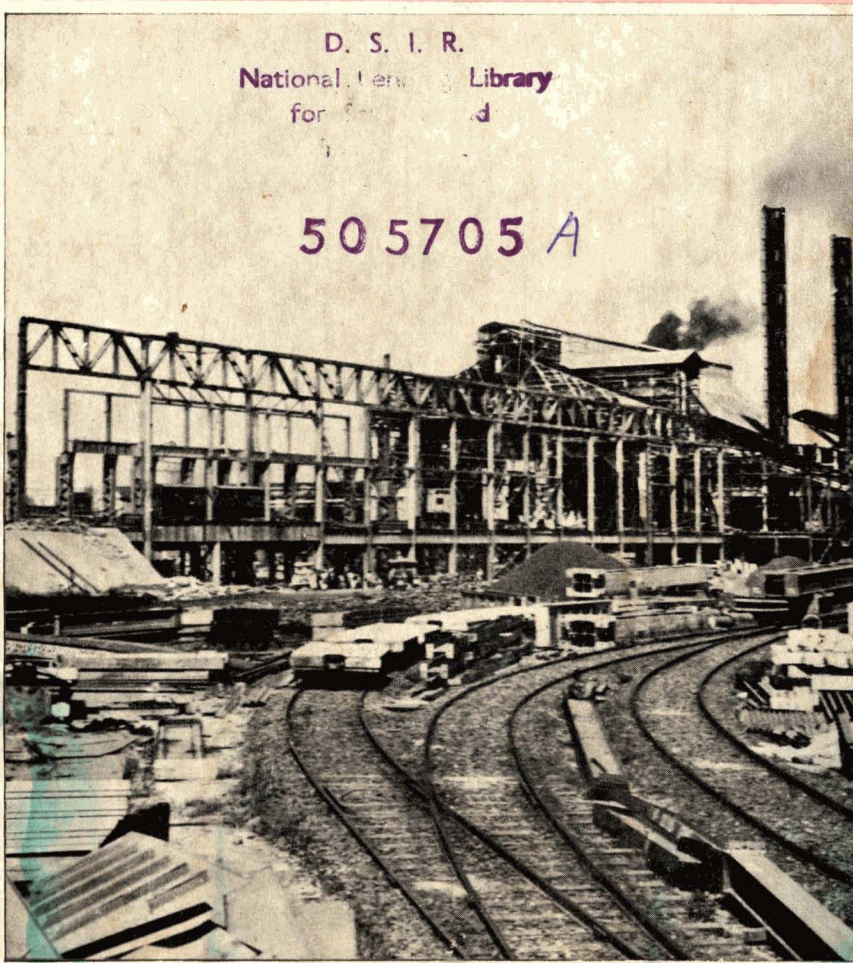
Journal of Scientific & Industrial Research

A — General

IN THIS ISSUE



THE COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, NEW DELHI

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Journal of
Scientific & Industrial Research

Vol. 16A, No. 5, MAY 1957

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COVER PICTURE

The picture on the cover shows a phase of the expansion activities of the Tata Steel Works, Jamshedpur, under their modernization programme. The programme involves rebuilding the open-hearth furnaces and the steel-melting shop. The capacity of the Works after expansion would be 2 million tons of steel per year.

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Atomic Energy Research Establishment	HARWELL, U.K.
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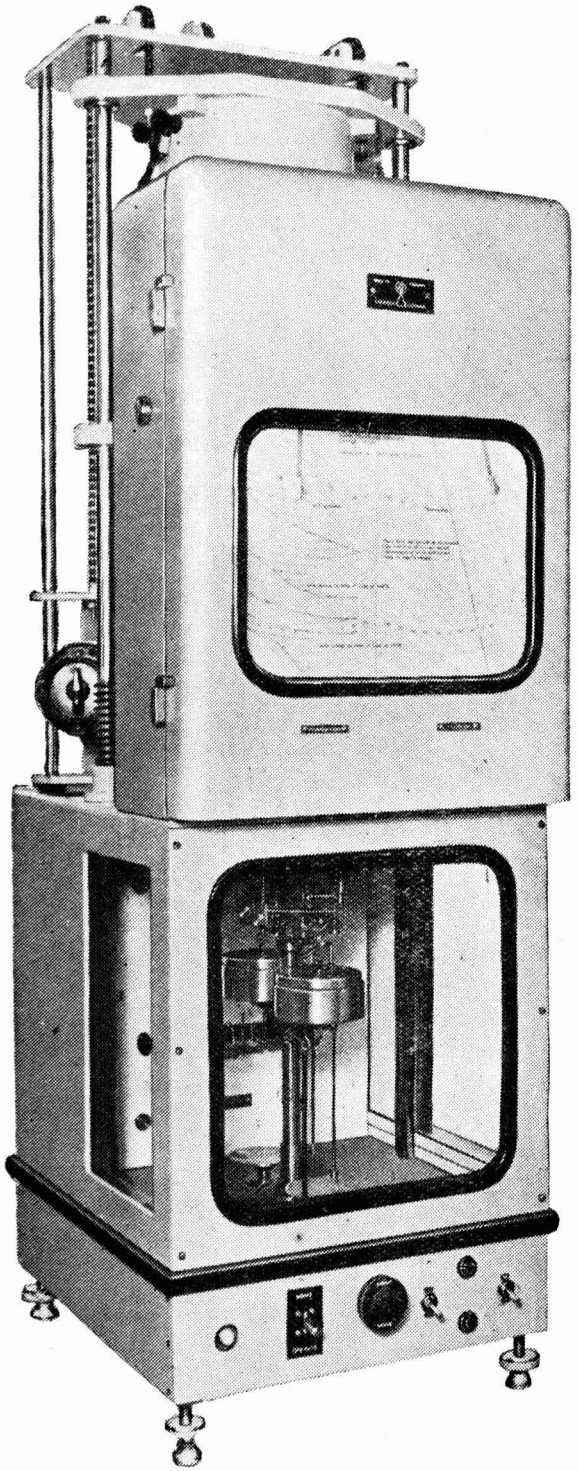

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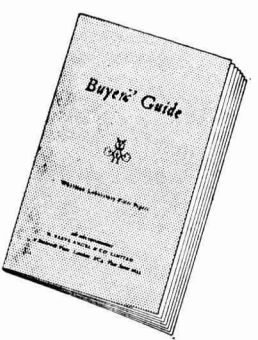

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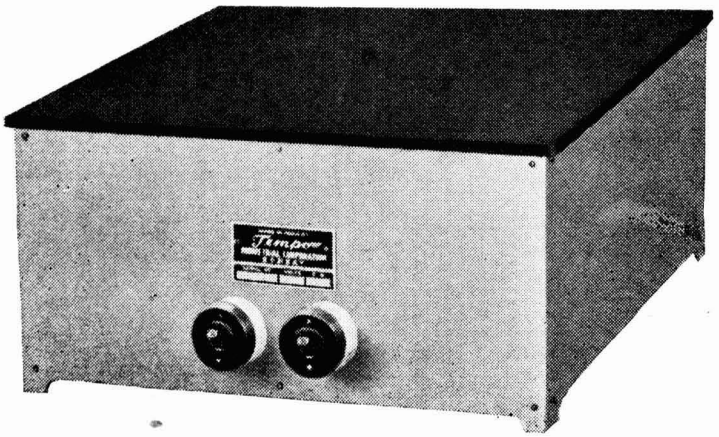

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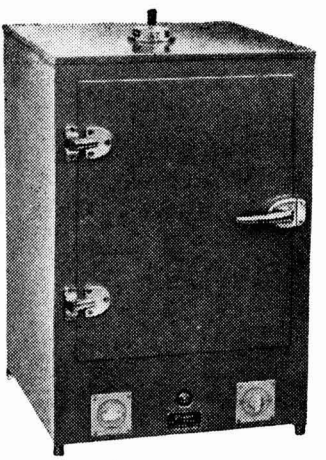

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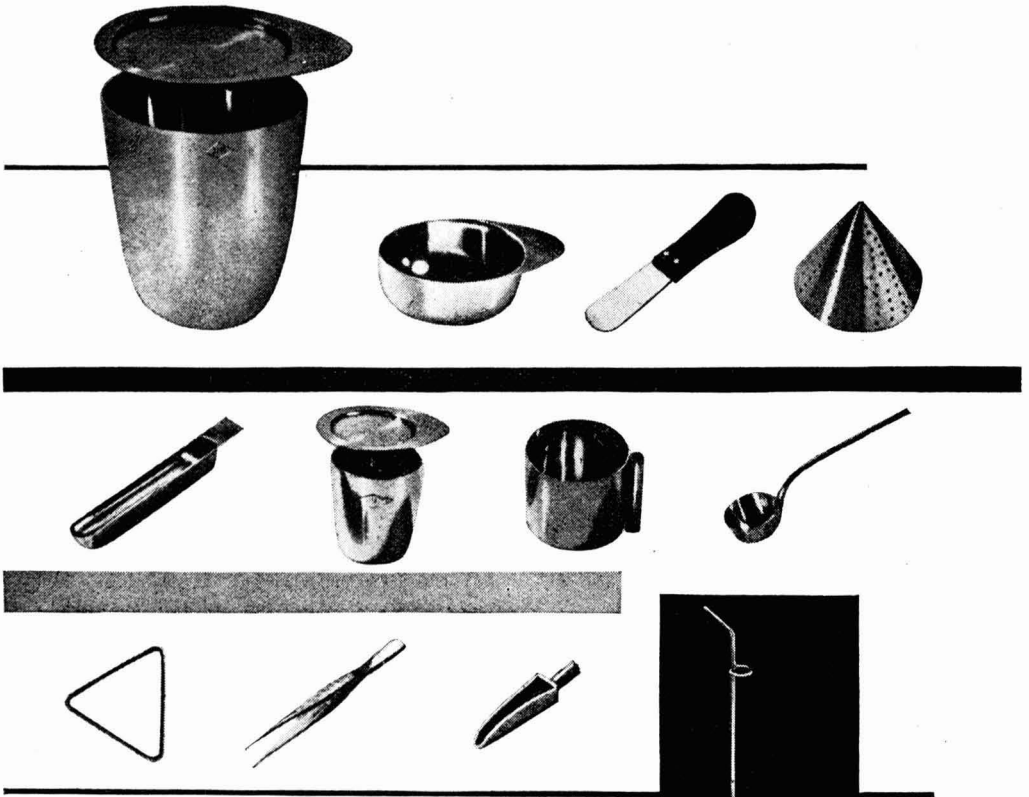

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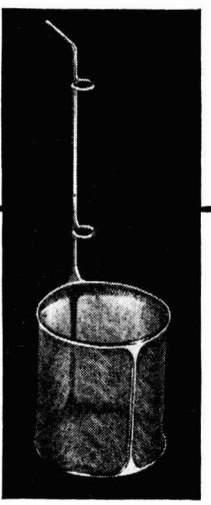

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INDEX TO ADVERTISERS

Soil Conservation — A Seminar

THE first seminar on Soil Conservation Problems in India, sponsored by the Central Soil Conservation Board, was held in Dehra Dun on 18-21 March 1957. Dr. F. W. Parker, Chief Agriculturist of the U.S. Technical Co-operation Mission (T.C.M.), inaugurated the seminar which was presided over by Dr. J. K. Basu, Director of Soil Conservation, Ministry of Agriculture. A large number of delegates including research and extension workers from States and Regional Centres and experts of the Technical Co-operation Mission and the Food and Agricultural Organization participated in the seminar.

Dr. Parker said that the seminar represented a big step forward in introducing soil conservation measures in the country. He suggested that the soil conservation work may be operated in close association with the *Gram Panchayats* which may give results comparable to those achieved in U.S.A. through similar methods.

Dr. J. K. Basu pointed out that Rs. 26 crores had been allotted for soil conservation work in over 3 million acres of land in India under the Second Five-Year Plan. He emphasized the need for a co-ordinated programme of work. He disclosed that besides the six regional Soil Conservation Research and Training Centres already opened at Dehra Dun, Kota, Ootacamund, Bellary, Vasad and Jodhpur, an additional centre will be set up at Chatra (Nepal) to work on problems of the Kosi river. About 1000 soil conservation workers would be trained in these centres during the Second Plan.

The papers presented during the three-day seminar covered the following subjects: Extension methods; Irrigation and soil conservation practices; Planning of research; Forestry in water-shed management; Aerial survey and soil conservation plan; and Training in soil conservation.

Irrigation and soil conservation practices — The importance of a close study of topography and soil conditions before introducing irrigation in a tract was emphasized by Shri Mahavir Prasad, Irrigation Adviser to the Ministry of Agriculture, who presided over this section. The problem is getting increasingly complicated as irrigation is being expanded from flat land into undulating tracts. The success of soil conservation practices in irrigated areas would depend, to a considerable extent, upon the evolution of suitable equipment for the cultivators.

In a paper entitled "Soil conservation with water conservation and management", Mr. Lloyd Signell of the T.C.M. explained in detail the method of approach to the conservation problem under the following heads: land capability; supply; distribution systems; and application. It is not considered advisable to bring irrigation water on undulating land without proper soil conservation measures. Due to such practice in U.S.A., $\frac{1}{4}$ million acres are losing 1 inch of top soil every three years and $\frac{1}{2}$ million acres are losing 1 inch every five years.

Planning of research — Presiding over this section, Dr. Basu pointed out that great importance has been attached to research by the Soil Conservation Board; nearly 12 per cent of the total provision has been allocated to survey and research. The important problems requiring attention are improvements in the pattern of land-use and in the productivity of land. In planning research on an all-India basis, the aspects to be considered are: recognition of problem areas; location of research stations; method of approach; statistical soundness of experiments; use of up-to-date equipment; trained personnel; and organization of research. Research on equipment and measuring devices demands special attention.

The research programmes of various Centres were presented by the respective soil conservation officers. Different aspects of conservation, such as soil, agronomy, forestry and engineering, have been integrated and a plan evolved for water-shed management for soil conservation for improving land fertility. Programmes of research on alkali soils at Rehman-Khera (U.P.), Hazaribagh (Bihar), Hoshangabad (M.P.) and Dehra Dun (U.P.) were discussed.

Forestry in water-shed management — The Chairman for this section, Dr. R. M. Gorrie (F.A.O.), suggested that torrent correction and alpine erosion control work, carried out in the European Alps for over 100 years, should be extended to Himalayan rivers, particularly those which were being harnessed for the major hydro-electric and irrigation projects. The only area in India where work on similar lines has been attempted lies in Hoshiarpur Siwaliks (Punjab). The work done in that region during the last ten years has shown that water conservation in hills can be of great service in reclaiming sandy land below.

Extension methods — A paper entitled "Method of approach to farmers" was presented by Mr. A. M. Hedge, who presided over this session. Mr. W. W. Hull, T.C.M. expert, showed how extension methods could be adopted on a complete water-shed basis in small holdings of farmers by re-allocating plots on contour. The results obtained by adopting such methods in the Damodar Valley area were illustrated by lantern slides. Mr. Hammund, T.C.M. expert working at Chandigarh, stressed the potentialities of using hybrid corns in dry areas to increase foodgrain production.

Training in soil conservation — Mr. W. S. Speer of the T.C.M. compared the American and Indian methods for training soil conservation staff at various levels. He said that India was at the stage where U.S.A. was 25 years ago when soil conservation work was organized there. India, however, has the advantage of several universities and schools where soil conservation has been included in the curricula of studies.

In the concluding session, specialists constituted themselves into a 'Brain Trust' with Dr. Gorrie as chairman and discussed the problem of bringing research results to the knowledge of farmers. Dr. Gorrie summed up the discussion by stating that there is a risk of soil conservation centres staying inside barbed wire, which can, however, be avoided by organizing "farmers' days". Research workers should go to villages and make farmers soil conservation-conscious by tackling village gullies. During "farmers' days", special emphasis should be paid to grazing problems and villagers should be apprised of the damage due to overgrazing by livestock. The trust recommended that an extension worker with special bias for soil conservation should be attached to each Centre to help farmers in soil conservation work.

Board of Scientific & Industrial Research, Thirty-eighth Meeting, New Delhi

THE thirty-eighth meeting of the Board of Scientific & Industrial Research was held in New Delhi on 21 March 1957. The Governing Body met on the following day. The Prime Minister Shri Jawaharlal Nehru presided.

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

1. *Study of oxidation ponds for treatment of sewage and industrial wastes*: PROF. N. R. SITHAPATHI, Engineering College, Madras

2. *Application of phase exchange method to demineralization of coal*: DR. E. WEINGAERTNER, Indian Institute of Science, Bangalore

3. *Fundamental studies on the solvent extraction of coal*: PROF. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta

4. *Catalytic conversion of tar acids in low temperature tars into phenol, etc.*: DR. K. L. ROY, University College of Science & Technology, Calcutta

5. *Colloidal and structural properties of humic acid and its precursors*: PROF. R. D. VOLD, Indian Institute of Science, Bangalore

6, 7. *Study of submerged combustion*; *Design of dust filters*: DR. B. GHOSH, College of Engineering & Technology, Jadavpur University, Calcutta

8. *Chemical and analytical studies on air pollution in Calcutta*: DR. A. S. BHANDARI, Calcutta University, Calcutta

9. *Investigation on some less known oilseeds (tea seed and tobacco seed) and oils with a view to determine their suitability in hydrogenation and allied industries*: DR. M. M. CHAKRABARTY, Calcutta

10. *Some constitutive studies of the seed fat composition of arid zones with particular reference to biogenetic factors*: SHRI A. SEN GUPTA, Birla College, Pilani

11. *Fractionation of fatty materials by clatherate compounds*: DR. T. N. MEHTA, Laxminarayan Institute of Technology, Nagpur University, Nagpur

12. *Studies on the essential oil of Canarium euphyllum resin*: DR. A. N. SAHA, Calcutta University, Calcutta

13. *Carbohydrate metabolism as affected by administration of sulpha drugs*: DR. S. BANERJEE, Presidency College, Calcutta

14. *Study of C_4 metabolism in Aspergillus niger*: DR. C. V. RAMAKRISHNAN, M. S. University of Baroda, Baroda

15. *Chemical and microbiological changes during the cold storage of fish and their effect on the keeping quality and nutritive value of fish*: DR. N. G. MAGAR, Institute of Science, Bombay

16. *Studies on phosphogens*: DR. (MRS.) RADHA PANT, Allahabad University, Allahabad

17. *Characteristics of gases obtained by fermenting fresh and partly digested primary sludges available from industrial and municipal waste waters*: DR. T. K. GHOSE, Jadavpur University, Calcutta

18. *Pigments of Indian lichens*: DR. S. SANKARA SUBRAHMANIAN, Andhra University, Waltair

19, 20. *Biosynthesis of fats*: *Isomerization of ingested fat (seed fat of Monorica charantia)*: *Formation of conjugated and non-conjugated fatty acids in certain seeds*: DR. M. M. CHAKRABARTY, University College of Science & Technology, Calcutta

21. *Cultural and chemical investigations on Brahmis and Balas*: DR. U. P. BASU, Bengal Immunity Research Institute, Calcutta

22. *Rotation-vibration, electron and Raman spectra of carbon disulphide*: SHRI DEVENDRA SHARMA, Allahabad University, Allahabad

23. *Dielectric properties of liquids in the radio and ultra-high frequency region*: DR. PREM SWARUP, Allahabad University, Allahabad

24. *Spectroscopy of diatomic molecules in the Schuman region*: DR. P. THIRUVENGANNA RAO, Andhra University, Waltair

25. *Absorption and dispersion of microwaves by polar gaseous molecules*: SHRI KRISHNAJI, Allahabad University, Allahabad

26. *Electronic levels and spectra of complex molecules*: DR. M. R. PADHYE, Bombay University, Bombay

27. *Determination of the structure of asymmetric molecules by microwave spectroscopy*

and their dipole moments: DR. S. N. GHOSH, J.K. Institute of Applied Physics, Allahabad University, Allahabad

28. *Action of leathers on photographic emulsion*: PROF. V. P. NARAYANAN NAMBIAR, Pachiappa's College, Madras

29. *Shrinkage temperature of hides and leathers*: DR. B. N. GHOSH, University College of Science & Technology, Calcutta

30. *Drift card scheme for the study of ocean currents*: DR. N. K. PANIKKAR, Central Marine Fisheries Research Station, Mandapam

31. *Development of sugarcane wax*: DR. K. N. MENON, Madras University, Madras

32. *Pilot plant preparation of ethylene oxide and its products*: DR. N. R. KULOOR, Shri Ram Institute for Industrial Research, Delhi

33. *Stability of electrokinetic potential of colloids*: DR. B. N. GHOSH, University College of Science & Technology, Calcutta

34. *Investigation on steroids*: DR. B. K. BHATTACHARYA, Jadavpur University, Calcutta

35. *Non-aqueous acid-base titrations*: DR. M. N. DAS, Jadavpur University, Calcutta

36. *Recovery of elemental sulphur from pyrite-bearing coal*: SHRI S. B. PANDYA, Bombay University, Bombay

37. *Synthesis of folic acid derivatives*: DR. J. N. RAY, Institute of Science, Bombay

38. *Rate of decomposition in insecticidal deposits*: DR. N. V. SUBBA RAO, Osmania University, Hyderabad

39, 40. *Sulphate complexes in solution between transitional, divalent and univalent metal sulphates with special reference to correlation of their thermodynamic constants to the periodic table*; *Polarographic investigation of known solid complexes*: DR. A. C. CHATTERJEE, Lucknow University, Lucknow

41. *Quantum mechanics of molecular interaction*: DR. S. BASU, University College of Science & Technology, Calcutta

42. *Synthesis of natural steroids and* 19-*norsteroids*: DR. D. K. BANERJEE, Indian Institute of Science, Bangalore

43. *Liquid crystalline detergent systems*: PROF. S. R. PALIT, Indian Association for the Cultivation of Science, Calcutta

44. *Spectroscopic and photometric study of the night air-glow*: DR. M. W. CHIPLONKAR, Poona University, Poona

45. *Mechanism of reaction between cellulosic fibres and resins derived from urea-formaldehyde and melamine-formaldehyde*: DR. P. C. MEHTA, Ahmedabad Textile Industry's Research Association, Ahmedabad

46. *Studies on the relation between molecular orientation and physical properties of mercerized cotton*: DR. B. K. VAIDYA & DR. T. RADHAKRISHNAN, Ahmedabad Textile Industry's Research Association, Ahmedabad

47, 48. *Manufacture of cellulose-ethers particularly carboxy methyl cellulose, hydroxy ethyl cellulose and ethyl cellulose*; *Cross bonding reaction of cellulose*: DR. V. B. CHIPALKATTI, Shri Ram Institute for Industrial Research, Delhi

49. *Microscopical studies on the degradation of jute fibre by micro-organisms*: DR. S. N. BASU, Indian Jute Mills Association Research Institute, Calcutta

50. *Modification of jute fibre properties by esterification or etherification*: DR. A. B. SEN GUPTA, Indian Jute Mills Association Research Institute, Calcutta

51. *Physico-chemical studies on Indian silk*: DR. S. BASU, University College of Science & Technology, Calcutta

52. *Kinetics and mechanism of interaction of phenol and substituted phenols with formaldehyde*: DR. L. M. YEDDANAPALLI, Loyola College, Madras

53. *Cellulose ion-exchange resins*: DR. P. K. CHOWDHURY, Calcutta University, Calcutta

54. *Measurement of atmospheric noise interference*: PROF. S. V. CHANDRASEKHAR AIYA, L. D. College of Engineering, Ahmedabad

55. *Application of helices in antenna problems*: DR. J. S. CHATTERJEE, Jadavpur University, Calcutta

56, 57. *Weldability and mechanical properties of high tensile weldable manganese steel*; *Low temperature impact properties of low alloy manganese steels made with electrolytic manganese*: SHRI J. S. VATCHAGANDHY, Tata Iron & Steel Co. Ltd., Jamshedpur

58. *Inducing spawning in food fish of India*: DR. L. S. RAMASWAMI, University of Mysore, Mysore

59. *Occurrence, morphology, etc., of cestode parasites of animals in Delhi*: DR. L. N. JOHRI, University of Delhi, Delhi

60. *Cell metabolism with special reference to* (*a*) *variation of metabolic pattern in cellular adoption and* (*b*) *metabolic behaviour of subcellular fractions*: DR. B. C. GUHA, Calcutta University, Calcutta

61. *Nucleotide metabolism and biosynthesis of proteins*: DR. A. SREENIVASAN, Bombay University, Bombay

62. *Carbohydrate metabolism with special reference to glucose cyclo-aceto-acetate and its derivatives*: DR. M. C. NATH, Nagpur University, Nagpur

63. *Metabolism of trace elements and phosphoproteins*: Dr. P. S. SARMA, Madras University, Madras

64. *Biosynthesis of* (*a*) *oligo saccharides and other plant carbohydrates and* (*b*) *coenzyme nucleotides*: DR. K. V. GIRI, Indian Institute of Science, Bangalore

65. *Analytical aspects of organic compounds*: *Determination of rare metals like thorium, zirconium, uranium, etc., with organic reagents*: DR. S. K. DUTTA, Darjeeling Government College, Darjeeling

New Institutes — The Governing Body approved of the proposals to establish a National Aeronautical Research Laboratory, a Wind Power Division at the Central Salt Research Institute, Bhavnagar, four centres for Essential Oil Research at Dehra Dun, Kanpur, Poona and Bangalore and two training-cum-research centres on Gas Turbines at Kharagpur/Calcutta and Bangalore. It was also decided to place the Ionosphere Field Station at Haringhata (Calcutta) on a permanent footing.

The creation of a centre for the design and fabrication of pilot plants and training of design personnel was another important decision taken by the Council.

Sulphur — The problem of indigenous production of sulphur was one of the important items discussed by the Board. Some of the concrete proposals made in this context are: proving the pyrite resources at Amjore in Bihar and Ingaldal in Mysore; taking steps to install a pyrite burner; undertaking of mining operation by the Ministry of Natural Resources and Scientific Research; utilization of gypsum as a source of sulphur and the setting up of a plant of 100 tons (sulphur) capacity and drawing a detailed project for the purpose to be taken up with the Ministry of Heavy Industries and Ministry of Production for implementation.

Symposia—The Governing Body approved the holding of the following symposia, to be sponsored by the various National Laboratories or Research Committees under it, during 1957-58:

1. *Recent developments in foundry technology*: National Metallurgical Laboratory, Jamshedpur

2. *Leather auxiliaries*: Central Leather Research Institute, Madras

3. *Vitreous enamels and high temperature ceramic coatings for metals*: Central Glass & Ceramic Research Institute, Calcutta

4. *Recent developments in building materials*: *Pre-stressing as applied to building*: Central Building Research Institute, Roorkee

5. *Detergents and detergency*: Chemical Research Committee and the Indian Association for the Cultivation of Science, Calcutta

6. *Symposium-cum-study seminar on atmospheric circulation and magneto-hydrodynamics*: Atmospheric Research Committee

7. *Cellulose*: Cellulose Research Committee and Forest Research Institute, Dehra Dun

8. *Manufacture of optical instruments*: Scientific Instruments Research Committee

9. *Host-parasite relations in diseases*: Indian Institute of Biochemistry & Experimental Medicine, Calcutta

10. *Microwaves and their application*: Physical Research Committee

Use of Tamarind Kernel Powder as a Cotton Warp Size—A Review

P. C. MEHTA, P. N. BHATT, S. S. TRIVEDI & C. C. SHAH
Ahmedabad Textile Industry's Research Association, Ahmedabad

ALTHOUGH the use of tamarind kernel powder (T.K.P.) in the sizing of warp was known to the textile industry for many years, it had little industrial importance as a sizing material before World War II. Its use as a sizing material was first suggested by Ghose and Krishna[1]. From analysis of tamarind seed kernels they[2] recommended a composition having 50-60 per cent ' pectin ' content for this purpose. Rao and Krishna[3] found that the ' pectin ' of T.K.P. is not a true pectin, but a carbohydrate composed of xylose, glucose and galactose and suggested the testing of colour, coarseness and ' pectin ' content for T.K.P. and the presence of testa in it before using it in cotton industry.

Macmillan *et al.*[5-7] made an extensive study on the application of T.K.P. for jute sizing and found that it can satisfactorily replace starch and effect considerable reduction in sizing cost. From their studies on the effect of testa on the colour of jute yarns and on the machinery during sizing they also felt the necessity of testing T.K.P. before use. They studied the viscosity behaviour of T.K.P. at different concentrations and temperatures and found that T.K.P. paste shows a stable viscosity on continued heating and agitation and thus differs from starch paste which progressively thins down under these conditions. This was found to be due to a fundamental difference in the mechanism of gelling which is simply a dispersion in the case of T.K.P., whereas with starches the dispersion is preceded by swelling and disintegration of the starch granules. Later, they found that, compared to maize starch, T.K.P. is more susceptible to bacterial attack and requires higher proportion of antiseptic to provide an equivalent protection[7].

T.K.P. size mixing for cotton

Abrasion resistance and weavability — Mehta and Shah[8] tried the use of T.K.P. for sizing cotton warp, covering a wide range of counts from 18s to 70s, and of fabric constructions from 56 to 112 ends per inch. Using breakage rate of warp during weaving as a measure of performance they found that T.K.P. compares well with any of the starches used in industry for sizing, and that lower concentrations of T.K.P. are required in the size mixings to give comparable results in weaving. Yarn sized with T.K.P. tended occasionally to be excessively soft, causing considerable dusting off in the loomshed, particularly in the case of heavy fabric constructions. They suggested that the natural fatty matter, present in T.K.P. to the extent of about 6 per cent, acts as a softener and that further addition of the usual quantity of an extraneous softener such as mutton tallow is responsible for this behaviour. A detailed study of yarns sized with T.K.P., with and without the addition of softener in the size mixing, was, therefore, undertaken with the help of a laboratory dummy loom, described elsewhere[9]. Elimination of the softener from the size mixing did improve the resistance to abrasion of the T.K.P. sized yarns. Later experiments with the addition of about 10 per cent (on weight of T.K.P.) commercial sodium silicate to the size mixing gave even better results.

Table 1 gives data on the influence of tallow and sodium silicate on the abrasion resistance of T.K.P. sized yarns.

The improved abrasion resistance was reflected in a corresponding improvement in weavability in large-scale weaving tests. This mixing, consisting of T.K.P., sodium silicate and an antiseptic, formed the basis for the use of T.K.P. on a large scale in mills for warp sizing of bleached sorts.

Homogenization of T.K.P. pastes was found to give better size penetration into the yarn, smoother yarn surface and improved performance in weaving. For materials such as T.K.P., which are available in compara-

TABLE 1 — PERFORMANCE OF YARNS SIZED WITH T.K.P. PASTES

Concentration of T.K.P. paste %	Tallow on weight of T.K.P. %	Sodium silicate on weight of T.K.P. %	Size pick up %	No. of breaks in 2000 abrasions on dummy loom*
5·0	5·0	—	6·1	13·00
5·0	—	—	6·6	6·75
5·0	—	10·0	7·9	4·00†
8·0	5·0	—	13·6	2·00†
8·0	—	—	13·1	1·00†
6·0	—	20·0	8·6	nil†
5·0	—	20·0	7·6	2·50†

*Mean of 4 observations.
†Number of breaks in 2500 abrasions.

tively coarser mesh, homogenization is expected to give better results.

Colour — The reddish colour of T.K.P. pastes was a serious obstacle in their use in sizes for grey calender sorts, which are sold in the loom state. Various oxidizing and reducing chemicals, such as hydrogen peroxide, hypochlorites, potassium permanganate, sodium sulphite, sodium bisulphite, sodium hydrosulphite and stabilized hydrosulphite, were tried to improve the final colour of the T.K.P. paste. Oxidizing agents did not show a satisfactory improvement. Reducing agents were more effective but all of them, except sodium sulphoxylate formaldehyde, decomposed at an extremely rapid rate at the high temperatures involved in size preparation. Sodium sulphoxylate formaldehyde gave satisfactory bleaching.

Cost — During the war years when the price of starches was much higher than at present the use of T.K.P. sizes for both bleached and grey sorts offered considerable financial savings. Now, however, there is not much advantage in using T.K.P. for grey calender sorts. It is still considerably cheaper when used for bleached sorts. The lower cost of T.K.P. size mixings is due to three reasons: (i) Good quality T.K.P. is about 30 per cent cheaper than maize starch; (ii) compared to starches, lower quantities of T.K.P. size have to be put on the warp for comparable weaving performance; and (iii) very little or no softener is required in T.K.P. sizes.

Table 2 gives data for weaving performance and cost, collected from some mills where T.K.P. size mixings have been introduced and worked for a sufficiently long time to permit reasonably accurate costing.

TABLE 2 — BREAKAGE AND COST DATA ON T.K.P., SIZING

Mill	Sort details		End breaks/loom hr.		Cost of sizing/lb. of yarn in pies	
	Reed/pick	Warp/weft count	Mill mixing	T.K.P. mixing	Mill mixing	T.K.P. mixing
A	68/48	28/38	3·4	2·5	8·6	4·8
C	48/48	18/18	5·2	4·8	4·8	3·6
D	52/44	44/60	—	—	7·3	6·0
E	68/44	34/42	5·4	4·8	6·9	4·6
F	64/56	58/78	5·0	4·7	9·9	4·5

Difficulties in the use of T.K.P. sizes

The difficulties experienced in the use of T.K.P. sizes are discussed below.

1. *Lack of standardization of T.K.P.* — For the successful use of T.K.P. sizes, it is essential to ensure its purity. T.K.P., conforming to I.S.I. specifications, except in fineness (60-80 mesh instead of the specified 85-100 mesh), was used throughout this work and found to give excellent results. Samples of T.K.P. received from mills often showed considerable adulteration giving an ash content as high as 20 per cent which accounts for the unsatisfactory working. Viscosity and ash content provide a good control on the quality of T.K.P. used in the mills.

2. *Colour of T.K.P. mixings* — The colour of the T.K.P. size mixing is due to the presence of testa. For bleached sorts, this colour is not a serious objection since the size is removed in subsequent processing. The reddish colour of the size mixing has an adverse psychological effect on the weavers. Reduction in the alkalinity of the size paste by the addition of acidic salts such as alum, aluminium sulphate or magnesium chloride improves its colour. The colour of size mixings in grey sorts can be improved by adding sodium sulphoxylate formaldehyde.

3. *Excessive frothing* — This is a common trouble encountered while using T.K.P. sizes in the sow-box. Entrapped air in the structure of the yarn and the presence of alkaline surface-active agents such as sodium silicate in the size paste are mainly responsible for this trouble. Since no foaming is observed in the cooking kettle when the size is prepared or boiled, live steam alone cannot be the real cause of this trouble. Escape of air entrapped in the yarn through the size paste in the sow-box is retarded by the viscous nature of the size. In many cases the construction of the sow-box also accentuates this trouble. The results of attempts to reduce

TABLE 3 — FROTHING IN T.K.P. SILICATE PASTE

[*Composition of the T.K.P. paste*: *T.K.P.*, 60 g.; *sodium silicate*, (80°*Tw*), 6 g.]

Addition agent	*p*H	Initial level of paste height *cm.*	Frothing level height *cm.*	Increase in height due to frothing *cm.*
—	11·0	5·5	8·5	3·0
2% china clay	11·0	5·5	8·0	2·5
5% china clay	11·0	5·5	8·0	2·5
Acetic acid to neutralize Na_2O in silicate	6·5	5·7	7·0	1·3
Hydrochloric acid (half the calculated quantity required to neutralize Na_2O)	7·5	5·5	8·0	2·5
0·75% $CaCl_2$	8·5	5·5	7·0	1·5

foaming by neutralizing the alkalinity of the paste and by adding different materials such as china clay to the paste are given in Table 3. A known volume of standard T.K.P. paste, prepared with the addition of sodium silicate, was taken in a one-litre beaker and air at a constant rate was blown throughout the paste through a sintered glass funnel for 10 min. The rise in the height of the size level due to foaming was noted. Similarly, the height of the foam was observed after addition of china clay, acetic acid, hydrochloric acid and calcium chloride respectively. Complete neutralization of the alkalinity of the paste with acetic acid was most effective in reducing frothing. This procedure, however, was not very much favoured by mills since the addition of an acid requires careful control and supervision. Subsequent experiments in which the alkalinity of the paste was neutralized with alum showed equally good results.

Foaming is not uncommon with starch sizes and is not necessarily detrimental to good sizing[10] unless it prevents the proper functioning of sow-box controls. The following measures are suggested to reduce foaming:

(a) Reduce the alkalinity of T.K.P. mixing to *p*H 7·0-7·5 by adding acidic salts such as alum.

(b) Check Na_2O: SiO_2 ratio in the silicate. The ratio should not be more than 1: 2.

(c) Control live steam supply to the sow-box and provide closed steam coils for the proper maintenance of temperature.

(d) Provide fluted guide rollers for the yarn.

(e) Add anti-foaming agent, if necessary.

4. *Accumulation of foreign matter on the fents* — It was found to be due to the presence of large quantities of fibrous and foreign matter in the T.K.P. paste; on using better qualities of T.K.P. this difficulty was not experienced. Accumulation of fibrous materials can be easily prevented by washing the fent of the squeeze roller, once a shift, with hot water.

5. *Sticking of fibres on the drying cylinders* — It is usually due to excessive high temperature of the drying cylinder. Reduction in alkalinity and proper drying temperatures remove this difficulty. For heavy sorts where drying cylinders have to be kept generally at higher temperatures, the first drying cylinder should be maintained at a slightly lower temperature than the second cylinder.

6. *Desizing and uneven dyeing* — For bleached sorts complete removal of size, prior to scouring and bleaching, is very essential to obtain uniform results. This is all the more important when the cloth has to be dyed. During early stages of introduction of T.K.P. size the normal desizing methods followed in mills did not work well with T.K.P. In a systematic investigation undertaken to find out the most efficient desizing method for T.K.P. various methods based on acid steeping, enzyme treatment and boiling with alkali were tried. It was found that boiling with 1 per cent soda ash is an efficient and industrially practical method for removing T.K.P. size. This method has been tried on a large scale in a number of mills and has been used as a routine process. Treatment with 1 per cent soda ash for 3 hr. at the boiling temperature is recommended for white goods, whereas for coloured goods, the same treatment at 70°C. is recommended. With effective desizing no difficulties are experienced due to uneven dyeing.

7. *Increased load on the drying cylinders* — T.K.P. gives much more viscous pastes than starch and has, therefore, to be used in lower concentrations to give pastes with viscosity in a workable range. To obtain the same amount of dry size on the yarn, a larger quantity of water has to be evaporated in the case of T.K.P. size. This drawback is partially offset by the fact that lower quantities of T.K.P. size have to be put on the yarn to give comparable weaving performance. It is also possible that more concentrated T.K.P. pastes with moderate viscosities can be prepared by homogenization.

An additional advantage of T.K.P. over starches is that it does not show retrogradation or thinning down. It is possible to use T.K.P. size mixing after storage for 24 hr. or more.

8. *Effect of humidity* — T.K.P. sized yarn gives poorer weaving efficiencies in excessively high humidities, as for example during the monsoon season. Humidities of the order of 75 per cent R.H. give best results.

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Dr. Rm. Alagappa Chettiar

We regret to record the premature demise of Dr. Alagappa Chettiar, the well-known industrialist-educationist on 5 April 1957.

Born on 5 April 1909, Dr. Chettiar was educated at the Presidency College, Madras, and took his Master's degree in Literature in 1930 before proceeding to England. In 1933 he was called to the Bar from Middle Temple, London. Later he joined the Chartered Bank of London where he was the first Indian to be entertained in their staff.

On return to India, Mr. Chettiar devoted himself with vision and skill to the textile industry, where he soon made a name as a leader. Industrialist by profession, he was deeply interested in the technological advance of the country. To this cause he donated much (of the order of ten million rupees) for the establishment of technical colleges and institutions in Southern India. The Central Electro-Chemical Research Institute at Karaikudi of the Council of Scientific & Industrial Research owes its origin to his munificence. He donated for this Institute about 1·5 million rupees and made available

Dr. Rm. Alagappa Chettiar

300 acres of land in Karaikudi for its establishment. He has been associated with the growth of this research institution and was the first Chairman of its Executive Council. Mr. Chettiar was associated with a number of university bodies and educational and scientific institutions. He was a member of the Governing Body of the Council of Scientific & Industrial Research. He represented India in the eighteenth Pacific Relations Conference held in Japan in 1954.

In recognition of his glorious service to the cause of education in general, and scientific and technological education in particular, the Universities of Madras and Annamalai conferred on Mr. Chettiar honorary doctorate degrees. The Indian Union honoured him with the title of 'Padma Bhushan' in 1957.

REVIEWS

AN ENCYCLOPAEDIA OF IRON AND STEEL INDUSTRY compiled by A. K. Osborne (Talor Gurnett Evans & Co. Ltd.), 1956. Pp. xi + 558. Price 90*s*.

The need for a single volume containing concise description of materials, plants, tools and processes used in the industry has long been felt and Miss Osborne is to be congratulated on having filled this gap with ability and distinction. The work is essentially a book of reference and although compiled by one in the ferrous industry, it covers both ferrous and non-ferrous metallurgy, and rightly so, because the underlying principles of metallurgical operations are essentially same. No better example of this can be given than the use of the Bessemer converter, initially a purely ferrous appliance, in the extraction of copper.

The subjects are listed alphabetically and the descriptions are brief and accurate. In some cases, perhaps, the descriptions could have been improved as under 'Rimming-steel Ingots', where mention of the uses of this type of steel would have been of advantage. Similarly, under 'Tungsten' and 'Manganese' the mention of the major producing countries would have been useful.

The volume contains also a number of very short biographical notes on eminent personalities in the field. There are also valuable appendices which include conversion tables, a list of properties of certain typical steels, and a most useful and comprehensive list of scientific, technical, and trade associations related to the industry.

Miss Osborne, who is the Technical Librarian and Information Officer of the Brown-Firth Research Laboratories, has put in an enormous amount of work in compiling this volume from the material gathered and indexed by her over twenty-five years.

The book is well brought out and contains 25 plates and diagrams. The author can have the satisfaction that goes with a job well done.

S. K. NANAVATI

COMPREHENSIVE INORGANIC CHEMISTRY, Vol. V by Harry H. Sisler & Alfred R. Pray (D. Van Nostrand Co. Inc., Princeton, New Jersey, New York, London), 1956. Pp. 203 + v. Price 37*s*. 6*d*.

The earlier volumes of this series have already been reviewed in this *Journal*. The present volume deals with the chemistry of the nitrogen family of elements, N, P, As, Sb and Bi. Part II of the volume, covering about fifty pages, is a review of 'non-aqueous chemistry', giving reactions in liquid ammonia, acetic acid, sulphur dioxide, hydrogen cyanide, phosgene and selenium oxychloride. Owing to the preponderance of known reactions in liquid ammonia over others, the inclusion of this chapter with a review of group VB is understandable.

Of the two chapters in Part I, the first is devoted entirely to nitrogen and its compounds and the second to phosphorus and its congeners. The treatment covers well-charted ground and is very good, though a more exhaustive treatment of sections on active nitrogen, phosphonitrilic chlorides, and industrial processes would have been welcomed. The treatment of Part II follows the 'nitrogen-system' line of Franklin and has rightly left the organic solvents out of this coherent picture, but the omission of anhydrous hydrazine and liquid hydrogen sulphide from the list is surprising.

These volumes, it may be recalled, were intended to serve as a ready reference to those engaged in chemical manufacture and development, and also to those pursuing advanced studies in chemistry. Though the stated objective of the editors was to present the material in a not too pedagogic fashion, the treatment of the present volume is essentially pedagogic, and the reviewer for one confesses that he sees nothing wrong in its being so. For the busy man in the industry the chapters may, indeed, seem drab and difficult reading; for the serious student, it is good stuff.

The volume comes as a worthy addition to the series.

J. GUPTA

TREATISE ON INORGANIC CHEMISTRY, Vol. II by H. Remy. Translated by J. S. Anderson and edited by J. Kleinberg (Elsevier Press Inc., New York; *Sole Distributors*: Cleaver-Hume Press Ltd., London), 1956. Pp. xxviii + 800. Price £5 5*s*.

The first volume of the treatise was reviewed in some detail in an earlier issue of this *Journal* [**15A** (1956), 407]. The second volume deals with the residual ' sub-groups ' of elements which correspond, in the author's system of classification, with Mendeléeff's sub-group B for the first and second groups, sub-group A for the third to seventh groups, the eighth group, the lanthanides and the transuranic elements. Special chapters are devoted to the geochemical distribution of elements, colloidal systems, catalysis and reaction kinetics, non-aqueous chemistry, reactions of solid substances, and a complete survey of radioactivity and nuclear chemistry is given. On this last item, " no efforts have been spared by the author in close collaboration with the translator — at the time at Harwell — to include the latest significant achievements in this expanding field ".

In the selection of topics, general treatment and readability of the text, the second volume is a worthy follower of the first. In so far as the reviewer could check from some statements made in the book, the information supplied is precise and up to date. There is little doubt that the two volumes will be considered a highly valued acquisition by all serious students of inorganic and general chemistry.

A useful appendix at the end contains suggestions for further reading, the electronic structure of the elements including term symbols for the ground states, and the new system of inorganic nomenclature revised and adopted by the International Union of Pure and Applied Chemistry in April 1956.

J. GUPTA

DEFECTS AND FAILURES OF METALS (THEIR ORIGIN AND ELIMINATION) by E. S. Polushkin (Elsevier Press Inc., New York; *Sole Distributors*: Cleaver-Hume Press Ltd., London), 1956. Pp. 399 + xvi. Price 72*s*.

Prof. Polushkin was Metallurgist at the Experimental Laboratories of the Institute of Ways of Communication, St. Petersburg, U.S.S.R., from 1912 to 1915 where also he was Instructor in Metallography at the Mining Institute. During World War I he was sent to the U.S.A. by the Russian Imperial Government, as Chief Inspector of Metals of the Artillery Commission. Later, under the Provisional Government he was Senior Inspector of Metal Products for the Russian Railway Commission in the U.S.A. After the collapse of the Provisional Government, he remained in the United States, where during the past 35 years he has occupied important posts in the metallurgical world as research worker and consultant, or professor.

The present volume is the outcome of the author's long and varied experience.

The book is divided into 16 chapters covering: Interpretation of Evidence, Segregation, Blowholes and Porosity, Pipe, Impurities, Decarbonization of Steel, Scaling, Harmful Effects of Residual Stresses, Fatigue of Metals, Flakes, Failures in Heat Treatment, Embrittlement of Metals, The Origin of Cracks, Defects in Shape, Surface, and Size of Metals, Wear of Metals, and Corrosion.

The subject of each of these chapters is treated systematically. The author first describes the phenomenon and its characteristics and discusses the origin, causes and contributory factors, along with the means of discovery and identification and the methods of testing. The common location of the effect and its relative seriousness are explained before passing to means of prevention, correction and elimination. In addition there is a great wealth of references to papers and other publications which number for the whole book over 2500, and occupy over 100 pages. Many excellent photographic and other illustrations are provided.

Here then is a mass of information and reference, put forward in the essentially practical language and judgement of an experienced metallurgist. The book is not one for the elementary student, nor is it a standard text-book: it is mainly a reference volume for the practising metallurgist or consultant, but most engineers would gain considerably from its perusal.

It is desirable that those who deal in the manufacture and uses of metals should be aware of the defects or ' diseases ' to which they are liable, and in this respect the book is to be commended. The subject

of corrosion of metals, however, is too wide and difficult to be packed neatly into one chapter.

J. W. WHITAKER

PROGRESSIVE GERMAN READER by Hargopal Biswas (Calcutta University). Pp. 368. Price Rs. 12/8

German is amongst the popular foreign languages in India, receiving the attention of students and scholars — particularly those connected with science and technology. There already exists a large number of books teaching elementary and advanced German to science students. *Progressive German Reader* by Mr. Biswas of the Calcutta University will act as another valuable guide to those initiated or to be initiated into the study of German. The author deserves well-merited praise for writing a book of quality wherein the difficulties met by the Indian students in learning German have been especially explained.

In particular, the grammar portion has been arranged admirably. After dealing with alphabets and pronunciation of German words, an exhaustive list of masculine, feminine and neuter nouns, which is a novel feature of this book, follows. The book then deals with 'Adjectives', wherein a list of adjectives and their declensions in all the three different genders are given. Pronouns get the same treatment as adjectives. The book also gives exhaustive charts of the declension of auxiliary verbs in different tenses and moods according to person and number of the noun they govern. The grammar part occupying in all 100 pages ends with some specimens of letter writing. After grammar, the literature section takes about 200 pages. The science section, which follows, is introduced with a list of German names for ordinary scientific apparatus. The author has also provided a list of useful words in chemical, physical and biological sciences.

The get-up of the book is good, though the price Rs. 12/8 may be above the means of an average student (and particularly of a beginner). It would have been better if the book was divided into 3 different volumes, and a few chapters of reading matter added under the grammar section.

R. C. BHATTACHERJEE

NOTES & NEWS

μ-Meson catalysed nuclear reactions

A NEW KIND OF NUCLEAR REACTION, somewhat resembling thermonuclear fusion of helium, but occurring at as low a temperature as that of liquid hydrogen instead of the million degrees or so needed in the hydrogen bomb, has been recently reported by Dr. L. W. Alvarez of the University of California, Berkeley. Experimental evidence of these reactions has been obtained using the liquid hydrogen filled 10 in. bubble chamber attached to the California University's bevatron. Fifteen instances of such reactions have been noticed so far. A negative μ-meson, which is the key to this discovery, plays the role of a catalyst and helps in bringing together and fusing a proton and a deuteron (nucleus of heavy hydrogen) into He^3 with the release of 5,400,000 eV. The possibility of such a nuclear reaction was predicted theoretically by Ya. B. Zel'dovitch of Russia.

For several years physicists have been studying what are called ' mesic ' atoms. The simplest of these is a hydrogen atom in which the orbital electron circling round the nucleus is replaced by a negative μ-meson. Since the μ-meson is 210 times heavier than the electron, it circles round the nucleus at a distance only 1/210th that of the electron, giving an atom which is electrically complete but has a very short life. In that state a μ-meson turns into an electron and energy in two-millionth of a second.

During the preliminary experiments conducted with μ-mesons, generated by the bevatron, it was observed from the tracks in ordinary hydrogen that occasionally a μ-meson paired briefly with a deuteron (whose abundance ratio is 1 in 5000 in ordinary hydrogen) to form a mesic atom and consequently fuse a proton and a deuteron into He^3. The reaction has been explained as follows: A μ-meson has a far greater tendency to briefly pair with a deuteron than with a proton. When a μ-meson latches on to a deuteron, the resulting short-lived particle attaches with a proton to form a μ-mesic molecule. As the μ-meson is very close to the nucleus it is able to bind the proton and deuteron together, to fuse into He^3. The nuclear mass of He^3 is less than the combined mass of the proton and deuteron. This mass difference is transformed into energy and at the time of fusion the μ-meson gets ejected out carrying the energy of 5,400,000 eV.

The theory has been confirmed by enriching the ordinary liquid hydrogen used in the bubble chamber with heavy hydrogen when an increase in the number of such catalysed reactions took place.

Because of the extremely short life-time of μ-meson, the reactions it catalyses are very rare and no immediate practical use for μ-meson as a catalyst is foreseen in power reactors or bombs. But a much longer-lived particle would be more useful and is being sought after. The Russian physicist Alikhanian has reported evidence of such a longer-lived particle [*Sci. News Lett., Wash.*, **71** (1957), 5].

Uses of fission byproducts

THE GAMMA RADIATION, EMITTED by radioactive materials, offers a novel method of sterilizing biological materials and preserved foods without appreciably raising their temperature. The usual sterilizing dose of 2×10^6 rads corresponds to only 2° or 3°C. rise in temperature. A dose of 10^3 rads prevents sprouting in potatoes up to 18 months without affecting their taste and odour. The penetrating radiation is also used for sterilizing the articles in sealed containers against chance recontamination. Hormones, drugs and surgical products have also been likewise sterilized.

The life cycle of the tape-worm *Trichinella spirales* can be broken by irradiation of infected pork with doses of 20,000 rads. Screw-worm fly, a major pest of American fruit industry, was rendered sterile by radiation, only small doses being required. It has been possible to treat several million pupae each day with a small radiation source; the sterilized male insects were then liberated in such numbers as to swamp the natural population. The female fly mates once only and the eggs laid after mating with sterile male are infertile. Within a very short time, the natural population decreased and ultimately the pest was entirely eliminated.

In agriculture, the radiations have been used for inducing mutations in cereal seeds. Barley with a shorter and stiffer straw has been produced. The other changes brought about are early maturity, an increased protein content in the grain and greater ability to utilize high nitrogen dressings. Mutants with increased or full resistance to rust have been obtained from strains of barley, flax, oats and wheat.

In chemical technology also, radiation has been put to use both in the actual process of polymerization and treatment of the finished polymer. By using radiation, reactions can be started under a much wider range of conditions than is possible with conventional catalysts, for example, ethylene can be polymerized at room temperature under normal pressure resulting in a highly crystalline material tougher than the conventional polyethylene produced at 200°C. and over 1200 atm. pressure. An additional advantage of the use of radiation is freedom of the finished material from catalysts.

The application of radiation to polymerization under a wide range of physical conditions is demonstrated in the solid state polymerization of acrylamide. Ordinarily its polymerization can be effected only at its melting point (80°C.), but with the help of radiation it gets polymerized at room temperature. Irradiation at a still lower temperature, −15°C., brings about no change, but the irradiated material on reaching the room temperature polymerizes spontaneously with almost explosive violence. Using radiation some vinyl monomers have been polymerized at temperatures as low as −70°. Emulsion polymerization, which is used in the paint manufacture industry, has also been efficiently carried out by irradiation.

An interesting new development in this field is graft polymerization in which radiation is used for grafting a new monomer

on to an already formed polymer. For example, methyl methacrylate and acrylonitrile can be grafted to rubber. For achieving this the base polymer is swollen with the monomer and is then irradiated. Even at comparatively low doses a substantial degree of grafting is attained. When a material such as polyethylene is irradiated in air at room temperature, unstable peroxide bonds are formed. When the material is heated in the presence of another monomer, these bonds break and act as centres for the polymerization of the added monomers. A graft of the two types of polymer enables the two highly desirable features of high temperature and solvent resistance to be combined in a single material. Graft polymerization can thus be applied for modifying the surface of polymers, to obtain desirable changes in the physical and chemical properties of the surfaces.

Chlorination can be initiated by radiation. The gamma radiation due to its enormous penetrating power can pass through the steel walls of the reaction vessel and the absorption of the radiation by the substance within the vessel can be made quite uniform [*Times Rev. Ind.*, (Nov. 1956), 24].

Metric scales for surveys and maps

CONSEQUENT ON THE INTRODUCTION of the metric system in India, the adoption of new scales based on the metric system for survey, land and forest maps was decided at a meeting of representatives of the Survey, Lands, Revenue and Forest Departments of State and Central Governments held in Delhi on 9 March 1957. The adoption of these uniform scales will facilitate survey work and maintenance of land records in contiguous States and enable easy reading and quick correlation of the forest and cadastral survey maps.

There are variations in the scales of the present revenue maps (ranging from 64 in. to the mile to 4 in. to the mile) though the common scale used for rural mapping is 24 in. to the mile. Cadastral and survey maps will, in future, be drawn in the following six scales: 1: 1000, 1: 2000, 1: 3000, 1: 4000, 1: 5000 and 1: 10,000. Sparser areas will be mapped in a scale of 1: 25,000. For highly populated areas a scale of 1: 500 is fixed. Forest maps will also be on the 1: 10,000 scale wherever such special enlargement is necessary. The new scales will become applicable only when fresh maps are drawn [*Press Information Bureau, Government of India*].

Radio telescope in West Germany

A 25 M. RADIO TELESCOPE LOCATED near Münstereifel on the Stockert Mountain was inaugurated recently. One of the special uses to which the telescope will be put is the examination of the expanded dark clouds of hydrogen in interstellar space. It has been designed for the dual purpose of making radio telescope, observations at 21·1 cm. wavelength as well as studying radar problems on longer and shorter wavelengths. The parabolic mirror (diam. 25 m.) of the telescope, largest yet to be constructed in West Germany, is made of light metals weighing 20 tons (including the reinforcing structure). The departure from the true parabolic form does not exceed ± 5 mm. at any point. It is mounted on an aiming stand capable of being aimed with an accuracy of one minute of arc. The mounting is so rigid that the combined strain due to winds up to 15 m./sec. velocity and a snow and ice deposit up to 75 kg./sq. m. does not distort the mirror by more than ± 15 mm. The lining of the mirror is made up of perforated deoxidized aluminium sheet, 2 mm. thick. The perforation of the reflecting surface reduces the wind resistance (by about 16 per cent) and also the amount of heat concentrated at the focal point. The simpler azimuthal mount was selected in preference to the parallactic since its construction is simpler; it is also more suitable for radar research, although its manipulation is more complicated. The mirror fitted to a concrete tower is capable of moving in a full circle and is able to follow every movement of the stars. As the tilting and rotary movements required for radar research lie at least two orders of magnitude apart, the gearing ratios are very different; a mechanical switch has been provided between the two sets of gearing. For radar research a maximum angular velocity of 1°/sec. is required for both movements; for radio astronomy, a maximum of 0·51°/sec. for rotation and 0·051°/sec. for tilting, with minima only 5 per cent of these values, are required. A receiver installed in the tower amplifies the high frequency signals and registers their intensity automatically [*German Scientific Information Note No.* 58 dated 7 Nov. 1956 and *Discovery*, **17** (1956), 446].

Temperature variation inside the earth

JOHN J. GILVARRY OF U.S.A. HAS deduced the following quartic polynomial relation between the temperature T (in 10^3K.) and depth d (in 10^3 km.) for approximately estimating the temperature inside the earth at any depth:

$$T = 0{\cdot}773 + 0{\cdot}750d + 0{\cdot}463d^2 - 0{\cdot}1148d^3 + 0{\cdot}00708d^4$$

The polynomial has been constructed by using four previously determined temperatures. These temperatures are (1) Bullard's estimate of $800° \pm 200°$K. at 35 km. depth; (2) Coster and Hughes (unpublished) experimental values of 1300°-1800°K. at 600-900 km. depth; (3) temperature at the base of the mantle taken as the average of the fusion temperature of the liquid core and of the solid mantle; and (4) the fusion temperature at the boundary of the inner core, assuming the inner core to be solid and the inner and outer cores to be of the same composition. The last two temperature estimates have been taken from Gilvarry's own recent results obtained from his studies on the thermal dependence of the intensity of reflexion of X-rays by a crystal from which the Simon melting equation is derived directly. In addition, the condition which follows from Gauss's law, that the temperature gradient vanishes at the centre of the depth, has been used in constructing the above interpolant polynomial. The temperatures derived from this relation are quite close to those given by Daly for greater depths in the mantle. This temperature distribution is consistent with solidification of the mantle from the base up. The mean temperature gradient (0·78°C./km.) for the outer core is close to the value 0·5°-0·7°C./km. for the adiabatic gradient arrived at by Birch [*Nature*, **178** (1956), 1249].

Ultrasonic velocity in liquids

A NEW METHOD OF MEASURING ultrasonic velocity in liquids based on the diffraction effects produced by two identical progressive ultrasonic waves has been developed in the Physics Department, Andhra University, Waltair. The principle employed in this method is as follows: When two identical progressive ultrasonic waves are set up side by side with their wave fronts parallel, the diffraction pattern due to a light beam traversing the gratings parallel to the ultrasonic wave front shows variations in intensity as the phase difference between the two trains of waves is continuously changed. The intensity of the diffraction pattern attains a maximum when the path difference is an integral multiple of the wavelength and a minimum when the path difference is an odd integral multiple of half the wavelength. The path difference is brought about by moving one of the ultrasonic gratings continuously along the direction of propagation and the intensity of the diffracted light reaches maxima or minima at regular intervals of one wavelength. Knowing the distance through which one of the gratings is moved to cover a known number of maxima or minima (measured by a spherometer), the wavelength λ can be determined. The velocity V can be calculated using the relation $V = \nu\lambda$ where ν is the frequency of the ultrasonic waves.

The usual Debye-Sears progressive wave diffraction set up is employed for observing the diffraction patterns. Two identical circular X-cut quartz crystals of 1 in. diameter and 1·265 Mc/s. fundamental frequency are connected in parallel across the output of a variable frequency Hartley oscillator for generating two separate trains of waves. The crystals are excited at about the third harmonic to facilitate setting up of progressive waves and to get a greater number of maxima. One of the crystals is mounted in a standard fixed crystal holder with the bottom surface in contact with the surface of the liquid in the ultrasonic cell and the other crystal in a movable crystal holder consisting of two tubes one telescoping into the other. Accurate parallelism of the surfaces of the two crystals is ensured and the difference in the spherometer readings for every ten consecutive maxima is noted from which the wavelength and the velocity can be easily evaluated. A sensitive photomultiplier photometer used for judging the positions of maxima and minima gave very high accuracy in the velocity measurement.

The value of ultrasonic velocity for water at 32°C. obtained by this method is found to be in good agreement with the literature value. To check the accuracy of the method, the variation of ultrasonic velocity with concentration in aqueous solutions of sodium chloride has been measured and found to be nearly linear, being 57 m./sec. for 1 molal concentration, again in close agreement with the value previously reported by Barthel.

The method is simple, accurate and reliable. However, it has the disadvantage that it is suitable only for transparent liquids available in large quantities because of the large capacity of the progressive wave tank [*Curr. Sci.*, **25** (1956), 390].

Surface damage studies

CUTTING, GRINDING AND POLISHING of solids often produce an undesirable layer of 'disturbed material' on the surface whose thickness is difficult to determine. Studies made by W. Van Roosbroeck of the Bell Telephone Laboratories, New York, employing photomagnetoelectric technique have made possible the quantitative determination and interpretation of such surface damages. These investigations, now confined only to semiconductors, may, in due course, provide valuable insight into the nature of surface damage of solids in general.

When the front surface of a piece of germanium is illuminated by light that is highly absorbed at the surface, excess pairs of oppositely charged carriers—electrons and holes—are produced which normally diffuse straight through the sample recombining in the interior or at the back surface. A magnetic field applied parallel to the surface causes electrons to curve in one direction and holes in the opposite direction, giving rise to a type of Hall-effect voltage difference, called the photomagnetoelectric potential, between two electrodes on the back surface along a line normal to both the magnetic field and the diffusion current. As the excess carriers recombine more rapidly at a damaged surface than at a relatively perfect one, the concentration gradient, diffusion current and voltage across the slab are smaller when the damage is present. Thus the magnitude of the voltage is a measure of perfection of the surface.

For studies on surface perfection of abraded germanium slabs, sensing electrodes for measuring the photo-induced voltage are permanently affixed to the sand-blasted back surfaces of thin slabs of germanium. The character of the surface is systematically altered and the voltage is determined. As disturbed material is progressively removed by chemical etching the voltage increases to an asymptotic limiting value.

Sand-blasting or lapping with relatively coarse abrasives leaves a damaged layer of considerable thickness (35 μ) while polishing with fine abrasives disturbs a layer of only 1-2 μ. Over a broad range, a clear correlation exists between the size of the abrasive particle and the depth of damage. The method has been used to determine the thickness of the damaged layer resulting from the momentary immersion of a 'perfect' surface in an ultrasonically agitated water suspension of 6 mesh abrasive.

The surface recombination velocity of the excess carriers (which is a measure of the surface damage) obtained from similar measurements ranges from 300 m./sec. for abraded surfaces to about 1 m./sec. for relatively undamaged ones and decreases rapidly as the outermost portion of the layer is etched away.

The photomagnetoelectric technique is also being used to study surface damages by high energy ion bombardment [*J. Franklin Inst.*, **262** (1956), 520].

Chemistry of defects in semiconductors

A WHOLE NEW CHEMISTRY OF THE solid state similar to that of aqueous solutions is emerging as a result of research carried out at the Bell Telephone Laboratories. The scientists in charge of these studies consider that solids, especially germanium and silicon, provide new media analogous to water, in which chemical reactions can be

investigated. Electrons and holes occurring in intimate association with impurities in these semiconductors are important in chemical interaction between donors and acceptors, and are now regarded as 'chemical entities' in these solids.

An understanding of the principles of this chemistry and its close similarity to the general chemistry may be gained by considering a single crystal of silicon containing boron and lithium as impurities. Boron is an electron acceptor but it cannot easily diffuse at temperatures below the melting point of silicon. Lithium a donor, however, diffuses readily at temperatures where boron is immobile (300°C.). Dissolved lithium is pictured as ionizing, in part, to yield lithium ions, Li^+, and electrons, e^-, while boron yields B^- and positive holes e^+. The electrons and hole thus produced then enter into a sequential equilibrium reaction to yield a recombined hole-electron pair, e^+e^-. This is a stable 'compound' at low temperatures and its formation exhausts the 'solution' of electrons, forcing the lithium ionization further towards completion and thus increasing the solubility.

Regarding e^+ as the solid-state analogue of the hydrogen ion in aqueous solution and e^- as the counterpart of the hydroxyl ion, lithium is a 'chemical' base and boron an acid. The system represents a classical neutralization reaction in which the weakly ionized compound e^+e^- corresponds to water. When immobile boron is replaced by donor phosphorus a decrease in the solubility of lithium results from an oversupply of electrons of e^+. This is the solid-state equivalent of the common ion effect.

By the application of the mass action principle to these new chemical equilibria, it has been possible to predict the solubilities of donor impurities in acceptor doped germanium and silicon. The solubility of lithium in germanium is increased by a factor greater than 10^5, in quantitative agreement with theoretical predictions, by the addition of 4×10^{-3} atom fraction of gallium; interaction has been observed when the atom fraction added is as small as 2×10^{-9}.

The process of ion pairing gives rise to new effects like ion pair relaxation. An ion pair, such as Li^+B^-, has a dipolar field so that its scattering cross-section for mobile charged carriers is very much smaller than that of a point charge. Therefore, the ion pair formation in semiconductors can, under some conditions, increase carrier mobility by decreasing scattering and the process of pairing can be followed by measuring mobility through the Hall constant.

To measure quantitatively the change in carrier mobility by ion pairing and to follow its course kinetically, a semiconductor containing unpaired donors and acceptors is abruptly cooled to a temperature at which the impurities pair. The pairing then occurs with a theoretically calculable relaxation time which depends, among other things, on acceptor concentration, diffusivity of the mobile donor dielectric constant of the lattice and the ionic charges. The significance of these techniques may be appreciated from the fact that donor diffusivities of 10^{-16} cm.^{2}/sec. can be determined in less than an hour and diffusivities as small as 10^{-20} cm.^{2}/sec. can be accurately evaluated.

The still largely unexplored phenomena of defect interactions in solids are also useful in providing a unique means of testing electrolyte theories of classical 'wet' chemistry [*J. Franklin Inst.*, **262** (1956), 524].

Transistor-grade silicon

A PHYSICO-CHEMICAL METHOD FOR obtaining transistor-grade silicon has been developed at the Air Force Research Centre, Cambridge. The method is free from the drawbacks inherent in the metallurgical method, viz. difficulty of removal of boron, container contamination, etc. The new method involves four steps: synthesis of a suitable compound of silicon; purification by crystallization; sublimation and zone refining; and decomposition of the compound into elemental silicon. Silicon tetraiodide is chosen as the compound of silicon to be synthesized in view of its special advantages. It is prepared by passing iodine vapour at 110°C. over silicon at 810°C. in which step the total impurities are reduced from 2794 to 1675 p.p.m.; the tetraiodide is then crystallized from dried, fractionally distilled toluene when the impurities are further reduced to 315·5 p.p.m. This is sufficiently low for zone refining to be effective. After 30 passes in zone refining, the resulting tetraiodide matrix is pure within 5 in 10^{11} parts. This highly pure tetraiodide can then be decomposed at 1000°C. in vacuum to give silicon suitable for semiconductor devices [*Chem. Engng. News*, **34** (1956), 5007].

Isomer of reserpine

RAUJEMIDINE, A NEW ALKALOID isomeric with reserpine developed by Ciba, U.S.A., shows both sedative and hypotensive properties in experimental animals.

It occurs in the weakly basic fraction of the methanol extract of *R. canescens* roots. The new alkaloid was isolated by chromatographic methods after removal of most of the reserpine and reserpidine by crystallization [*Chem. Engng. News*, **34** (1956), 4886].

Biologically stable casein

CASEIN PROTECTED WITH AN added preservative is utilized in the manufacture of a large number of products such as coated paper, casein glue, paints, insecticides, etc. But ordinary preservatives added are frequently lost or rendered inoperable in customary solutions. Generally oil and wax emulsions entrap them in oil phase thereby depriving casein of protection. A process has been developed at the Borden Casein Laboratory, New York, for producing biologically stable oxygenated casein solutions which are highly resistant to putrefaction. Chlorination is carried out by generating chlorine in the nascent state in the reaction mixture from hydrochloric acid and hydrogen peroxide.

Borden's biologically stable casein is light yellow in colour and has a pleasant aromatic odour. It is resistant to microbial spoilage, insect infestation and is non-toxic. It is more readily soluble in water than ordinary casein. It tends to associate intramolecularly in solutions rather than intermolecularly. It is used as a base for the manufacture of protective colloid emulsion, as a thickener and levelling agent for latex and as emulsion agent [*Chemurg. Dig.*, **15** (1956), 7].

Fermentation lysine

PFIZER LTD., U.S.A., HAVE DEVELOPED a two-step fermentation technique for the production of lysine. The first step employs a mutant of *Escherichia coli* that acts on a substrate consisting of glycerol, corn steep liquor, salts and water, and forms diaminopimelic acid in good yield. Since the organism lacks the enzyme diaminopimelic acid decarboxylase, the acid is not decarboxylated to form lysine in this step.

In the second step, a strain of *Aerobacter aerogenes* is added to the fermentation vessel. The subsequent addition of toluene breaks open the *Aerobacter aerogenes* cells and frees their content of diaminopimelic acid decarboxylase. This enzyme causes the conversion of the acid to lysine. No other enzymes are present to bring about the decomposition of lysine to other products.

l-Lysine is formed completely free of the *d*-form. Final purification of the product is achieved by ion exchange. The complete process takes about five days [*Chem. Engng. News*, **34** (1956), 5988].

Sulphonamides in the treatment of diabetes

EXPERIMENTAL DIABETES IN DOGS and rabbits has been treated successfully at the Applied Physiology Laboratory, Montpellier, France, by administering *p*-aminobenzene-sulphonamidoisopropylthiodiazole (2254 RP). Comparative studies on the effectiveness of compounds structurally similar to 2254 RP established that the sulphonamide group is necessary to reduce the blood sugar level. Variations in the chemical structure of the side chain in position 5 of the thiodiazole nucleus affect the hypoglycemic potency of the drug. The tertiary butyl or isobutyl derivatives of the thiodiazole are most active followed, in order of decreasing activity, by the butyl, amyl and isoamyl, propyl and isopropyl derivatives. Methyl, ethyl, hexyl, heptyl and amino derivatives are inactive.

The drug acts on the islets of Langerhas, stimulating insulin secretion or increasing the effect of insulin itself. It also promoted the accumulation of large quantities (up to 10 times the initial amount) of glycogen in the liver of a normal dog kept unfed for 4-5 days. The drug has no toxic effect on the hepatic cells, even in relatively large doses.

The drug is effective in treating diabetes due to sluggish insulin secretion and diabetes complicated by bacterial infection. It is also capable of reducing or curing the dog's alloxan diabetes in preliminary stages. In rabbits the compound is capable of curing even the most serious cases.

The drug offers promise of curing human diabetes too. The fact that it can be administered orally is a great advantage [*Ann. N.Y. Acad. Sci.*, **67** (1956), 185].

Sodium fluoride in filariasis

SODIUM FLUORIDE, ADMINISTERED orally at a dose of 0·1 per cent in water thrice daily, effected significant improvement in early cases of elephantiasis while chronic cases showed partial reduction in swelling. Sodium fluoride therapy lowers serum calcium level in blood, which is accompanied by reduction in swelling. It is, therefore, necessary that serum calcium level must be watched carefully during the treatment lest the level should fall well below normal and result in tetany [*Indian J. Pharm.*, **19** (1956), 15].

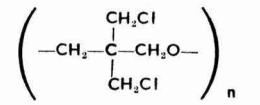
Fighting crop pests through 'antibodies'

A BIOLOGICAL CONTROL LABORATORY, the first of its kind in India, has recently been set up at Bangalore under the Indo-Canadian Agreement of 1955. The laboratory, equipped with most modern scientific apparatus in the field, will collect, store and distribute 'predators', the natural enemies of insects and weed pests to fight pests in India and in other Commonwealth countries.

The laboratory will also act as a centre for research and also for the collection and dissemination of information pertaining to the control of insect and weed pests by natural means.

Penton — a new plastic

A THERMOPLASTIC MATERIAL, PENTON, developed by Hercules Powder Company Ltd., U.S.A., has good moulding ability, high degree of dimensional stability, good chemical resistance and excellent electrical properties. Penton is a chloro polyether, with the structure:



Its resistance to hydrolysis in slightly acid or alkaline environments makes it preferable to fluorocarbon type of resistant plastics and modified styrenes. The water absorption (0·01 per cent) property of Penton renders it capable of passing from dry to humid atmospheres without any alteration in its dimensions. In boiling water its tensile strength is 300 lb./sq. in. It can withstand a fabrication temperature as high as 287°C. The surface resistance of Penton, which was 5×10^{15} initially, changed to 3×10^{15} ohms after one year's exposure to tap water.

A number of important applications of Penton, e.g. in water meters, in valves and parts of refrigeration equipment, in motors, in timing devices, in packaging materials, etc., are anticipated [*Chem. Engng. News*, **34** (1956), 6120].

High-pressure silicates

HITHERTO OUR KNOWLEDGE ABOUT the nature of materials existing in the earth at great depths has come primarily from seismology. Recent studies at the Carnegie Institution, Washington, and at other places in high pressure instrumentation have enabled investigation in the laboratory, of the stability of minerals up to a pressure of 70,000 atm. at high temperatures, corresponding to that obtaining at a depth of over 100 miles inside the earth.

Some of the results of these investigations were presented by F. R. Boyd in a paper submitted at the Autumn Meeting of the National Academy of Sciences, U.S.A., held at Washington D.C., during 8-10 November 1956.

The experiments showed that silicates with open, network structures, like quartz, feldspars and feldspathoids which constitute a major part of the earth's crust, are unstable in conditions of temperatures and pressures below the earth's crust. Under such conditions these minerals invert or break down to high-pressure phases discovered in the course of these experiments. Transitions to

high-pressure phases may be sharp as in the case of the simple transition, quartz ⇌ coesite. In chemically more complex systems, e.g. breakdown of feldspathoid nepheline, transitions extend over a range of temperature and pressure. It is probable that seismic discontinuities at the base of the earth's crust and in the upper part of the earth's mantle are due to similar phase transitions [*Science*, **124** (1956), 935].

Reinforcement of synthetic elastomers

CASE INSTITUTE OF TECHNOLOGY, Cleveland, U.S.A., has conducted a series of experiments on the effect of mica fillers in vulcanized GR-S rubber, the effect of carbon fillers in bonding butyl rubber to 70/30 brass and on the influence of particle size and type on tensile behaviour of synthetic elastomers.

The filler effect of mica was evaluated by tensile testing of a variety of vulcanized butadiene styrene compositions where mica was used at various concentrations with and without supplemental additions of carbon black. Wiegand ΔA values determined from the tensile data for various filler compositions show that mica at best has less than 30 per cent of the reinforcing effect of a typical carbon black. However, mica seems to confer a unique lubricity effect which improves elongation without affecting breaking strength and can also compensate for the elimination of softening oils from vulcanizate base mixes.

To find out whether interfacial adhesion effects are as important as the bulk properties of the adhesive in promoting overall strengths of bonds between rubber and brass, 24 butyl rubber vulcanizates were compounded using different proportions and types of carbon blacks, and the mixes were characterized in their vulcanized state by standard tensile measurements and by measuring their adhesive strengths when used to bond parallel plates of 70/30 brass. With few exceptions, the tensile failure of the rubber-brass sandwiches was by rupture in the body of the adhesive rather than by stripping away of adhesive at the metal interfaces. The strengths of the brass-rubber laminates were correlated with differences in energy of rupture effected by varying the type and concentration of carbon fillers in the rubber mixtures.

The tensile behaviour of butyl and GR-S rubber reinforced by carbon blacks and micas of different sources and particle sizes has been analysed in terms of detailed stress-strain behaviour. The number of apparent constraints per unit volume, expressed as a function of volume or weight per cent of filler, supports a mechanism of inforcement expressed for butyl rubber by the Blanchard-Parkinson equation, and for GR-S by this or a simpler relation. Zinc oxide decreases stiffness while increasing the number of constraints. Mica is less effective, and carbon black increases the number of constraints and decreases the average ultimate elongation [*Industr. Engng. Chem.*, **48** (1956), 2080-94].

Efficiency of foam-generating equipment

THE INCREASING DEMAND FOR fire-fighting foams of specified physical properties has necessitated an investigation on their methods of generation. Using the two foam characteristics of expansion and 25 per cent drainage time as criteria, eductor and pump-type foam producers were evaluated at the Naval Research Laboratory, Washington, for their efficiency and energy requirements. The positive acting devices which impart work into the air-stabilizer-water mixture were found to be the only satisfactory means of producing foam of uniform qualities under varied conditions of head and flow rate.

An analysis was made of the 100 cycles per second compression curve characteristic of a vane-type foam pump. This has furnished valuable data concerning the location and area of the pump porting and the ways of improving volumetric and compressor efficiency [*Industr. Engng. Chem.*, **48** (1956), 2031].

Rust and scale remover

TETRASODIUM TETRINE, DEVELOPED by Glyco Products Co. Inc., New York, for removing rust and scale from iron and steel, acts without earlier removal of paint, grease or other deposits. It can also be used for cleaning brass, copper, magnesium and other metals and for strip phosphate coatings.

It is composed of tetrasodium tetrine 33, sodium hydroxide 63-66 and foaming agent ½ to 1 per cent, dissolved in water. The part to be treated is immersed in the solution and heated to boiling point, followed by rinsing in hot water and drying. If the part is not to be surface-finished, it may be covered with a light protective oil [*Chem. Age*, **77** (1956), 127].

Lubrication by vapours

ZETTLEMOYER AND HIS RESEARCH group at Lehigh observed from their experiments on the mechanics of boundary lubrication by organic vapours that short-chain molecules having moderate vapour pressures produce very thin films of organic adsorbate which decrease sliding friction appreciably. Actually, boundary lubrication is provided by monomolecular layers of lubricant, where the sorbed monolayer on one rubbing surface contacts that on the other. The adhesional forces of the monolayers are of basic importance. The greater the polarization of the liquid, the more effective is the film as a boundary lubricant. Where a dipole is buried inside a molecule and cannot reach the metal surface to bond the molecule tightly, poor lubrication results. The experiments showed that, in general, at room temperature, the van der Waal's forces are important in considering adhesion of physically adsorbed films [*Chem. Engng. News*, **34** (1956), 5004].

Vibration calibrator

THE VIBRATION CALIBRATOR, model 501, originally designed for the U.S. Armed Forces, is now available from the Tel-Instrument Co., New York, to industry and research laboratories.

The unit, designed to calibrate vibration pick-ups or to measure vibration of non-magnetic metallic surfaces, has a vibration amplitude range of 0·00002, 0·0002, 0·002 and 0·020 in. at frequencies ranging from 10 to 20,000 cycles per sec. The accuracy rating is 5 per cent. The same accuracy is obtainable even when measuring vibrations of non-sinusoidal nature. The instrument allows direct meter reading of vibration displacement in thousandths of an inch and is provided with voltage terminals to permit observation of vibration waveform with a conventional oscilloscope.

The instrument finds application in a wide variety of fields like automobiles, aircraft, home appliances and instrument manufacture. It is useful for testing laboratories, universities and those concerned with vibration measurement problems.

Remote-control scope

CHANGES OCCURRING IN THE microstructure of metals exposed to radiation can be studied with a remote-control microscope developed at General Electric's Hanford plant in U.S.A. The radioactive sample is placed in a 38-ton steel cell and then manipulated by mechanical hands. Light beamed through a wall port is focussed to a point, illuminating the polished sample of metal inside the cell. Reflected light from a circular dot, sometimes as small as 0·005 in. in diameter, is collected by a compound lens and projected through another port to an external eyepiece where it is transformed into a vastly enlarged image of the circular area [*Chem. Engng. News*, **34** (1956), 6050].

Portable frequency meter

THE BRITISH THOMSON-HOUSTON Co., Rugby, England, have developed a portable frequency meter which gives a high order of accuracy over a wide range of frequency (15 c/s. to 100 kc/s.). The accuracy is independent of the range and waveform of the input which can vary between 0·1 V. and 500 V. The instrument is mains operated and incorporates junction transistors and germanium diodes and the frequency is shown on the linear scale of a moving coil instrument. The compact instrument having dimensions $10 \times 8 \times 4\frac{1}{2}$ in. weighs only 9 lb.

The instrument consists of a saturating transistor amplifier which charges and discharges a capacitor on each cycle of the input voltage. The mean current through the capacitor is proportional to the input frequency; the capacitor current is rectified and shown directly in terms of cycles per sec. on the scale of a d.c. moving coil meter. Frequency range selection is effected by a rotary switch with six positions for the six ranges: 15-300 and 300-1000 c/s.; 1-3, 3-10, 10-30 and 30-100 kc/s. The accuracy up to 70 kc/s. is better than 1 per cent of full-scale deflection and the inaccuracy due to limiting transistor characteristics is not greater than 5 per cent at 100 kc/s.

The meter can also be adapted for measuring the speeds of rotating shafts, with an accessory photoelectric head incorporating a light source and photo-cell. By focussing the photocell on to a suitably marked rotating shaft, the reading on the meter can be made to give directly the shaft speed by previous calibration [*Indian east. Engr.*, **119** (1956), 381].

New type of particle accelerator

A NEW TYPE OF 10 MILLION VOLTS Van de Graaff particle accelerator, the highest energy Van de Graaff announced to date, will be installed early in 1958 at the Chalk River facility of Atomic Energy of Canada Ltd. The machine will enable physicists to study in continuous detail, for the first time, the nuclear energy levels of heavy elements.

The 10 million volts unit, called Tandem Accelerator, consists of two 5 million volts accelerators placed end to end, with a common high voltage terminal. The 35-ton accelerator, 34 ft. long and 8 ft. in diameter, is to be mounted on a rail in an L-shaped building 150 ft. long and 60 ft. wide. A separate building houses controls and services.

The machine is to be equipped with a switching magnet that makes it possible to shift the intense beam of particles in any direction, depending on the type of study under way [*High Voltage Engineering Corporation News*].

Small atomic power stations

HUMPHREYS & GLASGOW LTD., A British company, have started constructing small atomic power stations with a capacity of 10,000-20,000 kW., sufficient to meet the power needs of 20,000-40,000 inhabitants. The 10,000 kW. plant, whose installation cost is estimated at £ 2,000,000, will occupy an area not greater than a lawn tennis court. The reactor uses enriched uranium as fuel and utilizes pressurized water for heat transfer. The design ensures complete protection to the surrounding area in the event of a nuclear explosion.

Inorganic Chemistry Division of A.C.S.

THE COUNCIL OF THE AMERICAN Chemical Society have recently established a new division — the Inorganic Chemistry Division — with Dr. John C. Bailar as Chairman and Dr. John F. Gall as Chairman-Elect. The first programme of the new Division included arranging of symposia on " The Present Status of Inorganic Chemistry " and " Unfamiliar Oxidation " at the time of the Society's National Meeting in Miami on 7 April 1957.

Symposia on " New Industrial Inorganic Chemicals " and " High Temperature Inorganic Chemistry " are being arranged for the National Meeting of the Society to be held in New York during 8-13 September 1957. A symposium on " The Metal-carbon Bond " is also being sponsored.

Membership of the Division is open to scientists, both in and outside United States, who are interested in inorganic chemistry. The membership dues of $ 3.00 per year should be sent to Dr. L. B. Asprey, Los Alamos Scientific Laboratory, Box 1663, Los Alamos, New Mexico.

Research in geophysics

A GEOPHYSICAL RESEARCH WING in the Geological Survey of India at its headquarters in Calcutta is to be established by the Government of India.

The work of the new wing will be directed towards bringing about improvements in the techniques and instruments of geophysical operations. To begin with, research will be carried out in the methods of geophysical prospecting by electrical, magnetic, gravitational and seismic methods. Investigations for the standardization of methods and determination of physical properties and constants of rocks and minerals will also be taken up at the wing.

Platinum Metals Review

THIS NEW QUARTERLY JOURNAL devoted to a survey of research on the platinum metals and of developments in their applications in industry is being published by Johnson Matthey & Co. Ltd., sole refiners and distributors of platinum metals from

the Rustenburg Platinum Mines, South Africa, since January 1957.

The indispensability of platinum and other noble metals in industry is due to a unique combination of some desirable properties in these metals that cannot be met by others at a comparable cost. Today, substantial quantities of platinum are employed in industry as contacts in telephone relays, as electrodes in industrial electrochemical processes, as thermocouples for measuring temperature of molten steel and as catalysts in the production of nitric acid and of high octane petroleum spirit. Platinum-wound electric furnaces are used in metallurgy, glass and ceramic industries, nuclear research and in molten glass handling equipment. In view of the ever-growing and special applications, particularly in chemical, electrical and nuclear engineering, this periodical published by one of the world's pioneers in the platinum field is timely and welcome.

The first article in the inaugural issue gives, against a brief historic background, an informative account of the platinum mining operations at the Rustenburg Platinum Mines in Transvaal, one of the earliest in platinum mining and now the world's largest individual producer of platinum. A number of technical articles which follow deal with the special and latest applications of platinum in engineering and industry such as: use of platinum metals for bursting discs in chemical processing and plant servicing; use of electrodeposited rhodium in coaxial radio frequency circuits and reliable high temperature, 'fifty-twenty' thermocouples which have been accepted as international standards and creep properties of platinum metals. Abstracts of current literature and new patent information on the platinum metals and their alloys are the other useful regular features of this review which seeks to provide scientists and technologists with current information on the properties and other applications of platinum and the associated metals.

Improving soil fertility

A THREE-DAY SESSION OF THE Soil Science Committee of the Indian Council of Agricultural Research was held during 7-9 March 1957 in New Delhi under the presidentship of Dr. S. P. Roy Chaudhuri. Seven new research schemes relating to maintenance and improvement of soil fertility in the country were sanctioned. Some of these schemes particularly relate to reclamation of saline and alkaline soils in Bombay, West Bengal, Punjab and Agra and to increasing soil fertility by biological nitrogen fixation. The other schemes deal with effecting improvement in soil structure by application of suitable chemical amendments and agronomic practices and standardization of methods of soil analysis.

The Committee also scrutinized the technical programme of work of 22 existing research schemes in India. Two schemes which have been completed in West Bengal and Bihar have yielded important data for chalking out suitable manurial schedules for certain districts in these States. The Committee also discussed the work on soil sciences and agriculture chemistry carried out in different states for purposes of inter-state co-operation.

The Committee recommended intensification of work on soil physics and soil microbiology both at the Centre and in the States.

Anterior pituitary hormones

THE ENDOCRINOLOGY STUDY SECtion of the National Institutes of Health, Bethesda, Madison, U.S.A., has announced a plan for supplying anterior pituitary hormones, other than ACTH, to qualified investigators in the medical sciences.

The first lots of bovine growth hormone and of ovine prolactin have been approved by the Study Section and are now available for distribution. The growth hormone and prolactin are packaged as sterile, lyophilized powders in vials of 50 mg. and 25 mg. respectively. Data on the estimated potency and degree of contamination and instructions for dissolving the materials are to be issued with each package [*Science*, **124** (1956), 926].

Announcement

Award of Doctorate Degrees — Shri M. Sri Rama Rao has been awarded the D.Sc. degree by the Andhra University for his thesis *Studies on ionospheric winds and radio fading.*

Shri Som Prakash Aggarwal has been awarded the Ph.D. degree by the Delhi University for his thesis *Investigations in the theory of ballistics.*

Shri B. Chaitanya Deva has been awarded the Ph.D. degree by the Poona University for his thesis *Psychophysics of speech melody in Dravidian.*

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Progress Reports

NUTRITION RESEARCH IN INDIA

THE ANNUAL REPORT OF THE NUTRITION RESEARCH Laboratories, Coonoor, for the year 1955-56 records the progress of about 30 research schemes in nutrition and clinical fields being investigated. An important activity during the year was an extensive survey of protein malnutrition in South India. The survey, confined to 2657 children under 5 years of age belonging to the poorer sections of the community, has led to the conclusion that the sanitary and environmental conditions of the communities studied are not satisfactory and the dietary intake of the children is uniformly poor. Extreme growth retardation and consistently low serum albumin values in the children indicated that this inadequacy was of severe and prolonged duration.

An account of the research activities during the year is given below:

Vitamins — Studies aimed at assessing the role of phosphorus content of the diet on vitamin A utilization and storage revealed that the growth of young rats on phosphorus-deficient diets is less than in the case of rats fed on normal phosphorus diet. The absorption and utilization of carotene was, however, independent of the phosphorus content of the diet.

Studies on citrogenase activity in the epiphyseal cartilage of rachitic and vitamin D treated rats showed that carbohydrate metabolism of the epiphyseal cartilage is adversely affected in vitamin D deficiency.

Proteins — Studies have been carried out to evaluate cereal and pulse proteins. It was observed that the nutritive value of the protein of the commonly consumed cereals is enhanced by supplementation with pulse and leafy vegetables such as amaranth. A comparison of the protein efficiency ratio of skim milk protein with cereal-pulse-amaranth mixtures brought out that dietary protein of high biological value can be obtained through vegetable sources. The mixture can also maintain normal levels of blood proteins.

Experiments have been conducted to determine (1) the effect of protein depletion and calorie restriction on the pancreas and liver of albino rats and (2) the influence of added calorie restriction on the effects of protein deficiency. It has been found that the dietary level of protein influences the lypolytic activity of pancreas, it being lower at lower levels of protein intake. Calorie restriction alone has a similar effect, although to a lesser extent. The effect of superimposed calorie restriction on protein-deficiency is beneficial in that the lipase activity under this double restriction was higher than that observed under protein restriction alone. With the progress of time the effect of protein deficiency was maintained while that of calorie restriction gradually decreased.

Regarding the effect on liver, absolute liver weights were significantly lowered both in protein deficiency and calorie restriction, a marked effect being observed in combined deficiency. The effect of protein depletion as seen in the reduction of liver weights gradually increased with time while that of calorie restriction was irregular. When expressed in terms of body weight, however, the liver weights were higher in protein-deficient animals.

Protein depletion reduced significantly the total nitrogen per 100 g. of liver, whereas calorie restriction caused an increase.

The activity of liver transaminase in protein inadequacy was significantly lowered while under calorie restriction it was significantly raised.

Inadequate intake of protein lowered the succinic dehydrogenase activity while the restriction of calories had the opposite effect. The beneficial effects of calorie restriction progressively diminished and were lost between 42 and 56 days due to the increased effect of protein deficiency.

Experiments show that calorie restriction, in general, affords some protection to the organs so far studied from effects of protein depletion.

Fats — Silica gel chromatography has enabled a quantitative estimation of the components of the 'iso-oleic acid' fraction obtained from cow butter fat and beef body fat. The results obtained established the presence of Δ^{-7}, Δ^{-8}, Δ^{-9}, Δ^{-11} and Δ^{-12} octadecenoic acids in butter fat and of all these except Δ^{-7} in beef body fat.

The possibility of isolating the iso-oleic acid fraction of vanaspati and other fats by the urea adducts method was explored. The adducts were formed in the usual manner by treating the fatty acids with urea in methanol and subjected to repeated crystallizations from methanol. The results obtained indicated the possibility of isolating a fraction rich in solid unsaturated acids by the process from both vanaspati and beef body fat.

Fruits and vegetables — During the period under review, 40 fruits and 17 vegetables were analysed for their moisture, fat, protein, mineral matter (including calcium, phosphorus and iron) and vitamins such as carotene, riboflavin, nicotinic acid and ascorbic acid contents. The leaves of root vegetables — knol khol (*Brassicac aulorapa*), beet (*Beta vulgaris* L.), turnips (*Brassica rapa* L.), etc.—were found to be rich sources of riboflavin, calcium, iron and carotene, and among the fruits, persimmon (*Diospyros kaki*) and apricots (*Prunus armeniaca* L.) are good sources of carotene; dried fruits and some fruits of the hilly regions contain appreciable amounts of iron.

Clinical investigations — Electrocardiographic studies on normal and malnourished monkeys showed that the most consistent change in the undernourished monkeys is a drop in the heart rate. The heart rates, however, reached abnormally low levels only in five cases.

The possibility of treating *kwashiorkor* by regulating daily intake of protein was examined. Cases were treated successfully with 60 g. of protein intake daily. Subnormal levels of serum, sodium and calcium rose to normal levels after treatment with high protein diet.

Pathology — The effect of replacement of rice in poor rice diet with tapioca on the nutritional disorders of the liver has been studied. Partial (25 per cent) replacement of rice with tapioca promotes a better growth rate by virtue of the higher calcium content. Supplementing the rice diet with an equivalent amount of calcium causes a much more satisfactory growth rate. Histologically, however, the livers of animal receiving the tapioca-rice diet show an accentuation of the protein deficiency type of liver damage.

CENTRAL LABORATORIES FOR SCIENTIFIC & INDUSTRIAL RESEARCH, HYDERABAD

THE ANNUAL REPORT OF THE LABORATORIES FOR THE year 1955 records the results of the research activities of its different divisions, some of which are reviewed below.

Oils — A modification of the official A.O.C.S. dry soap method of refining cottonseed oil worked out during the year gives about 20 per cent lesser refining losses and a better reduction of red colour. The new method involves adding hot water to the oil so as to dissolve and drain off the soap formed.

In view of the scarcity of methanol in India, its substitution by ethanol in the separation of fatty acids of natural fats was attempted. Practically complete recovery of saturated fatty acids was possible from beef tallow using diluted ethanol.

A standardized method for the preparation of estergum varnishes from dehydrated castor oil (DCO) and linseed oil was evolved. The varnishes prepared by this method were superior to commercial products. Castor oil modified alkyds of short oil length were prepared without using catalysts. The baked alkyds were resistant to water, 1 per cent alkali and mineral acids.

Entomology — The site and mode of action of allethrin on insects were studied using isolated heart of cockroach and taking frequency of the heart beat as a measure of the insecticidal action. At high (15^{-6}) and intermediate concentrations, allethrin acted as an inhibitor, while at low concentration ($1{\cdot}25 \times 10^{-9}$) it did not cause any inhibition of the heart beat. Atropine, a cholinergic blocker in vertebrates, antagonized the action of allethrin. The action of allethrin on the heart was shown to be due to the release of acetylcholine at the neuromuscular junction by its action on the cardiac ganglia.

Sesamin, a powerful synergist to pyrethrum, was found to be a stimulant for the heart of cockroaches.

The oil of *Pongamia glabra* (*karanja*) was found to be toxic to house-flies when applied topically. A thick brown paste (crude karanjin) obtained by refluxing *karanja* oil with alcohol was highly toxic to house-flies at 4 per cent concentration. A low mortality rate was, however, observed in the case of stored grain pest *Trilobium cartanium*.

Fuels — Optimum conditions have been determined for the briquetting of non-caking Hyderabad coal slacks using lime-tar mixture as binder. Briquettes of compression strength 1200 lb./sq. in. could be obtained by briquetting Kothagudem coal fines of size below $\frac{1}{8}$ in. at $50° \pm 5°$C. with the lime-treated heavy tar fraction obtained by low-temperature carbonization of coal in the Lurgi-spül gas pilot plant. The briquetting mixture containing 100 parts coal, 10 parts tar and 1 part slaked lime (all on dry basis) was prepared at 70°C. for 30 min. and briquetting was carried out at 4000 lb./sq. in. Briquettes made from coke fines gave on carbonization a stronger product than briquettes made of coal fines.

Heavy chemicals — Different sulphates were tried for the production of sulphur dioxide. The decomposition of gypsum by alumina was found to be facilitated by the presence of sodium sulphate at 900°.

A method has been worked out for the manufacture of sulphur from gypsum. The process consists in producing sulphur dioxide from sodium sulphate, and hydrogen sulphide from gypsum and combining the two in aqueous medium to get sulphur. Preliminary cost estimate indicates this process of producing sulphur from gypsum to be more economical than the existing methods. Sodium hydroxide, alumina and slaked lime are obtained as byproducts.

Biochemistry — Laboratory-scale studies on the production of citric acid by the fermentation of cane sugar with *Aspergillus niger* were completed. Yields of 50-60 per cent have been consistently obtained. Addition of methanol (1 per cent v/v) to the sterilized medium before inoculation with spores was found to raise the yields by 10-12 per cent. Higher concentrations of methanol were, however, not beneficial.

Two strains of *Aspergillus terreus*, viz. NRRL 265 and NRRL 1960, gave up to 50 per cent yields of itaconic acid from cane sugar. Best yields were obtained when the medium contained NH_4NO_3 (0·2 per cent), KH_2PO_4 (0·02 per cent) and $MgSO_4.7H_2O$ (0·1 per cent) in addition to 15 per cent cane sugar.

Studies involving addition of various inhibitors and activators to the fermentation medium led to the conclusion regarding the mechanism of formation of itaconic acid that pyruvic acid possibly takes part in condensation reactions either with a 3-carbon moiety (perhaps another molecule of pyruvic acid) followed by loss of one carbon as CO_2, or with a two carbon fragment such as an activated acetyl ester to yield itaconic acid.

The oxidation of glucose to 2-ketogluconic acid through the intermediate formation of gluconic acid by *Pseudomonas fluorescense* was studied in stationary and aerated cultures. The yield of 2-ketogluconic acid in stationary culture was always 50 per cent of the theoretical and the rate of conversion was slow. Aeration helped the growth of the medium and increased the yield to 75-80 per cent.

Modification of Kamala Seed Oil for Varnishes & Paints

V. N. OJHA, P. G. SHARMA & J. S. AGGARWAL
National Chemical Laboratory of India, Poona

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Benzene-extracted kamala seed oil on alcoholysis with monohydric alcohols yields modified oil having gelation properties similar to those of tung oil. The addition of more than 60 per cent of other drying oils to kamala seed oil is necessary to give a modified oil of the desired gelling quality; the gels of the blended oils are soft.

The addition of antioxidants or stabilizers increases the gelation time slightly.

IT has already been reported[1] that the oil extractable from kamala seeds by ethyl ether, ethyl acetate or benzene[2] has quick polymerizing and gelation properties, the Browne heat test value of the oil being about 2 min. 30 sec. as against 9-12 min. for tung oil which also gels under similar conditions. The gelation times of kamala seed oil and tung oil at 200°C. in an atmosphere of nitrogen are 15 min. and nearly 6 hr. respectively. Due to these extreme polymerizing tendencies, it has not been possible to utilize fully the entire quantity of oil present in kamala seed for preparing varnishes and other coatings. In the preparation of air-dry wrinkling compositions the petroleum extractable fraction of kamala oil (Browne heat test value, 9 min. 30 sec.) constituting only one-half of the total oil present in the seeds was used[3]. Modification of kamala oil, so that the whole of it may have polymerizing properties similar to tung oil, is necessary for its utilization in various coating compositions. The results of investigation carried out in this direction are presented in the present communication.

Experimental procedure

For controlling the polymerizing tendency of kamala seed oil extracted with benzene, three methods have been tried: (1) admixture with other drying oils, (2) addition of stabilizers, and (3) alcoholysis with lower monohydric alcohols.

Modification by admixture with other drying oils — Puntambekar[4] prepared a quick-drying paint oil from kamala fat by dissolving it in other drying oils such as linseed, safflower and tobacco seed oils. With a view to determine the gelation characteristics of such mixtures, blends of benzene-extracted kamala seed oil with raw linseed, linseed stand (20 and 50 poises) and dehydrated castor oils were prepared and the blended oils heated at 200°±2° in an atmosphere of nitrogen. The time taken to gel, the condition of the gels, and the Browne heat test values of these blends are given in Table 1.

TABLE 1 — GELATION TIMES OF BLENDS OF BENZENE-EXTRACTED KAMALA SEED OIL AND OTHER DRYING OILS

(*Temp.*, 200°C.)

Blending oil	Amount of oil added %	Gelation time at 200°C. in nitrogen		Condition of the gel	Browne heat test value		Condition of the gel
		hr.	*min.*		*min.*	*sec.*	
Tung oil (pure)	—	6	0	Hard	11	10	Hard
Kamala oil (benzene-extracted, pure)	—	0	15	do	2	30	do
Raw linseed oil	25	0	25	do	4	0	do
do	75	2	30	Soft	10	50	Soft
Linseed stand oil (20 poises)	25	0	25	Hard	3	40	Hard
do	75	2	15	Soft	12	12	Soft
Linseed stand oil (50 poises)	25	0	20	Hard	3	35	Hard
do	75	2	20	Soft	11	30	Soft
Dehydrated castor oil	25	0	25	Hard	3	50	Hard
do	75	2	10	Soft	10	0	Soft

Modification by the use of stabilizers — Some compounds reported to be effective in inhibiting and/or retarding polymerization in fatty[5] and mineral oils[6,7] and styrene[8] were tried in benzene-extracted kamala seed oil. The extract (40 ml.) was mixed with the stabilizer (1 per cent) and heated in an oil bath at 200°; nitrogen at the rate of 15 litres/hr. was passed into the oil throughout. The gelation time for a few typical cases are given in Table 2.

Modification by alcoholysis with lower monohydric alcohols — O'Neill *et al.*[9], from preliminary studies, concluded that kamala seed oil is, wholly or partly, a polyester of kamlolenic acid. Detailed investigations recently carried out in this laboratory have established that the oil consists mostly of polymerized glyceride molecules of different molecular weights in which some of the fatty acids have condensed with the hydroxyl group of kamlolenic acid (a triene conjugated fatty acid). This molecular constitution of kamala seed oil is perhaps responsible for its rapid gelation. The possibilities of retarding the extreme polymerization tendencies of kamala seed oil by alcoholysis with lower monohydric alcohols was, therefore, considered worth while.

Alcoholysis has been shown to be catalysed by both bases and acids[10-12]. Alkaline hydroxides, sodium alkoxides, aryl sulphonic acids, mineral acids such as hydrochloric or sulphuric acid and hydrogen chloride gas in 0·5 to 2·0 per cent concentrations have been employed for the alcoholysis of fats with lower monohydric alcohols at 30°-100°. Benzene-extracted oil samples were heated on a boiling water bath for a definite period with various lower monohydric alcohols in the presence of different catalysts, and after completion of the reaction the alcohol was distilled off under vacuum. The residual product (40 ml.) was submitted to the gelation test at 200° in an atmosphere of nitrogen. The results are given in Table 3.

The basic catalysts used formed emulsions and made the removal of the alcohol difficult due to excessive foaming. Sulphuric, phosphoric and *p*-toluene sulphonic acids did not prove effective catalysts. On the whole alcoholic hydrochloric acid (10N) proved to be the most promising catalyst and was employed in experiments with different alcohols. The Browne heat test values, gelation time at 200°, both in nitrogen and air, Lovibond colour (1 cm. cell), acid and acetyl values, and triene and diene conjugated acid contents in various modified oil samples were determined and are recorded in Table 4.

TABLE 2 — EFFECT OF STABILIZERS ON THE GELATION TIME OF KAMALA SEED OIL

(*Conc. of stabilizer*, 1%)

Stabilizer	Gelation time at 200°C. (*min.*)
Kamala seed oil (no stabilizer)	15
Diphenyl hydrazine hydrochloride	28
Salicyldoxime	27
1-Aminoanthraquinone	20
Diphenylguanidine	23
Thiodiphenylamine	24
p-Chloro-*m*-cresol	25
Toluquinone	22
Orcinol	17
o-Toluidine	20
Catechol	20
p-Nitrosodimethylaniline	15
Guaiacol	25
Phenyl α-naphthylamine	20
Pyrogallol	20
p-Toluidine	15
Phloroglucinol	20
Hydrazobenzene	17
m-Dinitrobenzene	18
Resorcinol	17
Eugenol	18

TABLE 3 — ALCOHOLYSIS OF KAMALA SEED OIL WITH MONOHYDRIC ALCOHOLS

(*Ratio of alcohol to oil*, 1 : 1·6)

No.	Monohydric alcohol	Catalyst (1% conc. on oil wt.)	Time of heating at 95°-100° *hr.*	Gelation time at 200°C. in nitrogen	
				hr.	*min.*
1	Ethyl alcohol*	No catalyst	10	(a)	—
2	do	Litharge	9·5	0	18(b)
3	do	Orthophosphoric acid	9	—	—
4	do	Calcium oxide	6	0	15
5	do	Hydrochloric acid conc.	9	4	45
6	do	*p*-Toluenesulphonic acid	10	(a)	—
7	do	Alcoholic hydrochloric acid	8	4	45
8	do	do	11	No reaction	
9	do	Sulphuric acid conc.†	4·5	0	45
10	do	Alcoholic hydrochloric acid (8N)	6	2	5
11	do	Alcoholic hydrochloric acid (6N)	9	4	45
12	do	Alcoholic hydrochloric acid (5N)	12	7	50
13	do	Alcoholic hydrochloric acid (4N)	15	8	30
14	*n*-Propyl alcohol	Alcoholic hydrochloric acid (4N)	6	6	30
15	*n*-Butyl alcohol	Alcoholic hydrochloric acid (4N)	6	6	0
16	do	Alcoholic hydrochloric acid (5N)	5	4	15
17	Iso-butyl alcohol	Alcoholic hydrochloric acid (6N)	6·5	3	0
18	Amyl alcohol	Alcoholic hydrochloric acid (5N)	6	8	0
19	do	Alcoholic hydrochloric acid (4N)	3·5	7	30

*Ratio of alcohol to oil, 1 : 2.

†0·5% conc. on wt. of oil; (a) gelled when alcohol was removed; (b) product turbid, partly gelled.

TABLE 4 — ALCOHOLYSIS OF KAMALA SEED OIL WITH MONOHYDRIC ALCOHOLS

(*Catalyst*, 10N *alcoholic HCl*, 1%)

Monohydric alcohol	Wt. of kamala oil g.	Time of heating on water bath (95°-100 C.)		Lovibond colour (1 cm. cell)		Browne heat test value		Gelation time at 200°C. in				Acid value	Acetyl value	Triene conjugated acid content %	Diene conjugated acid content %
								Nitrogen		Air					
		hr.	*min.*	Red	Yellow	*min.*	*sec.*	*hr.*	*min.*	*hr.*	*min.*				
Original oil (benzene-extracted	—	—	—	2·5	21·9	2	38	0	15	0	12	13·6	41·4	68·6	—
Ethyl alcohol	200	8	0	16·5	27·9	9	0	2	0	1	20	3·7	56·9	58·5	5·8
do	100	9	30	—	—	15	30	—	—	—	—	—	47·8	43·5	—
Propyl alcohol	100	3	35	12·8	27·9	11	30	3	25	1	50	3·8	60·8	54·9	11·3
do	200	6	30	—	—	15	15	—	—	—	—	—	65·2	44·1	—
Butyl alcohol	200	1	30	11·2	27·9	9	0	2	0	1	10	3·2	69·8	55·3	9·6
do	500	1	30	11·7	27·9	10	0	3	15	1	15	—	—	56·8	9·1
do	1000	1	30	9·0	27·9	9	5	2	10	1	10	1·0	64·8	54·3	7·4
Amyl alcohol	100	3	0	6·0	27·9	9	5	2	0	1	10	2·7	—	58·5	6·3
do	200	1	30	9·7	27·9	9	0	2	5	1	5	3·5	60·3	56·8	7·5
do	1000	1	30	8·3	27·9	9	0	2	10	1	5	1·0	61·8	54·8	8·9

Discussion

The results in Table 1 show that when about 60 per cent of linseed, linseed stand or dehydrated castor oil is mixed with kamala seed oil the Browne heat test values of the samples are about 8 min. and gelation time at 200° about 1 hr. The addition of such large amounts of these oils to kamala oil, however, makes the gel very soft. The use of these blended oils as coatings may, therefore, have limited application since they do not give the desired hard films having appreciable water and solvent resistance.

The addition of various stabilizers to kamala seed oil (Table 2) does not appreciably increase the gelation time and none of the substances used proved effective in decreasing the polymerizing tendencies of the oil.

Of the various catalysts tried for the alcoholysis of kamala seed oil (Table 3), alcoholic hydrochloric acid was most promising. Kamala seed oil is quite soluble in butyl and amyl alcohols but not so in ethyl and propyl alcohols, consequently longer periods of heating are necessary with the latter two to attain the same gelation time as with butyl or amyl alcohol.

Butylated or amylated kamala seed oil samples having Browne heat test values between 9 and 12 min. (comparable to tung oil) take 2-4 hr. for gelation in nitrogen and 1-2 hr. in air at 200°. The acetyl values of modified oils increase as expected, and the acid value decreases. The triene conjugated acid contents of the alcoholysed kamala oil also show a decrease, and nearly equivalent quantities of diene conjugated acids have been obtained (Table 4). The modified oils

TABLE 5 — CHARACTERISTICS OF ORIGINAL AND ALCOHOLYSED KAMALA SEED OIL

Characteristics	Original kamala seed oil	Butylated kamala seed oil	Amylated kamala seed oil
Sp. gr.$^{30°}$	0·9378	0·9287	0·9256
$n^{30°}$	1·5245	1·5140	1·5130
Sap. val.	190·2	185·8	186·3
Iod. val.	205·5	197·2	196·8
Unsaponifiable matter, %	2·1	1·8	2·0
Extractable matter, % (No. 17 of IS: 74-1950)	8·6	11·5	11·2
Insoluble bromide (No. 18 of IS: 74-1950)	A very small quantity of gummy matter separated	nil	nil
Mean mol. wt. (cryoscopic)	1686	840	846

are more coloured than the original oil and ordinary bleaching agents do not reduce the colour appreciably. Other properties of the butylated and amylated kamala seed oils besides those given in Table 4, alongside those of the original benzene-extracted kamala seed oil, are given in Table 5. These alcoholysed kamala seed oils are thus very similar to tung oil in many important properties. The utilization of these oils in various coating compositions and the comparison of the properties of the latter with identical materials prepared from tung oil are under investigation.

Acknowledgement

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Steam Economy in the Distillation of Absolute Alcohol

S. L. VENKITESWARAN

Development Wing, Ministry of Commerce & Industry, Government of India, New Delhi

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A new system of distillation of absolute alcohol from fermented liquids has been described wherein the heat content of the reflux vapours of the rectifying section is made use of for operating the dehydration column working on the azeotropic system. It is estimated that the steam consumption would be reduced by 10 lb. per Imperial Gallon of absolute alcohol.

The comparative steam economy which can be obtained by the vapour compression system has been discussed; and some combinations of vapour compression with the 'double effect' system, which might be adopted under special circumstances, have also been indicated.

THE problem of steam economy in the distillation of alcohol has evoked considerable interest in recent years[1-3]. Claims have been made in various patents[4] for reducing the requirements of steam in rectified spirit or absolute alcohol manufacture by employing techniques based on the principle of multiple effect evaporation. It is, however, difficult to gauge the extent to which economy has been achieved by such means.

In the conventional process, the vapours containing alcohol, with their heat content, are fed from the beer column to the rectifying column. There is, therefore, already inherent in the system a considerable amount of heat economy.

The reuse of the heat of one column in another by working the beer column and the rectifying column at different pressures, that is, adopting the principle of multiple effect evaporation, is not likely to entail any appreciable reduction in steam consumption,

except when the alcohol content of the liquor is very low, as in the case of sulphite liquor alcohol plants.

The present paper describes some modified designs in which greater economy can be achieved than has been possible so far.

The rectifier-dehydration-double effect system

In the system shown in Fig. 1(A), the heat content of the vapours from the rectifying column is made use of for dehydration. The relative pressures of the beer and the rectifying columns are kept at the same level, as in the conventional system, that is, the two columns work as a continuous set with vapours from the beer column going directly into the rectifying column. For applying the double effect technique, it is necessary to work both the columns at a pressure higher than the atmospheric pressure — 12-14 lb./sq. in. gauge at the bottom of the beer column, corresponding to 8-9 lb. gauge at the top of the rectifying column. The temperature of the spent wash would then be about 115°C. and that of the rectified spirit vapours 90°C. The temperature of the reflux vapours at the top of the rectifying column would be sufficiently high to provide effective exchange of heat for operating the dehydration column under atmospheric pressure.

In the conventional system, part of the heat content of the rectified spirit reflux vapours is recovered by preheating the feed wash in a dephlegmator-condenser [Fig. 1(B)]. This step can be avoided, with no disadvantage, by arranging direct heat exchange between the feed wash and the spent wash. The new design affords the same measure of heat economy in the rectified spirit section while making the entire heat content of the alcohol reflux vapours available for reuse in the dehydration system.

In the conventional dehydration of rectified spirit by azeotropic distillation with benzene, the steam consumption is of the order of 10-11 lb. per gallon. With the above technique, this requirement is entirely avoided and, in short, absolute alcohol can be produced with no extra consumption of steam than is required for rectified spirit.

To estimate the overall requirement of steam we may take the case of a feed containing 6 per cent alcohol by weight. The data are recorded in Table 1. Some of the requirements in the conventional and the new systems are identical, viz. purification of the alcohol, recovery of alcohol from the downflows of the entrainer recovery column and the rectifying columns, radiation losses, etc. Both systems would operate under the same reflux ratio for the rectification system, which is generally of the order of 4 to 5. The overall demand on the new system may be of the order of 24 lb. per gallon, as against a requirement of 34-35 lb. in the conventional system.

The alcohol content of rectified spirit vapour boiling at 1·5-1·6 atm. is 89·2 mol per cent as against 89·4 mol per cent at atmospheric pressure. Working the rectifying column at a higher pressure in the new design, therefore, would not materially affect the alcohol content of the final product, especially as it is dehydrated to 99·5 per cent strength. The difference in the composition of the vapour equilibrium mixture from the feed liquor containing 6 per cent alcohol by weight, due to operation under higher pressure, is also not such as to reduce the economy achieved in the new system.

There is little possibility of any increased scaling of the beer column due to the adoption of the higher working temperature on the feed plate, namely 105°-10°C. instead of 90°-95°C. in the conventional design, since the reduction in the solubility of calcium sulphate between 35° and 110°C. is not much greater than that occurring between 35° and 95°C. Even if scaling occurs, an important practical advantage is secured by avoiding the flow of feed wash through the tubes of a condenser and effecting direct heat exchange in a wide-serration plate-type heat exchanger. It would be possible to clean the heat exchanger at frequent intervals with little operational dislocation.

The working of the two main columns under pressure also results in a larger throughput per unit column diameter. Even if an extra thickness of segments is required for working the columns under 1·5 atm. pressure, the net cost would not be higher, since a smaller diameter would suffice for securing the same capacity.

Vapour compression system

Another means of effecting steam economy in alcohol distillation is the adoption of a vapour compression system, that is, generating steam at low pressure for reuse after

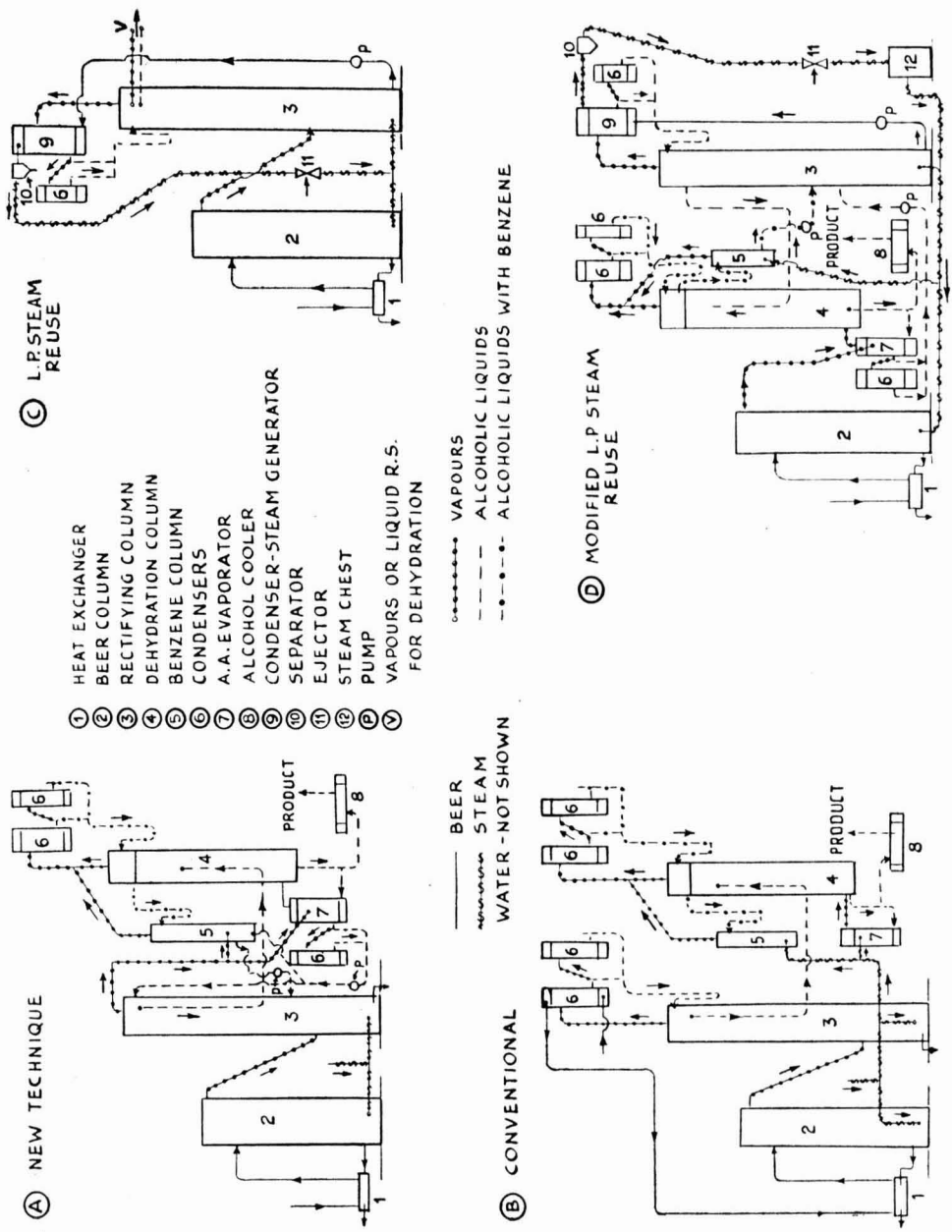

FIG. 1 — DESIGNS OF THE DIFFERENT DISTILLATION SYSTEMS

TABLE 1 — STEAM REQUIREMENT OF DIFFERENT SYSTEMS OF DISTILLATION OF ABSOLUTE ALCOHOL

[*Calculations are for* 1 *gal.* (7·9 *lb.*) *of product of* 99·5% *strength* (*by volume*) *distilled from* 135 *lb. of feed containing* 6% *alcohol by weight. Initial feed temperature taken as* 35°C. *for calculation*]

		Conventional	Rectifier-dehydration-double effect	Vapour compression system	Vapour compression with double effect between beer and dehydration columns	Vapour compression with double effect between rectifying and dehydration columns
1.	Temperature of feed (boiling point), °C.	95	105	110	95	95
2.	Temperature of spent beer from column, °C.	105	115	120	105	105
3.	Heat content of spent beer (initial), B.t.u.	16000	18300	19400	16000	16000
4.	Heat abstracted from (3) by feed wash at 35°C., B.t.u.	14600	17000	18200	14600	14600
5.	Net loss of heat in spent beer, B.t.u.	1400	1300	1200	1400	1400
6.	Alcohol content of vapour from stripping column (equilibrium comp. from 6%) volume, %	38	37	36·5	38	38
7.	Heat content of vapours leaving the stripping column-heat content of reflux vapours of rectifier, B.t.u.	15160	15960	16350	15160	15160
8.	Reflux ratio available for rectifier	*c.* 5	5	5	5	5
9.	Additional heat for dehydration column using benzene (in actual practice), B.t.u.	10000	nil	10000 (4000 only in case of glycerine or acetate process)	nil	nil
10.	Additional heat for entrainer recovery column, B.t.u.	1000	nil	1000	nil	nil
11.	Direct recovery from reflux vapours of rectifier, B.t.u.	nil (included in 4)	nil (included in 9 and 10)	12000 (10500 if glycerine or acetate process)	12000	13000 (from beer column vapours)
12.	Additional heat for alcohol recoveries from rectifier downflow and entrainer column downflow, radiation losses, etc., B.t.u.	6000	6000	6000	6000 +13000	6000 +13000
13.	Total heat requirement (excluding extra purification), B.t.u.	33560	23260	22550 (18000)	23560	22560
14.	Total heat requirement in terms of steam at 15 lb. pressure	34	24	23 (18·5 for glycerine or acetate)	24·2	23

compression[3]. In this system the feed wash can be used for the maximum recovery of heat from the spent wash directly and the heat content of the rectifying column reflux vapours can be used for the generation of low pressure steam (without its diversion to preheat the feed solution) to be reused either through a steam jet or after mechanical compression. It is more practical to generate low pressure steam from the condensers of the rectifying column than by vacuum expansion of the spent wash, since a constant boiling point (80°-90°C.) can be maintained in the former. An extra pressure of 10-15 lb. gauge would require to be maintained over the rectifier section to enable generation of low pressure steam at 85°-90°C. and secure economic working.

The design of a system for the manufacture of rectified spirit and absolute alcohol based on the use of a steam jet for the compression of low pressure steam generated in the condenser is shown in Fig. 1(C). Since steam at 150 lb. could abstract its own weight of low pressure steam at 5 lb., the system would be able to recover over three-fourths of the reflux heat as low pressure steam. The requirements of such a system are also indicated in Table 1. After accounting for exhaustion and miscellaneous losses, the net heat requirement works out to 11·8 lb./gal. of rectified spirit. When combined with benzene dehydration, the requirement would be 23 lb./gal. The saving would, therefore, be 10-12 lb. per gallon of rectified spirit or absolute alcohol as compared with the conventional system.

The vapour compression system is to be preferred when rectified spirit alone has to be manufactured as it reduces the steam consumption by 10 lb./gal. (i.e. 50 per cent). It is also possible to combine this system with the dehydration of rectified spirit by glycerine or acetates with the possibility of

much greater steam economy. Vapours of rectified spirit from the rectifying column can be directly fed into the dehydration column using glycerine or acetates, which is not possible in the case of a benzene dehydration system. As the reflux ratio in the rectifying column is quite high, there would still be enough heat in the reflux vapours to provide for the generation of 8-10 lb. of low pressure steam and its reuse. Assuming a net demand of 5 lb. steam per gallon of absolute alcohol with a dehydration system using rectified spirit vapours and glycerine, ethylene glycol or acetates, as dehydrating agents, the overall requirement would be only 18-19 lb./gal.

While the new design proposed in Fig. 1(A) appears to be more elegant and results in nearly the same degree of economy as the vapour compression system of Fig. 1(C), the latter is the method of choice for achieving steam economy in the manufacture of rectified spirit alone or in rectification coupled with dehydration by processes employing acetates, glycerine, etc.

Double effect cum compression system

To avoid working the beer column under pressure and keep only the rectifying column at a pressure, alternative arrangements are possible (Fig. 1(D)]. In this case, the beer column vapours are used as the source of heat for the dehydration column using benzene and the heat content of the rectified spirit reflux vapours is recovered by the vapour compression design using a steam jet compression system. The overall steam requirement is estimated to be 24 lb./gal. as per details in Table 1. The advantage of avoiding extra pressure on the wash or beer column may outweigh, under certain circumstances, the disadvantage of the slightly higher steam consumption than in Fig. 3. A greater steam economy would be possible by linking the rectifying column and the dehydration column in the double effect as in Fig. 1(A) and generating low pressure steam from the beer column vapours worked at the normal pressure (Table 1).

The designs discussed above would help to reduce the steam consumption in alcohol distillation to a substantial extent and in a more rational manner than some of the existing patented techniques. They can be readily applied to existing units.

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AROMATIC PLANT RESOURCES OF JAMMU & KASHMIR

K. L. HANDA, I. C. CHOPRA & S. N. SOBTI
Drug Research Laboratory, Jammu

THE essential oil industry in India was once at its peak and Indian perfumers were renowned for their skill in the art of extraction and blending of perfumes. The position has changed in recent years, the industry in India having received a setback. There has been a rapid advance of the perfumery industry in foreign countries and France and Germany are in the forefront.

Indian aromatic oils are known for their sweet and delicate aroma. Sandalwood oil, lemongrass oil and palmarosa oil are among the important essential oils produced in the country. Nearly 100 tons of sandalwood oil are annually produced in Mysore; about 750 tons of lemongrass oil in Kerala State; and 85 tons of palmarosa oil in Khandesh, Hyderabad and Madhya Pradesh[1]. These oils have a ready demand in foreign markets. Other aromatic oils of lesser commercial importance produced in India are gingergrass oil, eucalyptus oil, cinnamon oil and turpentine oil.

India imports annually essential oils worth about Rs. 75 lakhs, important among them being peppermint oil, bergamot oil, lavender oil, camphor oil and citrus oil. In addition, synthetic aromatics to the value of about Rs. 40 lakhs are imported every year.

The major factor responsible for the setback to the Indian essential oil industry is the competition from synthetic aromatics, which possess odours almost indistinguishable from natural oils. They are mixed with some bases and offered as natural indigenous *attars*. Among the other causes hampering the progress of the essential oil industry in India are: lack of necessary technical knowledge, obstinate adherence of Indian manufacturers to traditional methods of extraction, and absence of organized effort to cultivate perfume-bearing plants. At present, the raw materials are collected from wild plants, found in unsurveyed and often inaccessible places. India with its varied soils and climates offers favourable conditions for the cultivation of many types of aromatic plants. Cultivation of selected varieties on a plantation scale will provide a great fillip to the Indian essential oil industry. Suitable aromatic herbs can be grown also by farmers as cash crops or in admixture with other crops.

The State of Jammu and Kashmir with a great diversity of altitudes, climate and soils provides many favourable areas for the cultivation of aromatic plants. The altitude varies from 900 ft. in Jammu to 15,000 ft. and above in Kashmir; the temperature ranges from -40° to 120°F.; and all types of sub-tropical, temperate and alpine plants can be grown. It has been found that about 33 per cent of the plants used in the essential oil industry can be grown in the State. A tentative list of plants, excluding lower plants, growing in the State is given below:

Family	*Name of the plant*
Taxaceae	*Taxus baccata* Linn.
Pinaceae	*Abies webbiana* Lindl., *Cedrus deodara* (Roxb.) Loud., and *Picea morinda* Link
Cuperasaceae	*Thuja orientalis* Linn., *Juniper communis* Linn., and *J. macropoda* Boiss.
Magnoliaceae	*Magnolia grandiflora* Linn., and *Michaelia champaca* Linn.
Cruciferae	*Lepidium sativum* Linn., *Thalaspi arvense* Linn., *Brassica nigra* Koch., *B. juncea* Hook. f. & Thoms., *B. alba* Hook. f. & Thoms., *Raphanus sativus* Linn. var. *albus* DC., *Eruca sativa* Lam., and *Sisymbrium* spp.
Violaceae	*Viola odorata* Linn.
Hypericaceae	*Hypericum perforatum* Linn.
Theaceae	*Thea sinensis* Linn. [=*Camellia sinensis* (Linn.) Kuntze]
Malvaceae	*Althea officinalis* Linn.
Tropaeolaceae	*Tropaeolum majus* Linn.
Rutaceae	*Citrus* spp., *Zanthoxylum alatum* Roxb., *Aegle marmelos* Correa, *Murraya exotica* Linn., *M. koenigii* Spreng., *Skimmia laureola* Hook. f., and *Ruta graveolens* Linn.
Meliaceae	*Cedrela toona* Roxb.
Celastraceae	*Euonymus atropurpureus* Jacq.
Vitaceae	*Vitis vinifera* Linn.
Leguminosae	*Trifolium* spp., *Robinia pseudacacia* Linn., and *Dalbergia* spp.
Rosaceae	*Prunus amygdalus* Baill., *Rosa centifolia* Linn., *R. damascena* Mill., *Rosa* spp., *Spiraea* spp., *Pyrus malus* Linn., *Rubus* spp., and *Geum urbanum* Linn.
Caricaceae	*Carica papaya* Linn.
Lythraceae	*Lawsonia alba* Lam.
Umbelliferae	*Angelica archangelica* Linn., *A. glauca* Edgew., *Chaerophyllum villosum* Wall., *Carum carvi* Linn., *C. copticum* Benth., *Anethum graveolens* Linn., *Daucus carrota* Linn., *Bupleurum* spp., *Petroselinum sativum* Hoffm., *Ferula jaeschkeana* Vatke, *Heracleum cachemiricum* C. B. Clarke, *Sium* spp., *Carum bulbocastanum* Koch., *Foeniculum vulgare* Gaertn., *Eryngium* spp., and *Coriandrum sativum* Linn.
Caprifoliaceae	*Sambucus nigra* Linn.
Valerianaceae	*Valeriana officinalis* Linn., *V. hardwickii* Wall., and *V. wallichii* DC.
Compositae	*Saussurea lappa* C. B. Clarke, *Inula racemosa* Hook. f., *Tagetes erecta* Linn., *T. patula* Linn., *Tanacetum vulgare* Linn., *Artemisia absinthium* Linn., *A. dracunculus* Linn., *A. laciniata* Willd., *A. vulgaris* Linn., *Achillea millefolium* Linn., *Anthemis nobilis* Linn., *Matricaria chamomilla* Linn., *Senecio jacquemontianus* Benth., *Erigeron* spp., and *Blumea* spp.
Primulaceae	*Primula denticulata* Smith, *P. petiolaris* Wall., and *P. floribunda* Wall.
Oleaceae	*Jasminum dispermum* Wall., *J. humile* Linn., *J. officinale* Linn., *J. grandiflorum* Linn., and *J. sambac* Ait.
Verbenaceae	*Lantana camara* Linn.

Family	*Name of the plant*
Labiatae	*Ocimum basilicum* Linn., *O. canum* Sims., *O. sanctum* Linn., *O. gratissimum* Linn., *O. kilimandscharicum* Guerke, *Hyssopus officinalis* Linn., *Lavandula officinalis* Linn., *Origanum vulgare* Linn., *Pogostemon patchouli* Hook. f., *Mentha pulegium* Linn., *M. piperita* Linn. (White Eng., Black Eng., local), *M. arvensis* Linn., *M. arvensis* var. *piperascens* Holmes, *M. longifolia* Huds., *Salvia glutinosa* Linn., *S. officinalis* Linn., *S. moorcroftiana* Wall., *S. dumetorum* Andrz., *S. hians* Royle, *Nepeta cataria* Linn., *N. ciliaris* Benth., *N. ruderalis* Ham., *N. elliptica* Royle, *Plectranthus rugosus* Wall., *Thymus vulgaris* Linn., *T. serphyllum* Linn., and *Perilla ocimoides* Linn.
Chenopodiaceae	*Chenopodium ambrosioides* Linn., *C. blitum* Hook. f., and *C. botrys* Linn.
Polygonaceae	*Polygonum persicaria* Linn.
Lauraceae	*Cinnamomum tamala* Nees & Eberm., and *C. camphora* Nees & Eberm.
Moraceae	*Humulus lupulus* Linn.
Cannabinaceae	*Cannabis sativa* Linn.
Juglandaceae	*Juglans regia* Linn.
Urticaceae	*Pilea umbrosa* Wedd., and *P. scripta* Wedd.
Cupuliferae (Betulaceae)	*Betula utilis* D. Don (syn. *B. bhojpattra* Wall.)
Salicaceae	*Salix nigra* Marsh.
Iridaceae	*Iris kashmiriana* Baker, *I. kumaonensis* Wall., and *Crocus sativus* Linn.
Zingiberaceae	*Hedychium coronarium* Koenig, *Zingiber officinale* Rosc., *Curcuma longa* Linn., and *C. zedoaria* Rosc.
Liliaceae	*Allium sativum* Linn., *A. cepa* Linn., and *A. schoenoprasum* Linn.
Araceae	*Acorus calamus* Linn.
Cyperaceae	*Cyperus rotundus* Linn.
Graminae	*Cymbopogon nardus* (Linn.) Rendle

A systematic examination of aromatic plants, indigenous and exotic, growing in the State has been in progress in the Drug Research Laboratory for over ten years. The Council of Scientific & Industrial Research, through its Pharmaceutical & Drugs and Essential Oil Research Committees, and the Indian Council of Agricultural Research, through its Medicinal Plants Committee, have given financial assistance for this work. Viable seeds and live cuttings of several exotics required for introduction have been obtained through the courtesy of Unesco and other scientific organizations.

The results obtained so far reveal that aromatic plants growing wild in the region can be divided into three groups. The first group consists of well-known plants whose essential oil content compares well with that of plants grown in other parts of the world. The second group includes plants which do not grow elsewhere or have not been exploited as sources of essential oils. The third group consists of plants which give small yields of essential oil, but whose oil content may be increased by proper cultivation. The study has also revealed that exotics like Japanese mint, American wormseed, lavender, English dill, pennyroyal, *Mentha piperita* Linn., etc., can be successfully raised in the State. Some of them are being cultivated on a commercial scale in the drug farm of the Drug Research Laboratory.

Experimental cultivation of some of the local aromatic plants, such as *Valeriana* spp., *Inula racemosa* Hook. f. and *Saussurea lappa* C. B. Clarke (*Kuth*), and of exotics, e.g. *French basil, Pogostemon patchouli* Hook. f.,

German chamomile, *Sage* and *Parsley*, has been undertaken in the nursery of the Drug Research Laboratory. Three farms for the cultivation of aromatic and medicinal plants have been established in the State: two in Kashmir valley at Yarikah (7000 ft.) and Mansbal (5000 ft.) where dill, lavender and *Mentha piperita* are being raised on a moderately large scale, and one at Katra (2900 ft.), where Japanese mint, *Chenopodium* spp. and dill are being cultivated on a large scale. It may be possible to induce the local peasantry to take up the cultivation of aromatic plants in their spare holdings where the cultivation of food crops is not remunerative. Cultivation of aromatic plants can thus be established as a cottage industry in the State.

The results of studies on species belonging to the following genera of phanerogams are given in the present communication.

ANGIOSPERMS

Acorus Linn. (*Araceae*), *Aegle* Correa (*Rutaceae*), *Anethum* Tourn. ex Linn. (*Umbelliferae*), *Artemisia* Linn. (*Compositae*), *Carum* Rupp. ex Linn. (*Umbelliferae*), *Chaerophyllum* Linn. (*Umbelliferae*), *Chenopodium* Linn. (*Chenopodiaceae*), *Cinnamomum* Linn. (*Lauraceae*), *Elsholtzia* Willd. (*Labiatae*), *Eucalyptus* L'Herit (*Myrtaceae*), *Ferula* Tourn. ex Linn. (*Umbelliferae*), *Heracleum* Linn. (*Umbelliferae*), *Hyssopus* Linn. (*Labiatae*), *Inula* Linn. (*Compositae*), *Lavandula* Tourn. ex Linn. (*Labiatae*), *Mentha* Linn. (*Labiatae*), *Morina* Tourn. ex Linn. (*Dipsacaceae*), *Nepeta* Riv. ex Linn. (*Labiatae*), *Ocimum* Linn. (*Labiatae*), *Origanum* Tourn. ex Linn. (*Labiatae*), *Pogostemon* Desf. (*Labiatae*), *Prangos* Lindl. (*Umbelliferae*), *Salvia* Linn. (*Labiatae*), *Saussurea* DC. (*Compositae*), *Senecio* Linn. (*Compositae*), *Sium* Linn. (*Umbelliferae*), *Skimmia* Thunb. (*Rutaceae*), *Tanacetum* Tourn. ex Linn. (*Compositae*), *Thymus* Tourn. ex Linn. (*Labiatae*), *Valeriana* Tourn. ex Linn. (*Valerianaceae*), *Xanthoxylum* J. F. Gmel. (*Rutaceae*), *Zingiber* Adans. (*Zingiberaceae*).

GYMNOSPERMS

Abies Mill. (*Pinaceae*), *Cedrus* Trew (*Pinaceae*), *Juniperus* Linn. (*Pinaceae*), *Picea* Dietrich (*Pinaceae*), *Pinus* Linn. (*Pinaceae*), *Taxus* Linn. (*Taxaceae*).

In addition to the above, preliminary studies have been carried out on species belonging to the following genera; many of them, however, yield only traces of essential oils: *Achillea* Linn. (*Compositae*), *Anthemis* Mich. ex Linn. (*Compositae*), *Eryngium* Linn. (*Umbelliferae*), *Magnolia* Linn. (*Magnoliaceae*), *Macrotomia* DC. (*Boraginaceae*), *Matricaria* Linn. (*Compositae*), *Prunus* Linn. (*Rosaceae*), *Petroselinum* Hoffm. (*Umbelliferae*).

ANGIOSPERMS

Acorus calamus Linn.

Sweet flag

Vern., *Bach, vai*

A semi-aquatic perennial herb with indefinitely branched aromatic rhizomes, it is a native of Europe and North America and has been cultivated in India in damp marshy localities at altitudes of 3000-6000 ft. above the sea level. In Kashmir it grows on the borders of lakes and marshy areas. The rhizome is used in the indigenous system of medicine as emetic, nauseant, antispasmodic and carminative and in the treatment of asthma, diarrhoea and dysentery[2]. The normal oil of sweet flag is also used as a perfume and for imparting flavour to gin and some types of beers. The drug is available in sufficient quantities in the State and nearly 800-1000 maunds can be collected annually. The market price of the drug in the State is Rs. 20-25 per md. and the oil is quoted at Rs. 50-60 per lb. The oil is not in much demand in India but is reported to be used in perfumery in some of the foreign countries[3].

The rhizomes of plants were collected from Jammu and Kashmir and distilled for oil separately. The Jammu rhizomes yielded 3·1 per cent of a brownish oil possessing an agreeable odour[4]. The Kashmir rhizomes yielded 1·4 per cent of a light brown oil with camphoraceous odour. The characteristics of the oils are given in Table 1.

TABLE 1 — CHARACTERISTICS OF THE OIL FROM RHIZOMES OF *A. CALAMUS*

	Jammu oil	Kashmir oil
Sp. gr.	1·052 (17·5°)	0·9703 (19·5°)
Ref. index	1·5400 (20°)	1·5035 (18·5°)
Optical rotation	+1·2	—
Acid val.	0·5	1·8
Ester val.	2·7	10·9
Ester val. after acetylation	17·8	54·4
Solubility	Soluble in 1 vol. of 70% alcohol	Miscible with 90% alcohol

The oil has been considered to be of good quality by essential oil experts. The production of the oil on a pilot plant scale was carried out successfully and the Drug Research Laboratory has started large-scale production of the oil.

Aegle marmelos Correa

Vern., *Bael, bil*

A deciduous tree, 20-25 ft. high, indigenous to India and found all over the sub-Himalayan forests, in Bengal, Central and Southern India and in Burma. It is also cultivated at some places[5]. It is very common in the lower forests of Jammu province. The unripe fruit is regarded as an astringent, digestive, stomachic and is said to be an excellent remedy for diarrhoea and dysentery[2].

Both the fresh and dry fruits and leaves procured from Jammu were steam distilled for oil. The yield of the essential oil from the fruits was rather poor, but the leaves yielded (fresh 0·23 and dry 0·54 per cent) a pale yellow oil having sp. gr.$^{15°}$, 0·807 and $n^{20°}$, 1·448.

The oil has not found any use in cosmetics and perfumery nor is it reported to be produced in any appreciable quantities anywhere in India.

Anethum graveolens Linn.

Dill

An aromatic annual native of southern Europe, and cultivated as a commercial crop in Germany, Netherlands and to a lesser extent in England for its essential oil, it is not grown in India; an allied plant, *A. sowa* Kurz, containing 3-3·5 per cent of the essential oil with different physico-chemical properties and constituents, is cultivated as a winter crop in many parts of India. Dill oil and dill water are extensively used in medicine in the treatment of a large variety of gastro-intestinal disorders. The Indian oil derived from *A. sowa*, however, lacks carvone and is not effective in medicine. Large quantities of dill oil are, therefore, imported every year.

To raise this plant in the State[6], seeds of *A. graveolens* were obtained through the courtesy of Dr. W. O. James of Oxford University. The seeds were sown broadcast in well-prepared beds at Katra (3000 ft.) and Jammu (900 ft.) in November and at Yarikah (7000 ft.) in Kashmir province in May. At Katra and Jammu the plants germinated in about two weeks and bore flowers towards the end of February. The crop was harvested in April when the fruit started ripening. At Yarikah the plants flowered in July and the fruit ripened in September-October. The plants showed vigorous growth at all the three places.

The seed was collected from acclimatized plants and was again sown. The dry fruit collected from the acclimatized plants of all the three places on steam distillation gave a pale yellow oil. The yields and physico-chemical constants were determined and compared with those of the English, Hungarian[3] and B.P. standard oils (Table 2). The average yield of the seed was 400 lb./acre which compares favourably with the yields obtained in other countries.

Cultivation — Dill, a plant of temperate climate, can also be cultivated in the plains as a winter crop. The plant grows best on fertile loamy soil to which a dressing of farmyard manure has been applied. The plants grown from seed sown broadcast or in rows at site show more vigorous growth and yield better crop than the plants raised from seeds first sown in the nursery and later transplanted in the field. Fertilizers such as Chilian nitrate, superphosphate and lime have got an adverse effect on the growth of the plants.

TABLE 2 — YIELD AND CHARACTERISTICS OF THE OIL OF *ANETHUM GRAVEOLENS*

	Jammu (900 ft.) oil		Yarikhah (7000 ft.) oil		Katra (3000 ft.) oil	Hungarian dill seed oil	English dill seed oil	B.P. Standard
	First year	Second year	First year	Second year				
Yield, %	2·0	2·05	2·4	2·95	3·5	2·3-3·5	3-4	2·5
Sp. gr. $^{15°}$	0·8760	0·9195	—	0·9072	0·9179	0·8950-0·9150	0·8980-0·9150	0·8950-0·910
$n^{20°}$	1·473	1·486	—	1·4847	1·4852	1·484-1·491	1·483-1·488	1·481-1·492
Solubility								
Vol. 90% alcohol	1	—	—	1	1	—	0·2-0·5	1
Vol. 80% alcohol	2	—	—	5	6	4·0-9·5	7-10	8
Carvone, %*	45·9	52·0	50·6	—	62·2	40-60	48-57	43-63

*The B.P. 1953 method of assay was employed for the determination of carvone.

In cooler climates the seed is sown early in spring and the fruits mature in autumn (September-October). In plains where the summer is very hot, the seed is sown in September and the fruits mature in April when the crop is harvested. The seed should be sown in rows 1-2 ft. apart. The seedlings must be thinned out when 3 in. high so that the distance between the plants in a row varies from 6 to 15 in. A better seed crop is obtained if the plants are not too crowded. Harvesting should be done when the seeds are just beginning to ripen. In dry weather this should preferably be done early in the morning when the plants are damp with dew. The harvested material should be left in the field in cocks until dry, when the seed should be threshed out.

Observations made on the plants grown in the Kashmir State show that dill can be grown as a commercial crop. It yields 2·9-3·9 per cent of the essential oil containing 50-62 per cent carvone which is up to the official standards laid down in Pharmacopoeias. The average yield of the seeds is 400 lb./acre. The oil compares favourably in yield and quality with the oils obtained in England and Hungary. Dill has got very well acclimatized in this region and can be grown as a summer crop in the Kashmir province and as winter crop in Jammu province. Its cultivation is being extended on a large scale in the drug farms.

Angelica archangelica Linn. var. *Himalaica*

It is a stout, perennial aromatic herb, 5-10 ft. tall, commonly growing in Kashmir near the water channels at altitudes of 8000-13,000 ft., especially in the hills near Gulmarg and Gurez. It is extensively grown in Europe and U.S.A. for the essential oil, but its cultivation in India has not been taken up so far.

The herb is locally used as a flavouring agent and as a carminative. The fruit and the roots of the plant are reputed for their aromatic properties. In Europe *A. archangelica* is official and its essential oil is used as a flavouring agent in confectionery and in liquors[7]. The root oil is more important than the fruit oil because of its richer, characteristic odour and flavour. Oil of angelica is employed chiefly in liquors and high grade perfumery to which it imparts peculiar musky notes which cannot be easily distinguished from true musk odour.

TABLE 3 — YIELD AND CHARACTERISTICS OF THE OIL OF *ANGELICA ARCHANGELICA*

	Root oil		Fruit oil	
	Local	Foreign	Local	Foreign
Yield, %	0·5	—	2·8	0·7-1·5
Sp. gr.	0·921 (15°)	0·859-0·918	0·856 (20°)	0·851-0·890 (15°)
Ref. index	1·480 (15°)	1·476-1·488	1·4887 (20°)	1·486-1·489
Acid val.	4·0	Up to 5·0	0·54	Up to 2·0
Sap. val.	87·4	12·0-39·0	17·6	13-30
Ester value of the acetylation	150·8	30·0-75·0	32·1	—
Solubility (vol. 90% alcohol)	1·5	5-6	0·8	5-9

The yield and characteristics of the oil obtained by the distillation of dried roots and fruit collected from Gulmarg are given in Table 3. Values reported in literature[8] for imported oil are also given for comparison.

Nearly 400 to 500 maunds of the drug can be collected from wild sources and its cultivation can also be taken up.

A. glauca Edgew.

Vern., *Chora*

It grows plentifully in moist places at altitudes of 8000-10,000 ft. in western Himalayas and is very common in Kishanganga valley in Kashmir. Locally the root is used by the inhabitants as a spice. In the indigenous systems of medicine it is used in the treatment of dysentery and constipation and as a stimulant and cardiac tonic.

The dry roots of the plant were steam distilled and a brown yellow oil obtained; yield, 1·3 per cent; sp. gr.$^{15°}$, 1·0255; $n^{20°}$, 1·529; values reported in literature[8]: yield, 0·35-1·0 per cent; sp. gr.$^{15°}$, 0·859-0·918; $n^{20°}$, 1·477-1·488.

At present the oil has got no commercial value and is, therefore, not produced in India.

Arctium lappa Linn.

Great burdock

It is a tall, coarse, erect, biennial herb which grows in abundance in Kashmir at an altitude of about 7000 ft. The plant was recognized in the B.P.C. 1934 and is widely used in the treatment of gout. In U.S.A., a tincture prepared from the seeds is used in psoriasis, acne and prurigo. The roots are exported in fairly large quantities from Italy,

Germany and Belgium to U.S.A. and the drug is collected both from wild and cultivated sources in Europe.

The roots collected from wild plants growing in Gulmarg range yielded 0·75 per cent of an essential oil having sp. gr.$^{15°}$, 1·1315 and $n^{20°}$, 1·415.

The oil has not found any use in India and is, therefore, not manufactured.

Artemisia spp.

Many species of artemisia are found growing wild in Kashmir valley and *A. maritima* Linn. syn. *A. brevifolia* Wall. which grows wild in the drier regions of Gurez and Kishtwar is being exploited for the production of santonine. *A. absinthium* Linn. which yields the oil of wormwood grows in a state of nature all over the hills in the State. *A. dracunculus* Linn. which yields oil estragon, commonly used in high class perfumery, grows wild at higher altitudes near Banihal and in the dry region on the other side of Zojila pass. Besides these, *A. laciniata* Willd., *A. amygdalina* DC., *A. vulgaris* Linn. syn. *A. grata* Wall. and *A. parviflora* Roxb. grow wild all over the State.

A. dracunculus Linn.

A perennial herb found in western Tibet and western Himalayas at altitudes of 14,000-16,000 ft., it yields the Oil of Tarragon (estragon) of commerce which is used in preserves and in the preparation of aromatic vinegar. The flowering shoots of the plant on steam distillation gave a brown oil; yield, 0·7 per cent, sp. gr.$^{15°}$, 0·9499; $n^{20°}$, 1·5235; values reported for the foreign oil[8]: yield, 0·25-0·8 per cent; sp. gr.$^{15°}$, 0·90-0·945; $n^{20°}$, 1·502-1·514.

The other species yielded on steam distillation only traces of the essential oil. For this reason their other properties could not be studied.

The volatile oil obtained from some of the *Artemisia* species is used in soap and cosmetic industries. Although some of these species grow in a state of nature in the northern Himalayas, especially in the Jammu and Kashmir State, no attempt appears to have been made to extract oils from them. In some foreign countries *A. absinthium* and *A. dracunculus* are being extensively cultivated for the oil. Efforts are now being made to try the experimental cultivation of these and other species of artemisia in the State.

Carum carvi Linn.

Caraway

Vern., *Zira*

Caraway consists of the dried ripe fruits of *C. carvi*, an erect biennial herb indigenous to temperate regions and cultivated in northern and central Europe, chiefly in Holland, and central Asia. In India it is cultivated as a summer crop in the hills of Kashmir, Kumaon, Garhwal, etc., at altitudes of 8000-12,000 ft. In Kashmir, the plant grows in Astore, Drawa, Gurez and Skardu areas. The plant is cut when the fruit is ripe and the seeds are then separated by threshing. It is used as a stomachic and carminative. Caraway oil is also used for flavouring wines and scenting soaps in perfumery[2].

For studying the quality of caraway grown in Kashmir, caraway seeds from plants growing in Skardu (7700 ft.), Gurez (7900 ft.) and Baghbanpura (5500 ft.) were procured and the yield and properties of the oil obtained from them were studied and compared with the standards laid down in B.P.C. 1934[9] (Table 4).

TABLE 4—YIELD AND CHARACTERISTICS OF OIL OF *CARUM CARVI* FROM DIFFERENT SOURCES

	Baghbanpura	Gurez	Skardu	B.P.C. Standard
Yield, %	4·3	6·8	8·5	3·5-6·0
Sp. gr.$^{15°}$	0·9095	0·8902	0·8907	0·910-0·920
$n^{20°}$	1·491	1·486	1·485	1·485-1·492

The data in Table 4 show that the caraway growing in various parts of Kashmir gives very good yield of oil which is up to the B.P.C. Standard. Though good quality of caraway grows in Kashmir State and other parts of India, it is not used for the distillation of oil possibly because sufficient quantity of the seed is not available. The present high price of caraway (Rs. 12-15 per seer) is due to its insufficient production.

Chaerophyllum villosum Wall.

Vern., *Jangli gajar*

It is a perennial erect herb often found in the temperate regions of the Himalayas at altitudes of 5000-12,000 ft. In Kashmir the

plants grow abundantly in pine forests and the roots are eaten by the local people.

The whole flowering plant on steam distillation yielded 0·98 per cent of an essential oil having sp. gr.$^{15°}$, 0·9742 and $n^{20°}$, 1·463.

The oil of *C. sativum*, a European species, contains methyl chavicol and anethole as principal constituents and finds use in confectionery.

Chenopodium ambrosioides Linn.

Several species of Chenopodium are known to occur in India but none yields the therapeutically active oil. *C. botrys* Linn., occurring in the Himalayas from Kashmir to Sikkim, yields up to 0·18 per cent oil which does not contain ascaridole, the active constituent of the oil.

Chenopodium oil is an important anthelmintic, used for the expulsion of intestinal round-worms and dwarf tape-worms both in man and in livestock. The oil, known as wormseed oil, is obtained from the fruits of the plant *C. ambrosioides* Linn. var. *anthelminticum* A. Gray which is indigenous to the southern and eastern parts of North America. For the production of oil the plant is cultivated in a number of places in the United States but its cultivation is mainly concentrated roundabout Maryland in a radius of about twenty miles and this place is the chief centre of production of the oil in the world.

A considerable quantity of the oil of chenopodium is used in both veterinary and medical practice in this country though no reliable statistical data are available with regard to its total consumption and import. At present India has no indigenous source for this oil and the entire quantity used is imported.

In view of the importance of the drug, its experimental cultivation was started at Mungpoo in Darjeeling district and at Bangalore many years ago. The plants thrived in Mungpoo but the fruit yielded only 0·48 per cent of the oil. The ascaridole content of the oil was 46·0 per cent as against 65 per cent or more present in the American wormseed oil which is also the standard laid down in the pharmacopoeias. For these reasons the cultivation was given up and thereafter no attempt was made to reintroduce this plant with better strains of seeds or by improved methods of cultivation to get oil of standard quality[10].

After the partition of India, the areas yielding artemisia containing high percentage of santonin, an anthelmintic, went over to Pakistan and an acute shortage of santonin was felt in India. The necessity for the cultivation of artemisia and other drugs which can be used as effective anthelmintics was, therefore, felt. With this object in view the seeds of *C. ambrosioides* var. *anthelminticum* A. Gray were obtained from Turkey through the courtesy of Unesco and were sown broadcast at a number of places in Jammu and Kashmir State, i.e. Jammu (900 ft.), Katra (3000 ft.), Srinagar (5000 ft.) and Yarikah (7000 ft.). The seeds germinated in 10-15 days and bore flowers and fruits in the normal way. The growth of the plant was more vigorous at Jammu and Katra than at Srinagar or Yarikah. The stunted growth at Srinagar and Yarikah was due to excessive frost and winter. The plants harvested at the fruiting stage from Yarikah and Srinagar gave 1·16 and 0·82 per cent oil containing 8·5 and 7·2 per cent ascaridole respectively. The plants raised in Jammu and Katra were also harvested at the fruiting stage. They yielded a golden yellow oil with unpleasant odour and bitter and burning taste. The analytical results are given in Table 5 and compared with B.P.C. and I.P.L. Standards[10].

C. ambrosioides Linn. var. *anthelminticum* (Linn.) A. Gray as grown in the State has a branched stem 2-4 ft. in height with lance-shaped leaves. The lower leaves are 1-4 in. in length and the upper ones much smaller. The plant flowers in May or late in August-September according to the time of transplantation of the seedlings. The flowers are borne in close leafy spikes mixed with leaves and are followed by small green roundish fruits which contain a black seed. The seed is very small ($\frac{1}{30}$ in. in diam.) and more than

TABLE 5 — YIELD AND CHARACTERISTICS OF OIL OF *CHENOPODIUM AMBROSIOIDES*

	Jammu	Katra	B.P.C. Standard	I.P.L. Standard
Yield, %	0·75	1·15	0·6-1·0	—
Sp. gr.$^{15°}$	0·9792	0·9724	0·9550-0·9770	0·9000-0·9400*
$n^{20°}$	1·4750	1·4708*	1·474-1·470	—
Solubility (vol. 70% alcohol)	7·8	7·9	3·7	—
Ascaridole content, %	69·5	66·4	Not less than 65	Not less than 40

*At 15°C.

two million seeds weigh to a lb. The entire plant has a strong disagreeable odour due to the volatile oil present in the glandular hairs of the seeds, stems and leaves.

Cultivation — Since the experimental cultivation of the plant at Jammu and Katra gave very encouraging results, its propagation on a large scale at these places was taken up. The plant is propagated from seed which is sown in nursery beds in early spring, viz. March-April. The seed germinates in about 7-10 days and the seedlings are ready for transplantation when 4-5 in. high. After transplantation the plant requires liberal irrigation till it is well established. The seedlings should preferably be planted 3 × 1½ ft. apart. In Jammu and Katra the seed was raised in February and the seedlings were transplanted in the beginning of April. Once the plantation is established, numerous seedlings are found growing in the field which come up by seed dispersal. These can be transplanted in the month of September and October or March or April or even in the rainy season and fare well when transplanted.

The plants can also be transplanted in October-November. They mature in the following May-June for the first harvest. The second harvest can be taken in October-November depending on the weather.

The species grows well in almost any kind of soil but a good sandy loam is to be preferred. The land should be thoroughly prepared by 3 or 4 ploughings to a fine tilth. The field should be kept free of weeds by shallow cultivation. Weeding and hoeing should be done before and after the first flush of the crop is harvested. Weeding should be done at early stages of growth as it becomes impracticable when the plants have attained a bushy growth. The plant requires liberal and frequent irrigation, specially in summer months. Drainage is essential to avoid water logging.

Harvesting — The plant is harvested when the seeds have matured and have turned black. Usually the whole crop is cut with sharp sickles at 4 in. above the ground. The harvesting time of the drug is very important as the ascaridole content of the oil varies with the maturity of the plant.

The plants which were transplanted in April in Jammu started putting buds in May and flowers in June followed by fruits in July but at this stage the fruit was immature. After about one month, viz. in August, the fruit was fully matured and the seed became black. The plant was analysed for oil at various stages of development. The results are recorded in Table 6.

The first harvest was taken in August when the seeds had become black. At this time the plants were erect and there was not much branching. The whole plant was cut at about 4 in. above the ground with a sickle and dried in the sun. The yield of the fresh herb was 120 md. per acre. It contained nearly 50 per cent moisture and it took five days for the plants to dry. The yield of the dry fruit was 25-27 md. per acre. The ratio of stems and fruit in the harvest was about 50:50.

On irrigating the field the stumps put forth fresh shoots again and in about three months attained full maturity. These plants were full of seeds and mature branches were drooping. The number of leaves was lesser than at the time of the first flush. The second harvest was taken in the first week of December. The yield of the fresh herb was about 280 md. and it contained nearly 50 per cent moisture. The plants took a week to dry and then the fruit was separated by threshing. It contained stems and fruit in the ratio 40:60; the yield of the fruit was nearly 70 md. The second harvest was approximately double the first harvest.

The roots which had become very woody after the second harvest were again allowed to remain in the field and attended for weeding and watering at regular intervals. The roots sprouted in spring but the growth was stunted with very few shoots and it was uneconomic to continue with this foliage

TABLE 6 — OIL CONTENT OF *CHENOPODIUM AMBROSIOIDES* AT VARIOUS STAGES OF DEVELOPMENT

	Budding	Flowering	Fruiting (immature fruit)	Ripe fruit	
				First harvest	Second harvest
Yield {From fresh tops, %	0·66	0·58	0·58	—	—
{From dry tops, %	1·12	1·10	0·92	1·20	1·10
Sp. gr.$^{15°}$	0·884	0·925	0·946	0·968	0·985
$n^{20°}$	1·4747	1·4727	1·4745	1·4750	1·4760
Solubility (vol. 70% alcohol)	10-12	9-10	8-9	6-8	5-7
Ascaridole content, %	27·9	46·8	54·8	69·9	75·5

for harvest. The yield of the oil from the first two harvests, viz. 1·2 and 1·1 per cent respectively, was up to the standard laid down in the British Pharmacopoeia. The same was true of its quality, the ascaridole content being 69·9 and 75·5 per cent respectively (Table 6).

The oil content of the plants grown in U.S.A. has been reported to be maximum at the time of pollination[3], but the percentage of ascaridole is only 6-10 per cent at this time. Experiments were conducted to study the optimum time of harvest when the oil content and the ascaridole contents were maximum. The data in Table 6 indicate that the oil content was constant at the time of budding and flowering (1·12-1·1 per cent), but dropped at the time of fruit formation. This fall was, however, temporary and the oil content rose to 1·2 when the fruit ripened for the first harvest. It was 1·1 per cent at the time of second harvest when again the fruit was collected at the ripe stage. The ascaridole content showed a progressive increase from budding to the flowering and fruiting stage. The oil from the ripe fruit had 69·9 per cent ascaridole in the first flush and 75·5 per cent in the second flush. This is a very important observation as it indicates that only fully matured seeds from the ripe fruit have the maximum ascaridole content and are fit for harvesting.

The plant is reported to be very soil exhausting and thus requires a liberal supply of manures and fertilizers[3]. In U.S.A. it has been found that potash is very important from the point of view of ascaridole content of the oil. It has been recommended that a well-balanced phosphorus nitrogen ratio ensures proper maturity of the plant[3]. This is very important as the delayed maturity of the plant considerably lowers the ascaridole content of the oil. The addition of nitrogen, phosphorus and potash in the proportion 3 : 12 : 6 has been recommended for soils rich in potash while in other soils it may be 2 : 9 : 5. Although much data regarding the fertilizer requirement of the plant is not available in India, experiments carried out at Jammu indicate that various types of fertilizers and manures do not produce any marked effect on the yield of oil and its ascaridole content.

Distillation — The production of high grade chenopodium oil depends upon several factors, i.e. the stage of maturity and the method of distillation. Ascaridole, the anthelmintic principle of the oil, is a terpentic oxide, which is very labile and gets decomposed if the distillation is slow and is carried over a longer period. The oil obtained is of brown colour and possesses a low ascaridole content. For the distillation of oil from the local fruit a field distillation still of about 150 gal. capacity was employed. A pale yellow oil with characteristic odour was obtained, which conformed to the B.P. specifications. The method of Cocking and Hyman as given in B.P. 1953 was employed for the estimation of the ascaridole content of the oil.

The oil obtained was tested for its anthelmintic properties on earthworms according to Soloman's method[11]. It possessed activity comparable to that of the American chenopodium oil.

The plant is now well established in this area and the yields of the crop and the oil are fairly comparable to the yields obtained in U.S.A. Its cultivation in suitable areas in the State is being extended and the peasantry is being induced to take up its cultivation in their spare holdings.

Cinnamomum camphora (Linn.) Nees & Eberm.

Vern., *Kapur*

The camphor tree is not indigenous to India but has been introduced for cultivation at a number of places. The plants have been experimentally cultivated in Dehra Dun, Lucknow, Mysore, the Nilgiris, Madura, Cochin, etc. The trees thrived in these places, but the yield of the oil and camphor contents vary so widely that commercial exploitation is not economical. In the Nilgiris only this plant is being exploited for the production of camphor on a small scale. Efforts are being made to extend its cultivation.

C. tamala Nees & Eberm.

Vern., *Tejpat, dalchini*

The official cinnamon oil is obtained from the bark of *Cinnamomum zeylanicum* Breyn., a tree which is indigenous to Ceylon and southern coastal regions of western India. It possesses carminative and antiseptic properties and is used in medicine.

C. tamala grows wild in the Rajouri and Kathua forests of Jammu province. The

bark possesses a cinnamon-like odour and the leaves are used locally in place of cinnamon bark. Both the dry leaves and bark were steam distilled and a light brown oil was obtained. The bark and the leaves yielded 0·05 and 1·2 per cent oil respectively. The oil had sp. gr.$^{15°}$, 1·023 and $n^{20°}$, 1·5775; values reported for the oil from East Indies[4]: sp. gr.$^{15°}$, 1·0257 and $n^{20°}$, 1·52596.

The oil possesses aroma similar to that of the official cinnamon oil and its eugenol content is generally very high. The oil, therefore, can be used in confectionery as a substitute for cinnamon oil.

C. camphora was also raised in Jammu (800 ft.) many years ago. The tree thrived well and attained normal height. Green leaves of this tree, collected in spring, on steam distillation yielded 1·4 per cent of a pale yellow oil with camphoraceous odour having sp. gr.$^{15°}$, 0·9117 and $n^{20°}$, 1·473[12]. When the oil was, however, chilled no camphor separated. It, therefore, appears that this area is not suitable for the propagation of this tree.

Elsholtzia spp.

Many species of Elsholtzia are found growing wild in the Kashmir valley but only two species, i.e. *E. cristata* and *E. densa*, possess aromatic properties.

E. cristata Willd.

This plant is used in the indigenous medicine as an antipyretic and diuretic. It grows wild in the Kashmir valley on the banks of streams. The dry herb was steam distilled and a yellow oil, turning brown on standing, was obtained[3]; yield, 0·93 per cent; sp. gr.$^{15°}$, 1·023; $n^{20°}$, 1·529; values reported for the foreign oil[8]: yield, 2·0 per cent; sp. gr.$^{15°}$, 0·970.

The oil is reported to contain a ketone named elsholtzia ketone[8]. The oil is fragrant but is little used in perfumery or elsewhere.

E. densa Benth.

Vern., *Poodina*

It is an annual herb found commonly in Sindh division of the Kashmir valley. The whole dried herb on steam distillation yielded 0·98 per cent of a brownish oil having sp. gr.$^{15°}$, 0·9697 and $n^{20°}$, 1·4675.

Eucalyptus spp.

Eucalyptus trees are not indigenous to India but many species have been introduced from Australia in different parts of the country, notably in the Nilgiris, and oil of medicinal quality is produced by distillation on a large scale. Attempts to raise eucalyptus were also made in northern India and *E. viminalis* Labill. and *E. citriodora* Hook. were planted in Jammu many years ago. These have fared well under the local climatic conditions and have attained the normal height. The fresh leaves were steam distilled and a pale yellow oil was obtained from both the species. The yield and characteristics of both oils are recorded in Table 7 and compared with those of the Australian oils[12].

Though *E. viminalis* grows well and the yield of the oil is high, it contains a very low percentage of cineol. Its commercial exploitation, therefore, will not be advantageous.

TABLE 7 — YIELD AND CHARACTERISTICS OF EUCALYPTUS OIL

	Eucalyptus viminalis		*Eucalyptus citriodora*	
	Local oil	Australian oil	Local oil	Australian oil
Yield, %	1·4	0·35-0·74	0·83	0·596
Sp. gr.$^{15°}$	0·9007	0·9044-0·9162	0·9207	0·864
n	1·476 (20°)	1·4855	1·4924 (30°)	1·4651-1·4678
Acid val.	0·6	9·5	—	—
Sap. val.	—	—	8·5	7·5
Cineol, %	17	50	—	—
Solubility				
Vol. 90% alcohol	All vols.	—	1-3	—
Vol. 80% alcohol	2-3	1	7-10	—
Vol. 70% alcohol	—	—	—	1-5

Ferula spp.

F. foetida Regel, the plant which yields oil of asafoetida and gum resin asafoetida, does not grow in the State but a number of species of Ferula, e.g. *Ferula narthex* Boiss., *F. thomsoni* C. B. Clarke and *F. jaeschkeana* Vatke, grow wild in the drier regions.

F. jaeschkeana Vatke

Vern., *Hing*

It is an erect perennial herb growing commonly on the slopes of mountains at altitudes of 6000-12,000 ft. It is reported to be common in Baluchistan[7]. In Kashmir it

grows commonly in the Gulmarg, Verinag, Gurez and Kamri ranges. The gum resin (asafoetida) is used locally as a condiment and as a household remedy in the treatment of flatulence[7,10].

The dried roots and mature dry fruits of the plants collected from Verinag and Gulmarg ranges on distillation yielded 1·2 and 2·8 per cent of essential oils having sp. gr.$^{15°}$, 1·149 and 0·857 and $n^{20°}$, 1·453 and 1·464 respectively.

In view of the very limited use of the oil for flavouring purposes its exploitation is not advantageous.

Heracleum cachemiricum C. B. Clarke

This plant is commonly found growing wild in the mountainous regions of Kashmir, especially in the Gurez valley, up to an altitude of 11,000 ft. The fruit and leaves possess aromatic properties.

The dry fruits collected in September on steam distillation yielded 0·8 per cent of a brownish oil having sp. gr.$^{15°}$, 1·0304; $n^{20°}$, 1·504[4].

The oil is not reported to be used either in confectionery or in perfumery. Since the plant gives a high yield (0·8 per cent) of the oil and it grows abundantly in this area in a state of nature, further studies are being carried out.

Hyssopus officinalis Linn.

Vern., *Zufah-yabis*

Hyssopus oil is mainly distilled from *Hyssopus officinalis* which is indigenous to the Mediterranean countries and Central Asia. The plant grows in Baluchistan and in the Himalayas at altitudes of 8000-11,000 ft. It is not indigenous to Kashmir valley but has been successfully cultivated in the forest nursery at Baramula.

The leaves of the plant are used as a stimulant, stomachic, expectorant, diaphoretic and emmenagogue[2]. Hyssopus oil is also much esteemed for flavouring the French liquors. Hyssopus is planted in the same way as lavender. Slips are grown in nurseries during the fall and in the following spring are transplanted in the field. The first harvest is obtained after two years of planting and the life span of a Hyssopus field is 6-7 years.

The fresh and dry herbs procured from the nursery on steam distillation gave a brownish yellow oil with aromatic odour[3]. The yield of the oil from the fresh and dry herbs was 0·36 and 0·7 per cent respectively; sp. gr.$^{15°}$, 0·9375; $n^{20°}$, 1·4778; values reported for the foreign oil[8]: yield, fresh herb, 0·08-0·29; dry herb, 0·3-0·9 per cent; sp. gr.$^{15°}$, 0·927-0·945; $n^{20°}$, 1·473-1·486.

The yield and physical constants of the oil compare favourably with those of the foreign oil. It is clear from the data for yield and physical constants that the plant has adapted itself well in the Kashmir valley and can be commercially and economically exploited.

Inula racemosa Hook. f.

Vern., *Poshkar*

It is a moisture-loving plant which grows in Kashmir at altitudes of 7000-9000 ft. and is commonly met with in Gurez and Gulmarg areas.

The root is used in the indigenous system of medicine for its expectorant, diaphoretic and emmenagogue properties. It possesses a mild aromatic odour and is sometimes used to adulterate *Saussurea lappa* (*Kuth*) root which brings a much higher price in the market. It is collected early in autumn when the seeds mature. On steam distillation the dry root gave 0·38 per cent essential oil which solidified on standing[13]. The drug and the oil are extensively used in medicine.

Lavandula officinalis Chaix

Lavender

The plant is a native of southern Europe and grows in the Mediterranean region extending into western Africa. It is extensively cultivated in England and the United States of America for oil. Lavender oil is a constituent of a large number of pharmaceutical preparations and is extensively used in perfumery for preparing toilet perfumes and lavender water. It is not indigenous to India and the entire quantity of lavender (*c.* 1238 gal.) valued at more than a lakh of rupees is annually imported.

Experimental cultivation of the plant, though unsuccessful previously in various botanical gardens, has yielded encouraging

results in the nurseries at Baramula, Chattarnar, Yarikah and Srinagar at altitude of 5000 ft. The flower heads of the plant from these places yielded 2-4 per cent oil (dry flowers); sp. gr.$^{15°}$, 0·919; linalyl acetate content, 24·8 per cent; values reported for the English oil[13]: yield (fresh flowers), 0·8-1·7 per cent; sp. gr., 0·882-0·90; linalyl acetate content, 7-14 per cent.

The plant thrives best in light dry soils well supplied with lime, but can be grown in almost any well-drained loam. On low and wet land it does not grow at all. It can be grown from seeds but is more readily propagated from stem or root cuttings which are set in well-prepared soil, 12-15 in. apart in rows spaced 2 ft. apart. The plant requires frequent and thorough irrigation. The flowering tops are harvested when in full bloom and, if used for the production of oil, are distilled fresh without drying.

The experimental cultivation of the plant in Kashmir has yielded promising results and its propagation on large scale in suitable areas will be taken up in the near future. It should also do well in the temperate climate of other hilly areas in various parts of the country.

Mentha spp.

Peppermint oil is one of the most commonly used essential oils. About 2·25 million lb. of this oil are produced annually throughout the world for medicinal and flavouring purposes. It forms an ingredient of tooth pastes, dental creams, mouth washes, cough drops, chewing gums, tobacco, etc. It is also used in confectionery, alcoholic liquors and medicinal preparations. It is an excellent carminative, gastric stimulant, antiseptic and preservative. The chief constituent of the oil is menthol which is isolated from it. The entire quantity of both peppermint oil and menthol to the value of more than 10-15 lakhs of rupees which is consumed annually in India is mostly imported from U.S.A., China and Japan. There are hardly any indigenous sources from which it can be prepared. The Indian species of Mentha yield oil which has very little menthol.

Oil of peppermint produced in U.K. is obtained by steam distillation of the flowering herb of *M. piperita* Linn. This plant grows wild in European countries and is now being cultivated in America, Russia and many other parts of the world. Japanese and Chinese peppermint oils are obtained from *M. arvensis* Linn. subsp. Briq. var. *piperascens* Holmes. The plant is extensively cultivated in Japan and yields the bulk supply of menthol and Japanese peppermint oil which are exported to all parts of the world.

Before World War II, about 70 per cent of the world's total supply of menthol and dementholized mint oil came from Japan, the balance being supplied by China and other countries. There are a number of species of Mentha which either grow in a state of nature or are cultivated in India but none of these yields the peppermint oil of medicinal value. The necessity for the introduction and cultivation of *M. piperita* for preparing peppermint oil was felt in India as early as 1881 and the plant was raised in the Nilgiris and Mysore. Recently it has also been raised at the Forest Research Institute, Dehra Dun, but the oil did not come up to the official standard.

M. arvensis Linn.

Vern., *Pudina*

The plant is found growing in a state of nature in the Kashmir valley at altitudes of 5000-10,000 ft. and commonly grows in the Gulmarg area. It is used locally as a stimulant and carminative. The dried leaves and flowering tops on steam distillation gave a pale brown essential oil; yield, 0·45 per cent; sp. gr.$^{15°}$, 0·9161; $n^{20°}$, 1·474; values reported[14] for the Japanese oil: *natural oil*, yield, 1·07-1·6 per cent; sp. gr.$^{15°}$, 0·90-0·912; $n^{20°}$, 1·460-1·4635; *dementholized oil*, yield, 1·07-1·6 per cent; sp. gr.$^{15°}$, 0·894-0·906; $n^{20°}$, 1·459-1·465.

The oil obtained from these plants does not come up to the official standards of the pharmacopoeias and no menthol could be separated from the oil on chilling[13].

M. arvensis Linn. subsp. *haplocalyx* Briq. var. *piperascens* Holmes

Japanese mint

In order to introduce Japanese mint in the State a few live rooted suckers were obtained from Japan through the courtesy of Unesco and planted in nursery beds at Jammu

(900 ft.), Katra (3000 ft.) and Srinagar (5000 ft.). In Jammu and Katra the suckers were set for propagation late in March and in Srinagar in early May. The plants showed very vigorous growth but were rather stunted and did not bear flowers till late September[15]. The plants harvested at the flowering stage were steam distilled and the oil obtained was analysed. The yield of the oil from plants raised in Srinagar was low and determination of menthol and menthyl acetate in it could not be carried out. The results of analyses of the oil obtained from the other nurseries are given in Table 8 and compared with those for the Japanese and Brazilian oils[3].

Japanese mint introduced from Japan and under cultivation in the State has the following characteristics: Stem erect, short, 1·2 ft., branched, glabrate or with short dense black hair; leaves 1-2 in., shortly petioled, or sessile, oblong-ovate, or lanceolate, obtusely or acutely serrate, the upper similar and large covered with minute hairs, those on the ventral side of mid-vein prominent; flowers in axillary distant nodes, none at the top. Bracts acute, shorter than the flowers, calyx hairy, campanulate, throat naked, teeth triangular or lanceolate, fruiting calyx scarcely enlarged, pink, corolla white or creamy, hairy without and within, tube as long as the calyx or slightly exserted, lobes spreading, stamens exserted, style far exserted; nutlets smooth and dry.

Cultivation — As the plants raised in Jammu and Katra nurseries fared well and gave good yield of the oil containing adequate quantity of menthol, the propagation of the plant was extended in these localities in areas which could be liberally irrigated. For planting, rooted suckers were taken from old but vigorous plants. After ploughing and planking the field, the young juicy suckers cut into three or four pieces were planted in rows about 2-3 ft. apart. The cuttings were placed end to end at a depth of about 2 in. The rooted suckers were planted in early spring in Jammu and Katra. It was also observed that rooted suckers would do well when planted in Jammu and Katra during the rainy months of July and August or in October-November. The rooted suckers when planted in March in Jammu under irrigated conditions propagated well and flowered in July when the first flush of the crop could be harvested. The yield was 200-300 md. per acre of green herb, which contained 45 per cent stems and 50 per cent of leaves. The herb contained 75 per cent moisture.

The field was irrigated and weeded at regular intervals when in about two months the plants showed very vigorous growth. The plant again flowered in October when the second flush could be harvested and the yield was about 100 md. of green herb per acre. It showed nearly 75-80 per cent moisture and contained 30 per cent of stems. The total yield of the fresh herb works out to about 175-250 md. and of dry herb about 50-75 md. per acre. The stems form less than half of the total plant.

The rooted suckers were also planted in the rainy season (August); these plants blossomed in the last week of October when they were ready for the first harvest. The second harvest was, however, very poor due to cold spell of winter and the plant remained dormant for the winter. In spring, the plants again put up very vigorous growth like those which were planted in March-April of the previous year. The fields from which more than one crop were taken in the previous years were again kept under observation and irrigated at regular intervals. The plants sprouted in March and flowered in July when first crop of the year was taken. The second crop was taken in October. The yield and quality of the crop and yields of

TABLE 8 — YIELD AND CHARACTERISTICS OF OILS OF *MENTHA ARVENSIS* VAR. *PIPERASCENS*

	Plants raised in Jammu (900 ft.)	Plants raised in Katra (3000 ft.)	Plants raised in Srinagar (5000 ft.)	Japanese natural oil	Brazilian nautral oil
Yield, %	2·1	2·4	1·6	1·07-1·8	—
Sp. gr.	0·92 (15°)	0·9045 (31·5°)	0·9609 (15°)	0·895-0·902 (15°)	0·876-0·898 (25°)
$n^{20°}$	1·4568	1·4580	1·4553	1·4600-1·4635	1·4577-1·4695
Solubility (vol. 70% alcohol)	7·8	3	—	2·3	—
Congealing point	14°-15°	15°-17°	—	17°-28°	—
Acid value	0·64	0·57	—	2·0	—
Menthyl acetate, %	13·7	11·7	—	3·6	1·5-18·9
Menthol, %	70·1	77·6	—	69·91	65·2-88·9

the oil were practically the same as in the first year (Table 9).

Harvesting — The harvesting of *M. arvensis* requires special care because improper harvesting considerably lowers the quality of the oil. Harvesting is done when the plants are in full bloom. According to the climatic conditions prevailing in the locality, one or two flushes of the crop should be harvested in July-August and October when the plant is in blossom. It is advisable to cut the crop with a sickle in the morning on a bright sunny day after the dew has disappeared. The cut plants are tied into small bundles and hung in open air or under sheds and dried. The number of days required for drying vary in summer and autumn, the best state of dryness being when the weight of the fresh plant is reduced to one-third or one-fourth but the plant is not completely crisp. Care is taken to prevent the leaves from falling off during the process. Sometimes the plant is dried in the sun but this is considered unsatisfactory because of the loss of oil due to resinification and evaporation. The bundles must not be allowed to ferment. The plant gives good crop in the second and third year and then the yield of the oil diminishes. It is economical to uproot the whole crop in the fourth year and replant afresh after rotation.

The plant was raised at Jammu (900 ft.) and Panthal (2900 ft.). The yields of the green and dry crop and the oil are given in Table 10. The yields obtained in foreign countries[3] are also included in Table 10 for comparison.

Soil, irrigation and climatic requirements — The plant in its natural habitat fares well in a sandy or loamy soil rich in humus. A well-drained fertile soil and little rain during the harvesting period are considered ideal conditions for its cultivation. If planted on good sandy soil with rains in spring and ample sunshine in summer, the plant gives high menthol yield. The plants have been introduced on loamy soils of Jammu and Katra.

For easy and quick propagation of suckers, six deep ploughings with common plough and weeding out of roots and bushes from the soil are necessary. The plants can stand a lot of water and, therefore, liberal irrigation after planting and harvesting is beneficial for the propagation and healthy growth of the plant. Over-draining of water should be avoided.

Manuring and interculture — Japanese mint when planted in rows in the first year is known as ' row mint ' and requires weeding and hoeing at least twice for healthy growth. In the second year the plant propagates so vigorously by its suckers that it becomes a united field without any distinction of rows.

TABLE 9 — YIELD AND CHARACTERISTICS OF OIL OBTAINED FROM *M. ARVENSIS* VAR. *PIPERASCENS* HARVESTED AT DIFFERENT TIMES

Harvesting time	Yield of oil from whole fresh plants %	Yield of oil from leaves and flowering tops %	Characteristics of oil						
			Sp. gr.$^{15°}$	$n^{20°}$	Solubility (vol. 70% alcohol)	Congealing point °C.	Acid val.	Menthyl acetate %	Free menthol %
First year in July (first crop)	0·85	2·3	0·9120	1·456	5-6	17-18	—	8·8	77·6
First year in October (second crop)	0·86	2·5	0·9120	1·459	2-3	17-18	0·41	—	80·8
Second year in July (first crop)	1·10	2·4	0·9480	1·480	2-3	16-17	—	10·3	76·3
Second year in October (second crop)	1·04	2·4	0·9120	1·458	2-3	15-16	0·28	10·9	77·1

TABLE 10 — YIELD AND OIL CONTENT OF *M. ARVENSIS* VAR. *PIPERASCENS*

Source	Yield/acre				Oil content			Yield of oil (whole herb basis) *lb.*
	Green herb *md.*	Dry herb *md.*	Stems *md.*	Leaves *md.*	Leaves %	Stem %	Whole herb %	
Jammu	177	50·2	33·7	16·5	28·4	19·0	9·4	56·18
Panthal	78·0	28·75	11·25	17·50	2·56	0·523	1·745	40·71
Literature values								
(i) Poor soil conditions	133	34	22	12	3·482	0·234	1·30	34·8
(ii) Fair soil conditions	186	56	37	19	3·378	0·181	1·28	57·7
(iii) Good soil conditions	250	75	50	25	4·224	0·288	1·60	96·4

It is then known as ' meadow mint '. For purposes of aerating the soil, interculture by means of a cultivator or ploughing the field after harvesting the crop is necessary.

Mentha responds favourably to organic manures, e.g. farmyard manure or compost, which should be applied at the rate of about 12 tons per acre before planting. Green manuring can also be done before the mint is planted. Subsequent dressings of a mixture of equal parts of ammonium sulphate, superphosphate and potassium sulphate give good yields of the crop. The requirement of the fertilizers of course depends on the nature of the soil. Superphosphate mixed with organic manure has been reported to give good results[3].

For purposes of rotation, if green manuring is not possible, some other leguminous crop may be sown, preferably *Cassia angustifolia* Vahl (senna) which yields the drug senna leaf and pod of medicinal value. Growing of beans has also been recommended[8]. These rotations tend to increase the percentage of oil and menthol content in the plant.

Distillation — About 2·0 per cent yield of the oil was obtained by distilling the dry leaves of the herb in an ordinary field distillation still. The leaves from the dry herb were removed by threshing; stems constitute 40-50 per cent of the herb and contain only traces of the oil. The dried material yielded oil more readily and the distillation was complete within 1½-2 hr., while the fresh material took 3-4 hr. for complete recovery of the oil. Distillation of the leaves alone after separation from the shoots is easier, quicker and economical.

The distilled oil contained a lot of suspended dust and mucilagenous matter which was separated. The golden yellow oil having characteristic peppermint smell and slightly bitter taste was obtained and contained 70-80 per cent menthol. In a field distillation still (capacity 150 gal.) about 1½ md. of dry leaves can be distilled at a time.

Menthol separates in crystalline form on cooling the oil to a low temperature. By repeated chilling and filtration nearly 51-55·6 per cent of the menthol present in the oil can be separated. The separated menthol is spread in trays and dried at ordinary temperature when traces of the adhering oil are also removed.

The peppermint oil of medicinal value contains 45-50 per cent menthol. The dementholized oil can be used as peppermint oil. The natural oil obtained yielded on an average 40-50 per cent menthol and 50-60 per cent dementholized oil. The characteristic of oil along with those for the Japanese[8] and Brazilian[16] oils are given in Table 11.

TABLE 11 — CHARACTERISTICS OF PEPPERMINT OIL FROM DIFFERENT SOURCES

	Local oil	Japanese oil	Brazilian oil	B.P. Standard
Sp. gr.	0·904 (20°)	0·895-0·907 (15°)	0·894 (15°)	0·897-0·910 (20°)
$n^{20°}$	1·457	1·459-1·463	1·460	1·460-1·470
Solubility (vol. 70% alcohol)	3-4	2·5-4	3·5	4
Acid val.	0·56	2·0	—	—
Menthyl acetate content, %	24·9	4·15	20·9	4·9
Menthol content, %	46·3	46-63	54·5	Not less than 45
Menthone content, %	13·4	26·8	—	—

Menthol from the locally raised Japanese plants had well-defined crystals (m.p. 41°) and gave a residue (0·03 per cent) when heated at 105°. It compares well with the standard official product. After the separation of menthol the dementholized oil contained menthyl acetate, 24·4; free menthol, 44·8; menthone, 24·6 and hydrocarbons, 6·2 per cent. Among the hydrocarbons l-ʟ-pinene, ʟ-limonene, caryophyllene, cadinene and an unidentifiable sesquiterpene were found to be present[17].

Thus the Japanese mint has got very well acclimatized in the Jammu area and yields nearly 2 per cent oil containing 70-80 per cent of menthol. The yields of peppermint oil and menthol from the natural oil are very encouraging and the yield of the crop under the climatic conditions prevailing in Jammu also compares well with the yields obtained in Japan and Brazil. Large-scale cultivation of this plant in drug farms has been undertaken. Demonstration centres are being opened and efforts are being made to induce the peasantry to take up its cultivation in their spare holdings.

M. piperita Linn.

Vern., *Podina*

This plant is cultivated on an extensive scale in America, Germany, England, etc. It was experimentally cultivated in the Nilgiris in 1881 and recently the plant has

TABLE 12 — YIELD AND CHARACTERISTICS OF OIL OF *M. PIPERITA* LINN.

	LOCAL OIL	ENGLISH OIL
Yield		
Yarikah plants (7000 ft.)	0·7-1·0	0·5
Baramula plants (5000 ft.)	0·7	0·5
Sp. gr.	0·9046 (27°)	0·901-0·912 (15°)
n	1·4632 (27°)	1·460-1·463 (20°)
Optical rotation	−30°18′	−20°0′ to −33°0′
Acid val.	1·4	Up to 1·6
Methyl acetate content, %	20·01	3-21
Free menthol content, %	55·8	48·5-68 (total menthol content)
Solubility (vol. 70% alcohol)	2·7	2·5-3·5
Menthyl acetate content, %	20·01	3-21
Free menthol content, %	55·8	48·5-68 (total menthol content)
Solubility (vol. 70% alcohol)	2·7	2·5-3·5

been raised in Mysore and at the Forest Research Institute, Dehra Dun. Rooted suckers of this plant procured through the Punjab Agricultural College, Lyalpur, were propagated at Baramula (5000 ft.), Srinagar (5000 ft.) and at Yarikah (7000 ft.) in spring and these reacted favourably to the soil conditions at all these places. The flowering tops and leaves collected from these nurseries in August were steam distilled. The yield and characteristics of the oil are given in Table 12.

Though *M. piperita* raised in the State has yielded oil conforming to the standard specifications, the yields of the crop and oil and the prevailing market prices are such that it will not be a paying proposition to propagate this plant on a large scale. For this reason for the time being its cultivation is not being further extended. The oil obtained from the plants raised in the Kashmir valley contained menthyl acetate, 20·01; free menthol, 55·8; menthone, 9·11 and hydrocarbons, 15·07 per cent. Among the hydrocarbons L-α-pinene, limonene, cadinene and some unidentifiable terpenes were found to be present[18].

M. pulegium Linn.

This plant is indigenous to most parts of Europe, United Kingdom, U.S.A. and other places. Pennyroyal oil, yielded by this species, is used in cosmetic and soap industries. The principal constituent of the oil is pulgone, a ketone which can be changed to menthone and menthol. The plant is not indigenous to Kashmir but has been successfully raised in Baramula (5000 ft.). The yield of the oil from the local plants was 2-3 per cent; sp. gr.$^{15°}$, 0·8925; $n^{20°}$, 1·483; values for the oil from the Mediterranean region[14]: yield, 0·93-0·95 per cent; $n^{20°}$, 1·485-1·486.

The cultivation of *M. pulegium* is not being extended on a large scale because its oil has rather a limited demand in India.

M. sylvestris Linn.

Vern., *Jangli pudina*

It is found growing in a state of nature on the sides of water streams and other damp localities in Kashmir. The plant is used in the indigenous system of medicine as a carminative, antiseptic and stimulant. The dried leaves and flowering tops of the plant on steam distillation gave a pale yellow oil with a minty odour[3]; yield, 1·2 per cent; sp. gr.$^{15°}$, 0·985; $n^{20°}$, 1·471; ester val., 65·8; values reported for Cyprus oil[8]: yield, 0·9 per cent; sp. gr.$^{15°}$, 0·9852; $n^{20°}$, 1·4685; ester val., 20·9.

The oil possesses minty odour and can, therefore, be used as a substitute for the imported peppermint oil for flavouring confectionery.

M. viridis Linn.

Vern., *Pudina*

It is extensively cultivated in India as a garden plant. The green leaves are used in the preparation of *chutneys* and other household carminative preparations. The fresh leaves and flowering tops on steam distillation gave a pale yellow oil. The yield and characteristics of the oil are given in Table 13. The corresponding values for the American and German oils are also given for comparison[12].

TABLE 13 — YIELD AND CHARACTERISTICS OF OIL OF *M. VIRIDIS*

	LOCAL OIL	AMERICAN AND GERMAN OILS
Yield, %	0·25	0·92-0·94
Sp. gr.$^{18°}$	0·94	1·482-1·489
n	0·539 (at 18°)	—
Solubility (vol. 80% alcohol)	1·3	1·15
Acid val.	0·3	Up to 2
Ester val.	11·4	18-36
Carvone content, %	20	42-60

The oil has practically no commercial importance and is, therefore, not produced anywhere in India.

Morina longifolia Wall.

It is a tall spinous herb bearing pink flowers and is distributed in the temperate and alpine regions of the Himalayas at altitudes of 9000-14,000 ft. In Kashmir the plant grows wild at Khilanmarg, in the Sindh valley and Pir Panjal range. The roots of some other species of Morina have been reported to be used by Buddhists in Lahoul as an incense[19].

The plant possesses strong aromatic properties. The whole plant on steam distillation yielded 0·34 per cent of an essential oil having sp. gr.$^{15°}$, 0·9525 and $n^{20°}$, 1·4775.

No record of its use in perfumery has been reported except as an incense. The plant as such is used in preparing *dhup, agarbatties,* etc.

Nepeta spp.

The oil of catanip is obtained from *N. cataria* Linn. a plant which is indigenous to Asia Minor and southern Europe. It is not indigenous to either Kashmir State or any part of India nor is it being cultivated. A number of species of Nepeta, however, grow wild in Kashmir. These species are *N. ciliaris* Benth., *N. ruderalis* Hook., *N. elliptica* Royle ex Benth. and *N. erecta* Benth. The oil of catanip is extensively used as an efficient lure for the trapping of wild animals.

N. ciliaris Benth.

Vern., *Zufa yabis*

N. ciliaris Benth. commonly grows at altitudes of 6000-7000 ft. and a *sharbat* (syrup) made from its leaves and seeds is useful in coughs and fevers. The dried leaves and flowering tops on steam distillation yielded 0·543 per cent of an essential oil having sp. gr.$^{20°}$, 1·061 and $n^{20°}$, 1·499.

N. ruderalis Hook. [=*N. hindostana* (Roth) Haines]

Vern., *Billilotan, badranghoga*

It grows in the Kashmir valley and is used in the treatment of fever and gonorrhoea. The dried leaves and flowering tops on steam distillation gave only traces of the oil. The dried leaves and flowering tops of *N. erecta* also yielded only traces of oil on steam distillation. Attempts are being made to procure the seeds of *N. cataria* for propagation in this area.

Ocimum spp.

Several species of Ocimum grow wild and are also cultivated in India. *O. canum* Sims grows wild in the areas neighbouring the lower hills of Jammu while *O. basilicum* Linn. is cultivated as a garden plant throughout the Jammu province. Recently *O. kilimandscharicum* Guerke has been introduced in Jammu.

O. basilicum Linn.

Vern., *Niazboz*

It is an erect herbaceous plant growing wild in the Punjab. It is also cultivated in gardens throughout the greater part of India. The leaves are extensively used in the indigenous medicine as a carminative, stimulant, demulcent and febrifuge. The oil of basil, yielded by the species, does not find much use in perfumery but it is employed quite extensively as a flavouring agent in confectionery, baked goods, condimentary products, etc. For scenting soaps the low grade oil is generally employed. The oil also possesses insecticidal action against house-flies and mosquitoes.

The plant flourishes in ordinary loamy soil and requires frequent irrigation. It gives two harvests in a year. Harvesting is done at the time of flowering. The leaves and flowering tops on steam distillation yielded 0·53 per cent (fresh leaves) and 2·3 per cent (dry leaves) of an oil having sp. gr.$^{15°}$, 0·964; $n^{20°}$, 1·505; acid val., 0·7; ester val., 21·9; linalyl acetate, 3·6 per cent and alcohol content with reference to linalool, 17·7 per cent[12].

The seeds of *O. basilicum* procured from France through the courtesy of Unesco were sown in Jammu (900 ft.) in spring. The plants came up very well and bore flowers in July, when harvesting was done. The whole plant on steam distillation gave a pale yellow oil. The yield and characteristics of the oil and the corresponding values reported in literature[3] are given in Table 14.

Since basil oil has very limited use in India it is not being raised on an extensive scale.

TABLE 14 — YIELD AND CHARACTERISTICS OF BASIL OIL

	Local oil	Foreign oil
Yield from fresh herb, %	0·44	—
Sp. gr.	0·870 (30°)	0·895-0·9168 (15°)
n	1·4625 (30°)	1·477-1·488 (20°)
Acid val.	0·24	0·7-3·5
Sap. val.	9·5	3·5-9·85
Sap. val. after acetylation	232·9	—
Alcohol (calculated as linalool)	69·39	34·5-39·66

O. canum Sims (*O. americanum* Linn.)

Camphor basil

Vern., *Kali-tulsi*

It is an erect and branched herbaceous plant growing all over India. It is extensively used in the indigenous system of medicine in the treatment of fevers and skin diseases. The oil can be used in perfumes and cosmetics, especially in scenting soaps. The oil has very limited demand at present. The leaves and flowering tops of the plants growing wild in Jammu, on steam distillation, gave a sweet smelling oil. The yield and characteristics of the oil and the corresponding values for a sample of African oil are given in Table 15.

As the oil has very limited demand no attempt has been made to distil it on large scale.

TABLE 15 — YIELD AND CHARACTERISTICS OF OIL FROM *O. CANUM*

	Local oil	African oil
Yield of oil from fresh leaves, %	0·5	0·65
Yield of oil from dry leaves, %	2·1	1·0330
Sp. gr.$^{15°}$	0·9105	—
$n^{20°}$	1·4908	—
Solubility		
Vol. 70% alcohol	—	2½
Vol. 80% alcohol	2	All vols.
Acid val.	2·7	—
Ester val.	15·3	30·1

O. kilimandscharicum Guerke

Camphor is used in several chemical industries such as celluloid, smokeless gunpowder, etc. It is also used in medicine. India has always been deficient in camphor and large quantities have been imported, there being practically no indigenous source of this commodity. Although efforts have been made to grow *Cinnamomum camphora* Nees & Eberm. and to extract camphor therefrom, these plants have not flourished in this country. Manufacture of synthetic camphor is also not possible since the main supply of Indian turpentine oil is derived from Chir Pine (*Pinus longifolia* Roxb.) which is poor in its pinene content, the basic raw material for the synthesis of camphor.

O. kilimandscharicum was introduced into India during World War II when acute shortage of camphor was experienced. It is a herb indigenous to Kenya. Its oil was found to contain a commercially workable percentage of camphor.

The cultivation of this plant has been attempted in different parts of India. Encouraging results were reported from Uttar Pradesh, Bombay, Bengal and Mysore and its cultivation on a large scale, especially in U.P., has been undertaken. Attempts to raise this plant from seeds were also made in Jammu (900 ft.) and Srinagar (5000 ft.) about three years ago. In Jammu the plants thrived well and yielded 4·3 per cent oil, but no camphor could be obtained from it on chilling. The seeds also germinated in Srinagar but the plants did not put up good vegetative growth. Efforts were again made to propagate this plant in Jammu and seedlings were procured through the courtesy of the Forest Silviculturist, East Punjab, in August 1954 and planted in Jammu. The plants attained normal height and bore flowers in about three months. The whole plant was collected and studied for its oil and camphor contents (Table 16).

Dried Ocimum leaves from the plants raised in the State yielded 2·27 per cent oil containing 70·5 per cent camphor which separated on chilling[20]. The decamphorized oil had the following characteristics: colour, light yellow; sp. gr.$^{30°}$, 0·9004; $n^{30°}$, 1·470; miscible with all proportions of 90 per cent alcohol; acid val., 1·22; sap. val., 4·7 and eugenol content, 1·66 per cent.

O. kilimandscharicum is allied to *Tulsi* (*O. sanctum* Linn.) and can be grown without much difficulty. It can be coppiced a number of times each year and for a number

TABLE 16 — CAMPHOR AND CAMPHOR OIL CONTENT OF *O. KILIMANDSCHARICUM*

	Whole plant	Leaves	Flowering tops	Stems
Yield of oil from fresh herb, %	0·43	0·54	0·53	0·054
Yield of oil from air-dried herb, %	1·38	2·27	1·30	0·056

Camphor content of the oil, 70·5%; m.p. of camphor, 174·75°C.

of years, so that once introduced it can last for some years. Coppiced plants get bushy and give higher yields of leaves which are ready for harvesting within 4-5 months of sowing the seed. The plant is not browsed or grazed upon by the cattle and so does not require any protection against animals. Unlike many other plants the leaves of this plant do not lose camphor even when spared for a year or so. The yield of camphor also is not affected by drying or rotting of the leaves.

The plant can grow in any type of soil but clayey soils are more suitable and the plants grown in them give high yield of leaves. High atmospheric temperature does not effect the plant but temperatures below 30°F. kill the plant outright. The plant grows well in areas where the rainfall is 50 in. per annum or even less provided the rain is evenly distributed. It grows best in the plains but can also grow up to an altitude of 3000 ft.

When the plant is to be introduced for the first time the best method is to raise seedlings in a nursery and transplant them later. Once a crop is raised further extensions can be made either through planting of entire plants or branch cuttings, 6 in. long and about the thickness of a pencil. Under favourable conditions the plant reproduces through self-sown seeds near the mother plants. Natural seedlings can be utilized as transplants. The seeds are light and give a high percentage of germination. They should be sown in flat beds having fine pulverized soil towards the middle of March when the atmospheric temperature is high without much fluctuation in the daily temperature. The seeds should be mixed with 10-20 parts of sand for thin and uniform sowing. The beds should be watered regularly in such a way that the surface soil keeps moist. In no case the beds should be flooded or allowed to dry up. The seeds start germinating in 5-10 days and the germination is complete in 15-20 days. The seedlings are ready for transplanting when 5-7 weeks old and should be transplanted at the break of the monsoon at a distance of 2 ft. in rows 2 ft. apart.

The crop is harvested by cutting the plant 2-3 in. above the ground. The cut plants should be collected in heaps and kept until quite dry when they should be threshed. The plantation at Jammu is being further extended in order to study whether commercial production of camphor will be economical. The Forest Research Institute, Dehra Dun, have a scheme of growing it in the forests on a large scale.

O. sanctum Linn.

Vern., *Tulsi*

It is cultivated throughout India near sacred places. In the indigenous system of medicine the leaves are used as an expectorant, stomachic, carminative, diuretic and febrifuge. The leaves also possess insecticidal and insect-repellent properties. The main constituent of the oil is eugenol and its ester. The oil has little use except in medicine, and is not, therefore, produced in any appreciable quantity in India or abroad. The plant is raised throughout the warmer parts of the State for medicinal and religious purposes. The leaves and flowering tops collected from plants cultivated in Jammu on steam distillation gave 0·9 per cent of the oil; sp. gr.$^{15°}$, 0·967; $n^{20°}$, 1·5197; soluble in all proportions in 90 per cent alcohol; values reported for imported oil: yield, 0·6 per cent; sp. gr., 0·952; $n^{20°}$, 1·5170.

No efforts have been made to distil the oil on a large scale for detailed study because of its restricted demand.

Origanum vulgare Linn.

Vern., *Marjrom, satra*

The plant grows wild in the temperate regions of the Himalayas at altitudes of 6000-12,000 ft. In Kashmir it is commonly found at altitudes of 5000-9000 ft. in the forests.

It is reported to be eaten at certain places as a pot herb. In the indigenous systems of medicine the plant is considered to possess aromatic, stimulating and tonic properties. It is used in diarrhoea, rheumatism and earache[2]. The true oil of origanum is produced from other Origanum species in Spain in large quantities but the oil obtained from *O. vulgare* has not attained any commercial importance. The plants collected from the neighbourhood of Gulmarg on steam distillation yielded 0·76 per cent of an essential oil having sp. gr.$^{15°}$, 0·933 and $n^{20°}$, 1·477.

Pogostemon patchouli Hook. f.

It is a strongly aromatic herb cultivated in the Western Ghats and the Nilgiris for its leaves which yield an essential oil called

the Oil of Patchouli. The oil is extensively used in perfumery for its pleasant and persistent aroma and is in great demand. Root cuttings of the plant obtained from the Indian Institute of Science, Bangalore, were planted 2 ft. apart in the Jammu nursery. A large number of cuttings sprouted and mortality was quite low. The plants established very well and showed good growth. The dry leaves of the local plants on steam distillation yield an oil (5·0 per cent v/w) having sp. gr.$^{32°}$, 0·953; $n^{32°}$, 1·5040; acid val., 1·0; sap. val., 3·0 and ester val. after acetylation, 16·8. The oil is soluble in equal volumes of alcohol.

Prangos pabularia Lindl.

Vern., *Komel*

It is a large perennial herb growing at altitudes of 6000-11,000 ft. in Kashmir. The plant is reported to have carminative, diuretic and emmenagogue properties[21]. The dried leaves and flowering tops and dry roots of the plant procured from Pir Panjal range, on steam distillation, gave 0·65 and 1·2 per cent of an essential oil respectively. It has sp. gr.$^{15°}$, 1·129 and $n^{20°}$, 1·454.

The oil has not found any use either in perfumery or in medicine.

Salvia spp.

Sage oil which is largely used in foreign countries is obtained from *S. officinalis* Linn. It is indigenous to the Mediterranean area and is also cultivated in many countries with temperate climate for ornamental and medicinal purposes. The oil is largely distilled in Dalmitia and its yield ranges from 1·3 to 2·5 per cent[22].

A number of species of Salvia grow wild in the hills bordering the valley of Kashmir. These are reputed for both medicinal and aromatic properties. The following species occur commonly in the State[3]: *S. moorcroftiana* Wall. (vern., *Kaligarri*), *S. glutinosa* Linn., *S. dumetorum* Andrz., *S. hians* Royle, *S. lantana* Roxb., etc.

The first four species were collected from the Sindh division in Kashmir. Their dry leaves and flowering tops on steam distillation yielded 0·25, 0·32, 0·34 and 0·24 per cent of the oil respectively. The yield of the oils from these species is so low that they cannot be commercially exploited unless the yield of the essential oil is increased by adopting improved methods of cultivation.

S. officinalis Linn.

The seeds of this species, procured from abroad, were planted in Jammu (900 ft.) in spring; the plants came up very well and were harvested in August. The dry and the fresh leaves on steam distillation yielded 0·22 and 0·6 per cent respectively of a pale yellow oil. The characteristics of the local and foreign oils[22] are given in Table 17.

TABLE 17 — CHARACTERISTICS OF SAGE OIL

	Local oil	Foreign oil
Sp. gr.	0·9176 (30°)	0·915-0·923
n	1·4620 (30°)	1·4571-1·4639
Acid val.	0·66	—
Ester val.	53·3	—
Bornyl acetate, %	0·18	1·6-4·0
Sap. val. after acetylation	99·2	—
Total alcohol (calculated as borneol)	13·6	—
Ketone as thujone (hydroxalamine method)	77·5	41·6-61·2
Solubility (vol. 90% alcohol)	1	—

It appears that the quality of the sage oil distilled from plants raised here is fairly comparable with the foreign oil. The plants have also fared well. The oil at present is imported for use in soap and cosmetic industry. Efforts are, therefore, being made to extend its propagation in suitable areas in order to see if its large-scale cultivation can be an economic success.

Saussurea lappa C. B. Clarke

Vern., *Kuth*

It is a herbaceous plant growing wild in Kashmir forests in shady and moist places, especially under birch trees and dwarf willows. It grows abundantly in the Kishanganga valley and the higher elevations of the Chenab valley. It is also found in Reasi, Ramban and Udhampur divisions. The roots, which possess medicinal properties and yield costus oil, are collected in autumn before snowfall. The Forest Department of the State annually sells nearly 1000-1500 md. of the roots at Rs. 120-150 per md.

In India, the roots are used as a stimulant in cough, asthma, fever, dyspepsia and skin diseases. They are locally employed as a preservative for woollen goods. Large quantities of the root were annually exported to China where it was used as an incense in

pagodas[23]. The oil is in fair demand in Europe and America where it is used in high class perfumery.

The dry roots on steam distillation yielded 1·22 per cent of an oil having sp. gr.$^{17·5°}$, 0·988; $n^{20°}$, 1·6132; acid val., 17·8 and ester val., 56·7[13].

At present costus oil is not produced in any appreciable quantity in India. As a result of successful trials, the production of oil and resinoids on moderately large scale has already been started. The resinoids of costus have greater demand than the oil, the reason, perhaps, being that these are relatively low priced and can be used in high grade perfumery and cosmetics for blending purposes. The resinoids were also prepared with benzene and alcohol and the keeping quality of the former was found to be better. The resinoids prepared with benzene (yield 6·8 per cent) and alcohol (yield 8·6 per cent) had acid val. 13·9 and 20·5 and ester val. 280·5 and 171·6 respectively. The samples of the essential oil and the resinoids sent to various essential oil experts in India and abroad brought good reports.

The plant was propagated by root division in Yarikah where it is doing very well. The cultivated roots yielded 1·2 per cent oil. At present the drug is available in sufficient quantities from natural sources and in case the demand increases, the cultivation of the drug can be extended. Problems regarding the improvement in the method of cultivation, collection and drying, etc., in order to produce standard quality raw drug are also under study.

Senecio chrysanthemoides DC.

This plant is found distributed in the temperate to alpine regions of the Himalayas in Kashmir and is very common in the open and covered forest blanks at altitudes of 8000-11,000 ft. It flowers in July and August and emits a characteristic fragrance. On steam distillation the herb yields an essential oil which, though not much used in perfumery, is worthy of further study.

S. jacquemontianus Benth.

Vern., *Poshkar*

Amongst the many species of Senecio growing in abundance in a state of nature in Kashmir the study of this species was undertaken for its aromatic properties. The whole herb, particularly the root, is aromatic. The plant grows in the Himalayas at altitudes of 10,000-13,000 ft.[7]. In Kashmir it grows wild in the Gurez valley.

The roots of the plant were collected during autumn from Rajdhani area (11,000 ft.). On steam distillation they yielded 1·2 per cent of an essential oil having sp. gr.$^{15°}$, 0·9545 and $n^{20°}$, 1·483[9].

Sium latijugum C. B. Clarke

Water parsnip

This plant is widely distributed in Kashmir (Jhelum and Sindh valleys) and Baltistan at altitudes of 5000-9000 ft. as a weed and imparts strong fragrance to the atmosphere.

Flowering plants, collected from Yarikah (7000 ft.), on steam distillation yielded 0·94 per cent of a volatile oil having sp. gr.$^{20°}$, 0·8900 and $n^{20°}$, 1·4894[12,24].

Skimmia laureola Sieb. & Zucc. ex Walp.

Vern., *Ner*

The shrub is found in abundance as an undergrowth in the fir forests of the State at altitudes of 7000-9000 ft. It is very common in the Gulmarg, Pahalgam, Katra and Reasi areas. The leaves are used locally as an incense and it is burnt for purifying air near patients with smallpox[23]. The fresh leaves on steam distillation gave 0·49 per cent of an oil having sp. gr.$^{15°}$, 0·8058 and $n^{20°}$, 1·4784[13].

The oil has been found to contain a large percentage of linalyl acetate which is the main constituent of lavender oil. Skimmia oil can, therefore, replace lavender oil in perfumery and soap-making. Detailed study of the oil is in progress.

Tanacetum vulgare Linn.

Tansy

It is a perennial aromatic herb indigenous to Europe and is extensively cultivated there[25]. The leaves are large and pinnately divided. The flowers are in yellow heads borne in terminal corymbs.

The plant yields 0·1-0·3 per cent of a volatile oil containing thujone, borneol, camphor and resins and used as a flavouring agent.

T. vulgare has been found growing as an escape near the Drug Farm, Yarikah (Kashmir).

It may have been introduced as an ornamental plant but there is no record of its introduction into India. It is a hardy plant and can be easily propagated by cultivation on an extensive scale.

The whole flowering plants on steam distillation gave 0·6 per cent of the essential oil; sp. gr.$^{15°}$, 0·939; $n^{20°}$, 1·4615; values reported for the American oil[23]: yield, 0·2-0·8 per cent; sp. gr., 0·925-0·935; $n^{20°}$, 1·457-1·459.

There is no report of the oil being used either in perfumery or in medicine in India, and even in foreign countries the oil has a limited use.

Thymus serphyllum Linn.

Vern., *Ban-ajwain*

The plant grows wild throughout the Kashmir valley and is used in the Unani and Ayurvedic systems of medicine for stomach and liver ailments; it is also a household remedy for toothache. The whole dried plant on steam distillation gave a pale yellow oil; yield, 0·72 per cent; sp. gr.$^{15°}$, 0·9404; $n^{20°}$, 1·5110; phenol content, 51·2 per cent; values reported for the European oil[13]: yield, 0·15-0·60 per cent; sp. gr.$^{15°}$, 0·890-0·92.

The oil has not attained any commercial value because it does not contain thymol present in the thyme oil. It, however, possesses an agreeable odour reminiscent of thyme oil and can, therefore, be used as a cheap flavouring agent. Plants raised in Jammu (900 ft.) from seeds of *T. vulgaris* Linn. procured from abroad came up very well and bore flowers, but they could not stand the summer and died. Attempts are being made to raise the plants in the Kashmir valley where *T. serphyllum* grows in a state of nature.

Valeriana spp.

A number of species of Valeriana, i.e. *V. wallichii* DC., *V. hardwickii* Wall. and *V. officinalis* Linn., grow wild in the hills bordering the valley of Kashmir. The distribution of *V. officinalis* and *V. hardwickii* is rather sparse while *V. wallichii* grows in abundance. Large quantities of its roots are annually exported by the Forest Department of the State.

V. wallichii DC.

The roots divested of the rootlets are used in the indigenous system of medicine in the treatment of hysteria and nervous diseases. The importance of the drug increased during the last war because of its extensive use in shell shock cases. Valeriana roots contain a sweet smelling essential oil which is used in perfumery, in scenting soaps and as an adjunct to flavouring agents. The drug sells at Rs. 30-40 per md. The dry roots of *V. wallichii* on steam distillation yielded 0·5 per cent of an essential oil having sp. gr.$^{20°}$, 0·951; $n^{20°}$, 1·4785; acid val., 15·8 and ester val., 100·5. The oil is soluble in 2 vols. of 90 per cent alcohol.

At present, valeriana oil is not produced anywhere in India, but the resinoids of valeriana are in demand, their low price permitting their use in cosmetics, soaps, etc. Resinoids were prepared by extracting the roots with benzene and alcohol. The keeping quality of the resinoids from benzene was better than of the resinoids prepared with alcohol. The resinoids extracted with benzene (yield, 4·5 per cent) and with alcohol (yield, 15·4 per cent) had acid val., 23·9 and 26·9 and ester val., 398·0 and 242·9 respectively.

The plants propagated by seeds and root cuttings came up very well. It, therefore, appears that it can be propagated on large scale in Kashmir State if there is a fair demand for the drug or its oil.

Zanthoxylum alatum Roxb.

Vern., *Timbru*

The plant is usually a shrub but at times it becomes a short tree attaining a height up to 20 ft. It grows along the foot of the Himalayas from the Indus eastwards, up to an altitude of about 5000 ft., usually in rather hot, dry places[26]. In Kashmir the plant grows commonly in the Jhelum valley below Uri (25 miles from the Kashmir valley).

Every part of the plant possesses a peculiar aromatic, but pungent, smell. Walking sticks and clubs are made from its stems and fragrant twigs are used as tooth brushes. In the indigenous system of medicine the fruit and bark are used in the treatment of fevers, dyspepsia and cholera[2]. The oil obtained from the fruit forms an important constituent of a number of tooth powders. In America the oil of an allied species is used in insecticidal sprays. The fruit on steam distillation yields a pale yellow oil with a peculiar odour. The yield and characteristics of the local oil and those reported in literature[9] are given in Table 18.

TABLE 18 — YIELD AND CHARACTERISTICS OF OIL OF *Z. ALATUM*

	Local oil	Oil examined by Schimmel & Co.
Yield (from dry fruits), %	2·1	3
Sp. gr.$^{15°}$	0·8676	0·8653
$n^{20°}$	1·465	1·48131
Solubility, vol. 90% alcohol	1	—
Acid val.	0·9	—
Ester val.	11·4	—

Nearly 500-1000 md. of the fruit can be collected from the State forests. The market price of the fruit is Rs. 40-50 per md. Distillation of the drug for 4-5 hr. in a field distillation still gave satisfactory yield of the oil. The oil is not reported to be distilled on a commercial scale anywhere in India.

Zingiber officinale Rosc.

Common ginger

Vern., *Sunth*

It is a herbaceous plant cultivated in many tropical and subtropical countries, the most important regions being Jamaica, Japan, Nigeria and Cochin Calicut.

As a carminative and stimulant for the gastro-intestinal tract, ginger plays a useful role in pharmacy. It is largely used as a household remedy for flatulence and numerous preparations containing ginger are included in the British and other pharmacopoeias. The oil of ginger is employed for flavouring various types of food products, particularly baked goods, confectionery and spicy table sauces. It also finds use in perfumery.

Ginger is cultivated on a large scale in the State in Reasi, Katra, Udhampur and Basohli side in Jammu province. The ginger growing in the State is of excellent quality and its cultivation can be extended in other suitable areas in the State.

The fresh and dry roots yielded, on distillation, 0·25 and 1·2 per cent respectively of a colourless oil with pleasant odour. The characteristics of the oil are given in Table 19.

TABLE 19 — CHARACTERISTICS OF GINGER OIL

	Local oil	Official standards
Sp. gr.	0·878 (18°)	0·877-0·886 (15°)
n	1·4892 (18°)	1·849-1·494
Optical rotation	−21°	−26° to −50°
Solubility in alcohol	Sparingly soluble	Sparingly soluble
Acid val.	1·3	Up to 2
Ester val.	25·7	Up to 15
Ester val. after acetylation	120·2	24-50

The official standards laid down for the oil are also given for comparison.

Ginger oil is being produced in South India but no statistical data are available regarding its import and export.

GYMNOSPERMS

Pine needle oils

Pine needle oils obtained by the steam distillation of the needles and cones of various coniferous plants possess balsamic and refreshing pine-wood odour and are extensively used in the preparation of various pine essences for spraying dwellings and sick rooms and in the preparation of aromatic baths, perfumery and better quality soaps. The oil is distilled from tender leaves, twigs and one-year-old cones of pines, larches and firs. A number of species of pines and firs grow wild in the forests of Jammu and Kashmir, and can be exploited for good quality pine oil if there is a demand for it.

The oil contents of the leaves of the various species of pines occurring in Jammu and Kashmir have been reported by Handa *et al.*[12].

Abies pindrow Spach

Himalayan Silver Fir

Vern., *Tung*

It is an evergreen tree commonly growing wild at altitudes of 8000-11,000 ft. It grows even above the ' deodar zone ' in the mountains bordering Kishanganga and in the forests of Sindh, Liddar and Jhelum valleys. The leaves have a very fine aroma. Leaves from Gulmarg on steam distillation yielded 0·61 per cent of a pale yellow oil with balsamic odour having sp. gr.$^{15°}$, 0·8845; $n^{20°}$, 1·4641 and esters (as bornyl acetate), 0·38 per cent. The oil is soluble in 15-20 vols. of 80 per cent alcohol[12].

Cedrus deodara Loud.

Vern., *Deodar*

It is an evergreen tree growing commonly in Kashmir forests at altitudes of 5000-10,000 ft. particularly in the Kishanganga, Kishtwar and Jhelum valleys. The leaves possess a fragrant aroma. The leaves obtained from Gulmarg on steam distillation yielded 0·22 per cent of a pale yellow oil

TABLE 20 — CHARACTERISTICS OF CEDAR WOOD OIL

	Local oil	Oil studied by Schimmel & Co.
Sp. gr.	0·9212 (25°)	0·953-0·9576 (15°)
$n^{20°}$	1·516	1·516-1·523
Optical rotation	63°18′	34°-53°8′
Acid val.	0·13	1·6-5·6
Ester val. after acetylation	26·6	30·8-39·2
Solubility (vol. 90% alcohol)	4	All volumes

having sp. gr.$^{15°}$, 0·8645 and $n^{20°}$, 1·4721. The oil is soluble in 20-25 vols. of 80 per cent and in all proportions of 90 per cent alcohol.

Cedar wood oil — Large quantities of the sawdust of cedar wood are produced in the Joinery Mill which fabricates standard doors and windows. The sawdust on steam distillation yields a pale yellow oil (2·5 per cent) with balsamic odour. The characteristics of the oil and those of the oil produced by Schimmel & Co. are given in Table 20.

Distillation of the sawdust in a field distillation still gave quantitative yield of the oil. The residue after distillation of the oil can still be used as fuel and burns without giving the usual sooty flame. Essential oil experts gave good opinion about the quality of the oil. At present it is not reported to be produced on commercial scale anywhere in India. The Kashmir State can produce *c.* 10,000 lb. or more of this oil if there is a firm demand. The oil can find extensive use in scenting toilet soaps and in cosmetics. The Drug Research Laboratory has taken up the production of the oil on a moderately large scale.

Juniperus spp.

Juniper berries and the oil extracted from them have long been used for digestive and diuretic trouble. Juniper oil is commercially used for flavouring gin[12]. Three species of Juniper, viz. *J. communis* Linn., *J. macropoda* Boiss. and *J. recurva* Ham., grow in Kashmir. Out of these *J. recurva* is rather scarce.

J. communis Linn.

Vern., *Vither*

It is an evergreen shrub growing at altitudes of 9000-14,000 ft. in the inner dry mountain ranges of Kashmir. The ripe dry berries of the plant procured from the Sindh valley on steam distillation yielded 0·77 per cent of the oil having sp. gr.$^{15°}$, 0·9388[9] and $n^{20°}$, 1·488; values reported in literature[11]: yield, 0·5-1·05 per cent; sp. gr., 0·865-0·890; $n^{20°}$, 1·475-1·488.

J. macropoda Boiss.

Vern., *Padam*

It is a medium sized tree growing in the inner dry ranges of the Himalayas at altitudes of 8500-14,000 ft., especially in the Gurez valley. Its wood is used for pencil-making. The dry berries of the plant procured from Gurez valley yielded 3·3 per cent of a sweet smelling oil having sp. gr.$^{15°}$, 0·8571 and $n^{20°}$, 1·473.

A number of species of juniper grow in a state of nature at higher altitudes in the northern Himalayas, especially in Kashmir, but no attempt has been made to distil oil from them. The oil required by breweries and pharmaceutical concerns is imported.

The oil from *J. macropoda* resembles closely the imported juniper oil.

Picea morinda Link
[= *P. smithiana* (Wall.) Boiss.]

Vern., *Sprice, kachhlu*

It is an evergreen tree growing at altitudes of 6000-11,000 ft. in the forests of the State, especially the forests of Kishanganga, Drawa and Sindh valley, usually in association with the broad-leaved trees or pine trees. The leaves procured from Gulmarg range on steam distillation yielded 0·22 per cent of a pale yellow oil having sp. gr.$^{15°}$, 0·9199; $n^{20°}$, 1·4721 and ester (as bornyl acetate), 23·2 per cent. The oil is soluble in 20-25 parts of 80 per cent alcohol and in all proportions of 90 per cent alcohol.

Pinus excelsa Wall.
(= *P. wallichiana* A. B. Jackson)

Vern., *Kail, kairoo*

It is an evergreen tree growing commonly in the Kashmir forests at altitudes of 3000-8000 ft. It forms the major forest tree in the State. It is distributed in the valleys of Sindh, Jhelum, Kishanganga, Liddar, Chenab, etc. The leaves of the tree procured from Gulmarg range on steam distillation yielded 0·38 per cent of a pale yellow oil with balsamic odour having sp. gr.$^{15°}$, 0·9545; $n^{20°}$, 1·4647 and ester (as bornyl acetate),

23·3 per cent. The oil is soluble in 15-20 vols. of 80 per cent and in all vols. of 90 per cent alcohol.

P. longifolia Roxb.
(= ***P. roxburghii*** Sargent)
Vern., *Chir*

It is an evergreen tree growing abundantly at altitudes of about 5000 ft. in the Udhampur, Chenani, Reasi and Kathua forests division of Jammu province. Large quantities of the oleo-resins are tapped annually for the manufacture of turpentine oil and rosin at a factory situated near Jammu. Fresh needles obtained from Udhampur forests on steam distillation yielded 0·22 per cent of a pale yellow oil having sp. gr.$^{15°}$, 0·9116; $n^{20°}$, 1·4845 and esters (as bornyl acetate), 15·4 per cent. The oil is soluble in all proportions of 90 per cent alcohol[12].

Taxus baccata Linn.
Vern., *Burmi*

The tree is valued for its brick-red wood and is found in the pine forests of Jhelum, Kishanganga and Sindh valleys. On steam distillation of the leaves only traces of oil were obtained. It is, therefore, considered to be of little practical value as far as the essential oil is concerned.

MISCELLANEOUS PLANTS

Besides the above-mentioned important plants a large number of aromatic plants which grow wild or have been raised were also studied. They yielded only traces of oil.

Achillea millefolium Linn.
Vern., *Momadru-chopamdiga*

It is a common plant found in the temperate regions of the Himalayas at altitudes of 6000-11,000 ft. In the Kashmir valley it is found growing in abundance as a weed near the cultivated fields or forest blanks. The flowering heads of the plants on distillation gave only traces of the essential oil.

Anthemis nobilis Linn.
Vern., *Babune-ke-phul*

It is a small herb growing wild and is also cultivated in the temperate regions of the Himalayas for the medicinal properties recognized in the Tibbi system of medicine as a stimulant and tonic[2]. The flowers, collected locally, on steam distillation gave only traces of the essential oil.

Eryngium caeruleum Bieb.
Vern., *Dudhali*

It is a medium-sized erect herb growing commonly in the Kashmir valley at altitudes of 5000-6000 ft. The roots are taken as an aphrodisiac and nervine tonic. The plant collected from the neighbourhood of Srinagar on steam distillation yielded traces of an essential oil.

Magnolia grandiflora Linn.
Great Flower Magnolia

It is an evergreen tree attaining a height of 80-100 ft. with firm laurel-like leaves and large whitish highly fragrant cup-like flowers. It is a native of southern parts of the United States. It has been introduced in India and is cultivated for ornamental purposes.

Flowers collected from trees raised in Jammu on steam distillation yielded 0·12 per cent of an essential oil ($n^{20°}$, 1·478) with very pleasant aroma characteristic of the flowers.

Macrotomia benthami DC.
Vern., *Gaozaban*

The plant grows wild at altitudes of 10,000 ft. and is largely met with in Gurez and Chota Deosai in the Kashmir valley.

Water extract, *sharbat* (syrup) and jam prepared from the flowering shoots are extensively used in the indigenous system of medicine in diseases of tongue and throat and in the treatment of fevers[23]. The whole dry plant on steam distillation yielded traces of the essential oil.

Matricaria chamomilla Linn.
German Chamomile

This plant is not indigenous to India. Its seeds were obtained from France and raised in Jammu (900 ft.) and Katra (3000 ft.). The plants showed vigorous growth at both the places. The dried flowers harvested from Jammu gave 0·47 per cent and from Katra 0·17 per cent of a sweet smelling blue-coloured oil.

Prunus amygdalus Batsch

Vern., *Badam*

Almonds of bitter and sweet variety are cultivated in the Kashmir valley and exported in considerable quantity. They were found to contain on an average 46·6 per cent of the fixed oil and 0·32 per cent volatile oil.

Petroselinum sativum Hoffm.

Parsley

P. sativum Hoffm. does not grow in India. Its seeds procured from France were sown in spring in Jammu (900 ft.). They germinated in about two weeks. The whole fresh plant harvested in July gave 0·34 per cent oil.

Rhus succedanea Linn.

Vern., *Arkhar*

This plant commonly grows in the forests of Kashmir and is reputed for its aromatic properties. Both dry fruits and leaves were steam distilled, but only traces of the oil were obtained.

Tagetes erecta Linn. and ***T. patula*** Linn.

Marigold

Vern., *Gainda*

These plants are cultivated in the warmer parts of Jammu province for their flowers. The flowering season generally lasts from November to January. All parts of the plants contain essential oil but the flowers appear to be richer in the oil. The essential oil from the flowers is fly-repellent. It has also been recommended for use as a modifier in hair lotions[3]. The juice of the flowers is sometimes used as a blood purifier and as a remedy for piles. Due to lack of demand very small amounts of marigold oil are produced at present. The fresh flowers of *T. erecta* (yellow) and *T. patula* (red) procured locally on steam distillation yielded 0·02 and 0·05 per cent respectively of a pale yellow oil.

Vitex negundo Linn.

Vern., *Arhar*

This plant is extensively used in medicine and is also reputed for its aromatic properties. On steam distillation of the dry flowering shoots of the plant, very little of the essential oil was obtained.

The dried roots of *Iris kumaonensis* Wall. (vern., *Krisham*) and *I. kashmiriana* Baker growing wild in Kashmir and reputed for their aromatic properties gave only traces of the essential oil on distillation.

The dried bark of *Betula utilis* D. Don (vern., *Bhojpattra*) and the dried leaves and flowering tops of *Plectranthus rugosus* Wall. (vern., *Pumar*), which grow wild and are reputed for their aromatic properties, gave on steam distillation only traces of oil.

Capparis spinosa Lam., *Caucalis latifolia* Linn., *Senecio nudicaulis* Ham., *Pimpinella diversifolia* DC. growing wild in the State were also studied; they contained only traces of the oil.

Seeds of citronella grass (*Cymbopogon nardus* Rendle) and palmarosa grass (*Cymbopogon martini* Watt.) were also tried in rainy season in Jammu but these did not germinate.

In addition to the above-mentioned essential oil bearing plants there are many more that grow in the State. A list of these plants is given below:

Allium cepa Linn. (*Piaz*), *A. semenovii* Regel, *A. sativum* Linn., *A. atrosanguineum* Schrenk, *A. shoenoprasum* Linn., *A. fedschenkoanum* Regel, *A. rubellum* Bieb. (*Jangli piaz*), *A. stracheyi* Baker, *A. consanguineum* Kunth., *A. thomsoni* Baker, *A. wallichii* Kunth., *A. victorialis* Linn., *A. clarkei* Hook. f., *A. atropurpureum* Waldst. & Kit., *Jasminum auriculatum* Vahl, *J. grandiflorum* Linn. (*Chambeli*), *J. sambac* Ait. (*Motia*), *J. officinale* Linn. (*Chamba*), *Michelia champaca* Linn. (*Champa*), *Primula petiolaris* Wall., *P. denticulata* Smith, *P. floribunda* Wall., *P. involucrata* Wall., *Citrus aurantium* Linn., *C. reticula* Blanco, *C. limettioides* Tanaka, *Mimusops elengi* Linn. (*Moulsari*), *Nyctanthes arbortristis* Linn. (*Harshingar*), *Cestrum nocturnum* Linn. (Queen of night), *Mangifera indica* Linn. (Mango, *Aam*), *Colebrookea oppositifolia* Smith, *Curcuma longa* Linn. (*Haldi*), *Curcuma zedoarea* Rosc.

These plants will be studied shortly for their essential oil contents.

Conclusion

Jammu and Kashmir State has got a large number of aromatic plants growing in a wild state, and a good number of exotics have been cultivated for their essential oils. Out of about 400 essential oil bearing plants that

grow in a state of nature in this area more than 150 have been studied for their essential oils by the Drug Research Laboratory. As a result of this study it has been observed that *Saussurea lappa, Acorus calamus, Zanthoxylum alatum, Angelica archangelica, Valeriana wallichii, Cedrus deodara, Juniper* spp. (berries), *Angelica glauca, Carum carvi, Zingiber officinale*, etc., contain a good percentage of essential oils, which have a fairly large demand in the market. Their exploitation, therefore, for the production of essential oil can be taken up immediately. The raw materials from *Cinnamomum tamala, Heracleum cachemiricum, Ferula jaeschkeana, Morina longifolia, Nepeta ciliaris, Origanum vulgare, Prangos pabularia*, etc., are also available in sufficient quantities for the production of essential oils, but for these oils there is no demand. Their detailed investigation, however, is being carried out to study their chemical composition and samples of these are being sent to the essential oil experts for their opinion. It is likely that many of these oils may find use in perfumery and soap-making.

Successful cultivation of Japanese mint, wormseed oil plant, camphor basil, lavender, sage, parsley, *Hyssopus officinalis* and *Mentha pulegium* has been carried out. The essential oil contents of a majority of exotic plants, cultivated in the drug farms, have developed to the same extent as in their country of origin.

Besides the foreign plants, experimental cultivation of some plants growing wild in the State has also been taken up in suitable areas. It is hoped that improved methods of cultivation will not only help in increasing the oil contents of the plants that are already growing but will also enable the State to grow many new essential oil bearing plants.

Methods for the production of essential oils, resinoids, concentrates, etc., have been worked out for a number of plants and the Drug Research Laboratory has started moderate scale production of costus oil and its resinoids, valerian resinoids, zanthoxylum oil, calamus oil, Himalayan cedar wood oil, Japanese mint oil and menthol, chenopodium oil, etc. Samples of these were sent to the essential oil experts in the country and abroad and their quality has been found satisfactory.

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