The allyl chloride concentration in the aqueous solution is of the greatest importance and the optimum concentration maintained is about 1.25 N., i.e. corresponding to about 5 per cent sodium hydroxide as the hydrolysing medium. Another important factor in the hydrolysis reaction is the alkalinity of the solution. Using sodium carbonate instead of sodium hydroxide, the ether formation is successfully repressed well below 10 per cent. However, the evolution of carbon dioxide results in undesirably high pressure. Only a small amount of sodium carbonate is, therefore, employed and the proper pH is restored by successive additions of caustic soda to keep carbon dioxide in solution. An alcohol yield of over 90 per cent is obtained. The allyl alcohol is readily recovered in its azeotropic (71 per cent) composition by simple stripping.

The hydrolysis reactors must be carefully designed to prevent allyl chloride accumulating in overhead pockets and causing corrosion.

The allyl alcohol is readily chlorohydrinated in dilute solution by contact with gaseous chlorine. The reaction temperature must be maintained at 20°-25°C. by removing the heat of reaction. Starting with a 5 per cent solution of alcohol in water, 92 per cent yields of

the chlorohydrinated allyl alcohol can be readily obtained. The product of this reaction is hydrolysed without purification. Aqueous alkali containing 10 per cent caustic soda and 1 per cent sodium carbonate gives the best results. Preferred operating temperature is 150°C. with a contact time of 30 minutes. About 95 per cent yield can be attained in the hydrolysis.

The crude glycerol is concentrated to 85 per cent in flash evaporators. Further purification to 99 per cent is effected by a combination of solvent extraction (with xylene) and vacuum fractionation.

In the alternate and equally efficient method, also successfully worked out by *Shell*, the allyl chloride is directly chlorohydrinated. By close control of the pH and avoiding the presence of gaseous chlorine in the system, it has been possible to obtain yields of glycerol dichlorohydrin in excess of 95 per cent. Glycerol chlorohydrin is hydrolysed partially (50 per cent) by treatment with lime in a stripping column. The resulting glycerol epichlorohydrin is distilled overhead and is readily hydrolysed to glycerol by treatment with caustic soda and soda ash. This process results in a saving of nearly one-half of the caustic soda consumption by the substitution of lime.

The glycerol manufactured by the *Shell Chemical Corporation* meets the very stringent specifications of *U.S. Pharmacopoeia*. The product is water-white, odourless, and assays more than 90 per cent glycerol.

Lime-zeolites for Water Treatment

THE ADVANTAGES OF THE LIME-zeolite process for water treatment are being increasingly recognized (*Chem. & Ind.*, 1948, No. 44, p. 695). The use of carbonaceous zeolites for softening municipal and industrial water supplies in conjunction with lime, overcomes many of the disadvantages encountered in the lime and lime-soda methods. The carbonaceous zeolites, as ion-exchange materials, are immune to acid attack and are equally effective as the synthetic calcium-alumino-silicates in eliminating supersaturation due to calcium and magnesium salts and in absorbing small amounts of excess calcium hydroxide. They can be regenerated with acids.

The treatment is conducted in 3 stages. The first stage includes

treatment of water with excess of lime adding, if necessary, a coagulant such as activated sodium silicate, alone or in conjunction with aluminium sulphate. The effluent at this stage should analyse to the following: alkalinity to phenolphthalein, 40-50 parts CaCO₃ per million; alkalinity to methyl orange, 60-70 parts CaCO₃ per million; hardness, 60-70 parts CaCO₃ per million + the permanent hardness present in the untreated waters. It is not necessary to filter the water leaving the lime-treatment plant, as any suspended matter will be retained in the next stage.

The effluent is passed in the second stage through a pressure filter containing a stabilizing bed of carbonaceous zeolite in the calcium form. The carbonaceous calcium zeolite acts both as a catalytic and mechanical filter. It removes suspended matter, completes the lime-bicarbonate reaction, retains the precipitated calcium carbonate and magnesium hydroxide and absorbs any excess of lime. Tests on this stabilized effluent should be approximately as follows: alkalinity to phenolphthalein, nil; Alkalinity to methyl orange, 10-15 parts of CaCO₃ per million; hardness, 10-15 parts of CaCO₃ per million + the original permanent hardness in the untreated water, and pH 6.9-7.1.

The accumulation of calcium carbonate and magnesium hydroxide is periodically removed from the stabilizing bed by means of acid.

In the third stage the effluent from the stabilizing plant (suitable without further purification for many purposes) is passed through a normal base-exchange softener which may contain a zeolite of the natural sodium-alumino-silicate or carbonaceous type, in which the sulphates, chlorides and nitrates of calcium and magnesium are converted into the corresponding sodium salts.

The effluent from the base-exchange unit is ideal for most industrial purposes and should be of the following quality: alkalinity to phenolphthalein, nil; alkalinity to methyl orange, 10-15 parts of CaCO₃ per million; total hardness, nil; pH 7.0-7.2, and free carbon dioxide 2 p.p.m.

The zeolite is regenerated by treating the bed in an upward direction with a solution of sulphuric (0.5 per cent) or hydrochloric acid (up to 10 per cent). The base-exchange unit is regene-

rated with sodium chloride in the conventional manner.

Manufacture of Urea

THE THEORETICAL ASPECTS OF urea synthesis and the methods employed in its industrial production have been recently described (*Chem. & Ind.*, 1948, 60, 22).

The two fundamental steps in the synthesis starting from the relatively cheap raw materials, ammonia and carbon dioxide, are the formation of ammonium carbamate and the dehydration of carbamate into urea. The reaction being an equilibrium reaction, the rate of transformation of ammonia into urea in a single operation never exceeds 50 per cent. The recovery of residual ammonia and carbon dioxide becomes incumbent for economic production. Where gases are utilized in an auxiliary production, such as preparation of ammonium sulphate by the gypsum process, the recovery is relatively simple. Ammonia and carbon dioxide are compressed into an autoclave (min. pressure, 120-170 atm.) at 170° to 180°C. The transformation into carbamate, and its dehydration into urea is complete in 15 to 20 min. The reaction products enter a distilling column in which the pressure is reduced to 2 to 3 atm. and the temperature kept at 75° to 80°C. Unreacted ammonia and carbon dioxide are led out from the top of the column to the auxiliary plant. Urea is evacuated from the bottom in the form of a concentrated solution and crystallized. The heat of reaction serves to pre-heat the gases and maintain the temperature of the autoclave at the desired level.

The reactants must be pure. Corrosion of equipment is a serious problem, the outlet valves of the autoclave being the most vulnerable. A special alloy has been elaborated to overcome corrosion.

The gaseous products containing about 6 per cent of water vapour, escaping from the top of the distilling column, are recycled in the absence of an auxiliary plant. This proportion of water vapour is admissible. The compression of the gaseous mixture is not easy, and it is inconvenient to introduce them under pressure into the autoclave in a continuous manner. The gases may be introduced in the form of aqueous solutions pumped continuously into the autoclave under pressure and supplemented with additional quantities of gases. After the

reaction, the mixture is submitted to a double distillation. In the first distillation, carried out under pressure, the major portion of ammonia is liberated. It is liquefied and recycled. After the second distillation, at atmospheric pressure, the liberated gases are dissolved in a minimum quantity of water and recycled into the autoclave. This process is adopted by *Du Pont de Nemours* because of its several advantages.

The *A.F.C.* process operated in France employs a colloidal suspension of ammonium carbamate in a mineral oil medium. By mixing carbon dioxide and ammonia in a paraffin medium, suspensions containing 50 per cent or even more of ammonium carbamate are obtained. These are capable of being pumped without difficulty. The suspension is introduced under pressure continuously into the autoclave at the same time as fresh gases. After the reaction the oil is separated by decantation. The advantages are the non-formation of crusts by ammonium carbamate, and the easy dissipation of heat.

After entering the hot autoclave the carbamate melts or dissolves in the reaction mixture. If the reactants enter from the bottom, the oil rises to the top where it is constantly evacuated. The autoclave is always full of carbamate. The theoretical heat balance is nil or slightly positive starting from a rate of transformation into urea of 40 per cent, if ammonia is introduced above its critical temperature, and the suspension contains 50 per cent of carbamate. Urea solution is drawn from the bottom of the attached distilling column, concentrated under vacuum and crystallized. The gaseous mixture from the top is recycled to produce the suspension.

K. VYASULU

The Pneumatic Balance

THE PRINCIPLE OF THE PNEUMATIC balance and some of its applications have been recently described (*Ind. Chemist*, 1948, 214, 676). A number of devices based on the principle of the Electroflo Pneumatic Transmitter developed by the *Electroflo Meters Co. Ltd.* have been given with special reference to their applications in industry.

In the pneumatic balance the pan and the measuring weights of a conventional chemical balance are replaced by a diaphragm which is arranged so that an air pressure applied to it can be

regulated just to balance the material which is being weighed. If a baffle is attached to the indicating pointer of the balance, and a nozzle supplied with a constant source of air is fixed beneath it, the distance of the baffle from the nozzle will control the air pressure at the nozzle. This pressure can then be used to indicate on a gauge when the correct pressure is applied on the diaphragm to balance the material weighed. Such an arrangement will give a degree of precision comparable with the chemical balance, as a minute movement of the baffle will produce a big deflection of the gauge connected to the nozzle. By applying the nozzle pressure direct to the balancing diaphragm the system becomes self-balancing. Great sensitivity is attainable without any detectable hysteresis as there is absence of movement.

The obvious advantages of pneumatic balance are for those applications where it would be necessary to run connecting pipes containing corrosive, inflammable or toxic fluids into control rooms, etc., or employing electricity where there are fire and explosion hazards. The pressures and flows of corrosive fluids can be measured and transmitted by this means employing a diaphragm chamber and diaphragm constructed of suitably resistant materials, thus eliminating the need for liquid seals and purging systems in the majority of cases. The measurement of viscous fluids such as heavy fuel oil and pitch has been successfully undertaken; the only precaution being that the measuring chamber and the connecting lines are kept at the same temperature as the main feed line. The method may also be successfully employed with liquid ammonia and other fluids which evaporate at normal temperatures.

The pneumatic balance principle can be employed to convert into measurable air pressure any quantity or condition which can be caused to apply a force to the transmitter weigh-beam, and this pressure may be used not only for indicating or recording, but also for controlling the force. One application is, for example, that of the level measurement and control. Another adaptation of this principle is the detection of small force changes in a system where differences in vapour pressures of 2 fluids are to be determined. A device based on this principle has been perfected to

detect the presence of $\frac{3}{50}$ of 1 per cent of butane in isobutane.

Many of the difficulties usually encountered with orthodox flow meters may be successfully overcome by using the force balance method employing the same principle. Owing to the absence of displacement, the flows of condensable vapours such as steam may be measured without the necessity for constant-level reservoirs. Other applications in which the principle has found use are: measurement and control of speed of rotation, the pull of a speed governor being applied to the beam or of torque, weight, etc.

Grease for Rust Prevention

IN THE TROPICALIZATION OF MOTOR vehicles it was found necessary to devise a means for protecting the threads of nuts and bolts against rust, and to allow for their easy removal. A number of rust inhibitors were tried and an aluminium stearate grease composition was selected as satisfactory (*Can. J. Res.*, 1948, 26F, 347). The grease contains: 2 per cent zinc chromate (as used in paint formulation), 5 per cent graphite (fine flake), 7 per cent aluminium stearate and 0.2 per cent stearic acid; the remainder was acid and clay treated Columbia Distillate having a viscosity of approximately 90 S.U.S. at 210°F. The graphite and zinc chromate were slurried with some of the oil and passed twice through a colloid mill or other shearing device to disperse them. The remainder of the oil and other ingredients were then added and, after mixing in the cold, the dispersion was heated to 160°C. with constant stirring. This was then allowed to cool and let stand for 24 hr. before use.

Plates with bolts and nuts after treatment with the grease composition were subjected to immersion in sea water for 8 hr. a day; they were then heated in water at 50°C. and after 1 hr. the heat was cut off and the atmosphere allowed to cool and condense slowly. This cycle was repeated every 24 hr. After 10 weeks under these severe conditions of test it was found that the bolts and nuts treated with the special grease composition could be loosened by hand and easily turned.

New Uranium Mineral

A NEW RADIOACTIVE MINERAL containing uranium has been

reported from Belgian Congo by Dr. Paul F. Kerr of the Columbia University. The mineral was discovered by Dr. J. F. Vaes of *Union Minière, Jadotville, Belgian Congo*. Laboratory tests show that the material is an unknown uranium mineral. It has been named "Sengierite" in honour of Edgard Sengier who directed wartime mineral production in Belgian Congo.

Sengierite is found in small green crystals which cling to a chlorite-talc rock found in the mines. It is similar to the American uranium mineral, carnotite, except that sengierite is a copper uranium mineral while carnotite is a potassium uranium mineral (*Sci. News Letter*, Oct. 1948, p. 248).

Castor Oil in Steel-casting

CASTOR OIL PROMISES TO BE AN effective substitute for linseed oil in steel-casting as a binding material for sand cores. The quantity required is usually 2 per cent on the weight of sand employed. At a conference called at Leamington Spa by the Steel Castings Division of the *Iron & Steel Research Association*, it was reported that castor oil may be effectively substituted for linseed oil (*Chem. Age*, 1948, 59, 630).

New Instruments for

Textile-testing

EXHIBITED AT THE 19TH ANNUAL meeting of the *Textile Research Institute Inc.*, U.S.A., held in New York City last November, was a new tensile tester which incorporates new electronic principles of load-weighing and which provides full-scale load ranges from 2 gm. to 1,000 lb. In another instrument an acoustic pulse is introduced into the material being tested and its time of propagation is measured between a transmitter and a receiver. By this means the elastic modulus of the material is determined with great simplicity and speed. Electrical instruments for moisture determination and control as well as measuring instruments for accurately determining the diameters of yarns were on exhibition. Another instrument was a non-contact continuously indicating measuring device for the diameter of textile yarns and fibres.

Other instruments on display were a high-speed microtome for cutting extremely thin sections of textile materials for microscopical examination, and a knit fabric shrinkage tester.

Livestock Feed from Citrus Wastes

ONE OF THE MOST INTERESTING developments in the citrus fruit-processing industry in U.S.A. has been the development of valuable by-products which eliminate the high cost of citrus waste disposal. Waste pulp and peelings are converted into high-grade shredded livestock feed. It contains large percentages of carbohydrates and substantial quantities of fat and minerals. The liquor which drains from pulp and peel as it passes the livestock feed processing can be converted into valuable citrus molasses by vacuum evaporation and added to mixed cattle feeds as a substitute for more expensive sugarcane molasses. The juices can also be converted into industrial or beverage alcohol. Oils are used as bases for flavourings, beverage bases, perfumes and in the preparation of certain pharmaceuticals. Citrus seeds yield oils useful in the manufacture of sulphonated oils. 60 per cent of the pectin of commerce is obtained from waste orange, lemon and grape-fruit peel.

Other possibilities are: ascorbic and citric acids can be obtained from the waste; sugars can be utilized in the production of food yeast; enzymes useful in the early processing of fruit juices can be prepared. — U.S.I.S.

Photo-typesetting Machine

AT THE RECENTLY OPENED LABORATORIES of the *Printing Research Association* at Leatherhead, Surrey, equipment has been installed to demonstrate a system of photo-typesetting which dispenses with cast metal type. Its trade name is "Rotofoto".

The new method is a purely photographic process which should be useful in printing type by the lithography and gravure processes now widely used in the production of books and periodicals. The new system appears to be as cheap as standard printing practice; and it has the obvious advantage that the photographic master-copy of a book's typescript, from which reprints can be made, can be stored in a small space.

The "Rotofoto" equipment comprises a Monotype keyboard, a line-projector, and a make-up machine for producing paper proofs and film transparencies. A punched paper record, representing the "copy", is first made by a Monotype keyboard operator. This paper record is transferred to the line-projector which contains the mechanism of the Monotype composition caster with the main difference that a photographic negative takes the place of the matrixes.

The letters punched in the record are photographed on a roll

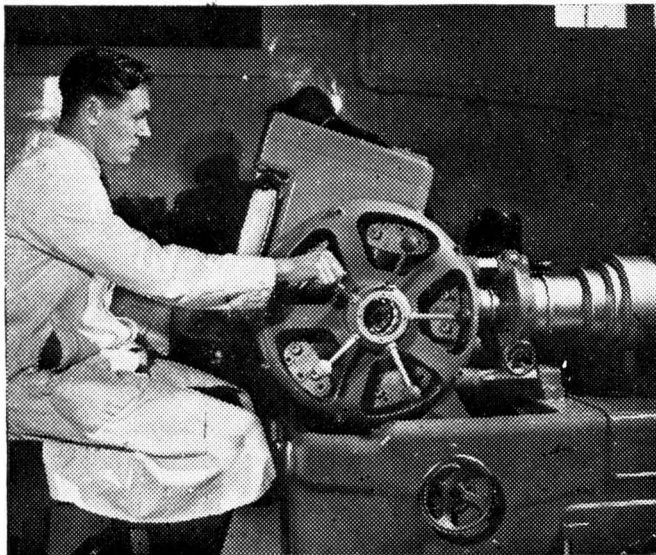


PHOTO-TYPESSETTING MACHINE.

of 35 mm. cinematograph film carried in a camera under the type negative. After a full line has been completed the film is advanced, the distance depending on the space required between the lines, and the next line is photographed. The line-projector operates at about the same speed as a Monotype casting machine.

Readers' and authors' corrections are dealt with separately and contained in other rolls of films; the make-up machine operator introduces the corrected lines during the process of making a perfect photographic transparency of the type matter.

The operations are simple and rapid and produce transparencies of high fidelity. Any type-face can be employed by using the appropriate negative, the type sizes can be controlled by the magnification employed in the make-up machine. At present 3 negatives are used to cover the complete range of composition sizes.

Mica Substitutes

GERMANY PRODUCED, DURING THE World War II, large sheets of mica using natural mica available in powder form (usually a waste product in mica industry). The mica powder was melted in graphite crucibles at 2,350°F. and cooled under regulated conditions in the complete absence of any vibration. During cooling a temperature gradient and a horizontal magnetic field are imposed. This process of forced formation of crystals in large laminated sheets was developed in the *Kaiser Wilhelm Institute for Silicate Research*.

Various substitutes for mica were developed in Germany during the war. They were mainly compressed paper products impregnated with artificial resins. The more important of these were: "Pertinax" developed for high-tension condensers, "Paxolin" and "Formalite", two phenol-formaldehyde compositions, and "Leatheroid", a fibrous material produced from cellulose. None of them seriously threatened the natural mica market.

The Massachusetts *Institute of Technology* has announced (*U.S. Tariff Commission Report, No. 130*) recently the development of inorganic films closely resembling mica in their important electrical and physical properties. When certain highly hydrated gels such as, for example, bentonite are suspended in water, and substan-

tially monodisperse fractions of the colloidal particles are separated out, the gels of these fractions form, upon drying, coherent, self-supporting and flexible films. No binder is necessary. When these films are heated under pressure their strength and transparency are greatly increased and their electrical resistance is comparable to that of mica. Although relatively polydisperse fractions also form films, those made from substantially monodisperse fractions are of superior quality. Monodisperse fractions may be obtained by allowing suspensions of clay to separate into layers according to size by gravity, and later to separate them in a super-centrifuge.

Such films, when made from bentonite (hydrated aluminium or magnesium silicates), are very similar in chemical composition to mica and when dried to a low-water content, exhibit many of the properties of mica. Films of different thicknesses can be made, depending upon the thickness of the original layer of gel. Similarly, a laminated product may be made from a number of thin sheets.

Intensive research is under way to obtain more information regarding the characteristics of the films under a variety of conditions, and in order to develop more fully the theory of their formation. Careful consideration is being given to the suitability of various treated films as substitutes for natural mica in condensers, radio tubes and other applications.

An arrangement has been made by the *Institute* with the *Research Corporation* of New York to undertake the commercial development of the patented process.

Colloidal clays are inexpensive and widely distributed. The quantities required for synthetic mica sheet production are relatively insignificant. The process would yield films or thick sheets as desired, which are technically perfect in physical structure and chemical analysis. The possible substitution of synthetic sheets for the built-up mica now universally used in electrical designs, appears to be the most significant economic aspect of the synthetic development.

D. B. SAHANA

Sterols from Wool Fat

A RECENT PATENT TAKEN OUT BY a Netherlands worsted yarn-spinning mill relates to an improved method for separating sterols, e.g. cholesterol, from the liquors ob-

tained in wool-washing. The sterols may subsequently serve as basic materials for the manufacture of vitamin D and some hormone preparations.

The unsaponifiable portion of wool fat is heated in the presence of a metal salt, e.g. anhydrous calcium chloride, the resulting addition product is treated with a solvent, e.g. acetone, whereby the addition product is partially or entirely dissolved. The method, it is claimed, is economical and gives a higher yield of sterols.

Storage Life of Adhesives

THE STORAGE LIFE OF RESIN adhesives is an important criterion in their applications and usefulness. Studies on the storage life of "Tego-gluefilm" under tropical conditions are described in the *Indian Forest Leaflet No. 99*. The tests were conducted with veneers obtained from *Mangifera indica*, *Cedrela toona* and *Dalbergia sissoo*.

The studies reveal that the films when kept in an ordinary carton container, termed "open parcel", lose their power of adhesion in about 3 months. When packed in paper and then placed in an air-tight metal container, termed "sealed parcel", the films are usable up to about a year.

Notes on Soldering

IN A NEW EDITION OF THE *Tin Research Institute's* handbook, *Notes on Soldering*, W. R. Lewis, reviews the recent researches on soldering process and presents a compilation of the more important facts which are likely to be of value in a large variety of industries.

Advances in soldering technique, with particular reference to mass-production methods of assembly, are discussed and the various forms of solder and methods of applying heat to the joints are described briefly so that their principles may be easily discerned and readily adapted for any particular application.

The principles underlying the production of "wiped joints" in lead pipes are fully covered and alternative types of joint in lead pipe are described and illustrated.

Aluminium, stainless steel, cast iron and other difficult-to-solder alloys are capable of being soldered by the special methods suggested.

Data on the behaviour of solders at various temperatures under tensile and shear stresses,

and under creep conditions, so important to the designer and to the production engineer, have been presented, together with notes on the properties and metallurgical constitution of the tin-lead solders.

The book also contains an adequate bibliography and a detailed scheme for the chemical analysis of tin-lead solders devised by Dr. J. W. Price.

This 88-page booklet, which is suitably illustrated with 47 photographs and diagrams, is available, free of charge, on application to the *Tin Research Institute*, Fraser Road, Greenford, Middlesex, England.

Tars & Bitumens in Road Construction

ROAD RESEARCH TECHNICAL paper No. 12, *Properties of Road Tars & Asphaltic Bitumens in Relation to Construction*, published recently by the *D.S.I.R.*, London, discusses the properties of road tars and bitumens and their significance in terms of the behaviour of surfacings in which they are employed.

Bituminous and tar road-surfacings must resist the transient forces imposed by traffic, but yield to slower forces of expansion and contraction and they must retain these properties under conditions of severe exposure to weather. The properties of the binder such as viscosity, its capacity to adhere to aggregates and its resistance to deleterious effects of weather are discussed in the paper in relation to various types of road-surfacings.

The phenolic constituents of the tar are reported to give better adhesion properties than bitumen in the presence of water. Bitumens fluxed with tar oils have better adhesion than those fluxed with petroleum oils. It has been found that improved adhesion in pre-mixed surfacing materials can be obtained by the incorporation in the binders of surface active materials such as heavy metal soaps and sulphonated oils. In surface-dressing improved adhesion in wet weather can be obtained by treatment of the stone with adhesion agents such as calcium oleate and iron oleate.

The measurement of brittle characteristics of tar and bitumens at low temperatures provide a useful means of following the deterioration in the binders caused by exposure to weather.

Road tars and bitumens are amenable to oxidation at atmospheric temperature, the effects being more detrimental to tar. Atmospheric oxidation, which is accelerated by light, is largely a dehydrogenation process leading to brittle resinous compounds. Removal of the phenolic constituents of tar reduces susceptibility to oxidation. The outstanding problem in this field is the development of an oxidation test for bituminous materials which will make it possible to predict road performance. Oxidation under pressure provides a reliable accelerated test.

Building Research in U.K.

LOAD TESTS CARRIED OUT BY THE *Building Research Station, D.S.I.R.*, London, on full-scale structures which have been accepted as standards are described in the Special Report No. 1, published by the *H.M.S. Office*, London. Standard impact tests have been enumerated. Under strength requirements a factor of 2 has been suggested analogous to the factor of safety which allows for errors in assumptions, calculations and workmanship. Stiffness requirements prescribe that the structural part should recover appreciably after the test load is removed. The exact requirements under this head for each structural part are enumerated in a summary at the end of the report. Actual application of test loads and measurements of deflection or deformation are described including a number of photographs and a sketch to illustrate the testing of panels of a roof or floor. Vertical loads like dead load, superimposed load, impact load and lateral load (wind load mainly) are also dealt with.

The report is valuable to the designer, safety engineer, factory engineer and the industrialist interested in building design and construction.

Clay-building Bricks — This Bulletin, the first in the National Building Studies series, issued by the *D.S.I.R.*, London, contains the researches carried out at the *Building Research Station* on clay-building bricks.

The Bulletin is in 3 parts. The first part deals briefly with the manufacture of bricks from raw clay. The second describes the characteristic properties of brick such as compressive strength, water absorption and other properties including thermal conductivity, sound insulation, resis-

tance to weathering and the effect of soluble salts. Results of tests on the efficiency of brickwork are summarized in the last part. These notes are intended to indicate the limited applicability of the test data in actual practice.

The Bulletin stresses that in order to guarantee a satisfactory construction more attention should be paid to planning and design of building as a supplement to the test data.

References have been given to the relevant British Standard Specifications and the publications of the *Building Research Association*.

Concreting in Cold Weather — Measures which can be taken to enable concreting and bricklaying work to proceed normally in cold weather are described in the National Building Studies Bulletin No. 3, issued by the *Building Research Station, D.S.I.R.*, London. Precautions to ensure the continuation of work on buildings in cold weather chiefly relate to concreting and bricklaying, because (a) the water in mortar and concrete mixes freeze, and (b) such mixes harden more slowly at subnormal temperatures.

Among the steps that could be taken to allow concreting to continue under winter conditions, the use of calcium chloride in the mix is recommended to reduce the period of setting and hardening. The incorporation of calcium chloride (2 per cent on the weight of cement gives maximum efficiency) increases the rate of strength development, especially at the early stages and reduces the time-period during which it is necessary to protect the concrete. It also increases the rate at which heat is evolved from the cement during the early period of hardening. Another effect is to lower the freezing point of the wet mix. In order to obtain full benefits of the addition of calcium chloride use of insulation is recommended in order to conserve the heat liberated during setting.

Calcium chloride may be used with either ordinary or rapid hardening cements. It is pointed out that calcium chloride should not be used in reinforced concreting work where thin cover is allowed.

Special precautions recommended for urgent work when frost conditions are severe are: to pre-heat the materials and heating the framework and keeping the

newly placed concrete warm. The use of rapid hardening cement is recommended for concreting in cold weather.

Bricklaying is not influenced to the same degree as concrete-laying by winter weather. The composition of the mortar mix is varied; 2 parts of cement, 1 part of lime and 5-6 parts of sand gives good results. The use of calcium chloride in the mortar is not beneficial; mixing in a warm enclosure, pre-heating of water, keeping the mortar warm and insulation of the brickwork are the other precautions recommended to ensure work to proceed normally. The bricks employed should be kept dry and should not be dipped in water before laying but used in a dry condition allowing for the suction by adjusting the amount of mixing water in the mortar.

N. K. P.

Rubber Seed Oil

EXPERIMENTS CONDUCTED BY THE Ceylon Government rubber technologist confirm the opinion expressed by the *Rubber Commission* that oil extracted from rubber seeds may form a suitable substitute for linseed oil. A ton of rubber seed oil fetches £150 and the extraction of oil on a large scale is regarded as a reasonable commercial proposition (*Chem. Age*, 1948, 59, 594).

On a conservative estimate, it is expected that Ceylon can produce about 10,000 to 12,000 tons of oil worth 10-12 million rupees. Ceylon may be able to export 3,000 tons of oil when the necessary plant for large-scale extraction is erected.

Rubber Production Plan

A RS. 15 CRORE SCHEME FOR making India self-sufficient in rubber is envisaged by the *Indian Rubber Board* at its fourth annual meeting held at Bangalore. The *Board* suggested that steps should be taken for stepping up the country's rubber production of 16,000 tons to at least 40,000 tons within five years.

World Rubber Production in 1948

THE TOTAL WORLD OUTPUT OF natural rubber during the first 9 months of 1948 by the Rubber Study Group of the *F.A.O.* was 1,140,460 metric tons, an increase of 213,360 metric tons over the comparable period in 1947. World stocks of rubber, excluding

stocks in Russia, are estimated at 812,800 metric tons, as on September 30, 1948, an increase of 36,474 metric tons since June 1948.

World production of 40,640 metric tons of synthetic rubber in September 1948 brought the total for 9 months to 403,860 metric tons and consumption for the year to date was 373,380 metric tons. Stocks of synthetic rubber increased from 70,740 metric tons at the beginning of the year to 114,300 metric tons at the end of September 1948.

Mica Marketing Control Board

THE GOVERNMENT OF INDIA HAVE decided to appoint a Committee consisting of 15 members to consider and report on the practicability of setting up a Mica Marketing Control Board in India, and, if such a Board is considered feasible, to suggest its constitution and functions and also to work out a detailed scheme for the efficient marketing of mica.

Dr. M. S. Krishnan, Director, *Indian Bureau of Mines*, is the Chairman of the Committee. A representative of the Ministry of Commerce, one representative each of the Governments of Bihar, Madras, West Bengal and Rajasthan, and eight representatives of the trade are the other members of the Committee.

A meeting of the *Interim Mica Advisory Committee* was held at Madras on December 20 and 21 to consider, among other subjects, a scheme for mica-mining classes for training mine managers, levy of Mica Mines Labour Welfare Cess, railway priority for scrap mica and a revised rate of royalty for mica.

Show Rooms for Forest Products

THE ESTABLISHMENT OF INDUSTRIAL show rooms at important centres in India, for the display of products utilizing timber and other forest produce on a commercial scale, is engaging the attention of the *Forest Research Institute*, Dehra Dun. Chambers of Commerce and Forest Departments of Provinces and States have been asked to make suggestions regarding the establishment and maintenance of the show rooms.

The purpose of the show rooms will be to bring out effectively the resources of the forests of the adjacent regions, to draw atten-

tion to established industrial uses for them and to indicate the scope for extending the utilization as revealed by research and development. The exhibits will be collected from Provincial and State Forest Departments, established industries utilizing forest products, and from the *Forest Research Institute*, Dehra Dun.

The questions likely to be examined separately for each centre will be whether the show rooms should form part of a general or industrial museum, whether it should be set up as an independent show room under Government management, or whether it should be attached to a recognized or large industrial undertaking.

Exemption of Duty on Insecticides

AS AN EXPERIMENTAL MEASURE, the Government of India have decided to exempt from payment of customs duty insecticides, fungicides and weedicides, including the basic chemicals employed in their preparation. This exemption will remain in force for one year, after which the position will be reviewed.

To ensure that the materials imported are used for the purposes for which the concession is granted, importers are required to produce from manufacturers and agriculturists employing them, a certificate, within 6 months of importing them, to the effect that they have been properly utilized.

The Indian Standards Institution

THE FIRST ANNUAL REPORT OF the *Indian Standards Institution (I.S.I.)* for the year ending 31st March 1948 shows an impressive development in the activities of the *Institution* in the short period of a year. The *Executive Committee*, in addition to dealing with the day-to-day administrative and organizational matters, has, at 4 meetings held during the year under review, made many important decisions relating to the basic structure of the *Institution* and its various Councils and Committees to deal with standardization in the national and international spheres.

The *I.S.I.* represents India on the *International Organization for Standardization* and new Secretariats for 2 Technical Committees for shellac and mica have been entrusted to the *I.S.I.* Accordingly, secretariats have been set

up and draft terms of reference for both have been prepared for circulation. The *Institution* has admitted 333 Sustaining Members and 23 Ordinary Members during the year. Invitation to neighbouring countries for Sustaining Membership of the *Institution* and collaboration in its activities were extended by the first President of the *I.S.I.*, Sri C. Rajagopalachari. The Government of Ceylon has already become a Sustaining Member.

The Textile Division Council of the *I.S.I.* held its first meeting on 7th August 1947, and appointed 6 Sectional Committees to deal with an approved list of subjects falling under the following groups : Textile standards (standard methods for testing textiles), cotton yarn and cloth, jute, wool; Textile chemistry; and Textile stores. Five of these, excepting Jute Committee, at their first meeting, appointed 22 Sub-Committees to deal with specific subjects.

The Textile Division Council has also been entrusted with the work of drawing up a specification for the Indian national flag in consultation with the Ministry of Defence. The specification is under preparation. Standardization of filter cloth for shellac is another subject under the active consideration of the *Institution*.

The Engineering Division Council at its first meeting, held during November 1947, appointed 13 Sectional Committees to deal with an approved list of technical subjects.

A report suggesting the adoption of the metric system of weights and measures was prepared by the Director and forwarded to the Ministry of Industry and Supply as directed by the *Executive Committee*.

The establishment of the Chemical Division Council has been expedited. Nearly 100 subjects for standardization have been proposed by the members and other bodies for consideration of the Division.

The formation of the Agricultural and Food Products Division Council and the Building Division Council has been postponed for the time being.

At the instance of the first President of the *I.S.I.*, Sri C. Rajagopalachari, the Director prepared a report on the rationalization of Indian coinage on the basis of the decimal system.

Close liaison has been maintained through *I.S.I.* between

India and National Standards Bodies of all countries, members of the *International Organization for Standardization* and the British Commonwealth of Nations. Information on standardization is being constantly exchanged between India and these countries. More than 170 references were received inviting opinions on draft specifications.

The sale of publications, in India, of foreign standard bodies, particularly those of the *British Standards Institution*, has been undertaken by the *I.S.I.*

A Sectional Committee on Quality Control and Industrial Statistics consisting of 18 members has been appointed, including Dr. W. A. Shewart, for the purpose of finalizing draft standards on quality control methods for India on the basis of existing standards. The Committee has since reprinted the *American Standards Association Standard Z-1.3* on "Control Chart Method of Controlling Quality during Production", pending the formulation of an Indian Standard, on which a Sub-Committee is now working.

A nucleus of a library has been started. The present collection includes standards issued by various bodies in India, Great Britain, United States, Canada, Russia, Australia and a few other countries. During the period under review, 5412 specifications, 171 draft specifications and 89 proceedings of Committee meetings of various national organizations were received in the library.

A New Statistical Series

A NEW STATISTICAL SERIES, ENTITLED "Monthly Abstract of Statistics", showing the changing pattern of the economic activity in India, has been brought out by the Statistician to the Government of India in the Ministry of Commerce.

Figures are provided in the "Abstract" on population; employment; agriculture, industrial, mineral and power production; transport including civil aviation; value of contracts, foreign trade; banking, currency and finance; stocks and consumption of food, raw materials and manufactures; postal traffic; prices of precious metals, securities and commodities; cost of living; and industrial profits and disputes.

The statistics which have been collected from various sources are compiled and presented according to the International Standards.

The publication is priced annas 9 or 10d. per copy, and can be had from the *Manager of Publications*, Delhi.

Aeronautical Society of India

The *Aeronautical Society of India* was inaugurated by Pandit Jawaharlal Nehru, Prime Minister of India, on December 27, 1948, at Bangalore. The *Society* (*President*, Mr. N. C. Ghosh, Director of *Civil Aviation* in India) has been formed for promoting the advancement of the profession of aeronautics. Its membership includes scientists, engineers and key-technical men of aviation organizations. The Prime Minister of India was elected Patron-in-Chief of the *Society*.

Electrical Communication Engineering Department — Indian Institute of Science, Bangalore

THE FOUNDATION-STONE OF THE new premises for the Department was laid by the Prime Minister of India on December 27, 1948, at the *Indian Institute of Science*, Bangalore.

The Government of India have made a grant of Rs. 4.25 lakhs for the construction of the building and equipment. In the design of the building, provision has been made for future expansion. The ground floor with a plinth area of 19,000 sq. ft. will be constructed for the present at an estimated cost of Rs. 2.75 lakhs. This will provide 4 big size laboratories and several smaller ones besides the lecture halls.

Instruction and research in electrical communication is being carried on at the *Institute* for the past 25 years as a part of electrical technology. The *Institute* was the first in India to introduce the subject as a separate study.

Crystallographic Exhibition

THE FIRST CRYSTALLOGRAPHIC exhibition in India was recently organized at Bangalore in connection with the 14th Annual Meeting of the *Indian Academy of Sciences*. The exhibits were arranged in the Physics Department of the Central College, Bangalore, and was visited by Pandit Jawaharlal Nehru, Prime Minister of India, who was on a visit to the city then.

Explaining the exhibits, Sir C. V. Raman, President of the *Indian Academy*, and the Founder-Director of the Raman Re-

search Institute, stated that unity of science was very well illustrated by the science of crystallography. The homogeneous nature of thousands of particles contained in the minerals could be seen there. Sir C. V. Raman, world's leading exponent of crystal physics, intends to start a museum of crystals with his fine collection as the nucleus. It may be mentioned here that the *Indian Academy of Sciences* has published, most appropriately, a symposium of papers on crystal physics to commemorate his sixtieth birthday which was recently celebrated in Bangalore.

UNESCO Book Coupon Scheme

\$150,000 WORTH OF BOOK COUPONS were delivered to representatives of 13 participating countries by the Acting Director-General, Gordon Menzies, during a special ceremony held during December 1948 at the UNESCO House, Paris. The scheme, devised to overcome foreign exchange difficulties will enable educational and scientific institutions of "soft" currency countries to buy publications from hard currency countries, while making payment in their own national currency. Coupons worth \$50,000 will be donated by UNESCO to Austria, China, Czechoslovakia, Greece, Hungary, Italy, Indonesia, Iran, the Philippines and Poland. The additional \$100,000 worth of coupons will be put on sale in China, Czechoslovakia, France, India, Poland and the United Kingdom.

A distributing body in each of the 13 countries will be in charge of allocating these coupons and will indicate the rate applicable for their purchase. The coupons can be used to buy books on education, science and culture

and can be used for subscription to periodicals or photo-copies.

Booksellers who accept these book coupons will be repaid by UNESCO in their respective national currencies.

Announcements

Indian Science Congress Session, 1950: The 37th Session of the *Indian Science Congress* will be held at Poona from 2nd to 8th January 1950. Professor P. C. Mahalanobis, F.R.S., has been elected as the President of the Session.

The following have been elected Sectional Presidents: *Mathematics*: Prof. N. M. Basu (Aligarh); *Statistics*: Dr. P. V. Sukhatme (New Delhi); *Physics*: Dr. R. N. Ghosh (Calcutta); *Chemistry*: Dr. J. K. Chowdhury (Calcutta); *Geology and Geography*: Mr. J. Coats (Digboi); *Botany*: Prof. P. Maheswari (Calcutta); *Zoology and Entomology*: Dr. B. C. Basu (Izatnagar); *Anthropology and Archaeology*: Dr. Christoph Von Furer Haimenderf (Hyderabad); *Medical and Veterinary Sciences*: Dr. M. V. Radhakrishna Rao (Bombay); *Agriculture*: Rai Bahadur R. L. Sethi (New Delhi); *Physiology*: Dr. Kalidas Mitra (New Delhi); *Psychology and Educational Science*: Prof. Kali Prasad (Lucknow); *Engineering and Metallurgy*: Mr. D. R. Malhotra (Ajmer).

The Association of Scientific Workers of India: The following office-bearers for the year 1949 have been elected: *President*: Pandit Jawaharlal Nehru; *Vice-President*: Dr. B. C. Guha; *General Secretaries*: Dr. P. K. Kichlu and Mr. C. R. Mitra.

The 5th International Congress for Comparative Pathology will be held at Istanbul, May 17-20, 1949, and will be under the

chairmanship of Akil Moukhtar Ozden. Papers on problems of medical, veterinary, or plant pathology sciences may be submitted to: Dr. Louis Grollet, Secrétaire Général, Comité International Permanent des Congrès de Pathologie Comparée, 7 rue Gustave Nadaud, Paris, 16e, France.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, is currently interested in obtaining the following "wanted" chemicals: lecithin phosphatase, *p*-tolylphosphorus dichloride, pyrosulphuryl chloride, 2-fluoroethanol, copper hydride, pelargonin chloride, *l*-borneol, mesobilirubinogen, clupanodonic acid, altrose, tagatose, *iso*-fenchyl alcohol, myrtenol, sabinol, verbenol, thuyil alcohol, bufotenidin, 5-(hydroxymethyl)-2-furaldehyde, hydodesoxycholic acid, phosphopyruvic acid, and coproporphyrin.

UNESCO New Director-General—M. Jaime Torres Bodet, Mexican Foreign Minister, has been elected Director-General in succession to Dr. Julian Huxley at the third General Conference of UNESCO held last December at Beirut.

Nobel Prize for Medicine—The Nobel Prize for Medicine for the year 1948 has been awarded to Dr. Paul Moller of the Geigy Company of Basle for his discovery of the insecticidal effect of DDT.

Dr. James W. McBain, Professor of Chemistry at the Stanford University, U.S.A., has been appointed Director, *National Chemical Laboratory*, Poona.

Prof. S. N. Bose of the Calcutta University has been elected President of the *National Institute of Sciences of India* for the year 1949.

Reports from States & Provinces

MYSORE

Mineral Investigations

The Records of the Mysore Geological Department for the year 1945 (Supdt., Govt. Press, Bangalore, pp. iv+104, 1948, Vol. 44, price Rs. 2), includes an interesting and exhaustive paper on "Gold Investigations in Mysore" by Mr. B. Rama Rao. The paper reviews the position of India in the world with regard to gold production, and shows that out of about 1 per cent of India's share, 99 per cent comes from Mysore. It is stated that ancient miners had touched all the possible gold-bearing quartz reefs, and these, though not always rich, have provided guidance for further investigation and exploration. The Kolar Gold-fields have been developed on ancient gold-workings. In recent years there have been many explorations for gold and the laterite-covered schistose ground near Manighatta, where extensive geophysical and trenching surveys were conducted, revealed no workable gold-bearing quartz reefs. Other explorations include alluvial gold extractions in the Tungabhadra river near Holalur and Govinkere villages, and at Kudurekonda and Palavanahalli; but these also did not prove to be paying on account of water scarcity and poor concentration of gold in the washings. The explorations at Kudurekonda-Palavanahalli and Bellara, where the mode of occurrence of gold in the quartz reefs is almost similar to that at Kolar, did not turn out to be hopeful, due mainly to difficulties encountered in mining operations in areas with heavy inrush of water or the poor quality of the ore. Only sporadic occurrences of comparatively rich gold shoots and splashes occur. The paper ends with a list of localities for future investigation with geological aspects and mining possibilities. The author strikes an optimistic note about the investigations to be carried out in spite of the cost involved.

The paper "On the occurrence of road metals and lesser minerals

in Kunigal taluk, Tumkur District" is of special interest. Besides road metals, the author mentions the availability of *kankar* for extraction of lime, alluvial clays in the valleys and tanks useful for roofing and flooring tiles, and of semi-precious ruby corundum and pink garnet crystals in the gneiss and pegmatites. Amphibole asbestos is also found in small stringers in the amphibolites.

The results of geophysical prospecting for graphite near Mavinahalli, Mysore District, carried out by Mr. M. B. Ramachandra Rao, are included in the *Records*. The occurrence of a graphitic lode in a small band of ultra-basic rock amidst the thick scrub jungle had been reported previously, and geophysical technique was employed to discover the extent of the graphite load beneath the cover of thick jungle and soil. An area of about 60 acres was surveyed by the spontaneous polarization and the earth resistivity methods along 15 lines totalling 15,400' involving 1,472 determinations. The electrical reactions obtained on the known lode were too poor and indistinct to offer any clue about the probable extent of the lode since graphite occurs therein mostly in an unevenly disseminated flaky form, which does not react as a continuous conductor. The conductive anomalies noticed in the area were due to the presence of the clayey materials with entrapped moisture which serves as a continuous ionic path for the current. The results, though not encouraging, contain valuable information about the practical details of geophysical techniques and their interpretation.

The occurrence of the felsite series near Marconahalli with a brief petrographic description of a few of the types found therein are reported in another paper. The chief types are vitrophyric, felsophyric, granophyric, and some modified types, among which there is a felspathic rock resembling the contact metamorphic rock "Unakite". It is

concluded that the felsite series are products of crystallization from an acidic magma, which later emplaced older hornblende schists and have given rise to the modified members by partial assimilation and metamorphism following granitization.

A report containing the occurrences, quality and extent of quartz deposits within an area of 15 miles' radius around Mysore, suitable for the manufacture of ferrosilicon in the *Ferro-alloy Factory*, Mysore, forms the next paper in the *Records*.

The last paper in the *Records* contains a note on "Bowenite and Talc-Picrolite intergrowth in the Ultra-basic rock from Hole-narsipur area". The optical properties and chemical analyses of talc and picrolite are given, and the latter is remarkable in having no ferric oxide but in containing about 5 per cent of aluminium oxide. The apple-green serpentine, which has greater hardness than the usual varieties, is identified to be "Bowenite".

N. V. R. SUBRAHMANYAM

Plastics Factory for Bangalore

MACHINERY AND OTHER EQUIPMENT worth Rs. 8 lakhs for the Plastics Factory is ready for shipment in Britain. The machinery were especially designed in one of Britain's most up-to-date factories at Upper Basildon, Berkshire. The plant consists of four 3", six 2" and eight 1½" extruders, with wire covering and cable equipment, conveyor and take-off mechanisms, extruder dies and nozzles.

Two apprentices from Mysore have been trained at the Berkshire factory and three British experts will be in charge of erection of plant at the site.

HIMACHAL PRADESH

Fruit Development

A PROPOSAL TO BRING UNDER fruit cultivation about 7,000 acres of unused forest land in the Himachal Pradesh is under the consideration of the Central Ministry of Agriculture. A recent survey of two *tehsils* in the Himachal Pradesh showed that the area is suitable for growing walnuts, almonds, apricots, raisins, chilgoza and grapes.

INDIAN PATENTS

The following is a list of a few of the Patent Applications notified as accepted in the *Gazette of India*, Part II, Section I, for December 1948. Patents from the *Council of Scientific & Industrial Research* are indicated by an asterisk.

Plastics & Plasticizers

39251. HAPPE : Urea formaldehyde composition : *Plasticizing urea-formaldehyde resin with albuminous substances in the presence of free urea.*

Inorganic Chemicals

37421. DELHI CLOTH & GENERAL MILLS CO. LTD., SHARMA, JAIN & CHIPALKATTI : Process for the production of raw material rich in titanium from residue of bauxite after separation of alumina : *Treatment with sulphuric acid to dissolve only aluminium and iron.*
37422. DELHI CLOTH & GENERAL MILLS CO. LTD., SHARMA & CHIPALKATTI : Process for the production of a solution rich in titanium from bauxite or residues of the same obtained after separation of alumina : *Bauxite treated with sulphuric acid till all constituents dissolve, then water added.*
37419. DELHI CLOTH & GENERAL MILLS CO. LTD., PARTHASARTHY & ARVAMUTHACHARI : Process for the preparation of chloro-sulphonic acid : *Mixing contact gas directing with HCl gas within the limits of 20 : 1 to 30 : 1 at a temperature 30° to 100°C.*
37420. DELHI CLOTH & GENERAL MILLS CO. LTD., KUMAR, PARTHASARTHY & ARVAMUTHACHARI : Process for the preparation of chloro-sulphonic acid : *Passing HCl gas in liquid SO₃ produced by condensing the vapours obtained by distilling oleum.*
38308. STANDARD OIL DEVELOPMENT CO. : Synthesis of hydrocarbons from carbon monoxide : *Contacting carbon monoxide and hydrogen with a relatively dilute catalyst, withdrawing the unreacted CO and H and contacting them with a dense fluidized mass of catalyst.*
30340. I.C.I. LTD. : Purification and compression of ethylene : *Forming solid ethylene hydrate and recovering ethylene from it.*
37860. E. I. DU PONT DE NEMOURS & Co. : Production of aromatic aldehydes : *Subjecting an aromatic hydrocarbon and carbon monoxide to the action of mixed hydrogen fluoride-boron trifluoride catalyst.*

Analytical Chemistry

38754. AMERICAN CYANAMID CO. : Separation of sugar from molasses : *Passing molasses through an organolite charged with hydrogen ions, and then concentrating sugar from it.*
30888. THE ALUMINIUM PLANT & VESSEL CO. LTD. : Distillation of complex mixtures : *Distilling the mixture of acetone-methanol-water in presence of a paraffinoid aromatic hydrocarbon mixture.*
40242. ANGLO-IRANIAN OIL CO. LTD. : Refining of kerosene : *Subjecting to the treatment with sulphuric acid and then with liquid sulphur dioxide.*
38389. AMERICAN CYANAMID CO. : Purification of aqueous solutions of sugar : *Passing of solution through ion exchanger, adding about 0.01 to 0.1*

per cent of phosphoric acid and keeping the pH near about 6.8.

Miscellaneous Chemicals

37426. DELHI CLOTH & GENERAL MILLS CO. LTD., GUPTA, JAGANNATHAN & CHIPALKATTI : Improved composition for preparing sizing material for textile fibres and process for making same : *Comprising rosin, glue, an emulsifying oil and a preservative.*

Fuels & Lubricants

39057. KOPPERS CO. INC. : Coking expanding coals : *Expanding coal admixed with pitch, forming the oven charge, is surrounded by a stratum of non-coking solid fuel, and coking the charge while it is maintained stationary.*

Leather & Leather Products

- *38063. SIDDIQUI & DHAR : Compositions and process for the manufacture of patent leather : *Dissolving oil-resin along with film scraps in butyl acetate and solvent naphtha.*

Metal & Metal Products

32435. I.C.I. LTD. : Copper alloys : *Copper alloy comprising nickel 9-30 per cent, manganese 5-30 per cent, aluminium 0.1-2 per cent and rest copper.*
32434. I.C.I. LTD. : Copper alloys : *Consisting of copper, manganese 5-30 per cent and iron 0.5-5 per cent and nickel 5-30 per cent.*
37205. ELECTRIC FURNACE PRODUCTS CO. LTD. : Iron-base alloys : *Containing 15-25 per cent chromium, 15 per cent nickel, 10 per cent to 25 per cent cobalt, 1 per cent to 3.5 per cent molybdenum, 0.5 per cent to 3 per cent of one or more of niobium, tantalum, and vanadium, 2 per cent manganese, 1 per cent silicon, 35 per cent carbon, 0.5 to 2.5 per cent nitrogen, characterized by having a tungsten content before 7.5 to 15 per cent, and iron content at least 15 per cent of the alloy.*

Rubber & Rubber Products

38224. WINGFOOT CORP. : Method of making improved sponge rubber from latex : *Heating latex with 1 to 3 per cent of paraffin or wax followed by the addition of vulcanizers, gellers, anti-oxidants and accelerators at 160°-400°F.*

Textile & Textile Products

39202. RAO : Preparation of solutions or dispersions of cellulose and their application in textile sizing, finishing, dyeing and printing : *Textile is sized, finished or dyed with a solution or dispersion of cellulose activated by metallic catalyst.*

Miscellaneous

39431. NATIONAL RADIO & ENGINEERING CO. LTD. : Method of preparing electrodes for capacitors : *Silver nitrate mixed with water and glycerine and heated to effect reduction of silver nitrate, silver separated from glycerine being mixed with a lacquer, the paste being suitable for making electrodes.*

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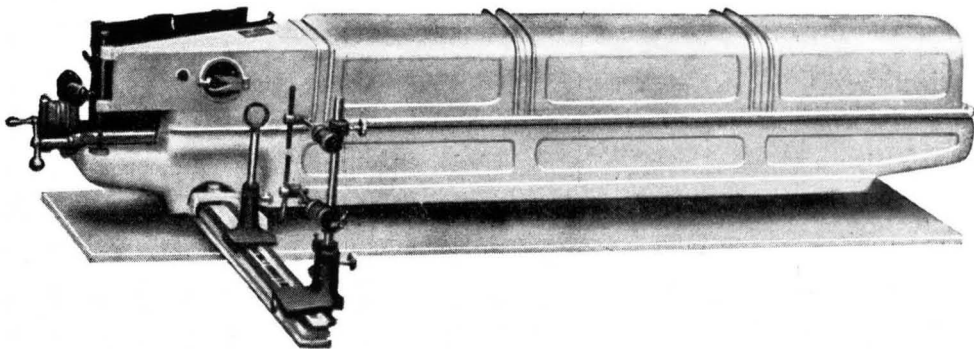
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The Raman Spectra at Low Temperatures— Diphenyl Sulphide, Diphenyl Methane & Sulphur Monochloride

N. C. MAJUMDAR

University College of Science, Calcutta

IT was observed previously by Sirkar and Bishui¹ that in the case of some substituted benzene compounds new lines in the low frequency region appear in the Raman spectra when the substances are solidified at low temperatures. It was suggested by them that this phenomenon might be due to the peculiar nature of the molecule so that in the solid state there might be polymeric groups of the substituted benzene molecules giving rise to new lines in the low frequency region. It was thought worth while to investigate the Raman spectra of some compounds in the molecules of which two benzene rings are attached to an atom, because a comparison of the values of the frequency shifts of the lines observed in the case of such molecules with those observed in the case of molecules containing a single benzene ring might throw some light on the origin of these lines. The Raman spectra of diphenyl sulphide and diphenyl methane have been studied with this object in view.

Since the molecule of diphenyl sulphide contains a sulphur atom, the study of the Raman spectrum of another type of molecule containing sulphur atoms but no benzene ring would be interesting in order to understand the significance of the changes which are observed with the solidification of these compounds. For this reason sulphur monochloride (S_2Cl_2) has been chosen and its Raman spectra have been investigated in the liquid and solid states.

Experimental

The arrangement used for the study of the Raman spectra of the substances in the solid state at low temperatures is the same as that used by Bishui². The liquid was put in a sealed pyrex tube which was held vertically inside a transparent Dewar vessel of pyrex glass, the mouth of which was closed with a cork and sealing wax. Through a tube fitting in a hole in the cork, liquid air was introduced by reducing the pressure inside the transparent Dewar vessel with a *Cenco Hyvac* pump connected to a glass tube passing into the Dewar vessel through another hole in the cork. The temperature of the substance in the pyrex tube could be regulated by adjusting the position of the surface of liquid air in the transparent Dewar vessel. A Fuess glass spectrograph having a dispersion of about 13.5 A.U. per mm. in the region of 4046 Å was used. The 4046 Å line of mercury in the spectrogram taken with this spectrograph showed a coma on the short wave-length side, but on the longer wave-length side there was no such coma, and therefore it was possible to detect the presence of new Raman lines lying close to the Rayleigh line.

Diphenyl sulphide was obtained from old stock in this laboratory from a Kahlbaum's sealed bottle. Diphenyl methane was obtained from a sealed bottle from *Eastman Kodak*, Rochester, New York, and sulphur monochloride (S_2Cl_2) was obtained from a sealed bottle from *E. Merck*. This

sulphur monochloride was originally found to be deep yellow in colour but on repeated distillation the colour became paler. The 4358 Å line of mercury, however, was extremely weak in the spectrum of the light scattered by the liquid. The absorption of the 5461 Å line was also appreciable because a long exposure was required to photograph the Raman spectrum of the liquid. In the case of sulphur monochloride in the solid state only four hours' exposure was enough to record the Raman lines excited by the line 5461 Å of Hg with fairly large densities. The dispersion of the spectrograph in this region is about 50 A.U. per mm. Both diphenyl sulphide and diphenyl methane were distilled repeatedly in vacuum and the spectrogram showed no continuous background. Slight weakening of the line 4046 Å due to absorption was observed in the spectrogram due to the light scattered by these liquids.

Results & Discussion

The spectrograms due to the three substances in the liquid and solid states are reproduced in Figs. 1, 2 and 3. The frequency shifts in wave numbers of the Raman lines observed are given in Tables I, II and III. In the first column of these Tables the data published by some of the previous workers have been included for comparison.

Diphenyl Sulphide

It can be seen from Table I that some of the feeble lines observed by Donzelot and Chaix³ in the case of liquid diphenyl sulphide have not been observed in the present investigation. Of these the line 1155 cm.⁻¹

is actually found to be a line at 1165 cm.⁻¹ and the line 1180 cm.⁻¹ reported by them seems to be the line 1003 cm.⁻¹ excited by 4077 Å. Similarly, the line 1475 cm.⁻¹ excited by 4358 Å is almost superposed on the line 3057 cm.⁻¹ reported by them. The existence of this line excited by 4046 Å could not be confirmed. It can also be seen that in the case of diphenyl sulphide the frequencies of the lines 1003 cm.⁻¹ and 1026 cm.⁻¹ diminish to 995 cm.⁻¹ and 1015 cm.⁻¹ respectively with the solidification of the substance and lowering of the temperature to -150°C. These two lines are due to the C-C valence oscillations of the benzene ring in the molecule and the fact mentioned above shows that this bond is weakened a little in the solid state. Further, the line 1584 cm.⁻¹ shifts to 1578 cm.⁻¹ and the line 1095 cm.⁻¹ also shifts to 1085 cm.⁻¹ and its intensity diminishes considerably at the low

TABLE I—DIPHENYL SULPHIDE (C₆H₅)₂S

LIQUID		SOLID
Δ ν in cm. ⁻¹ Donzelot, P. & Chaix, M. ³	Δ ν in cm. ⁻¹ At about 32°C. Present author	Δ ν in cm. ⁻¹ At about -150°C. Present author
187 (f)	.....	46 (1s) k
216 (f)	225 (1) e	.....
270 (ff)	265 (1) e	268 (o b) e
410 (fff)	403 (o b) e	400 (o) e
516 (fff)	523 (o) e	.....
614 (m)	618 (2) e, k	618 (o) e
692 (m, large)	695 (2) e, k	697 (o) e
999 (F)	1003 (10) e, k	995 (5) e, k
1023 (m)	1026 (2) e, k	1015 (o) e
1081 (ff)	.....	.....
1092 (aF, b)	1095 (5b) e, k	1085 (ob) e, k
1155 (f)	1165 (1) e	.....
1180 (ff)	.....	.....
1327 (fff)	.....	.....
1440 (fff)	1440 (o)	.....
1475 (fff)	.....	.....
1580 (F)	1584 (6) e, k	1578 (2) e, k
3057 (aF)	3062 (8) e, i, k	3062 (3) e, k

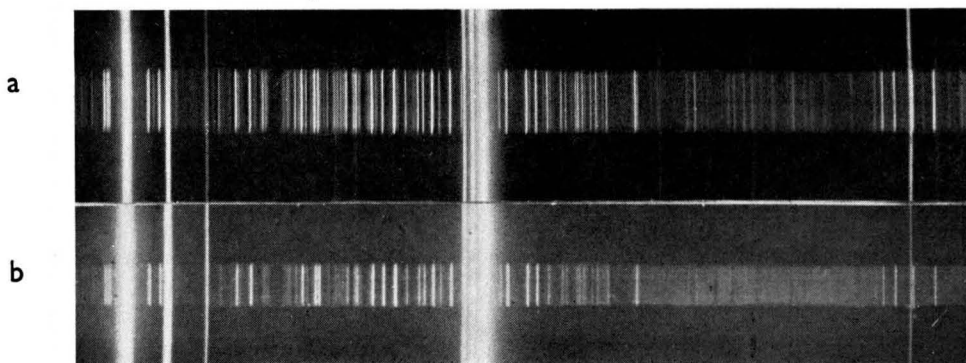


FIG. 1—(a) DIPHENYL SULPHIDE (LIQUID AT 32°C.). (b) DIPHENYL SULPHIDE (SOLID AT -150°C.).

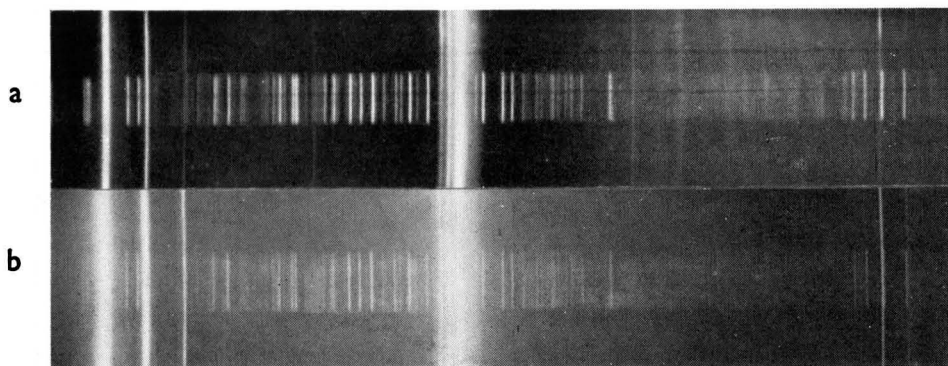


FIG. 2—(a) DIPHENYL METHANE (LIQUID AT 33°C.). (b) DIPHENYL METHANE (SOLID AT -70°C.).

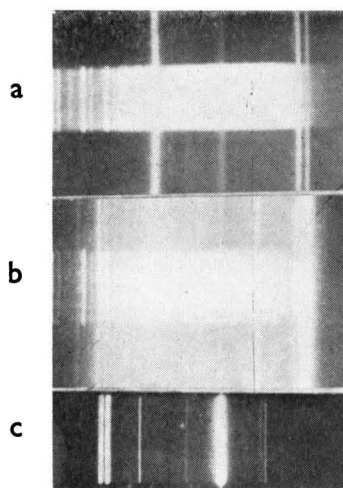


FIG. 3 — (a) SULPHUR MONOCHLORIDE (LIQUID AT 33°C.). (b) SULPHUR MONOCHLORIDE (SOLID AT -170°C.). (c) MERCURY ARC (DIFFERENT MAGNIFICATION).

temperature. It is remarkable, however, that the line due to C-H valence vibration of the benzene ring remains in its original position even at $-150^{\circ}\text{C}.$ and this fact shows that the majority of the C-H groups remain unaffected in the solid state at low temperature.

A new line at 46 cm.^{-1} is observed in the case of solid diphenyl sulphide at the low temperature and it is very sharp. As will be seen later, two such new lines are also observed in the case of diphenyl methane at the low temperature. Recently it has been pointed out by Rousset⁶ that in the case of naphthalene and some derivatives of benzene in the solid state the new lines

TABLE II — DIPHENYL, METHANE (C_6H_5)₂CH₂

LIQUID		SOLID
ΔV in cm.^{-1} Donzelot, P. & Chaix, M. ³	ΔV in cm.^{-1} At about 33°C. Present author	ΔV in cm.^{-1} At about -70°C. Present author
.....	.....	50 (1) k
.....	.....	65 (o) k
199 (f)	196 (2) e	.....
234 (f)	238 (2) e	238 (1) e
286 (fff)	289 (1) e	270 (o) e
457 (fff)	.....	.....
547 (ff)	553 (1) e	.....
599 (fff)	.....	.....
617 (f)	623 (3) e, k	623 (1)
734 (f)	737 (3) e, k	737 (2)
813 (f, large)	817 (3b) e, k	.....
840 (ff)	.....	.....
1001 (F)	1004 (8) e, k	1004 (5) e, k
1026 (m)	1028 (2) e, k	1024 (1) e, k
1155 (f, large)	1154 (o) e	.....
1184 (f, large)	1188 (2b) e	1192 (2) e
1436 (fff)	1425 (o) e	.....
1583 (f)	.....	.....
1601 (m)	1598 (5) e, k	1598 (2) e
2909 (m)	2920 (3) e, k	2920 (o) e
3054 (F)	3060 (10) e, i, k	3060 (3) e, k

TABLE III — SULPHUR MONOCHLORIDE, S_2Cl_2

LIQUID			SOLID
ΔV in cm.^{-1} Venkateswara- ran, S. ⁴	ΔV in cm.^{-1} Gerding, H. & Westrik, R. ⁵	ΔV in cm.^{-1} At about 33°C. Present author	ΔV in cm.^{-1} At about -170°C. Present author
107 (4d) c	106 D	115 (3) \pm c	115 (3) \pm c
210 (2) c	206 P	202 (3) \pm c	141 (0) c
248 (o) c	245 D	238 (1) c	202 (3) \pm c
449 (6d) c	443 P	454 (8) c	238 (1) c
545 (o) c	537 D	545 (1b) c	349 (3b) c
			442 (8) c
			536 (1b) c
			620 (3b) c
			692 (1) c

in the low frequency region can be explained on the hypothesis put forward earlier by Kastler and Rousset⁷ and also independently by Nedungadi⁸ that these lines are due to rotational oscillations of the molecule about its three axes in the field of the lattice. It is difficult to say whether this hypothesis

can explain the appearance of the new lines in the low frequency region in the case of the two compounds containing the benzene rings mentioned above, because there is only one new line in one case and two such lines, in the other case. It has to be pointed out, however, that whatever be the nature of oscillation that gives rise to these new lines, some virtual bond is probably responsible for the frequency observed, because some of the lines due to the intramolecular oscillations of the molecule are shifted from their original position when the two substances mentioned above are solidified.

Diphenyl Methane

In the case of diphenyl methane two new lines at 50 cm.^{-1} and 65 cm.^{-1} are observed in the Raman spectrum due to the solid state and these lines are absent in the Raman spectrum of the liquid. Further, the lines at 289, 1028 and 1188 cm.^{-1} shift respectively to 270, 1024 and 1192 cm.^{-1} with the solidification of the substance. There are slight changes in the positions of a few other lines also. It is interesting to compare the Raman spectrum of diphenyl methane with that of benzene at room temperature. The line 990 cm.^{-1} due to breathing vibration of the benzene molecule is split up into two lines at 1004 cm.^{-1} and 1028 cm.^{-1} and this phenomenon is observed in the case of almost all monosubstituted benzene compounds. The lines 403 cm.^{-1} and 695 cm.^{-1} , however, though present in the Raman spectra of benzene and diphenyl sulphide, are not present in the Raman spectrum of diphenyl methane. It is obvious from this fact that the attachment of the carbon atom of benzene ring to that of CH_4 alters the frequencies of these vibrations while such an attachment to the sulphur atom in diphenyl sulphide does not affect these frequencies. The behaviour of some of the prominent lines of diphenyl methane on solidification of the liquid is, however, quite different from that of the same lines in the case of diphenyl sulphide. For instance, in the former case the lines 1004 and 1598 cm.^{-1} remain in their original positions in the Raman spectrum due to the solid while these lines shift slightly to lower frequencies in the latter case. It is thus evident that the C-S bond in the latter case is affected primarily with the solidification of the substance and this change in the strength of the C-S bond affects indirectly the frequencies of the vibrations of the

benzene ring mentioned above. It is not unlikely that the appearance of the new lines in the solid state in both these cases may be due to the same cause as is responsible for the change in the frequencies of some of the Raman lines mentioned above.

Sulphur Monochloride

Sulphur chloride attracted the attention of a large number of workers previously. Venkateswaran⁴ showed that the number and frequencies of the Raman lines could be explained by assuming the form by Cl-S-S-Cl of the molecule and that the view held by previous workers was not correct. Mizushima and Morino⁹ pointed out that the finite value of the permanent electric moment of the molecule cannot be explained by assuming that the molecule Cl-S-S-Cl has a trans-configuration. They, therefore, suggested that the plane through one of the S-Cl group might make an angle of 90° with the plane through the other S-Cl group in this molecule. Gerding and Westrik⁵ have shown that of the five Raman lines of S_2Cl_2 in the liquid state, three are totally depolarized and two are polarized, and they have concluded from these results that there is hindered rotation about the *cis* position of the Cl-S-S-Cl structure of the molecule. In the present investigation also only five lines have been observed in the Raman spectrum of S_2Cl_2 in the liquid state, and the solid state at about -170°C . yields altogether nine Raman lines. Of these the lines 349 cm.^{-1} and 620 cm.^{-1} are superposed on the halations produced by the over-exposure of the Hg lines 5461 \AA and $5770 \text{ \AA}-5791 \text{ \AA}$ doublet. The other new lines 141 cm.^{-1} and 692 cm.^{-1} are quite sharp. Besides these, the lines 454 cm.^{-1} and 545 cm.^{-1} shift to 442 cm.^{-1} and 536 cm.^{-1} respectively in the solid state. These changes suggest that the molecule undergoes profound changes in the solid state.

The presence of lines having frequency shifts above 545 cm.^{-1} cannot be explained by assuming that the molecule has the form Cl-S-S-Cl. On the contrary, the presence of the line 692 cm.^{-1} in the solid state shows that there is definitely S=S bond in the solid state and the molecule has the configuration $\text{S}=\text{S}<\overset{\text{Cl}}{\text{Cl}}$. This molecule also should have yielded only six Raman lines and cannot account for all the nine lines actually ob-

served. The diminution in the frequency of the lines 454 and 545 cm.^{-1} due to S-Cl valence oscillation indicates that some changes occur in this bond. The extra lines might, therefore, be due to the formation of a dimer in the solid state, each of the two molecules having the structure $\text{S}=\text{S} \begin{smallmatrix} \text{Cl} \\ < \\ \text{Cl} \end{smallmatrix}$.

Summary

The Raman spectra of diphenyl sulphide, diphenyl methane and sulphur monochloride in the solid and liquid states have been investigated. In the case of the first two compounds in the solid state new lines have been observed in the low frequency region. The frequency shift in the first case is 46 cm.^{-1} and in the second case 50 and 65 cm.^{-1} respectively. In the case of diphenyl sulphide the frequencies of some lines due to C-C vibrations have been observed to diminish in the solid state. In the case of diphenyl methane only three lines 289 cm.^{-1} , 1028 cm.^{-1} and 1188 cm.^{-1} shift slightly when the substance is solidified. In the case of sulphur monochloride the liquid state yields only five lines, but in the solid state nine lines are observed. It is pointed out that the single molecule of S_2Cl_2 cannot produce so many

Raman lines and that one of the new lines is due to S=S oscillation, so that in the solid state the structure of the molecule changes from Cl.SSCl to $\text{SS}(\text{Cl})_2$ and that the molecules form dimers in the solid state.

Acknowledgement

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Preparation & Study of Synthetic Drying Oils

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FOR many years attempts have been made to synthesize oils having good drying properties. The last war gave a great impetus to the development and production of chemically treated, isomerized, reoriented synthetic drying oils¹.

The shortage of tung oil led to a search for substitutes obtainable by processing available drying oils. Three possibilities suggested themselves: (1) dehydration of castor oil; (2) increasing the effective unsaturation of fatty acids by chemical treatment, fractionation or solvent extraction, and conjuga-

tion of double bonds by treatment with catalysts; and (3) esterification of unsaturated fatty acids by alcohols more polyhydric than glycerol. The last, in particular, had many interesting possibilities.

The method of re-esterification is a natural and logical development based on Carother's theory of functionality², especially as expanded and interpreted by Bradley³. In practice, pentaerythritol and higher polymerized alcohols have proved useful for this purpose.

Blagonravova and Drinberg⁴ showed that the esterification rates for pentaerythritol

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are essentially the same as those for other polyhydric alcohols, while Burrel⁵ showed that the primary hydroxyl groups of pentaerythritol undergo esterification slightly faster than glycerol with its one secondary group. Besides these alcohols sugar alcohols, such as sorbitol and mannitol, can also be employed.

The most widely accepted theory of drying oils is one which is based on the dimensional polymer structure. According to this theory, all polymers which are infusible and insoluble are of the cross linked 3-dimensional form. Natural and synthetic drying oils should possess a structure which will permit the formation of a 3-dimensional polymer.

In order to get a good drying oil from semi- or non-drying oil fatty acids possessing a functionality of 2 (one due to the COOH group, and the other due to unsaturation), the esterification should be carried out with polyhydric alcohols which are more functional than glycerol (which has 3 —OH groups). The greater the number of —OH groups in the alcohol, the better will be the drying and bodying properties of the esters obtained. The introduction of conjugated double bonds during the esterification of the fatty acids will enhance the drying properties. This can be achieved by co-esterifying the given fatty acids with drying oil fatty acids which are rich in conjugated double bonds. The functionality of fatty acids containing conjugated double bonds as a major portion of the total unsaturation may be taken as more than 2 because it is presumed that the Diels-Alder reaction takes place during polymerization.

The advantages to be gained by the presence of conjugated unsaturation in the final esters (oils) can be seen from the results of Lanson and Spoerri's experiments⁶. The polymerization rate of tung-methyl ester is 8 — 9 times that of soyabean-methyl ester under identical conditions. Further, the copolymerization of one part of tung-methyl ester and two parts of soyabean-methyl ester after 3 hours at 300°C. is 1.8 times the theoretical rate calculated on the basis of individual rates of polymerization of two methyl esters. The probability of conjugated alcostearate radicals reacting with non-conjugated fatty acids by a Diels-Alder type of reaction is assumed.

Experimental

The present work is divided into 4 parts : In the first part (Series I) cotton seed fatty

acids are esterified with polyhydric alcohols of the type of glycerol, mannitol, sorbitol isomerized mixtures, " Pentek " (a mixture of 85 per cent pentaerythritol and 15 per cent related solid polyhydric alcohol), " Dipentek " (dipentaerythritol alcohol), and " Polypentek " (mixture of polymers of pentaerythritol).* The effect of changing the top temperature during esterification on the properties of the final oils were also studied. The second part (Series II) deals with the esterification of " Dipentek " with fatty acids obtained from cotton seed, fish liver oil, fish oil, peanut oil and tall oil. In the third part (Series III) the co-esterification of semi- or non-drying oil fatty acids and drying oil fatty acids is carried out with " Dipentek ". In the last part (Series IV) the rate of bodying of the synthetic oil prepared by esterifying cotton seed fatty acids with " Dipentek " is compared with alkali-refined linseed oil with different additives used as accelerators.

The reaction is carried out in a weighed open varnish kettle made of monel metal and having a capacity of about 3-4 gallons. The reaction mixture is stirred at moderate speed. The kettle is weighed after charging, and then put on the fire-grate and heated with a gas burner. The compressed air-driven stirrer is started when the mass has almost melted. The rate of heating is so adjusted that the top temperature is reached in about 60-70 minutes. The first sample is drawn as soon as the top temperature is attained. The temperature is then maintained constant and samples are drawn periodically. After the completion of the reaction, the kettle is cooled, weighed and the product filtered through a strainer. The loss in weight during cooking is calculated by taking the material balance before and after the reaction. The loss is due mainly to the loss of water of esterification and, to a small extent, also due to the escape of volatiles present in the fatty acids.

Results

Table I shows the formulation and properties of oils produced in the first series of experiments. Figs. 1 and 2 give the rates of esterification. Table II shows the formulation and properties of oils produced in the second series of experiments. Fig. 3 gives the rates of esterification. Table III

* " Pentek ", " Dipentek " and " Polypentek " were obtained from *Heyden Chemical Corporation*, New York.

TABLE I—SERIES I. FORMULATION & PROPERTIES OF OILS PRODUCED

CODE NUMBER	FORMULATION	% TOTAL CHARGE	TOP TEMP. °F.	% LOSS IN COOKING	BODY*	REF. INDEX AT 55°F.	PROPERTIES OF PROCESSED OIL			REMARKS
							Gelling time at 530°F. or body after 6 hr. at 530°F.	Drying of film of 1.5 mil thickness with 0.24 Ca as Ca-naphthenate at room temp.	Acid No.	
Co-V	Cotton seed fatty acids	89.0	450	15.5	Semi-solid	...	...	...	...	...
Co-VI	Glycerol	11.0	450	12.6	½hH	1.4808	U	Tacky after 12 days	11.2	...
	Cotton seed fatty acids	83.8								
Co-VIII	Sorbitol isomerized mix.	16.2	450	14.7	F	1.4809	V	Very tacky aft. 12 days	23.5	...
	Cotton seed fatty acids	84.6								
Co-IV	Mannitol	15.4	450	10.4	¼ thin	1.4785	½hW	,,	10.5	...
	Cotton seed fatty acids	87.0								
Co-III	"Pentek"	13.0	450	11.3	½hJ	1.4790	¼ thin Y	,,	11.7	...
	Cotton seed fatty acids	85.0								
Co-VII	"Dipentek"	15.0	450	7.5	½hI	1.4815	X	Tacky aft. 12 days	12.5	8.3% gel
	Cotton seed fatty acids	84.0								
Co-X	"Polypentek"	16.0	450	7.4	½hE	1.4795	¼ thin U	Tacky aft. 8 days	11.5	...
	Cotton seed fatty acids	87.0								
Co-XI	"Pentek"	13.0	500	11.6	½hF	1.4800	½hT	Slightly tacky aft. 8 days	3.8	...
	Ca-naphthenate	0.012								
Co-XII	Cotton seed fatty acids	87.0	500	12.4	½hI	1.4815	Y	Very slightly tacky aft. 8 days	11.0	...
	"Dipentek"	13.0								
Co-XIII	"Dipentek"	15.0	500	11.8	K	1.4815	Y	Slightly tacky aft. 8 days	16.0	...
	Cotton seed fatty acids	84.0								
	"Polypentek"	16.0								

*Gardner-Holdt Scale, see Gardner, H.A., *Physical & Chemical Examination of Paints, Varnishes, Lacquers & Colors* (Institute of Paint & Varnish Research, Washington D.C.), 1939, 9th ed.

TABLE II—SERIES II. FORMULATION & PROPERTIES OF OILS PRODUCED

CODE NUMBER	FORMULATION	% TOTAL CHARGE	TOP TEMP. °F.	% LOSS IN COOKING	BODY*	REF. INDEX AT 55°F.	PROPERTIES OF PROCESSED OIL			REMARKS
							Gelling time at 530°F. or body after 6 hr. at 530°F.	Drying of film of 1.5 mil thickness with 0.24% Co as Co-naphthenate at room temp.	Acid No.	
C-4	Cotton seed fatty acids	86.3	500	12.0	½hI	1.4780	¼ thin Y	Very slightly tacky aft. 12 days	9.5	...
C-5	"Dipentek"	13.7	500	13.7	½hT	1.4890	Z-6	Very slightly tacky aft. 5 days; tack free aft. 12 days	6.7	...
	Fish liver fatty acids	88.0								
C-9	"Dipentek"	12.0	500	12.0	1 bubble thin A	1.4690	...	Tack free aft. 1 day	15.8	Diluted to 50% oil with benzene
	Tall oil	87.2								
P-4	"Dipentek"	12.8	500	12.5	J	1.4790	...	Tacky aft. 9 days	9.2	...
	Peanut fatty acids	86.3								
F-1	"Dipentek"	13.7	500	11.4	¼ thin U	1.4878	350 min.	Tack free aft. 1 day	9.2	...
		Fish-oil fatty acids									87.6
	"Dipentek"	12.4								

*Gardner-Holdt Scale.

shows the formulation and properties of oils produced in the third series of experiments. Figs. 4-8 give the rates of esterification. Table IV shows the formulation and properties of oils produced in the fourth series of experiments and indicates the rates of bodying when various additives are employed as accelerators.

Discussion

The tables and graphs give a picture of the rates of esterification, and the drying properties of products obtained by esterifying cotton seed fatty acids with glycerol, mannitol, sorbitol isomerized mixture, "Pentek", "Dipentek", and "Polypentek". Considering the penta series of alcohols, it will

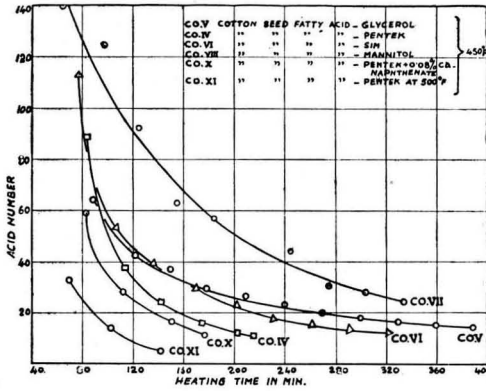


FIG. 1 — RATE OF ESTERIFICATION.

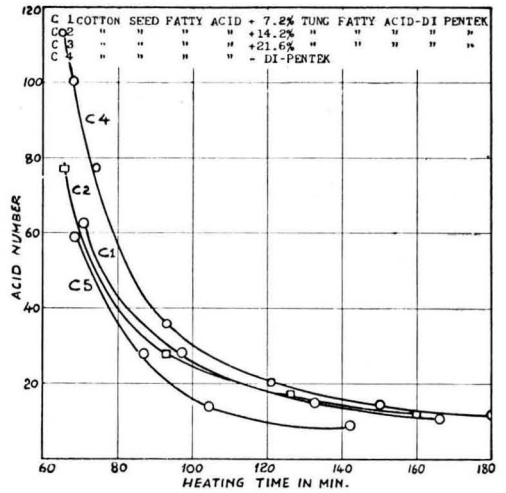


FIG. 4 — RATE OF ESTERIFICATION.

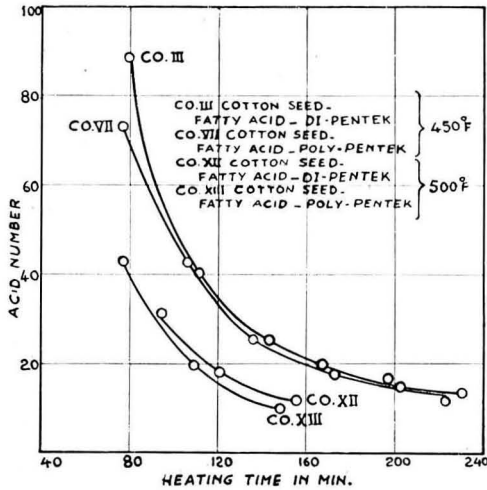


FIG. 2 — RATE OF ESTERIFICATION.

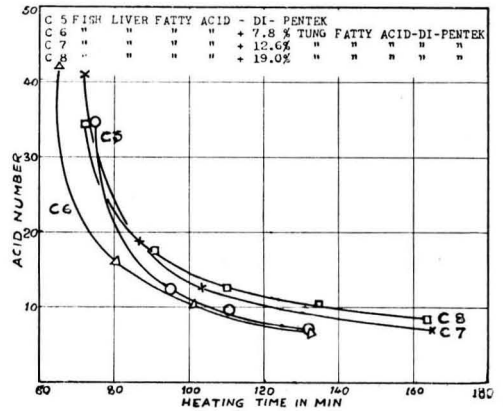


FIG. 5 — RATE OF ESTERIFICATION.

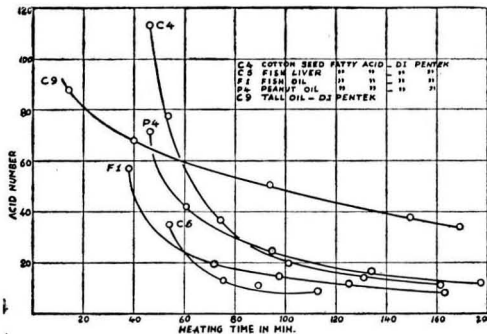


FIG. 3 — RATE OF ESTERIFICATION.

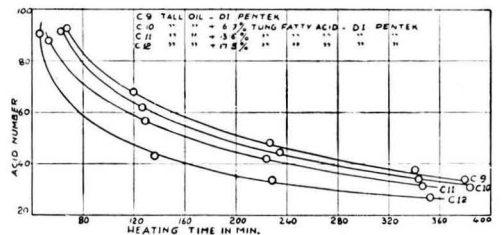


FIG. 6 — RATE OF ESTERIFICATION.

be seen that esterification of the fatty acids with "Polypentek" is faster than that with "Dipentek", which in turn is faster than that with "Pentek". The rate of esterification increases with temperature.

The use of 0.08 per cent calcium (as Ca-naphtenate) on the weight of "Pentek" enhances both the rate of esterification of cotton seed fatty acids, and the rate of drying of the final product.

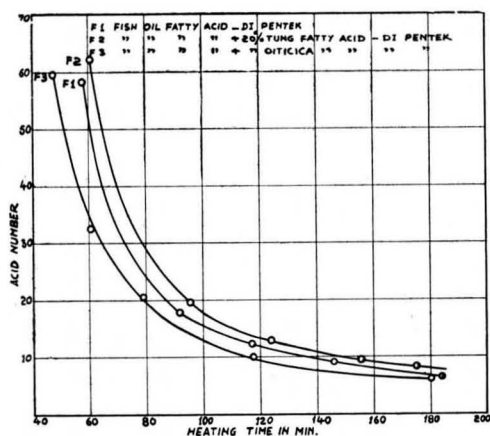


FIG. 7 — RATE OF ESTERIFICATION.

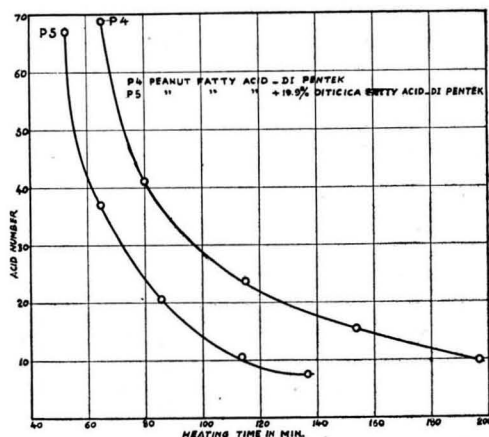


FIG. 8 — RATE OF ESTERIFICATION.

TABLE III — SERIES III. FORMULATION & PROPERTIES OF OILS PRODUCED

CODE NUMBER	FORMULATION	% TOTAL CHARGE	TOP TEMP. °F	BODY*	% LOSS IN COOKING	REF. INDEX AT 72°F.	PROPERTIES OF PROCESSED OIL			REMARKS
							Gelling time at 530°F. or body after 6 hr. at 530°F.	Drying of film of 1.5 mil thickness with 0.24% Co as Co-naphthenate at room temp.	Acid No.	
C-1	Cotton seed fatty acids Tung fatty acids " Dipentek "	79.0 20.2 13.8	500	R	10.8	1.4815	½ thin Z-4	Tack free aft. 29 hr.	10.1	
C-2	Cotton seed fatty acids Tung fatty acids " Dipentek "	72.0 14.2 13.8	500	½hV	11.1	1.4840	Almost solid	Very slightly tacky aft. 6 hr. and tack free aft. 1 day	11.2	...
C-3	Cotton seed fatty acids Tung fatty acids " Dipentek "	64.6 21.6 13.8	500	½ thin Z-6	11.5	1.4880	85 min.	Very slightly tacky aft. 6 hr. and tack free aft. 1 day	8.0	...
C-6	Fish liver fatty acids Tung fatty acids " Dipentek "	80.2 7.8 12.2	500	W-1	15.1	1.4912	Z-6	Slightly tacky aft. 1 day and tack free aft. 8 days	6.7	...
C-7	Fish liver fatty acids Tung fatty acids " Dipentek "	75.2 12.6 12.2	500	½hZ-1	22.4	1.4932	250 min.	Vey slightly tacky aft. 1 day and tack free aft. 5 days	6.7	...
C-8	Fish liver fatty acids Tung fatty acids " Dipentek "	68.7 19.0 12.3	500	Heavier than Z-6	21.5	1.4950	80 min.	Tack free aft. 1 day	8.3	...
C-10	Tall oil Tung fatty acids " Dipentek "	80.3 6.7 13.0	500	thin A	13.6	1.4691	...	Tack free aft. 1 day	14.6	Diluted to 50% solids with benzene
C-11	Tall oil Tung fatty acids " Dipentek "	73.6 13.4 13.0	500	thin A	11.7	1.4692	...	Tack free aft. 1 day	15.0	do
C-12	Tall oil Tung fatty acids " Dipentek "	69.5 17.5 13.0	500	C	...	1.4705	...	Tack free aft. 1 day	12.6	do
F-2	Fish oil fatty acids Tung fatty acids " Dipentek "	72.8 14.6 12.6	500	2½h Z-6	10.4	1.4920	0.0 min. (before top temp. is reached)	Very slightly tacky aft. 1 day and tack free aft. 2 days	7.8	...
F-3	Fish oil fatty acids Oiticica fatty acids " Dipentek "	72.0 15.0 13.0	500	½h Z-4	11.3	1.4920	100 min.	Tack free aft. 7 hr.	5.8	...
P-5	Peanut fatty acids Oiticica fatty acids " Dipentek "	66.6 19.9 13.7	500	½h Z-4	17.2	1.4910	...	...	7.8	...

*Gardner-Holdt Scale.

In the case of "Polypentek"-cotton seed fatty acids esters, a certain degree of gel formation is noticed. This is attributed to the impurities in "Polypentek" (technical grade) used for the esterification and also to the very complex structure of the alcohol.

TABLE IV — CHANGES IN BODYING, REF. INDEX & ACID NUMBER OF SYNTHETIC OIL CO-XII, & ALKALI-REFINED LINSEED OIL WITH DIFFERENT ADDITIVES

	SAMPLE NO.						
	1	2	3	4	5	6	7
1. Cov-I — 95.5 parts Co-XII oil & 4.5 parts maleic anhydride							
Hr. after top temp.	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Body in poises	5.7	10.7	12.9	16.0	22.7	30.2	54.3
Acid No.	18.4	13.0	10.0	7.75	7.0	6.25	5.2
Ref. index at 50°F.	1.4830	1.4845	1.4852	1.4855	1.4860	1.4862	1.4865
2. Cov-II — 95.5 parts linseed oil & 4.5 parts maleic anhydride							
Hr. after top temp.	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Body in poises	0.85	1.65	2.75	4.85	9.32	19.2	41.2
Acid No.	15.5	6.25	6.75	8.75	9.25	9.0	7.75
Ref. index at 55°F.	1.4870	1.4884	1.4898	1.4910	1.4922	1.4931	1.4944
3. Cov-III — 95.5 Co-XII oil & 4.5 parts crotonic acid							
Hr. after top temp.	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Body in poises	2.44	3.05	3.85	5.5	7.55	9.7	15.2
Acid No.	2.5	2.25	2.5	3.25	2.5	2.75	3.25
Ref. index at 64°F.	1.4800	1.4802	1.4804	1.4813	1.4819	1.4822	1.4828
4. Cov-IV — 95.5 linseed oil & 4.5 parts crotonic acid							
Hr. after top temp.	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Body in poises	0.45	0.65	0.85	1.0	1.65	2.13	3.3
Acid No.	6.0	2.5	1.75	1.5	1.25	1.25	1.25
Ref. index at 70°F.	1.4819	1.4822	1.4830	1.4836	1.4845	1.4849	1.4859
5. Cov-V — 95.5 parts Co-XII oil & 4.5 parts sorbic acid							
Hr. after top temp.	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Body in poises	2.92	3.85	4.7	6.27	8.86	9.7	15.3
Acid No.	11.0	5.5	3.0	2.0	1.75	1.5	1.25
Ref. index at 73°F.	1.4778	1.4787	1.4798	1.4802	1.4810	1.4815	1.4820
6. Cov-VI — 95.5 parts linseed oil & 4.5 parts sorbic acid							
Hr. after top temp.	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Body in poises	0.58	0.75	1.0	1.4	2.25	3.15	4.18
Acid No.	4.25	5.0	4.75	4.0	3.5	3.5	3.25
Ref. index at 70°F.	1.4820	1.4832	1.4840	1.4848	1.4856	1.4865	1.4872

REMARKS: Films of 1.5 mil thickness, and 0.24% Co as Co-naphthenate tack free at room temperature after: (1) 4 days; (2) 4 days; (3) 7 days; (4) 4 days; (5) 7 days; (6) 4 days.

Comparing the properties of esters obtained by the use of alcohols other than those of the "Pentek" series, it will be noticed that the product obtained with sorbitol isomerized mixture shows a good drying rate.

The drying rates of the esters are improved as the temperature of esterification is increased. At a temperature of 450°F. "Polypentek" ester dries better than "Pentek" or "Dipentek" esters. The "Pentek" ester prepared at a top temperature of 500°F. is comparable in drying properties to the "Polypentek" ester prepared at a top temperature of 450°F.

The rate of bodying of oils increases in the order: sorbitol isomerized mixture, mannitol, "Pentek", "Dipentek" and "Polypentek" esters.

The fish liver oil fatty acids are the fastest, and the tall oil the slowest, to esterify with "Dipentek" as judged by acid numbers. Fish oil fatty acids, cotton seed oil fatty acids and peanut oil fatty acids come in

between the fish liver oil fatty acids and tall oil acids.*

The refractive indices of the esters decrease in the order, fish liver oil, fish oil, peanut and cotton seed fatty acids.

The drying rate of fish oil fatty acids esters is high, that of the peanut fatty acids esters being the lowest. The cotton seed fatty acids esters dry better than fish liver fatty acids esters, but the film obtained is tacky even after 12 days. Cotton seed, fish liver and fish oil fatty acids esters progressively show an increasing rate of bodying.

The use of tung oil fatty acids in co-esterification enhances the drying rate, the rate of bodying and the refractive index of the fatty acids esters. The higher the percentage of tung oil fatty acids in the mixture, the higher is the improvement in

*Since tall oil (Union Bag & Paper Corporation, New York; fatty acids 48.52 per cent and rosin acids 42.46 per cent) ester is a semi-solid due to the presence of abietic acid ester, a 50 per cent solution in benzene is used for evaluating its properties.

the drying rate, bodying rate and refractive index. The addition of oiticica oil fatty acids also improves the drying rate and the rate of bodying. These improvements are due to a net increase in the amount of total as well as conjugate types of unsaturation per molecule of ester formed.

The rate of bodying of the synthetic oil CO-XII is compared with the bodying rate of alkali-refined linseed oil in the presence of different additives. The synthetic oil bodies faster than the alkali-refined linseed oil, but the refractive index of bodied linseed oil is higher than that of the synthetic oil CO-XII. The drying rates of bodied linseed oils are superior to those of the corresponding bodied synthetic oil.

The fast rate of bodying (heat polymerization) of the synthetic oil compared to linseed oil may be explained on the basis that the polyhydric alcohol "Dipentek" used in the former case is much more complex and polyhydric in nature than glycerol which is present in linseed.

The fast drying rate (oxygen polymerization) of the boiled linseed oil indicates that

(a) the total amount of unsaturation per molecule of bodied linseed oil is more than that present in a molecule of the bodied synthetic oil; and/or (b) a part of the total unsaturation of the linseed oil molecule is of the conjugated type. In so far as oxygen polymerization is concerned, conjugate unsaturation is considered to be more effective than an equivalent amount of unsaturation due to isolated double bonds as the former gives Diels-Alder reaction.

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Carotenoid Pigments of Common Indian Fruits

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IN earlier papers, the results of investigations on the carotenoid pigments of different varieties of maize¹, mango², carrots³, oranges⁴, and common vegetables⁵ have been reported. The results relating to the carotenoid pigments of some common Indian fruits such as water-melon, peach, mango, papaya, apricot, pine-apple, banana, guava, musk-melon and Mosambique oranges are reported in this paper.

The carotenoid pigments of fruits are varied, and isomers of the same pigment are often present. Observations on the total hydrocarbon pigments of fruits have been reported by earlier workers⁶⁻¹⁴.

All the fruits were obtained from the market, and were of the quality commonly

consumed. The procedure followed for the complete extraction, isolation and estimation of the different carotenoid pigments has been described in an earlier paper⁴. The quantities of different pigments were estimated colorimetrically by referring to a standard curve of β -carotene against 0.04 per cent potassium dichromate. The same curve was used for the estimation of all the pigments except for lycopene and neo-lycopene. In the case of these two pigments, the solutions of the pigments were matched against 0.001 per cent methyl orange and the quantities read off from a standard curve showing the relation between the colour intensities of different concentrations of pure lycopene and 0.001 per cent methyl orange.

The results are expressed as $\mu\text{gm./gm.}$ of the fresh material.

On the basis of the biological activity of the various carotenoid pigments reported in the literature, the vitamin A potency is calculated according to the following formula :

Vitamin A potency in I.U. per gm.

$$= \frac{\mu\text{gm. } \beta\text{-carotene}}{0.6} + \frac{\mu\text{gm. } \alpha\text{-carotene}}{1.2} \quad (\text{Wilkinson}^{15}) + \frac{\mu\text{gm. } \gamma\text{-carotene}}{1.2} \quad (\text{Kuhn, et. al.}^{16}) + \frac{\mu\text{gm. neo-}\beta\text{-carotene B}}{1.2} \quad (\text{Deuel, et. al.}^{17}) + \frac{\mu\text{gm. neo-}\beta\text{-carotene U}}{2.4} \quad (\text{Kemmerer and Fraps}^{18}) + \frac{\mu\text{gm. kryptoxanthin}}{1.2} \quad (\text{Deuel, et. al.}^{19}) + \frac{\mu\text{gm. neo-kryptoxanthin}}{1.2} \quad (\text{Fraps and Kemmerer}^{20})$$

The analytical data on the carotenoid pigments present in the various fruits are given in Tables I to III. Table I gives the results of analyses of fruits rich in carotenoids, viz. water-melon, peach and mango ; Table II of fruits moderately rich in carotenoids, viz. papaya and apricot ; and Table III of fruits poor in carotenoids.

Discussion

Water-melon (Citrullus vulgaris)—Lycopene and carotene from the fruit were isolated by Zechmeister and Tuzson²¹ who showed that lycopene, the chief pigment, was responsible for its red colour. Zechmeister and Polgar²² detected 6 different carotenoid pigments in this fruit, viz. xanthophyll, lycopene, γ -carotene, β -carotene and α -carotene and an unknown carotenoid which is located between γ -carotene and β -carotene in the adsorption column. In our studies we have not been able to detect γ -carotene and the unknown pigment which is adsorbed on the column between γ -carotene and β -carotene in Zechmeister and Polgar's²² investigations, but an additional unidentified band which is adsorbed just below xanthophyll was detected.

A typical chromatogram is shown in Fig. 1.

Peach (Amygdalus persica)—Strain²⁵ and Mackinney²⁶ using magnesium oxide as an adsorbant found the carotenoids in peaches to consist of β -carotene, 35-40 per cent ; kryptoxanthin, 25-30 per cent ; and the remainder to be lutein and zeaxanthin. Thaler, et al²⁷, showed that the meat from

yellow peaches contains lutein, β -carotene and lycopene in the ratio 8 : 2 : 1 ; Kemmerer and Fraps²⁸ reported that peaches do not contain measurable quantities of lycopene. It cannot occur to the extent of 9-10 per cent as indicated. In our studies, 5 pigments were isolated from peach, viz.

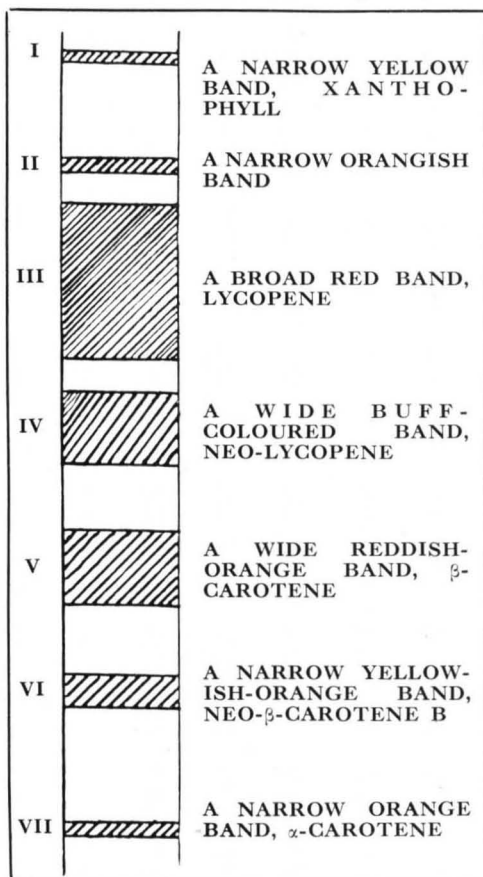


FIG. 1—TYPICAL CHROMATOGRAM OF THE PIGMENTS OF WATER-MELON.

- BAND I REPRESENTS XANTHOPHYLL AS SHOWN BY PHASE SEPARATION.
- BAND II IS DUE TO A PIGMENT WHICH HAS NOT BEEN IDENTIFIED.
- BAND III REPRESENTS LYCOPENE AS SHOWN BY ITS ABSORPTION SPECTRUM.
- BAND IV IS PRESUMABLY AN ISOMER OF LYCOPENE, CALLED NEO-LYCOPENE BY ZECHMEISTER AND TUZSON²¹.
- BAND V REPRESENTS β -CAROTENE AS SHOWN BY ITS ABSORPTION SPECTRUM.
- BAND VI IS AN ISOMER OF β -CAROTENE CALLED NEO- β -CAROTENE B BY POLGAR AND ZECHMEISTER²².
- BAND VII HAS BEEN IDENTIFIED AS α -CAROTENE BY ITS ABSORPTION SPECTRUM.

TABLE I — RICH SOURCES OF CAROTENOID PIGMENTS

FRUIT AND SOURCE OF THE SAMPLE	TOTAL PIGMENTS	XANTHO- PHYLL	NEO- XANTHO- PHYLL	UNIDENTI- FIED PIGMENT	KRYPTO- XANTHIN	LYCOPENE	NEO- LYCOPENE	NEO-β- CAROTENE U	β-CAROTENE	NEO-β- CAROTENE B	α-CAROTENE	TOTAL ACTIVE PIGMENTS AS β-CAROTENE		VITAMIN A POTENCY I.U./gm.
												μgm./ gm.	%	
Water-melon (<i>Citrullus vulgaris</i>)														
Delhi	34.2	0.3	0.9	0.2	0.6	33.6	98.2	0.1	0.3	0.1	0.3	0.1	0.3	0.2
	75.4	0.4	0.5	0.2	0.3	59.6	79.0	0.3	0.4	0.3	0.4	0.3	0.4	0.5
Gukhar	138.6	0.8	0.6	1.0	0.7	103.3	74.4	27.6	19.9	0.6	0.2	0.1	5.5	4.0
Farukhabad	140.7	0.6	0.4	1.1	0.8	108.3	76.9	26.4	18.7	3.3	2.6	0.1	3.8	2.7
Peach (<i>Amygdalus persica</i>)														
Delhi, unripe	2.3	1.5	65.2	0.2	8.7	0.2	8.7	0.3	13.0	0.1	4.3	0.1	4.5	19.6
" ripe	20.0	16.0	80.0	1.1	5.5	0.6	3.0	2.0	10.0	0.3	1.5	0.1	2.70	13.5
Quetta	68.3	56.0	81.9	5.6	8.2	0.9	1.3	4.9	7.1	0.9	1.3	0.1	8.15	11.9
Peshawar	78.3	62.5	79.8	5.9	7.5	2.4	3.1	6.5	8.3	1.0	1.2	0.1	9.95	12.7
Mango (<i>Mangifera indica</i>)														
Bombay, Terry	62.8	31.5	50.2	0.2	0.2	0.2	0.2	3.1	5.0	23.0	38.0	4.3	6.8	44.7
" "	12.7	2.0	21.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
" India	137.4	61.2	45.1	3.5	2.6	0.4	1.8	51.6	38.0	16.0	19.3	0.1	60.87	48.7
" Sapsida	17.3	5.9	34.1	0.4	2.3	0.4	2.3	0.4	2.3	0.1	1.6	0.1	9.95	57.5
" Surkha	14.9	7.5	50.3	0.5	3.3	6.2	41.6	0.7	4.6	0.7	4.6	0.1	6.67	44.8
" Tota Pari	21.9	10.4	47.5	0.3	1.3	10.0	45.6	1.2	5.5	0.1	1.1	0.1	10.67	48.7
" Malda	10.0	4.9	49.0	0.3	3.0	3.7	37.0	1.1	11.0	0.1	0.1	0.1	4.32	43.2
Sabarapur	17.5	8.5	48.5	0.1	0.1	0.1	0.1	1.0	5.7	7.0	40.0	1.0	5.7	44.3
Ramkaila	164.9	42.1	25.5	7.3	4.4	96.3	58.4	19.2	11.6	0.1	0.1	0.1	7.75	44.3
Saroli													107.72	65.3

TABLE II — MODERATELY RICH SOURCES OF CAROTENOID PIGMENTS

FRUIT AND SOURCE OF THE SAMPLE	TOTAL PIGMENTS	ZEAXANTHIN	XANTHOPHYLL	KRYPTO- XANTHIN	NEO-KRYPTO- XANTHIN	LYCOPENE	NEO-β- CAROTENE U	β-CAROTENE	NEO-β- CAROTENE B	TOTAL ACTIVE PIGMENTS AS β-CAROTENE		VITAMIN A POTENCY I.U./gm.
										μgm./ gm.	%	
Papaya (<i>Carica papaya</i>)												
Lucknow, pale yellow, unripe	3.9	2.3	59.0	1.2	30.8	0.3	7.7	0.1	2.6	0.95	24.4	1.6
" light yellow, unripe	5.6	2.2	39.3	2.9	51.8	0.4	7.1	0.1	0.8	1.90	33.9	3.2
" light yellow, ripe	9.2	3.8	41.3	4.9	53.2	0.4	4.3	0.1	1.1	2.90	31.5	4.8
" deep yellow, ripe	19.99	4.1	20.5	11.7	58.5	0.29	1.5	3.1	15.5	0.8	4.0	15.8
" deep yellow, ripe	21.9	4.8	22.0	13.0	59.3	0.3	1.4	3.3	15.0	0.5	2.3	17.0
Apricot (<i>Prunus armeniaca</i>)												
Kashmir, light yellow	2.7	1.0	37.0	0.4	14.8	1.1	40.7	0.2	7.4	1.2	44.4	2.0
Simla, orange	8.2	1.9	23.2	0.2	4.6	56.1	0.5	6.1	4.9	59.2	8.2	8.2
" "	15.7	3.2	20.4	0.9	5.7	8.6	54.8	1.4	8.9	9.5	60.5	15.8

TABLE III—POOR SOURCES OF CAROTENOID PIGMENTS

FRUIT AND SOURCE OF THE SAMPLE	TOTAL PIGMENTS	XANTHOPHYLL		NEOXANTHOPHYLL		NEO- β -CAROTENE U		β -CAROTENE		NEO- β -CAROTENE B		TOTAL ACTIVE PIGMENTS AS β -CAROTENE		VITAMIN A POTENCY I.U./gm.
		μ gm./gm.	μ gm./gm. %	μ gm./gm.	%	μ gm./gm.	%	μ gm./gm.	%	μ gm./gm.	%	μ gm./gm.	%	
Pine-apple (<i>Ananas sativus</i>)														
Assam	1.9	1.3	68.5	...	...	0.1	5.2	0.4	21.0	0.1	5.2	0.47	22.9	0.8
Singapore	7.7	5.7	74.0	0.3	3.9	0.2	2.6	1.2	15.6	0.3	3.9	1.40	18.2	2.3
Banana (<i>Musa sapientum</i>)														
Gallaon (Bombay), red	5.1	2.2	43.1	...	...	0.3	5.9	2.6	51.0	...	...	2.67	52.3	4.5
Basin (Bombay), chitri	1.7	1.0	58.8	...	...	0.1	5.8	0.6	35.3	...	...	0.62	36.5	1.0
Guava (<i>Psidium guajava</i>)														
Allahabad, pulp	0.2	0.1	50.0	...	...	...	...	0.1	50.0	...	...	0.1	50.0	0.2
" peel	1.9	1.2	63.1	...	...	...	...	0.7	36.9	...	...	0.7	36.9	1.2
" peel	2.1	1.5	71.4	...	...	...	...	0.6	28.6	...	...	0.6	28.6	1.0
Musk-melon or Kabul-melon (<i>Cucumis melo</i>)														
Quetta	0.2	0.1	50.0	...	...	...	...	0.1	50.0	...	...	0.1	50.0	0.2
" "	0.8	0.3	37.5	...	...	...	...	0.5	62.5	...	...	0.5	62.5	0.8
Grapes (<i>Vitis vinifera</i>)														
Peshawar	1.6	1.1	68.7	...	...	...	...	0.5	31.2	...	...	0.5	31.2	0.8
Chaman	2.1	1.4	66.6	...	...	...	...	0.7	33.3	...	...	0.7	33.3	1.1
Mosambique oranges														
Bombay, thick rind, juicy	2.8	2.3	82.1	...	...	...	...	0.4	14.3	0.1	3.6	0.45	16.0	0.8
" not juicy	3.1	2.4	77.4	...	...	...	...	0.5	16.1	0.2	6.4	0.60	19.3	1.0
" thin rind, juicy	2.9	2.4	82.7	...	...	...	...	0.4	13.8	0.1	3.5	0.45	15.5	0.75

xanthophyll, kryptoxanthin, lycopene, β -carotene and neo- β -carotene B.

Mango (*Mangifera indica*)—The carotenoids of 10 different varieties of mangoes have already been reported². 10 more varieties have been examined. 5 different pigments were isolated from the various varieties examined. These are xanthophyll, neo-xanthophyll, β -carotene, neo- β -carotene U and neo- β -carotene B.

Papaya (*Carica papaya*)—In 1933 Yamamoto and Tin²⁹ discovered a new pigment in the fruit of the papaya to which they gave the name "caricaxanthin" and which they found was similar to the pigment found in oranges. Karrer and Schlientz³⁰ pointed out that caricaxanthin of Yamamoto and Tin was similar to kryptoxanthin as both these pigments had the same absorption spectrum and melting point. Karrer and Schlientz³⁰ isolated zeaxanthin, kryptoxanthin, and β -carotene from the papaya fruit. In our studies 5 different pigments were isolated and identified. These include zeaxanthin, kryptoxanthin, β -carotene, neo- β -carotene B and neo- β -carotene U.

Apricot (*Prunus armeniaca*)—Morgan and Madsen⁷ reported that xanthophyll was absent in apricots as the methyl alcohol washings were colourless. Brockmann³¹ isolated from dried apricots, β -carotene in crystalline form and lycopene in small amounts, and also reported the presence of small amounts of γ -carotene. Mackinney, Aronoff and Bornstein³² reported that xanthophyll, lycopene and γ -carotene do not

account for 10 per cent of the total carotenoids. Kemmerer and Fraps³³ demonstrated the presence of 4 different pigments in canned apricots. These are β -carotene, 56.1 per cent; neo- β -carotene U, 5.9 per cent; neo- β -carotene B, 7.2 per cent; and an impurity A to the extent of 3.8 per cent. In our studies 5 different pigments were isolated and identified. These include xanthophyll, lycopene, neo- β -carotene U, β -carotene, and neo- β -carotene B.

Pine-apple (*Ananas sativus*)—Pine-apple fruit owes its yellow colour to carotene and xanthophyll. Magistard³⁴ reported that in the pine-apple fruit xanthophyll was present to the extent of 2.7 μ gm./gm. and carotene to the extent of 2.8 μ gm./gm. Two varieties of pine-apples grown in India were studied for their carotenoid content. 5 different pigments were isolated, namely xanthophyll, neo-xanthophyll, β -carotene, neo- β -carotene U and neo- β -carotene B.

Banana (*Musa sapientum*); *Guava* (*Psidium guajava*); *Musk-melon* (*Cucumis melo*); *Grapes* (*Vitis vinifera*) & *Mosambique Oranges*—The amount of carotenoid pigments present in these fruits is very small. 2 different pigments were isolated from all the fruits except in the case of Mosambique oranges and banana. In the former neo- β -carotene B and in the latter neo- β -carotene U were also detected in addition to xanthophyll and β -carotene. In the case of guava the carotenoid pigments present both in the peel and the pulp were determined separately. The guava peel has been found to be

richer both in carotene and xanthophyll than the pulp.

Summary

The carotenoid pigments present in different varieties of 11 common Indian fruits have been isolated, identified and estimated by the chromatographic technique. The fruits studied include water-melon, peach, mango, papaya, apricot, pine-apple, banana, guava, musk-melon, grapes and Mosambique oranges.

Out of the fruits examined, mango has been found to be a rich source of vitamin A, while peach, papaya and apricot are moderately rich sources of the vitamin. Water-melon, though rich in total carotenoids, is poor in the provitamin A. Banana, pine-apple, grapes, guava, musk-melon and Mosambique oranges are poor sources of vitamin A.

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Grain-size Properties of Some Railway Steels

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IT has now been universally established that austenitic grain-size control of steel confers upon it a set of characteristic beneficial properties. The theories and mechanisms of austenitic grain-size control have been discussed by the author in an earlier paper¹. Briefly, austenitic grain

size of steels is influenced by the deoxidation practice of steel making in general and by aluminium additions in particular. Strong deoxidation with aluminium renders the steel fine grain, while a steel containing little or no aluminium is coarse grained — its austenitic grains coarsen rapidly at high

temperatures. The aluminium content of coarse grained steels varies up to 0.003 per cent. Normally an excess of 0.02—0.04 per cent aluminium over that required for deoxidation makes the steel fine grained. Railway steels made two decades back were mostly coarse grained.

It is with the railway steels of past days, and with some of those of recent make, partially or fully deoxidized with aluminium, that this investigation is concerned. The railway steels made twenty to thirty years ago were taken for investigation after the products made from them, e.g. tyre, wheels, etc., had worn down too thin to be safely employed. The old tyre steels examined had mostly done 300,000 to 400,000 miles of actual service mileage under heavy traffic loads, whereas the new steels put up for relative study had yet to enter service. These new steels contained up to a maximum of 0.015 per cent aluminium in solution.

Several factors determine the amount of aluminium added to steel, e.g. the carbon content, temperature, state of deoxidation, silicon content of the bath, the manner of adding aluminium and the form of aluminium used. Generally, the lower the carbon content, the greater is the amount of aluminium required for grain-size control. Less aluminium will be required for a steel of 0.25—0.30 per cent silicon than one of 0.15—0.20 per cent silicon. The state of deoxidation of the bath at tap is indicated by the residual silicon content.

Coarse & Fine Grained Steels

Inherently fine grained steels possess certain marked favourable physical properties compared to the inherently coarse grained type, the most outstanding of which is their high impact toughness.

Impact & Tensile Properties — In normalized condition the fine grained steels have a slightly lower ultimate tensile strength, a higher elongation and a substantially higher notched-bar toughness. This is illustrated in a 0.40 per cent carbon steel as follows :

Grain size	Tensile strength tons/sq. in.	Elongation %	Izod impact ft. lb.
Coarse	44	22	15
Fine	40	28	55

The author obtained the following values with 0.20 per cent carbon steels, one treated with aluminium and the other aluminium free, both in the normalized state :

Fine grain .. 82.4 ft. lb. average.
Coarse grain .. 37.6 ft. lb. average.

When inherently fine and coarse grained specimens of the same steel are quenched from above the critical temperature range and tempered under the same conditions, the former have a slightly lower tensile strength, a slightly higher elongation and reduction in area and a substantially higher notched-bar toughness. Swinden and Bolsover¹ obtained the following results in the case of 0.5 per cent carbon steel oil quenched from 840°C. in the form of 1½" diameter bar and tempered at 650°C. :

Grain size	Tensile strength tons/sq. in.	Yield stress tons/sq. in.	Elongation %	Reduction of area %	Izod impact ft. lb.
Coarse	53.1	37.0	25.5	59.2	16.7
Fine	50.0	35.1	27.0	61.6	76.0

The impact toughness of the fine grained steel was distinctly superior. When this fine grained steel after quenching was tempered at 600°C., it gave the following values :

Tensile strength tons/sq. in.	Yield stress tons/sq. in.	Elongation %	Reduction of area %	Izod impact ft. lb.
53.4	...	26	57.2	54.7

The tensile strength was the same as that of coarse grained steel but the izod value was much higher. Scott² has shown that when the coarse and fine grained types of the same steel are heat treated to give the same hardness value, say between 400 and 600 V.P.H.No., the toughness of the fine grained type is much greater than that of the coarse grained.

Grain size	Hardness value	Izod impact value ft. lb.
Fine	440	37
Coarse	440	8
Fine	600	25
Coarse	600	6

Davenport and Bain³ took one carbon tool steel, heated to different temperatures above the critical temperature range to develop different austenitic grain sizes, quenched from a uniform temperature and tempered at different temperatures to give a Rockwell hardness of C 50. The results obtained are given below :

Heating temperature °C.	Quenching temperature °C.	Austenitic grain size developed at the heating temperature	Hardness C Rockwell	Impact ft. lb.
780	780	Very fine	50	11
845	780	Fine	50	3
930	780	Coarse	50	2
1010	780	Very coarse	50	1

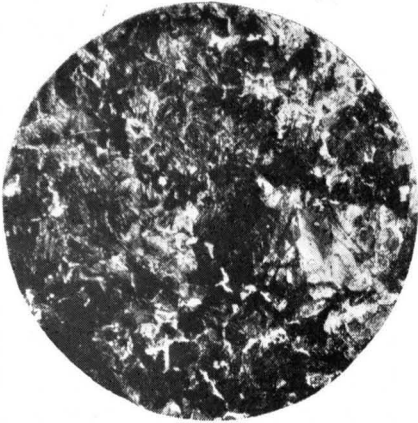


FIG. 1

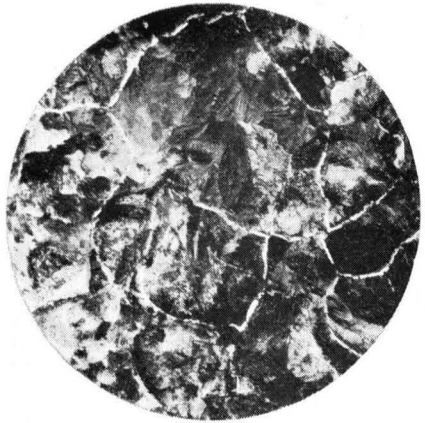


FIG. 2

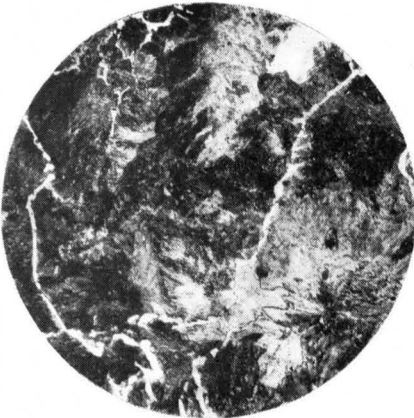


FIG. 3

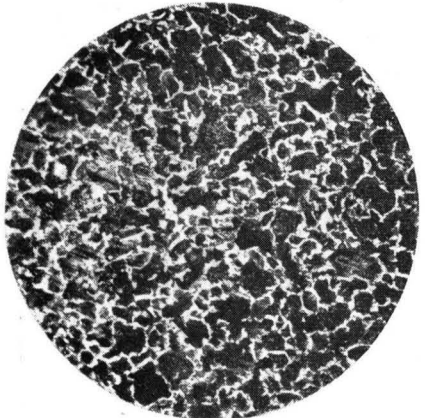


FIG. 4

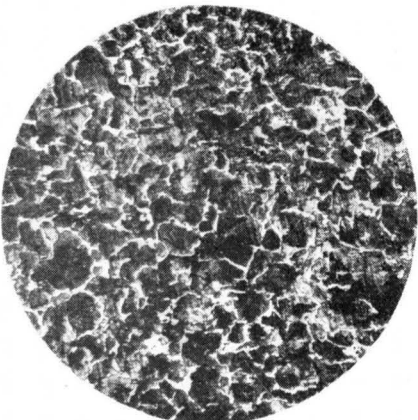


FIG. 5

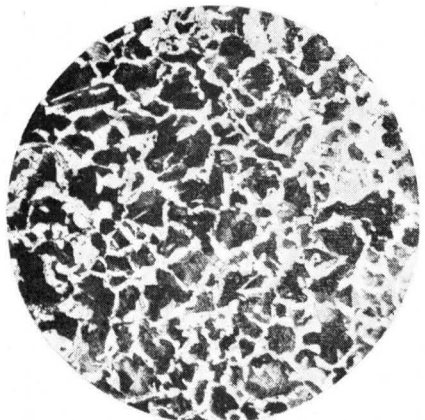


FIG. 6

FIGS. 1-6 — NITAL ETCH. ($\times 100$).

TABLE I

No.	MATERIALS	CHEMICAL COMPOSITION							TENSILE PROPERTIES			
		Carbon %	Manganese %	Silicon %	Sulphur %	Phosphorus %	Nickel %	Chromium %	Maximum stress tons/sq. in.	Yield stress tons/sq. in.	% elongation	% reduction of area
Set I:												
1	Tyre steel, mileage run 36,342 miles by tyre	0.56	0.53	0.405	0.035	0.027	nil	0.57	57.88	26.31	14.06	30.72
5	Tyre steel, mileage run 295,570 miles by tyre	0.60	0.57	0.34	0.036	0.035	nil	nil	60.42	28.32	14.06	31.30
10	Tyre steel, mileage run 312,656 miles by tyre	0.59	0.58	...	0.040	0.036	nil	0.57	58.61	28.02	14.84	32.03
11	Tyre steel, mileage run over 350,000 miles by tyre	0.63	0.88	...	0.039	0.025	nil	nil	57.4	25.02	13.28	25.14
12	Tyre steel, mileage run 445,668 miles by tyre	0.62	0.72	0.348	0.038	0.038	nil	nil	53.63	25.11	16.4	26.71
Set II												
A	Tyre steel	0.58	0.62	0.385	0.043	0.030	nil	nil	50.60	23.08	18.75	30.16
B	Tyre steel	0.56	0.62/3	0.415	0.042	0.023	nil	nil	49.17	26.49	17.06	34.04
C	Wheel steel	0.49/50	0.70	0.360	0.038	0.051	nil	nil	46.86	21.87	17.18	35.61
D	Wheel steel	0.50	0.66/5	0.347	0.045	0.048	nil	nil	45.95	23.10	21.00	39.50
E	Wheel steel	0.51	0.68	0.350	0.048	0.045	nil	nil	51.28	23.27	15.62	28.81

From a correlation of the grain structures revealed by the McQuaid-Ehn carburizing austenitic grain tests as also to some extent by the normalized structures, it would be observed that with identical steel compositions, the coarse McQuaid-Ehn grain size is associated with much lower izod impact value, slightly higher tensile and yield strengths, lower percentage elongation or reduction of area and slightly higher hardness value than the fine McQuaid-Ehn grain size steel. This contrast in the properties is appreciably shown by steel No. E (Set II) possessing coarse grain size in relation to steel Nos. C and D (Set II) showing fine grain sizes. Steel No. E (Set II), although of practically the same composition as C and D (Set II), possesses a lower izod impact toughness, slightly higher tensile strength, lower percentage elongation and reduction of area, and slightly higher hardness than the fine grained steel Nos. C and D (Set II).

The same contrast in physical properties and austenitic grain sizes is afforded by fine grained steel Nos. A and B (Set II) and coarse grained Nos. 5, 10 and 1 (Set I). These two different makes of steel are of identical composition except for slight residual chromium in steel Nos. 1 and 10. Steel No. 5 (Set I) was of practically the same composition as steel Nos. A and B (Set II). Set I steels possessed coarse austenitic grain sizes and gave somewhat higher tensile and yield strengths, lower percentage of elongation and reduction of area, and

TABLE I

PHYSICAL TESTS						METALLURGICAL EXAMINATIONS					
IZOD IMPACT VALUES				BEND TEST		HARDNESS TEST		Micro examination of normalized structures	Inclusion count determination (average of 5 fields, on longitudinal sections at ($\times 100$), field diameter 8 cm.)		McQuaid-Ehn austenitic carburizing grain-size structures
1st notch ft. lb.	2nd notch ft. lb.	3rd notch ft. lb.	Average ft. lb.	Longitudinal, angle of bend on fracture	Transverse, angle of bend on fracture	Longitudinal, V.P.H. No.	Transverse, V.P.H. No.		Elongated type	Globular type	
4	4	4	4	...	33°	266, 265, 267, average 266	263	Sorbo-pearlitic grains with ferrite mesh work. Normalized structure (Fig. 1)	4-6	1-3	Fairly coarse grain structure (Fig. 9, sodium picrate etching)
3.5	4	4	3.83	62°30	39°	263, 263, 263, average 263	262	do	6-10	1-2	Coarse grain size (Fig. 10, sodium picrate etching)
5	5	5.5	5.16	54°30	31°	266, 268, 262, average 265	260	do	6-10	1-2	Coarse grain structure (Fig. 11, sodium picrate etching)
5	5	5.5	5.16	36°	20°	262, 269, 269, average 266	262	Coarse sorbo-pearlitic grain structure with ferrite network (Fig. 2)	6-10	1-2	Coarse grain structure (Fig. 12, sodium picrate etching)
6.5	3	5	4.83	40°	20°	236, 232, 236, average 234	236	Coarse sorbo-pearlitic grain structure with ferrite network (Fig. 3)	4-6	1-3	Coarse grain structure (Fig. 13, sodium picrate etching)
10.5	11	10	10.5	61°30	52°	216, 215, 216, average 216	225	Very fine sorbo-pearlitic grain structure with boundary ferrite enclosures (Fig. 4)	4-6	1-3	Fine grain size in general with area of duplexed grain structure. (Former grain structure, Figs. 14 & 15; latter, Figs. 16 & 17, sodium picrate etching)
12	10.5	10	10.83	104°	24°	216, 216, 216, average 216	217	Very fine sorbo-pearlitic grain enclosed in boundary ferrite (Fig. 5)	4-8	4-6	do
10	10	10	10	94°	49°	208, 209, 207, average 208	210	Very fine sorbo-pearlitic grains with boundary ferrite (Fig. 6)	2	6-10	do
15	14	14	14.3	93°	45°	204, 205, 204, average 204	208	Very fine sorbo-pearlitic grain structure with ferrite enclosures (Fig. 7)	4-6	1-2	do
6	6	6.5	6.16	50°	31°	235, 235, 235, average 235	235	Extremely coarse sorbo-pearlitic grain structure with ferrite boundaries (Fig. 8)	6	1-2	Coarse grain structure in general (Fig. 18 sodium picrate etching)

hardness values and fairly lower izod impact values in relation to the finer austenitic grain-size steels Nos. A and B of Set II which gave somewhat lower tensile and yield strengths and hardness values, higher percentage elongation and reduction of area and fairly higher izod impact values.

The transverse bend tests give a good indication of the relative inclusion contents of the various steels — the longitudinal bend test, however, is a function of the relative ductility of the materials. The excellent physical set of properties of the steels of Set I after 300,000-400,000 of service mileage should dispel the doubts of engineers who fear that steel gets "fatigued" or "deteriorates" during prolonged service in quality.

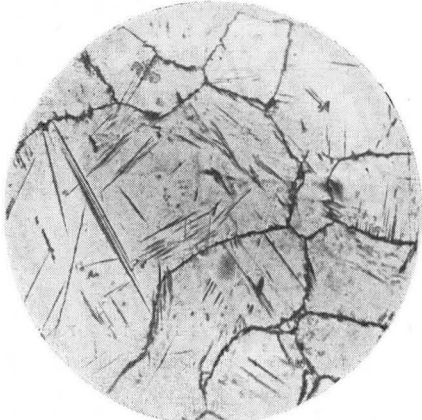


FIG. 7

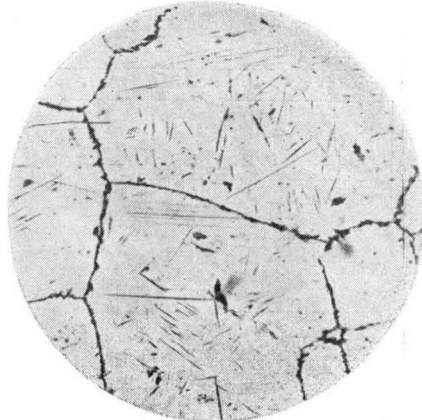


FIG. 8

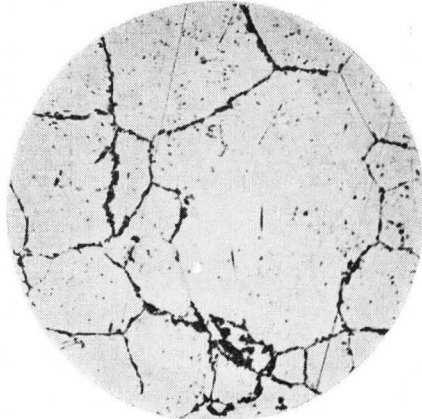


FIG. 9

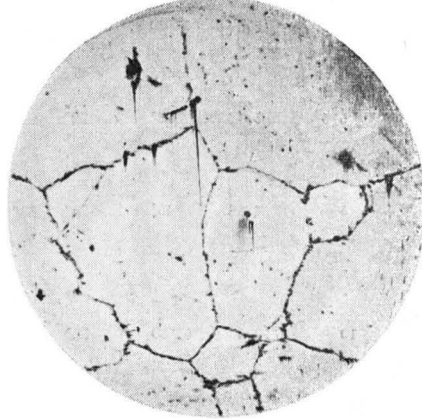


FIG. 10



FIG. 11

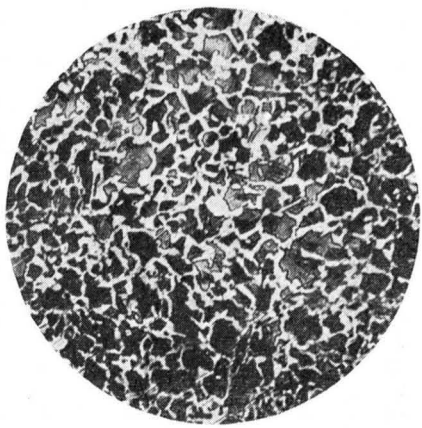


FIG. 12

FIGS. 7-8 — NITAL ETCH. (×100). FIGS. 9-12 — SODIUM PICRATE ETCH. (×100).

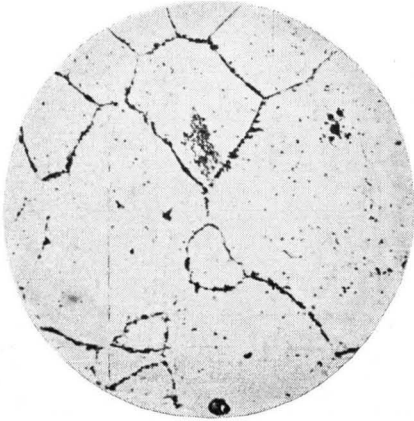


FIG. 13

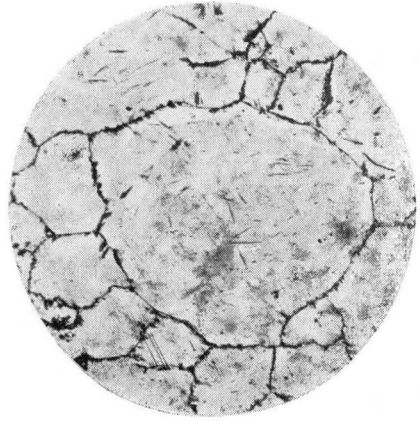


FIG. 14

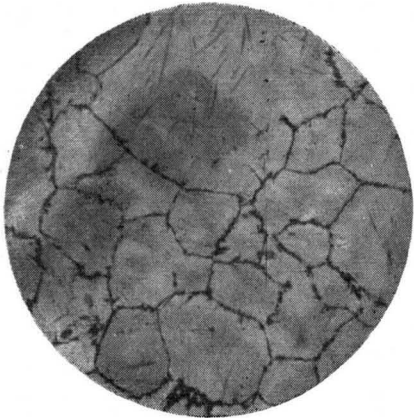


FIG. 15

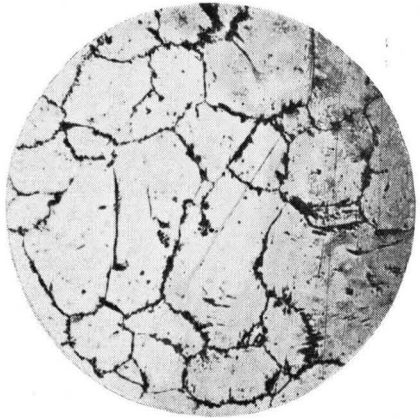


FIG. 16

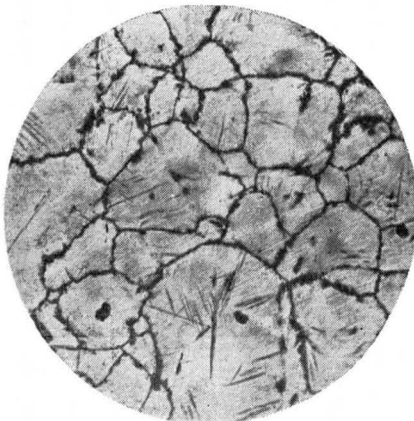


FIG. 17

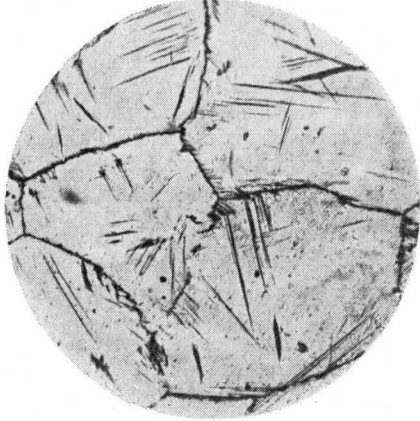


FIG. 18

FIGS. 13-18 — SODIUM PICRATE ETCH. ($\times 100$).

These results show that the austenitic grain size established during heating greatly influences the toughness of the heat-treated steel.

O'Neill⁴ gave the following results for straight carbon steels in coarse and fine grain condition :

	A %	B %
Carbon	0.35	0.35
Silicon	0.22	0.25
Manganese	0.95	0.96
Sulphur	0.027	0.027
Phosphorus	0.036	0.036
Nickel	0.44	0.46
Chromium	0.06	0.09
Aluminium	0.001	0.009
<i>Grain</i>	<i>Coarse</i>	<i>Fine</i>
Yield stress, tons/sq. in.	20.4	30.4
Max. stress, tons/sq. in.	44.6	43.4
Elongation, %	64	66
Izod value, ft. lb.	12	93

Properties of Railway Materials

The materials examined consisted of 2 sets. Set No. I comprising of railway locomotive tyres fabricated about a couple of decades ago and which had given excellent service mileage of, in some cases, 300,000 to 400,000 miles under heavy traffic loads. Set No. II was made up of railway tyres ready to go into service. The steels of Set No. I contained but traces of aluminium in solution of the order of 0.002 per cent while those of Set No. II contained between 0.008-0.01 per cent of dissolved aluminium except steel No. E, which showed an aluminium content of the same order as that of Set No. I.

Table I gives the results of the chemical, physical and metallurgical tests carried out. For each test, test pieces of standard dimensions were taken. To start with, a block of standard size (10" x 1 1/2" x 4") was cut out of the railway tyres and wheels. The blocks were then "normalized" under standard conditions. From such blocks standard dimensioned test pieces were machined out for each of the physical and metallurgical tests.

Hardenability — The properties of quenched steels are more directly related to their austenitic grain size than those of annealed or normalized steels. It is necessary to differentiate between the potential maximum hardness attainable and hardenability or the depth of hardening of the mass of the metal. The maximum surface hardness attained on quenching does not greatly depend upon the austenitic grain size for a given mass but the depth of hardening is influenced by the austenitic grain size to a marked degree. This is illustrated in Fig. 19.

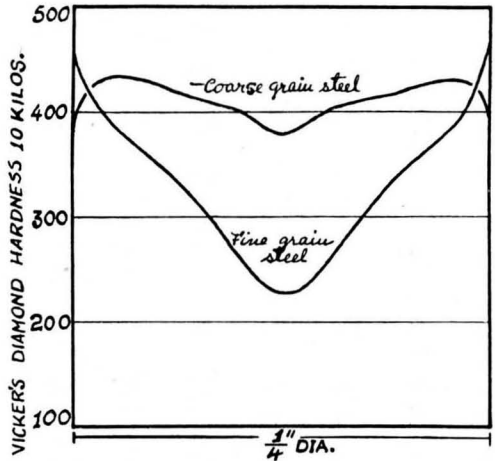


FIG 19 — VARIATIONS IN HARDENABILITY WITH GRAIN SIZE : FINE GRAINED STEEL CONTAINED 0.02 PER CENT ALUMINIUM WHILE THE COARSE GRAINED WAS ALUMINIUM FREE. BOTH STEELS WERE QUENCHED FROM 980°C.

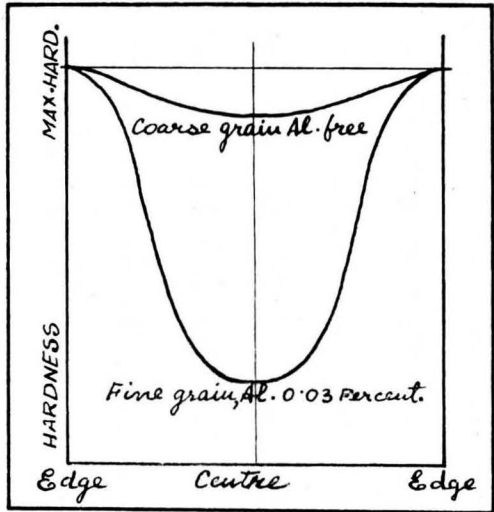


FIG. 20 — VARIATION OF HARDENABILITY WITH GRAIN SIZE : UPPER CURVE REPRESENTS A DEEP HARDENING COARSE GRAINED STEEL AND THE LOWER CURVE A FINE GRAINED SHALLOW HARDENING STEEL IN WHICH THE HARDNESS DROPS TO A VERY LOW VALUE IN THE CORE. THE SURFACE HARDNESS IS THE SAME IN BOTH THE CASES. BOTH THE STEELS WERE QUENCHED FROM THE SAME TEMPERATURE.

In general, the fine grained steels are shallow hardening and the coarse grained types are deep hardening and less subject to mass effect (Fig. 20).

Due to large austenitic grain boundary surface areas in the case of fine grained steels, the transformation rates of these steels on quenching are faster than the coarse grained types. So in the case of the former the core undergoes comparatively rapid transformation and liberates more of the ferrite which makes it less hard and renders the steel shallow hardening.

Since the toughness or impact values of hardened steels increase as the hardness diminishes, fine austenitic grained steels are not so hard in the core as coarse austenitic grained steels. Therefore, they have tougher cores and resist dynamic stresses to a greater extent than similar deep hardening coarse austenitic grained steels. Fine grained plain carbon steels can be economically substituted for low alloy steels where high core toughness is important. However, in tool and certain other types of steels where deep hardening properties are essential, the fine grained steel is unsuitable. Alloying elements like manganese, etc., add to the deep-hardening properties of the steel.

Fine grained steels are less liable to macroscopic cracking during quenching. Cases are on record where, by making the steel inherently fine grained through suitable deoxidation, the rejections due to cracking in the heat treatment were entirely eliminated. Fine grained steels are also less liable to warping and distortion during heat treatment. It has been further established that the micro-cracks observed in quenched steels result from large dimensional changes that increase with increasing grain size. Thus, the superior toughness of fine grained steels is due, to some extent at least, to the existence of a smaller number of microscopic cracks. Coarser grained steels have a higher internal stress after quenching and are, therefore, more susceptible to grinding cracks than the finer grained types.

However, due to their more rapid rates of transformation, finer grained steels are more prone to soft spots on quenching and are not suitable where full uniform hardening throughout the section is desired.

Machinability & Surface Finish & Forgeability & Pressing—The view is widely held in America that coarse grained steels machine better than fine grained. It is stated that in the coarse grained steels the size of the final ferrite and carbide lamellae resulting from the transformation of austenite is coarser and hence better machin-

ability is imparted. However, completely identical results have not been obtained. Where there is a great difference in the machinability as in the case of free cutting and ordinary steels, it is easily perceptible, but when the difference is small, it is difficult to discover which of the two types possess superior machining properties. However, the coarse grained structure causes roughness of the finished surface and the fine grained steels give a superior finish. In punch press operations fine grained steels exhibit several advantages over the coarse grained types. It has been shown that the finished surfaces of fine grained mild steels were much superior to those of coarse grained steels since the latter became rough after deep drawing whereas the fine grained steel remained smooth and uniform. In blanking, fine grained types shear cleaner and exhibit smaller burrs and are less embrittled by cold work and, therefore, may be drawn deeper and show fewer defects than the coarse grained steels. Fine grained steels are more suitable for heavy punching operations, drastic cold rolling, shearing and trimming.

Coarse grained steels forge more readily than fine grained types due to low interference to slip in the coarse grained types and coarse grained types give better fibre structures than the fine grained steels on forging.

Carburizing Characteristics—It has been observed that the rate of diffusion of carbon into fine grained austenite is less rapid than in the coarse grained austenite and so fine grained types carburize less deeply and more slowly than the coarse grained steels. Fine grained steels are prone to give abnormal or soft spots on quenching after carburization. Abnormal spots refer to a coalesced state of carbide which causes low hardness values. The object of carburization is to obtain components with a case possessing a high surface hardness and of sufficient depth and a soft but tough core. The carbon content of a low carbon steel is usually raised by heating for a sufficient length of time in a carburizing atmosphere, i.e. usually in a container packed with a solid carburizing compound. The carburized material is then quenched to harden the case. Apart from the shallow-hardening characteristics of fine grained steels, these are ideal for carburizing. During the prolonged heating at the carburizing temperature, pronounced grain growth occurs in

steels which have not been suitably de-oxidized and are, therefore, coarse grained. So after case-carburization, grain-refining treatments have to be carried out. The following is a complete cycle :

(a) Carburization and air cooling of the box after carburization.

(b) Heating the material to just above the critical temperature range of the core, about 850°-880°C. to refine its grain size, followed by quenching in oil or water.

(c) Heating just above the critical temperature range of the high carbon case, about 750°-770°C. to refine its grain size, followed by quenching in oil or water.

(d) Final tempering at about 200°C. to relieve the internal stresses.

Where fine grained steels are employed, the core and case retain fine grained characteristics after prolonged heating at the carburizing temperature and hence the core and case grain-refining operations, etc., can be safely omitted and the case-carburized material quenched directly from the carburizing box. In some cases even the final tempering may also be dispensed with. It is now realized that so long as an allowance is made for the slower penetration of carbon in fine grained steels, these have pronounced advantages over the coarse grained types in materially cutting down heat-treatment costs and time, yielding more production of an equally good, if not better, case-hardened material. There is always the danger of warpage, distortion, macro-cracks in the heat-treatment cycle following carburization of the coarse grained steels, e.g. in case-hardened gear applications. Such dangers practically do not exist in fine grained steels.

"Pipe" : *Shrinkage Cavity*—Fine grained steels tend to give a deeper pipe than normal coarse grained steels.

Decarburization—Coarse grained steels show a greater tendency towards decarburization than the fine grained types.

Ageing—Fine grained steels age much less than coarse grained steels. The coarse grained steels show after ageing an increase in the hardness, tensile strength, yield point and a greater loss in the impact toughness, reduction of area and elongation values than the fine grained steels. In one case,

the impact toughness of a fine grained steel was actually shown to increase after ageing.

Temper-brittleness—Temper-brittleness is the name applied to the loss of ductility or impact toughness that results after tempering hardened specimens to a temperature below the critical range followed by slow cooling. Steels containing alloying elements like nickel, chromium are chiefly susceptible to temper-brittleness. It has been shown by various workers that after tempering in the temper-brittleness range the izod impact values of the fine grained steels are much greater than coarse grained steels although the latter is somewhat less susceptible to temper-brittleness than the fine grain aggregates.

Magnetic Properties—Rüder⁵ has correlated the existing data of the effect of grain size upon the magnetic properties of steels and has shown that hysteresis, coercive force and residual magnetism all decrease with increase in grain size. This condition varies with prior treatments, whether mechanical or chemical, and consequently the effect of grain size cannot readily be ascertained.

Grain Size Control & Its Practical Applications

A full understanding of the characteristics of fine and coarse grained steels has led to the choice of each type for different purposes. Coarse grained steels are recommended for easy machinability, deep hardening, etc., and fine grained steels are preferred for advantages hitherto obtained from alloying elements, e.g. greater toughness with given strength and hardness, wide heat-treating range, freedom from danger of cracking, warpage, etc., and the elimination of grain-refining treatments after carburizing. All these attributes should be taken into consideration for the purpose of selection of the steel for a particular purpose.

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Supplement

AROMATIC PLANTS OF INDIA
PART IX

BY

S. KRISHNA & R. L. BADHWAR

FOREST RESEARCH INSTITUTE, DEHRA DUN

FAMILY

40. Leguminosae



Journal of Scientific and Industrial Research, Delhi

1949, Vol. VIII, No. 2 (Pages 145-160)

NATIONAL INSTITUTE OF SCIENCES RESEARCH FELLOWSHIPS

Applications are invited for the following N.I.S. Research Fellowships tenable ordinarily for two years in any branch of Science at any University or Institution in India :

- (a) **Four Senior, monthly stipend Rs. 500, age of applicant not to exceed 45 years.**
- (b) **Seven Junior, monthly stipend Rs. 350, age of applicant not to exceed 35 years.**

A sum not exceeding Rs. 1,000 per annum will be made available in each case for special apparatus. Three copies of application in prescribed form, duly forwarded by the Head of Laboratory in which research is proposed to be undertaken, should reach the Secretary, National Institute of Sciences, University Buildings, Delhi, before 4th March 1949. For copies of application forms, which are separate for Senior and Junior Fellowships, send a large addressed envelope.

IMPERIAL CHEMICAL INDUSTRIES (INDIA) RESEARCH FELLOWSHIPS

Applications are invited for six Imperial Chemical Industries (India) Research Fellowships tenable ordinarily for two years in Physics (including Mathematics), Chemistry or Biology (Botany and Zoology) at any University or Institution in India. Monthly stipend Rs. 400. A sum not exceeding Rs. 600 per annum will be made available in each case for special apparatus. Age of applicant not to exceed 35 years. Four copies of application in prescribed form, duly forwarded by the Head of Laboratory in which research is to be undertaken, should reach the Secretary, National Institute of Sciences, University Buildings, Delhi, before 4th March 1949. For copies of the form of application send a large addressed envelope.

Aromatic Plants of India

Family XL — LEGUMINOSAE

(Pulse or Bean Family)

THIS is one of the most cosmopolitan and the second largest family of flowering plants, with about 500 genera and 12,000 species of herbs, shrubs, lianas, and trees. The flowers are usually irregular and papilionaceous (like that of pea) or rarely regular. The fruit is a true pod or legume.

The family comprises three subfamilies; the largest is the Papilionatae which is cosmopolitan and the other two, Caesalpinioideae and Mimosoideae, are found mostly in the tropical and warm temperate zones. These subfamilies are nowadays recognized by botanists to constitute distinct families, but for the sake of convenience are being dealt with together under Leguminosae in this work.

The Leguminosae, taken as a whole, is the most important family in India from the economic point of view. A large number of species yield food, fodder, drugs, insecticides, fibres, gums and resins, fatty oils, tanning materials, dyes, timbers, etc., and many others are grown in gardens and avenues as ornamental plants, shade trees and for hedges. A very interesting feature, which gives to this family an outstanding importance, is the power of fixing the free nitrogen of the air by means of the peculiar bacterial organisms, present in the root-nodules of many plants, thus automatically rejuvenating the soil on which they grow. This fact has been taken advantage of in economic agriculture.

The seeds of many plants of the family are edible, and some of the familiar ones are: groundnut or peanut (*Arachis hypogaea* Linn.), gram or chick-pea (*Cicer arietinum* Linn.), pea (*Pisum sativum* Linn.), pigeon pea or harhar [*Cajanus cajan* (Linn.) Millsp., syn. *C. indicus* Spreng.], lentil or masur (*Lens esculenta* Moench, syn. *Ervum lens* Linn.), urd (*Phaseolus mungo* Linn., var. *roxburghii* Prain), mung (*Phaseolus radiatus* Linn.), French bean or kidney bean (*Phaseolus vulgaris* Linn.), Lima bean or Duffin bean (*Phaseolus lunatus* Linn.), moth (*Phaseolus aconitifolius* Jacq.), rawan or barbatti [*Vigna sinensis* (Linn.) Savi ex Hassk.,

syn. *V. catjang* Walp. and *V. catiang* Fl. Brit. Ind.], soya bean [*Glycine max* (Linn.) Merr., syn. *G. soja* Sieb. & Zucc.], broad bean (*Vicia faba* Linn.), chickling vetch or khesari (*Lathyrus sativus* Linn.), etc. The young pods of sem (*Dolichos lablab* Linn.), jack bean or horse bean [*Canavalia ensiformis* (Linn.) DC.], cluster bean or guar [*Cyamopsis tetragonoloba* (Linn.) Taub., syn. *C. psoraloides* DC.] and some species of *Phaseolus*, *Vigna*, etc., are also extensively eaten in this country. The leaves of fenugreek or methi (*Trigonella foenum-graecum* Linn.) are commonly eaten as a vegetable. Horse gram or kooltee (*Dolichos biflorus* Linn.), lucerne or alfalfa (*Medicago sativa* Linn.), clovers and sweet clovers (species of *Trifolium* and *Melilotus*) are some of the famous fodder plants. Kudzu bean [*Pueraria thunbergiana* (Sieb. & Zucc.) Benth.] of Japan and E. Asia has been recently introduced into India. It is a perennial vine which yields good fodder. A valuable starch is prepared and marketed in E. Asia from its large tuberous roots, which, in favourable climates, are said to attain a weight of over 80 lbs.

As sources of fatty oils or solid fats, groundnut, soya bean, and karanj [*Pongamia pinnata* (Linn.) Merr., syn. *P. glabra* Vent.] are well known.

Important dyes are obtained from the indigo plant (*Indigofera tinctoria* Linn.), palas [*Butea monosperma* (Lam.) Kuntze, syn. *B. frondosa* Koen. ex Roxb.], sappanwood (*Caesalpinia sappan* Linn.), red sanderswood or red sandalwood (*Pterocarpus santalinus* Linn. f.), barwood or camwood (*Baphia nitida* Afzel ex Lodd.) of Africa, logwood (*Haematoxylon campechianum* Linn.), etc. Logwood is the source of the well-known laboratory stain haematoxylin, and is sometimes cultivated in Indian gardens.

The dried decoction of khairwood [*Acacia catechu* (Linn.) Willd.] is the katha, which is an important ingredient of pan or betel-leaf preparation. Katha consists of catechin which is used in medicine, and catechu which is used for dyeing, especially brown and composite shades on cotton, tanning,

preserving fishing nets, etc. Similar preparations are also made from *Acacia chundra* Willd.

Like the wattle bark from *Acacia mollissima* Willd., the barks of babul [*Acacia arabica* (Lam.) Willd.] and tanner's cassia, *avaram* or *tarwad* (*Cassia auriculata* Linn.) are among the most important tanning materials of India. The pods of divi-divi or American sumach [*Caesalpinia coriaria* (Jacq.) Willd.] are rich in tanning materials; this plant is often cultivated in India.

One of the most important commercial gums is obtained from a plant of this family. This is the gum tragacanth from *Astragalus gummifer* Labill. and other species of *Astragalus*. The gum arabic is obtained from *Acacia senegal* (Linn.) Willd. and the gum babul from *A. arabica* (Lam.) Willd. *Pterocarpus marsupium* Roxb. is the source of kino, an astringent gum used in medicine and also for dyeing and tanning purposes. The mesquite gum is obtained from the American *Prosopis glandulosa* Torr. and *P. chilensis* (Molina) Stuntz [*P. juliflora* (Sw.) DC.], which are cultivated in India. Tragacanth is derived from the pods of the Syrian carob tree (*Ceratonia siliqua* Linn.). Attempts have often been made to cultivate the carob tree in India, but have not on the whole succeeded very well. The tree fruits very scantily under Indian conditions.

Several African trees yield copals (hard resins), which are used in making varnishes. The Zanzibar copal and the closely allied Madagascar and Mozambique copals are obtained from *Trachylobium verrucosum* (Gaertn.) Oliver. Zanzibar copal is the hardest of all resins, except amber, and is very valuable. The resin exudes naturally from the trunk, branches and fruit, but most of the commercial supply is obtained from the semi-fossil material from the still living trees, and the fossil material from the trees which no longer exist. Congo copal is derived from *Copaifera demeusei* Harms and *C. mopane* J. Kirk ex Benth. of the Congo basin. Sierra Leone copal is obtained from *C. guibourtiana* Benth. and *C. salikounda* Heckel of Sierra Leone. The S. American copal is derived from the S. American locust (*Hymenaea courbaril* Linn.); it is the softest of all copals, and consequently the least valuable.

The acid fruit-pulp of tamarind (*Tamarindus indica* Linn.) is extensively eaten in India, and the seed kernels are largely used for sizing purposes. The kernels are by

far the cheapest source of a "pectin", called jellose, which, though differing chemically from the fruit pectins, is better than the latter in performance in so far that it sets to a jelly with sugar even without acids.

Sunn hemp from *Crotalaria juncea* Linn. is a valuable fibre, and so is *jayanti* [*Sesbania bispinosa* (Jacq.) Fawcett & Rendle, syn. *S. aculeata* (Willd.) Pers.]. Solar hats or *sola topees* are made from the spongy stems of *sola* or pith plant (*Aeschynomene aspera* Linn.), a stout aquatic perennial plant.

Considerable trade is done in the saponaceous pods of *shikekai* [*Acacia concinna* (Willd.) DC.] which are used for shampooing.

Many plants, such as sissoo or *shisham* (*Dalbergia sissoo* Roxb.), Indian rosewood (*Dalbergia latifolia* Roxb.), ironwood [*Xylia xylocarpa* (Roxb.) Taub., syn. *X. dolabriformis* Benth.], siris [*Albizia lebbek* (Linn.) Benth.], Andaman padauk (*Pterocarpus dalbergioides* Roxb., syn. *P. indicus* Baker, in part, non Willd.), Burma padauk (*Pterocarpus macrocarpus* Kurz), red sanderswood or red sandalwood (*Pterocarpus santalinus* Linn. f.), *bijasal* (*Pterocarpus marsupium* Roxb.), babul [*Acacia arabica* (Lam.) Willd.], American ebony, cocus wood or granadillo [*Brya ebenus* (Linn.) DC.], Australian blackwood (*Acacia melanoxylon* R. Br.), etc., yield valuable timber; the last-mentioned is extensively planted in the Nilgiris. Recently, during the World War II, when the supplies of *lignum vitae* for the manufacture of marine propeller shafts became scarce, the wood from the Indian *Acacia chundra* Willd. was considered to be an excellent substitute and a considerable demand for it has arisen.

Of the most familiar plants found in gardens and along roadsides in India may be mentioned, in addition to the several of the above, the sweet pea (*Lathyrus odoratus* Linn.) with various coloured flowers; *gul mohur* or gold-mohur tree [*Delonix regia* (Boj. ex Hook.) Rafin., syn. *Poinciana regia* Boj. ex Hook.] with red flowers; *asoka* tree (*Saraca indica* Linn.) with brilliant orange-scarlet, fragrant flowers; coral tree [*Erythrina variegata* Linn., var. *orientalis* (Linn.) Merr., syn. *E. indica* Lam.] with brilliant scarlet flowers; Indian laburnum (*Cassia fistula* Linn.), *sau* [*Albizia chinensis* (Osbeck) Merr., syn. *A. stipulata* Boiv.] grown for its shade and for protecting tea plantations; *colvillea* (*Colvillea racemosa* Boj.) with bright-orange flowers; peacock flower

or Barbados pride [*Caesalpinia pulcherrima* (Linn.) Sw.] with scarlet or yellow flowers; species of *Bauhinia*, etc.

The family contains the largest number of plants which are poisonous to fishes. Many of these, which are spread over 27 genera, are used as insecticides. The most important of these are some species of *Derris*, such as *D. elliptica* (Roxb.) Benth. (tuba), from the roots of which an active insecticidal principle, rotenone, has been isolated. Rotenone has also been isolated from members of the genera *Lonchocarpus*, *Millettia*, *Tephrosia*, and others. The aromatic fenugreek or *methi* (*Trigonella foenum-graecum* Linn.) is used as an insect repellent for stored grains in the Kangra district of the Punjab.

The family contains a large number of medicinal plants, but only some of the more important ones are mentioned below. Liquorice root (*Glycyrrhiza glabra* Linn.) is largely used as a remedy for cough, as a purgative, and also to mask the taste of bitter and nauseous medicines; it contains the glycoside glycyrrhizin. Balsam of Tolu is obtained from *Myroxylon balsamum* (Linn.) Harms (*M. toluiferum* H. B. & K.), a native of Venezuela, Columbia and Peru, and contains an essential oil; the balsam is much used as an expectorant, and as an ingredient in cough lozenges. The Calabar or ordeal bean (*Physostigma venenosum* Balf.), a tropical W. African climber, contains several alkaloids of which eserine (physostigmine) is the most important. The alkaloid is used in ophthalmic practice to contract the pupils. Senna leaves and pods from *Cassia angustifolia* Vahl and *C. acutifolia* Delile are well known as mild purgatives. The pulp of the pod of Indian laburnum or purging cassia (*Cassia fistula* Linn.) is used as a mild household laxative in India. *Acacia senegal* (Linn.) Willd. and *A. arabica* (Lam.) Willd. are the sources of gum arabic and gum babul which are commonly used for emulsifying oily preparations, but have no medicinal value. *Astragalus gummifer* Labill. and other species of *Astragalus* of W. Asia yield gum tragacanth, which is used as an excipient for pills and for emulsions to suspend heavy powders in water; none of the species yielding this gum is found in India. The gum kino from *Pterocarpus marsupium* Roxb. is used as an astringent, particularly for inflamed throats and as a mouthwash for spongy gums. The European broom (*Cytisus scoparius* Link), which has

been introduced in the Nilgiris (Ootacamund), is used in Western medicine, chiefly as a diuretic. It contains sparteine and other alkaloids, and a soluble phenol, scoparin.

Some plants are known to yield essential oils, while some others, though odoriferous, still remain uninvestigated.

The yellow, strong-scented flower-heads of *Acacia farnesiana* (Linn.) Willd. constitute the cassie flowers which yield the cassie perfume of commerce. This perfume is very delicate, and is usually extracted in the form of a pomade. The yellow, sweet-scented flower-heads of the Australian *Acacia dealbata* Link and of some other species of *Acacia* are used for the preparation of the well-known mimosa perfume. Both these species are described in detail later.

Sweet pea (*Lathyrus odoratus* Linn.) is a well-known garden plant having elegant, sweet-scented flowers. Natural perfume from these flowers is not extracted on any large scale, and the bulk of the sweet-pea perfumes of commerce is synthetic.

The flowers of the Spanish broom (*Spartium junceum* Linn.), a European shrub which is also sometimes cultivated for its fibre, have a powerful pleasant odour, which changes quickly after the flowers are cut. They are treated in Grasse by volatile solvents, and on rare occasions by maceration in a pomade. The extraction products of these flowers are among the precious raw materials for perfumery. The yield of petroleum ether concrete, which has a waxy aroma, varies between 0.09 and 0.18 per cent., and this concrete gives 30 to 40 per cent. of absolute. The concrete has congealing point 49.8° and saponification val. 44.8. The absolute has acid val. 33.6 and ester val. 85.9. A distillate having ester val. 101.1 has also been obtained in a yield of 5 per cent. (Naves & Mazuyer, 1947. *Natural Perfume Materials*: p. 170).

The flowers of another foreign broom (*Genista tinctoria* Linn.) have yielded 0.161 per cent. of a petroleum ether concrete, which gave 53 per cent. of absolute and contained 2.26 per cent. of yellowish steam-distillable products with heavy odour (Naves & Mazuyer, *loc. cit.*).

The S. American trees *Dipteryx odorata* (Aubl.) Willd. and *D. oppositifolia* (Aubl.) Willd. are the source of the well-known tonka beans, those from the latter (Para beans) being smaller and not so valuable

as the former (Angostura beans). The tonka beans contain about 3 per cent. of coumarin, which is of considerable importance in the manufacture of perfumes. The beans, and their extract are used for flavouring snuff, tobacco, and sachet powders, and as a substitute for vanilla in cocoa, candy, and ice cream. Although *Dipteryx odorata* is the most important natural source of coumarin, the latter is found in several species of *Dipteryx*, *Myroxylon*, *Melilotus*, etc., belonging to this family, and also a number of plants of other families. The tonka beans have, however, been largely replaced by synthetic coumarin. For a detailed account of tonka beans the reader is referred to an article by Albes (1916. *Amer. Perfum.*, 10: 278).

The reddish-brown, thick, syrupy, viscous balsam of Peru, obtained from the Central American tree *Myroxylon pereirae* (Royle) Klotzsch, is of great value as a fixative in the preparation of heavy odours of Oriental type, and is a desirable addition to all perfumes intended for lipsticks owing to its soothing qualities. The balsam, which has a penetrating and very sweet odour, contains 55 to 65 per cent. of cinnamein (a mixture of benzyl benzoate and benzyl cinnamate), small amounts of free aromatic acids, benzyl alcohol, nerolidol, and a trace of vanillin. When pure it has sp. gr. 1.1400 to 1.6120 and n_D^{20} 1.5800 to 1.5855. The balsam is now available as a water-white viscous oil for use in good-quality perfumes.

Apart from the balsam there is also an essential oil in the wood of *Myroxylon pereirae*. This oil, which has recently been reported by Naves (1948. *Perfum. essent. Oil Rec.*, 39: 280), can be obtained by steam distillation of the wood of even those trees which have been tapped for the balsam. The oil is recovered in a yield of 0.736 to 1.08 per cent., and its main constituent is free nerolidol (50 to 70 per cent.), together with cadinenes and free cadinol. This finding points out a commercial source of nerolidol, which has a demand in high-class perfumery and which has been scarce so far. According to Naves (1947. *ibid.*, 38: 191), nerolidol is also obtainable from the essential oil (cabreuva oil) from the wood of the Brazilian species *Myrocarpus frondosus* Allem. and *M. fastigiatus* Allem. to an extent of 60 to 80 per cent. Further, according to him, nerolidol can be converted into farnesol, another rare ingredient used in perfumery.

The balsam of Tolu, a brown or yellowish-brown plastic substance with a sweet hyacinth-like fragrance, is obtained from *Myroxylon balsamum* (Linn.) Harms (*M. toluiferum* H.B. & K.) of Venezuela, Columbia, and Peru. Considerable amounts of it are used as a fixative in perfumery and for flavouring cough syrups. It contains up to 80 per cent. of resin, together with benzoic and cinnamic acids, vanillin, benzyl benzoate, benzyl cinnamate, and a small quantity of volatile oil. A genuine balsam of Tolu has an acid value from 92 to 135 and an ester value of 59 to 91. Like the balsam of Peru, a colourless Tolu balsam is also now available.

An oil described as bois d'ohlio, ohlio vehermilho or oleo vermelho has been distilled from the wood of *Myropermum erythroxyllum* Allem. (probably a synonym of *Myroxylon peruriferum* Linn. f.), a Japanese tree which is also found in Brazil. This is a light-yellow mobile oil having an odour recalling that of a mixture of sandal, cedar and rose, and is obtained in a yield of 1 per cent. The oil has a use as a fixative in soap industry (Anon., 1925. *Perfum. essent. Oil Rec.*, 16: 117, 163). It contains a high percentage of nerolidol (Naves 1948. *Perfum. essent. Oil Rec.*, 39: 280).

Copaiba, known also as copaiba balsam or copaiva, is the oleoresin obtained from *Copaifera officinalis* Linn., *C. lansdorfii* Desf. and other species of *Copaifera* of tropical S. America. Its chemical and physical characters differ slightly according to the source, but a large percentage of volatile oil is always present. The Maracaibo variety from *C. officinalis* is a viscid, somewhat brownish-yellow and slightly fluorescent liquid, yielding 35 to 55 per cent. of volatile oil, while the Para variety from *C. lansdorfii* is a thinner, lighter yellow liquid, yielding up to 80 per cent. of volatile oil. The essential oil consists chiefly of sesquiterpenes among which caryophyllene is present. Copaiba oleoresin has not a wide application in perfumery, but it is an excellent fixative for perfumes used in the soap industry. In medicine it is used as a disinfectant, laxative, diuretic, and mild stimulant.

The African copaiba or illurina balsam (also known as hardwickia balsam) is a very fragrant oleoresin with a thick, pungent, pepper-like odour, and is obtained from a W. African tree, *Daniella thurifera* F.F. Benn. (Sierra Leone frankincense). It con-

tains 40 to 55 per cent. of an essential oil which is sometimes used as an adulterant of other oils. An oleoresin similar to illurin balsam is obtained from *D. oliveri* (Rolfe) Hutch. & Dalz. This oleoresin, under the name of wood oil, is one of the chief products of Nigeria.

The white, aromatic flowers of *Robinia pseud-acacia* Linn. (false acacia, black locust) of N. America, on solvent extraction, yield the robinia oil. This oil is dark coloured, and contains methyl anthranilate, indole, linalool, heliotropin, etc. (Elze, 1910. *Chem. Z.*, **34**, 814). The oil has a typical acacia odour.

Oil of supa is derived from *Sindora wallichii* Benth. of the Philippines. It consists of a mixture of sesquiterpenes in which cadinene is the chief constituent (Finnemore).

The fruits of the foreign ornamental shrub *Amorpha fruticosa* Linn. yield 1.1 to 3.5 per cent., and the leaves 0.5 to 0.8 per cent. of essential oils. The fruit oil has an odour similar to that of pepper oil. Its constants and constituents have been given by Finnemore.

From the roots of the foreign *Ononis spinosa* Linn. a small quantity (0.0066 per cent.) of an essential oil, known as cammock oil, has been reported (Haensel, 1910. *Apothekerztg, Berl.*, **25**: 303), but the Himalayan undershrub *O. hircina* Jacq. has not been investigated so far.

The following genera containing aromatic species have been described in detail later. They are distributed among the three sub-families of Leguminosae as under:—

Subfamily I. Papilionatae. *Dalbergia*, *Indigofera*, *Lathyrus*, *Melilotus*, *Psoralea*, *Trifolium*, and *Trigonella*.

Subfamily II. Caesalpinioideae. *Caesalpinia*, *Cassia*, and *Kingiodendron*.

Subfamily III. Mimosoideae. *Acacia*.

In addition to the plants belonging to the above eleven genera, a number of other plants are also aromatic. *Crotalaria occulta* R. Grah., a small undershrub of Assam, has terminal racemes of flowers with a delightful scent of violets; the corolla is sky blue with darker blue or purple veins. It is well worth cultivating in gardens. The asoka (*Saraca indica* Linn.), a middle-sized handsome tree found in different parts of India both in a wild state as well as under cultivation, bears orange-scarlet, fragrant flowers 1 to 1½ in. in length. The black siris [*Albizia odoratissima* (Linn. f.) Benth.]

is a large deciduous tree of the Sub-Himalayan tract, Bengal, Central, Western and South India, with few-flowered heads of sweet-scented, white flowers. The kokko or siris [*Albizia lebeck* (Linn.) Benth.], a large deciduous tree of the Sub-Himalayan tract, Bengal, Central and South India, which is also often planted as a roadside tree in various parts of the country, bears greenish-white fragrant flowers in pedunculate heads. The *kalkora* [*Albizia kalkora* (Roxb.) Prain] of Assam is a large tree bearing heads of white flowers which are delightfully scented. The pink siris (*Albizia mollis* Boiv., syn. *A. julibrissin* Durazz., var. *mollis* Benth.), a medium-sized tree of the outer Himalayas, bears heads of fragrant flowers. It is extremely handsome at the time of flowering, with innumerable pink tassels of delicate silky blossoms.

The heartwood of *karanj* [*Pongamia pin-nata* (Linn.) Merr., syn. *P. glabra* Vent.], a moderate-sized tree found in many parts of India, both wild and planted, has a disagreeable odour when first exposed. The wood of the Burmese *Millettia leucantha* Kurz (*M. pendula* Benth. ex Baker) has a faint odour of tar.

The red sandalwood or sanderswood from *Pterocarpus santalinus* Linn. f., unlike as its name suggests, is nearly inodorous. Its powder, however, has been used as a cosmetic in India either in place of or with sandalwood to obtain a rose tint.

Pterocarpus indicus Willd. (Fl. Brit. Ind., in part, syn. *P. pallidus* Blanco) of Burma and the Philippines, bears sweet-scented flowers. From a specimen of its wood a solid aromatic substance, m.p. 70°, has been obtained by steam distillation (Anon., 1913, October. *Ber. Schimmel u. Co. Lpz.*: p. 68).

Among the constituents of essential oils reported from various members of the family may be mentioned: heptacosane, triacontane, unknown paraffin, styrene (styrol, vinylbenzene), phellandrenes, 'tolene' (C₁₀H₁₆), cadinene, caryophyllenes, copaene, unknown sesquiterpenes, azulene, benzyl alcohol, geraniol, nerol, linalool, farnesol, nerolidol, α-terpineol, sesquiterpene alcohol, phenol, vanillin, heliotropin, unknown aldehydes, unknown ketones, palmitic acid, cinnamic acid, methyl anthranilate, benzyl benzoate, benzyl cinnamate, coumarin, hydro-coumarin (melilotin, melilotol), cineole, and indole.

1. ACACIA (Tourn.) Linn.

(From the Greek *akakia*; originally a thorny tree found in Egypt.)

This genus comprises about 550 species of trees or erect or climbing shrubs. The leaf-bearing groups are scattered over the tropics and subtropics of the whole world, and the great phyllodineous series is almost restricted to Australia. In India it is represented by about 20 indigenous species as well as several introduced ones.

The acacias are important economically, not only for the timber of some species, but also for ornamental purposes and as the source of tanbarks, gums, and essential oils. Many of them are small trees and furnish excellent hard wood, which is serviceable for tool handles and for other small objects. The wood of the S. African *A. giraffae* Willd. is said to be extraordinarily hard. A few species like the Hawaiian *A. koa* A. Gray grow to a fairly large size, so much so that the Hawaiians formerly converted its trunks into dug-out war-canoes. The Australian blackwood (*A. melanoxylon* R. Br.) is used for cabinet work, coach-building, railway carriages, and agricultural implements, but the wood from the Indian-grown trees is said to be not so good as that from the Australian-grown plants. Most acacias are, however, used as firewood.

The bark of babul [*A. arabica* (Lam.) Willd.] has till recently been one of the premier tanning materials in India, and thousands of tons were being used annually by the tanneries in the country. It is, however, being ousted, in big tanneries at least, by the wattle bark from *A. mollissima* Willd. (black wattle), *A. decurrens* Willd. (green wattle), and related species, which is imported from S. Africa. Wattles are indigenous to Australia, but have been introduced into other countries, particularly Natal, S. Africa, and S. India. *A. pycnantha* Benth. (golden wattle) is much grown in Australia, but not in S. Africa. In Australia *A. mollissima* and *A. pycnantha* are of primary importance, while in S. Africa and in India *A. mollissima* and *A. decurrens* are the leading wattles. Of lesser importance as a tanning material is the bark of *A. dealbata* Link (silver wattle) in these countries.

Saponins are found in a number of acacias and a considerable trade exists in the saponaceous pods of *shikakai* [*A. concinna* (Willd.) DC.] which has already been dealt with.

A number of species yield gums, but the gum arabic from *A. senegal* (Linn.) Willd. and gum babul from *A. arabica* (Lam.) Willd. are commercial products which enjoy considerable trade. The best forms of these gums are colourless, odourless and tasteless.

The manufacture of *katha* and catechu from *A. catechu* (Linn.) Willd. (khair) and *A. chundra* Willd. (*lal-khair*) is an important industry in India, giving employment to hundreds of thousands of people. These products have already been referred to in the account of the family.

The leaves of Australian *A. dodonaeifolia* Willd. and *A. verniciflua* A. Cunn. are coated with resins.

The cassie perfume of commerce is obtained from the flower-heads of *A. farnesiana* (Linn.) Willd., while the flower-heads of *A. dealbata* Link and of some other species are used for the preparation of the well-known mimosa perfume. Both these are described in detail later.

A. cavenia Hook. & Arn. (Roman cassie, cassie Romaine) is cultivated in S. France for extraction of a perfume from its flowers. This species demands less care and yields a larger harvest of flowers than *A. farnesiana*, but the perfume is not so suave and well blended as that of cassie flowers. The flowers of Roman cassie are, for this reason, about half the price of the cassie flowers. Very little pomade is made from these flowers, but a concrete is prepared by extraction in petroleum ether. The yield of concrete varies from 0.60 to 0.84 per cent. (Naves & Mazuyer, 1947. *Natural Perfume Materials*: p. 165). The essential oil from flowers contains 40 to 50 per cent. of eugenol, 8 per cent. of methyl salicylate, and 42 to 52 per cent. of substances insoluble in dilute aqueous sodium hydroxide, consisting of benzyl alcohol (about 20 per cent.), geraniol, anisaldehyde, and eugenol methyl ether. Linalool, decyl aldehyde, and a ketone with an odour of violets, ionone or irone, are also probably present but could not be identified with certainty. The oil does not contain methyl anthranilate [Walbaum, 1903. *J. prakt. Chem.*, **68**: 235; vide *J. chem. Soc. (Abstr.)*, 1903, **84**(1): 845]. A distillate described by Naves, Sabetay & Palfray (1937. *Perfum. essent. Oil Rec.*, **28**: 336) had these characteristics: sp. gr. 1.031^{15} , $[\alpha]$ inactive, n_{20}^{20} 1.512, acid val. 11.2, and ester val. 96.0. Another set of readings was as follows: sp. gr. 1.028^{15} , $[\alpha]$ 0.1° , n_{20}^{20} 1.514, acid val. 22.0, and ester val. 112.0.

A small quantity of perfume is obtained for local use in Australia from the flowers of various species of *Acacia*, commonly known as wattle blossoms.

A. jacquemontii Benth., a bushy, thorny shrub of the dry regions of the Punjab, Sind, Rajputana and Gujarat, extending to the Suleman Range and lower Himalayas west of the Jhelum (usually along watercourses and in ravines), bears yellow, fragrant flowers in globose heads which are $\frac{1}{3}$ inch in diameter. No essential oil has, however, been extracted from the flowers.

1. *Acacia dealbata* Link

Fl. Brit. Ind., II, 292 (without description).

(Silver Wattle, Mimosa)

This is a small to middle-sized, unarmed, evergreen Australian tree which was introduced into India before 1840. It bears grey foliage and bright-yellow, very sweet-scented flowers in globular beads about $\frac{1}{3}$ inch in diameter. It has been tried in many places in the Himalayas, such as Abbottabad in the N.-W.F. Province, Almora in Kumaon, and Shillong in Assam, but nowhere has it succeeded so well as in the Nilgiris and Pulneys, where it has become completely naturalized.

The wood is used as a fuel. The bark, which contains 9 to 17 per cent. tannins, is a useful tanning material.

The flowers of this plant are used for the preparation of the well-known mimosa perfume, more or less in the same way as those of the next species *A. farnesiana* (Linn.) Willd. for the cassie perfume. Although *A. dealbata* is the principal species from which mimosa perfume is prepared, there are many others which are commercially known as mimosa. According to Poucher, "there are over 30 varieties cultivated on the Cote d'Azur and the cut branches are sold principally as cut flowers. The trade is so extensive that a special train leaves Mentone daily in January and February, and conveys to Paris large quantities of this favourite flower. Consignments average about 600,000 baskets of flowers each season... Visitors to the Riviera in February will have been charmed with the delicious fragrance and picturesque appearance of the mimosa trees as the train wends its way along the red rocky coast between Saint-Raphael and Cannes."

The next in importance to the flower-heads of *A. dealbata*, from the point of view of perfumery, are the flower-heads of *A. floribunda* Willd. The perfume of mimosa is faint (in small bunches) but captivating. In the case of *A. floribunda* it resembles cassie, while in the case of *A. dealbata* it is slightly coarser and resembles ylang-ylang. If several bunches were placed in a closed room, their fragrance is overpowering.

The first flowers from the middle of January to the end of March are sold as cut flowers in France. It is after this period, in April, when the trees flower profusely and the blossoms are more open and highly scented, that the flowers are collected and extracted for perfumery. In some years as much as 180,000 lbs. of flowers are collected for this purpose. They are then extracted with petroleum ether, since distillation and maceration yield inferior products.

The yield of concrete varies from 0.70 to 0.88 per cent., although in specially sorted flowers even 1.06 per cent. has been obtained. From this 20 to 25 per cent. of absolute is obtained. In humid season the yield of absolute is lower (Naves & Mazuyer, 1947. *Natural Perfume Materials*: p. 219).

The absolutes from both *A. dealbata* and *A. floribunda* are comparatively cheap and give excellent results in floral Colognes, while in de luxe perfumes, particularly honeysuckle and heliotrope, they give floral notes which are unique. Very fine bouquets of honey-like odour can be obtained by combination with muguet (lily of the valley) or jasmine (Poucher).

Very little is known about the chemistry of the oil, but von Soden (1925. *J. prakt. Chem.*, **110**: 273) distilled with steam an absolute prepared by volatile solvents, and, calculated on fresh flowers, obtained 0.018 per cent. of a yellowish-green oil, which solidified towards 0° to a flaky crystalline mass. Its constants were: sp. gr. ^{15°} 0.816, $[\alpha]$ inactive or slightly laevorotatory, acid val. 12, and ester val. 20.5.

A distillate described by Naves, Sabetay & Palfray (1937. *Perfum. essent. Oil Rec.*, **28**: 336) had the characteristics: $[\alpha] + 0.3^\circ$, n_{20}^{20} 1.4812, acid val. 3.6, and ester val. 22.0.

A number of commercial mimosa oils are prepared synthetically without any floral extract. These artificial perfumes, which resemble cassie, are compounded from methylacetophenone and its homologues, together



FIG. 33 — *Acacia farnesiana* (Linn.) Willd.

with methyl heptine carbonate, terpineol, and hydroxycitronellal. Although good results are obtained by this method, the addition of 10 per cent. of mimosa absolute makes all the difference to the smoothness and fixity of the blended mixture.

2. *Acacia farnesiana* (Linn.) Willd.

Fl. Brit. Ind., II, 292.

(Cassie Flower, *Vilayati-babul*)

This is a spiny shrub or low tree with slender, zigzag branches marked with grey dots. It bears during the cold season bright-yellow, very fragrant flowers in globose heads $\frac{2}{3}$ to $\frac{3}{4}$ inch in diameter, which per-

fume the surrounding atmosphere very pleasantly. A native of tropical America, this plant is now widely cultivated all over India and in the East, especially as a hedge plant. It is also found in Egypt, Syria, Algeria and France, where it is specially cultivated for the industrial extraction of perfume.

The stem yields a gum which is said to be collected and marketed in Sind and the Punjab, especially as an adulterant of gum babul. The bark and the pods contain tannins.

The round, yellow flower-heads constitute the cassie flowers (known in France as *cassie ancienne*) which are used in European perfumery. Their odour closely resembles

a perfectly blended combination of orange blossom and violet with just a suggestion of cumin.

In France it is commercially cultivated in Provence on the outskirts of Cannes, Cannet, Vallauris, and Saint-Laurent-du-Var. It thrives best on a light sandy granite soil. The plants are raised from seeds and begin to bear flowers after 3 years. They blossom from the end of September to the beginning of February, but the main collection is usually made during September to November. The flowers collected during October are the most valuable. In the spring season the trees are trimmed.

The flowers are collected twice a week, one by one, during the day time and are conveyed to the works in the evening. The blooming is successive, some flowers being ready for collection before the others are scarcely formed. The total yield per tree in one year varies from 4 to 10 lbs.

In Algeria and Egypt also the principal harvest is collected during October and November.

The perfume of cassie flowers is very delicate and is destroyed if distilled in steam. The flowers are, therefore, extracted by maceration in fats at 35° to 50°C., or by petroleum ether. The absolute is prepared from both pomade and concrete.

The yield of concrete generally varies between 0.50 and 0.70 per cent. The flowers gathered at the end of the season usually give a higher yield than those of the autumn. The concrete yields about 30 per cent. of absolute, which furnishes 6.5 to 9 per cent. of steam-distillable products. It is of a soapy consistency, dark brown in colour, becoming lighter on contact with light and air. The distillate is colourless and very refractive (Naves & Mazuyer, 1947. *Natural Perfume Materials* : p. 166).

Walbaum & Rosenthal (1929. *Ber. Schimmel u. Co. Lpz.* : p. 193) have observed a concrete having the following characteristics : congealing point 46.5° and saponification val. 103.6.

Naves & Mazuyer (*loc. cit.*) mention the following characteristics of an absolute of Grasse origin : sp. gr. ^{15°} 0.988, acid val. 62.8, and ester val. 33.5.

Rovesti (1925. *Profumi ital.*, 3 : 277) gives the following constants for an absolute prepared in Liguria : sp. gr. ^{15°} 1.020 to 1.070, $[\alpha]$ 0° to -3°, n 1.514 to 1.521, acid val. 18 to 55, and ester val. 97 to 243.

Naves & Mazuyer (*loc. cit.*) give the following analytical data for the products obtained by steam distillation. These have been compiled from the works of von Soden (1904. *J. prakt. Chem.*, 69 : 270), Schimmel & Co. (1907, April. *Ber. Schimmel u. Co. Lpz.* : p. 18), and Naves, Sabetay & Palfray (1937. *Perfum. essent. Oil Rec.*, 28 : 336).

The distillate from the pomade concentrate prepared in India was obtained by Schimmel & Co. (1904, April. *Ber. Schimmel u. Co. Lpz.* : p. 21), with a yield of 0.171 per cent., based on pomade. This distillate had a pale-yellow colour, with the following characteristics : sp. gr. ^{15°} 1.0475, $[\alpha]$ 0°, n^{20} 1.5133, and saponification val. 176.0.

Schimmel & Co. (1899, Oct. *Ann. Rep.* : p. 58 ; 1901, Apr. *ibid.* : p. 18 ; 1903, Apr. *ibid.* : p. 17) report an Indian cassie pomade to contain 11 per cent. of methyl salicylate, small amounts of *p*-cresol, benzaldehyde, benzyl alcohol, a ketone possibly menthone, anisaldehyde, decyl aldehyde, cuminaldehyde, and possibly geraniol and linalool. A constituent of importance as far as odour is concerned is a ketone of violet odour and unknown constitution. Farnesol has also been reported (Haarmann & Reimer, *vide* Wehmer).

In practical perfumery cassie absolute is used in the preparation of numerous violet bouquets to which it imparts a delightful and peculiar aroma unobtainable with any other product. Owing to the high cost, it is not possible to add natural violet absolute when compounding synthetic violet ottos. Cassie absolute in these cases serves as an excellent cheap substitute, and about 5 per cent. of it may be used with satisfactory results.

ORIGIN AND % YIELD	CONGEALING POINT	SP. GR. ^{15°}	OPTICAL ROTATION	REFRACTIVE INDEX ^{20°}	ACID VAL.	SAAPONIFICATION VAL.		
France : 0.084 of flowers	18-19	1.040(27°)	0.4°	—	42.50	114.0
5.65 of concrete	liq.	1.0575	0.3°	1.5158	25.40	229.0
Egypt } 6.5 to 9 of concrete	liq.	1.032	0.6°	1.5045	5.60	154.0
Egypt } 6.5 to 9 of concrete	liq.	1.037	0.2°	1.5082	3.70	148.0
Egypt } 6.5 to 9 of concrete	liq.	1.029	1.1°	1.5018	4.20	166.0
Egypt } 6.5 to 9 of concrete	liq.	1.043	0.2°	1.5120	6.30	182.0
Egypt : 26.4 of absolute*	liq.	—	inactive	1.5212	30.50	169.0

*Prepared from a commercial product of guaranteed purity

FIG. 34 — *Caesalpinia sappan* Linn.

On the basis of constituents given above synthetic cassie oil is manufactured, and rounded off with a judicious addition of concrete of natural flowers.

It is said that a good deal of pomade was at one time made in India, perhaps in the Punjab and to a certain extent in the United Provinces, but for some unknown reason this industry has died. Efforts should be made to revive this since cassie perfumes command, even today, a good market.

2. CAESALPINIA Linn.

(In honour of Andreas *Caesalpinii*, professor of medicine at Pisa in the sixteenth century. He was the first botanist to classify plants by the flowers and fruits.)

This genus comprises about 60 species of tropical and subtropical trees, shrubs or

often prickly climbers, out of which 12 are represented in India.

The trees have a hard wood, which in several species yields a dye. The sappan-wood (*C. sappan* Linn.) yields the well-known red dye which was in considerable use formerly. Other important dyewoods are *C. crista* Linn. (redwood), *C. brasiliensis* Linn. (Brazil wood), and *C. echinata* Linn. (peachwood), all of America.

The barks and pods are usually rich in tannin. The pods of divi-divi or American sumach [*C. coriaria* (Jacq.) Willd.], which is often cultivated in India, are a valuable tanning material and contain 40 to 50 per cent. of tannin. The pods of *teri* (*C. digyna* Rottl.) are also one of the richest sources of tannin, and are used in India for tanning purposes.

Some species are used in medicine, and contain a resin.

The peacock flower or Barbados pride [*C. pulcherrima* (Linn.) Sw.] is a handsome shrub with scarlet or yellow flowers. It is commonly cultivated in Indian gardens as an ornamental plant.

C. nuga (Linn.) Ait., a large prickly climbing shrub of the coastal forests of India, bears yellow, fragrant flowers in long-peduncled terminal racemes 10 to 15 inches in length.

Caesalpinia sappan Linn.

Fl. Brit. Ind., II, 255.

(Sappanwood, *Patang*)

This is a small prickly tree with panicles of yellow flowers $\frac{3}{4}$ inch in diameter, and obliquely oblong, 3- to 4-seeded, woody pod having a short curved beak at the upper angle of the obtuse apex. It is found in Bengal, S. India and Bombay, usually cultivated.

The dark-red or orange-yellow wood yields a valuable red dye which was in considerable use formerly, and even exported. This dye, which is still used to an extent, is soluble in water, and is employed in dyeing wool and in calico-printing.

The leaves, on distillation, yield 0.16 to 0.25 per cent. of an almost colourless oil having sp. gr. $^{25^{\circ}}$ 0.825 and $[\alpha] + 37.3^{\circ}$ to $+ 50.3^{\circ}$. The odour of the oil is pepper-like, which appears to consist chiefly of *d*- α -phellandrene. The bulk of the oil boils at 170°C . (Gildemeister). An olefinic hydrocarbon is also reported (Romburgh, 1925, *vide Chem. Abstr.*, 1926, 20 : 2722).

3. CASSIA Tourn. *ex* Linn.

(The classical name of some trees with aromatic bark.)

This genus comprises 400 species of trees or shrubs, rarely herbs, of tropical and warm temperate regions, and is represented in India by 15 species. Its members have abruptly pinnate leaves and large, showy, nearly regular, usually yellow flowers in racemes or clusters.

Several species are extensively cultivated throughout the tropics for the elegance of their foliage combined with the beauty of their flowers. Among these may be mentioned the arboreal *C. fistula* Linn. and *C. renigera* Wall., and the shrubby *C. bicapsularis* Linn., *C. tomentosa* Linn. *f.*, and *C. laevigata* Willd.

A number of species are of considerable importance from the medicinal point of view, and some are widely used for their cathartic properties. The senna leaves and pods, which are widely used as purgatives, are derived from the Indian or Tinnevely senna (*C. angustifolia* Vahl) and the Alexandrian senna (*C. acutifolia* Delile). The pulp of the fruit of *C. fistula* Linn. (Indian laburnum, purging cassia) is one of the commonest domestic medicines, and acts as a simple purgative. The purging property of cassias depends upon chrysophanic acid and other oxanthraquinone derivatives which they contain. Some species, such as the ringworm shrub (*C. alata* Linn.), are used in skin diseases.

The bark of a number of species contains a fair quantity of tannin. That of *C. fistula* is commonly used in India for tanning purposes under the name of *sonari* bark.

The seeds of some species are used by the poor people as a substitute for coffee.

From the point of view of essential oils, this genus has no economic importance. The leaves of *C. angustifolia* are said to have a tea-like odour and to contain traces of an essential oil (Tschirch, 1898. *Ber. dtsh. pharm. Ges.* : p. 189). The seeds of *C. occidentalis* Linn. (*kasondi*), when roasted, emit an aroma similar to that of coffee; they are known as negro coffee. The leaves of *C. tora* Linn. (*chakunda*) have a foetid smell, but the seeds on roasting develop a coffee-like aroma. Both these species are common weeds of roadsides, river banks, and fallow lands in most parts of India.

4. DALBERGIA Linn. *f.*

(In honour of Nicholas Dalberg, a Swedish botanist, 1730-1820.)

This genus comprises over 200 species of tropical trees, shrubs, and woody climbers, out of which about 20 are found in India. Its members bear copious, papilionaceous flowers in terminal or lateral panicles, and oblong or strap-shaped, thin and flat, indehiscent, 1- to 4-seeded pods.

The genus is very important in Indian forest economy, as it contains two of the most valuable and important Indian forest trees, besides several others of interest on account of their woods and other products or their value in silviculture. The Indian *D. sissoo* Roxb. (*sissoo*, *shisham*) and rosewood or Bombay blackwood (*D. latifolia* Roxb.) enjoy considerable trade. *D. latifolia*, to-

gether with the Burmese species *D. cultrata* R. Grah. ex Benth. (Burma blackwood) and *D. oliveri* Gamble ex Prain (Burma tulipwood, *tamalan*), is of great ornamental value and is, therefore, of interest to connoisseurs of fancy woods. *D. sissou* produces a valuable timber which seasons well and is esteemed for all purposes where strength and elasticity are required. *D. melanoxylon* Guill. & Perr. is the African blackwood or Senegal ebony of the trade, and *D. nigra* Allem ex Benth. is the Brazilian rosewood. Cocobolo is derived from the American *D. retusa* Hemsl. and related species, and is one of the showiest and most strikingly coloured woods. The heartwood is orange to orange red in colour, streaked with jet black. It is very hard, tough and strong, and is largely used in cutlery. The dye in cocobolo appears to be allied to that of *Acacia catechu* (Linn.) Willd.

The highly ornamental heartwood of the Indian *D. latifolia* has a fragrant scent. Similarly the heartwood of the Burmese *D. oliveri* has a faint, pleasant odour.

D. rimosa Roxb., a suberect or climbing often tendril-bearing shrub of the E. Himalayas and Assam, bears panicles of sweet-scented, very small flowers (among the smallest in Papilionatae).

The scented wood of *D. cumingiana* Benth., of the Philippines and the Dutch East Indies, yields about 0.5 per cent. of an essential oil with aromatic odour. The oil has the following characteristics: sp. gr. $^{26^{\circ}}$ 0.891, $[\alpha]$ -4.3° , ester val. 5, and the same after acetylation 116 (Parry).

The heartwood of the thick stems near the ground and of the roots of the climbing *D. parviflora* Roxb.* of Malay Peninsula and Sunda Islands is scented and exported to China for the manufacture of joss sticks. It is used in Borneo and Celebes as an incense. According to Prain (1895. *Ann. R. bot. Gdn. Calcutta*, 10: 35), this is the *kayu-laka* of commerce. Spoelstra (1931. *Rec. Trav. chim. Pays-Bas*, 50: 433) has obtained an essential oil from the wood in a yield of 0.45 to 0.8 per cent., with *l*-nerolidol ($C_{15}H_{26}O$) as the main constituent. According to him traces of furfural and probably farnesol are also present. The oil has the following characteristics: sp. gr. $^{15^{\circ}}$ 0.8878 to 0.8929, n^{20} 1.4809 to 1.4825, $[\alpha]$ -0.20° to -4.75° , acid val. 0.5 to 1.6, ester val. 0 to 1.2, and the same after acetylation 139.5 (=61.6 per cent.).

*This plant is probably also found in the Andamans.

5. INDIGOFERA Linn.

(From the Latin *indicum* — a blue pigment believed to be indigo, and *fero* — I bear; species of this genus yield the indigo of commerce.)

This genus comprises about 350 species of herbs or shrubs of warm regions. In India it is represented by 40 species having odd-pinnate leaves and pink or purple papilionaceous flowers in axillary racemes.

The most famous of its members is *I. tinctoria* Linn. which furnishes indigo.

The seeds of several species are said to be poisonous.

Indigofera galeoides DC.

Fl. Brit. Ind., II, 100.

This is a tall shrub about 12 ft. high, with twiggy branches and pale-red flowers in dense racemes 2 to 3 inches in length. It is found in the Khasi Hills at an altitude of about 5,000 ft., generally in shady localities.

The fresh plant, mashed with water, yields on distillation 0.2 per cent. of a light-yellow essential oil. This oil has an odour of bitter almonds, but differs from the latter in having a herbaceous aroma. Its sp. gr. is 1.046. It contains benzaldehyde, hydrocyanic acid, and small quantities of ethyl and methyl alcohol (Anon., 1894, Oct. *Ber. Schimmel u. Co. Lpz.*: p. 75; Anon., 1896, Apr. *ibid.*: p. 75).

6. KINGIODENDRON Harms

This genus comprises two species of which one is found in India.

Kingiodendron pinnatum (Roxb.) Harms

Hardwickia pinnata Roxb., Fl. Brit. Ind., II, 270.

(Piney, *Shuruli*)

This is a very large, handsome tree having leathery leaflets and numerous, very small white flowers in panicles of racemes. It is found in the evergreen forests of W. Ghats from S. Kanara to Travancore.

The wood is dark red or reddish brown, and is locally used for building purposes as well as for making furniture.

The tree yields a viscous, dark reddish-brown balsam with not an unpleasant odour. In smell and taste, this resembles copaiba balsam which is derived from the

foreign *Copaifera officianalis* Linn. and allied species. The balsam is used in indigenous medicine, and also as a varnish for wood after thinning with turpentine. It is obtained from the tree trunk by tapping, for which purpose large trees with a girth of 5 to 6 ft. are selected. A notch is cut in the trunk, into which a tube or a trough is inserted to carry the exudation to a receptacle at the base of the tree. The balsam begins to drain at once, but the flow stops in about four days. This operation is performed when the rains have set in, since during this period the yield is more. In some places the trees are tapped in the dry season from December to May. A healthy tree of 8 ft. girth is reported to yield as much as 12 gallons of the balsam.

According to Weigel (1906. *Pharm. Zentralh.*, 47: 773) kingiodendron balsam is analogous to copaiba balsam. Hooper (1907. *Pharm. J.*, 78: 4), who examined two genuine Indian samples, gives a resumé of the work done on the balsam by various workers and concludes that the physical constants easily distinguish kingiodendron balsam from the copaiba and gurjun balsams. Iyer & Sudborough (1918. *J. Indian Inst. Sci.*, 2: 29), who examined two samples from Travancore and Mysore, are of the opinion that kingiodendron balsam resembles copaiba balsam more closely than it does gurjun balsam. The following are the characteristics of the balsam as recorded by Iyer & Sudborough; Hooper's values are also given:—

	TRAVANCORE SPECIMEN	MYSORE SPECIMEN	HOOPER'S VALUES
Specific gravity 15°	1.008	0.997	1.007-1.012
Acid val. ...	90.2	84.6	97.2-99.8
Saponification val. ...	112.9	103.7	106-112
Acetyl val. ...	79.6	83.0	—
Per cent. of volatile oil ...	42.7	47.0	39.5-41.1

Schimmel & Co. (1905, Apr. *Ann. Rep.*: 1907, Apr. *ibid.*) by steam distilling the balsam obtained 44 per cent. of a colourless oil having the following constants: sp. gr. 15° 0.9062, $[\alpha]$ 7.4°, acid val. 0.85, ester val. 2.88, and soluble in about 5 and more volumes of 90 per cent. alcohol.

Iyer & Sudborough (*loc. cit.*) obtained from 2 samples on steam distillation by superheated steam 42.7 and 47.0 per cent. of a practically colourless oil having a characteristic odour and a pungent bitter taste. The major portion of the oils distilled at 257° to 271°C. at ordinary pressure. They have recorded the following constants:

	TRAVANCORE OIL	MYSORE OIL
Specific gravity 15°	0.931	0.908
Refractive index 20°	1.500	1.500
Optical rotation 20° in 100 mm. tube	-1.72°	-7.86°
Acid val. ...	trace	trace
Saponification val. ...	nil	nil
Acetyl val. ...	12.6	1.4

These physical characteristics resemble those of caryophyllene, the main constituent of clove oil, but the kingiodendron essential oil needs further careful examination for caryophyllene with a view to discovering an alternative source of clove oil which is not produced in India.

Iyer & Sudborough (*loc. cit.*) have also examined the resin obtained after the distillation of the essential oil. The resin melts at 53° to 56°C., and has the following characteristics:

	TRAVANCORE RESIN	MYSORE RESIN
Specific gravity ...	1.088	—
Acid val. ...	162.2	160.0
Saponification val. ...	193.9	200.0
Ash ...	0.05%	0.02%
Solubility in 90% alcohol ...	99.2%	complete

7. LATHYRUS Linn.

(From the Greek *lathyros*, a kind of pulse.)

This genus comprises 110 species of annual or perennial climbing herbs, which are distributed chiefly in the north temperate zone. Of the eight species found in India, *L. sativus* Linn. (*khesari*) is the most important, since it is largely cultivated all over the country as a cold-weather crop for use as a fodder and by the poorer classes of people as a food. The whole plant as well as the seeds, under certain circumstances, have been incriminated in the production of poisonous symptoms or the disease called lathyrism.

The sweet pea (*L. odoratus* Linn.) is cultivated in gardens for the sake of its various coloured, sweetly fragrant flowers. This is described below in detail.

Lathyrus odoratus Linn.

(Sweet Pea)

This climbing herb is commonly cultivated in the Indian gardens for the sake of its elegant, various coloured flowers having a delicate and sweet fragrance, recalling that of orange flowers and hyacinth with a suggestion of rose.

The flowers contain a small amount of essential oil, but this does not appear to have been systematically investigated. It is also doubtful whether they have ever been extracted for use in perfumery, although there is reason to believe that euffleurage would capture the floral fragrance faithfully. The odour of the flowers suggests the presence of methyl anthranilate.

The sweet pea perfumes of commerce are synthetic and are generally compounded from methyl anthranilate, benzylideneacetone, hydroxycitronellal, and terpineol. Numerous other synthetic perfumes are employed, and are rounded off with natural essences, such as jasmine and bergamot.

8. MELILOTUS Tourn. *ex* Hall.

(From the Greek *meli* — honey, and *lotos* — lotus ; the flowers are much visited by bees.)

This genus comprises 20 herbaceous species (sweet clovers) which are distributed over the temperate and subtropical regions. It is characterized by trifoliate leaves and slender racemes of yellow or white flowers succeeded by subglobose or oblong, indehiscent or tardily dehiscent pods.

The sweet clovers are a valuable fodder either in the green condition or when made into hay. They are also cultivated for pasture and for soil improvement. In India they are represented by three species, namely (1) *M. alba* Desr. the white-flowered sweet clover, (2) *M. indica* (Linn.) All. (*M. parviflora* Desf.) the pale-yellow-flowered sweet clover, and (3) *M. officinalis* Lam. the yellow-flowered sweet clover.

All species of *Melilotus* contain coumarin, which is concentrated mainly in mature and drying branches. Coumarin is one of the important perfumes, and is a basic material for all perfumes of the type of *foin-coupé* or "new-mown hay". It is found in the largest amount (3 per cent.) in tonka beans [*Dip-teryx odorata* (Aubl.) Willd. and *D. oppositifolia* (Aubl.) Willd.]. Commercial coumarin is, however, invariably a synthetic product.

1. *Melilotus alba* Desr.

Fl. Brit. Ind., II, 89.

(White-flowered Sweet Clover)

This is a biennial herb very much like *M. officinalis* Lam., but bears white, scented flowers. It is found in the plains

of N. India, ascending up to an altitude of 12,000 to 13,000 ft.

The entire plant contains coumarin.

2. *Melilotus indica* (Linn.) All.

M. parviflora Desf., Fl. Brit. Ind., II, 89.

(Pale-yellow-flowered Sweet Clover, *Banmethi*, *Senji*)

This is a slender annual 1 to 2 ft. high with pale-yellow flowers in spicate racemes. It is found in Bombay, Bengal, the United Provinces, and the Punjab, either cultivated or as a weed of cultivation.

The plant is said to contain coumarin (Watt.).

3. *Melilotus officinalis* Lam.

Fl. Brit., Ind., II, 89.

(Yellow-flowered Sweet Clover, *Aspurk*)

This is a tall and robust annual or biennial herb bearing yellow, odorous flowers crowded in bunches 1 to 2 inches long. It is found at Nubra and in Ladakh at altitudes of 10,000 to 13,000 ft., and is occasionally cultivated in India as a fodder.

The entire plant contains coumarin (0.2% on dry basis) together with melilotic acid, coumaric acid and an oily substance. Hydrocoumarin has also been reported (Vogel, 1820, *vide* Wehmer ; Zwenger, 1867. *Ann. Chim., Suppl.*, 5 : 100 ; Phipson, 1875. *Chem. News*, B2 : 25).

The flowers yield 0.0133 per cent. of an essential oil (melilot oil) containing coumarin (Haensel, 1900. *Apothekerztg, Berl.*, 15 : 516). The seeds yield 7.83 to 8.35 per cent. of a fatty oil with coumarin smell.

9. PSORALEA Linn.

(From a Greek word *psoraleos*, meaning scabby.)

This genus comprises about 100 species of tropical and subtropical herbs and undershrubs having glandular compound leaves and spicate or racemose, purple or white flowers. It is represented in India by two species, *P. corylifolia* Linn. and *P. plicata* Delile. Besides these, the S. African shrub *P. pinnata* Linn., with blue flowers and narrow leaflets, has also established itself about Ootacamund.

The N. American *P. esculenta* Pursh (prairie turnip) has edible roots. The S. American *P. glandulosa* Linn. is locally used for tea.

The leaves of *P. bituminosa* Linn. of the Mediterranean region have an asphalt-like odour when crushed. They yield 0.048 per cent. of an essential oil, which is semi-solid at ordinary temperature. It has sp. gr. ^{25°} 0.8988, acid val. 57, and ester val. 12. Fatty acids, melting point 38° to 40°, have been isolated (Finnemore).

Psoralea corylifolia Linn.

Fl. Brit. Ind., II, 103.

(Babchi)

This is an erect annual 1 to 3 ft. high, having firm branches copiously covered with conspicuous gland dots. It has gland-dotted leaves and bluish-purple flowers. The pods are small, black, 1-seeded. The seeds are aromatic with a pungent bitterish taste. The plant occurs in the plains throughout India, from the Himalayas to Ceylon.

The seeds have a persistent odour and are employed locally in the preparation of certain types of medicated oils and incense preparations. They are commonly used in indigenous medicine, particularly against cutaneous diseases, such as leucoderma and leprosy. Their essential oil has a powerful effect against the skin streptococci. Local applications of oleoresinous extracts from the seeds have recently been found to be beneficial in the treatment of leucoderma of non-syphilitic origin.

On distillation with steam, the powdered seeds yield 0.05 per cent. of a pale-yellow oil with a marked odour of the seeds. The petroleum ether extraction of the seeds gives a reddish-brown oil and crystalline solids psoralene and isopsoralene which are coumarone-coumarin compounds. The oil contains a considerable quantity of resin (Jois, Manjunath & Rao, 1933. *J. Indian chem. Soc.*, 10 : 41; Jois & Manjunath, 1936. *Ber. deutsch. chem. Ges.*, 69 : 399; Späth *et al.*, *Ber. deutsch. chem. Ges.*, 69 : 1087).

The leaves are gland dotted and may contain an essential oil like the foreign *P. bituminosa* Linn.

10. TRIFOLIUM (Tourn.) Linn.

(The Latin name for clover; referring to the three leaflets.)

This genus comprises about 300 species of herbs (clovers) having trifoliate leaves,

small red or white sometimes yellow flowers in dense axillary heads, spikes or umbels, and minute membranous, 1- or few-seeded indehiscent pods. Its members are found in the temperate and subtropical regions. It is represented in India by 5 species.

Clovers are important pasture and hay plants, although some of the species are believed sometimes to produce untoward symptoms in animals feeding on them. For example, although *T. pratense* Linn. (red clover or cow grass) and *T. hybridum* Linn. (alsike clover) are normally considered as valuable fodder plants, some authors refer to symptoms of "photosensitization" when taken by animals in large quantities. Similarly *T. repens* Linn. (Dutch clover, white clover), normally an excellent fodder, is said to contain in fresh plants a cyanogenetic glycoside and to produce poisonous symptoms in animals.

The blossoms of a number of clovers exhale a honey-like fragrance. Of the odorous species, *T. incarnatum* Linn. (carnation clover, scarlet clover) of Europe and *T. odoratum* Shrank (probably a synonym of *T. montanum* Linn.) of Italy are the best known. Rogerson (1910. *J. chem. Soc.*, 97 : 1004) has obtained from the flowers of *T. incarnatum* 0.029 per cent. (calculated on dry clovers) of a powerfully odorous pale-yellow essential oil having sp. gr. ^{20°} 0.9597 and $[\alpha]_D - 1.5^\circ$. He has identified furfural as constituent of the oil.

The odour of clover is not extracted on a commercial scale, and the trèfle (trefoil) perfumes marketed by a number of perfumers are not the products of any species of this genus. On the other hand perfumes bearing the name trèfle are manufactured synthetically, and are based on a large proportion of amyl salicylate, together with isobutyl salicylate, phenylacetic acid, vanillin, benzylideneacetone, jonquil, ylang-ylang, tuberose, jasmine, etc.

Trifolium pratense Linn.

Fl. Brit. Ind., II, 86.

(Cow Grass, Red Clover, Trèfle)

This is a perennial herb about a foot or more high with usually red-purple flowers in dense roundish heads $\frac{3}{4}$ to $1\frac{1}{2}$ inches in dia-

meter, and 1-seeded pods. It is found in the Himalayas from Kashmir to Garhwal at altitudes of 4,000 to 8,000 ft. It is one of the common forage clovers in these regions. It is regarded as a good cropper where the commoner clover fails.

A rather unpleasant-smelling oil containing furfural has been obtained in a yield of 0.028 per cent., calculated on dry flowers. The oil has sp. gr.^{20°} 0.9476 and $[\alpha] + 4.0^\circ$ (Power & Salway, 1910. *J. chem. Soc.*, **97**: 231).

11. TRIGONELLA Linn.

(From the Greek *treis* — three, and *gonia* — an angle; referring to the triangular form of the flowers.)

This genus comprises 70 herbaceous species out of which 8 are found in India. It is found in the Mediterranean region, Europe, Asia, S. Africa, and Australia. Its representatives are fragrant annuals having trifoliolate leaves, small, yellow or white flowers in heads or racemes, and linear many-seeded pods.

Trigonella foenum-graecum Linn.

Fl. Brit. Ind., **II**, 87.

(Fenugreek, *Methi*)

This strongly and pleasantly scented annual is widely cultivated, particularly in N. India, for the sake of its leaves and seeds.

The green leaves are eaten as a potherb, and the dried ones as a flavouring agent. The seeds are used in medicine and as a spice.

Fenugreek is locally used as an insect repellent. The agriculturists in the Kangra district in the Punjab mix the dried plant with their grains stored up in bags, in order to protect the cereals from attacks of insects during the rainy season.

In Java the seeds are said to be used in cosmetics and hair oils.

The seeds contain the alkaloid trigonelline, choline, and 0.014 per cent. of a brown essential oil of intense odour. The oil has sp. gr.^{13°} 0.870 and $[\alpha] + 0.8^\circ$ in 10 per cent. alcoholic solution (Haensel, 1910. *Apothekerztg., Berl.*, **25**: 303).

The odoriferous principle of the leaves does not appear to have been examined.

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