Journal of Scientific & Industrial Research

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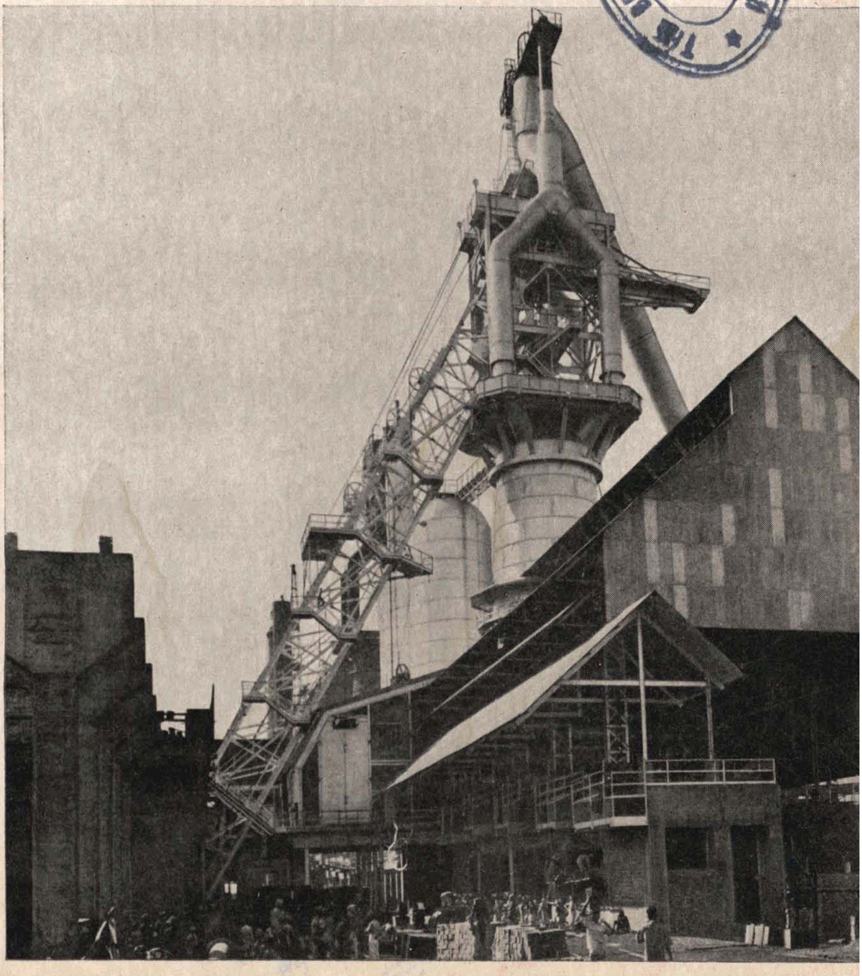

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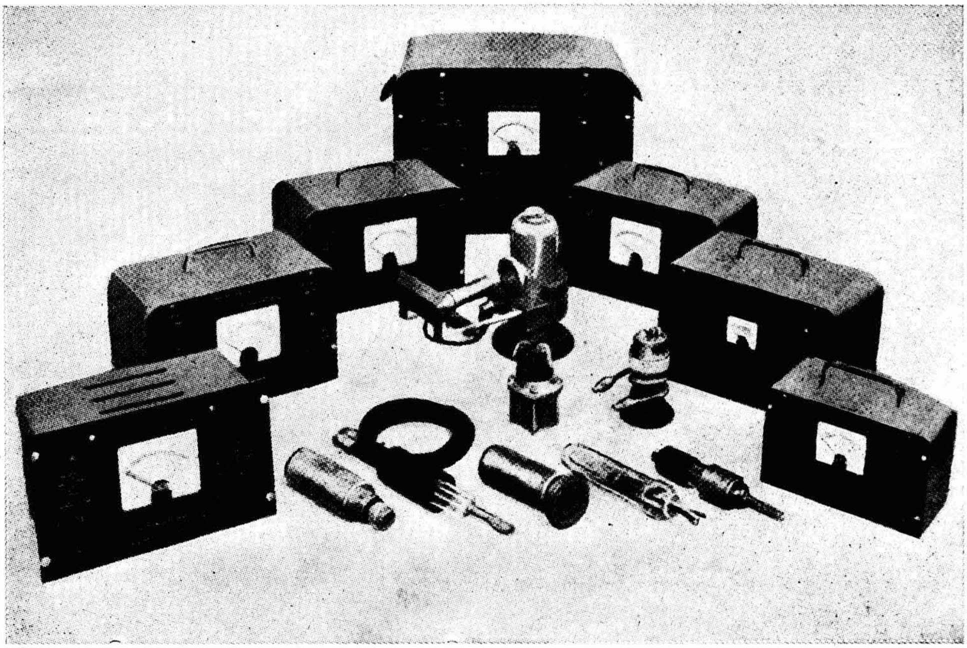

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Scientific & Industrial Research

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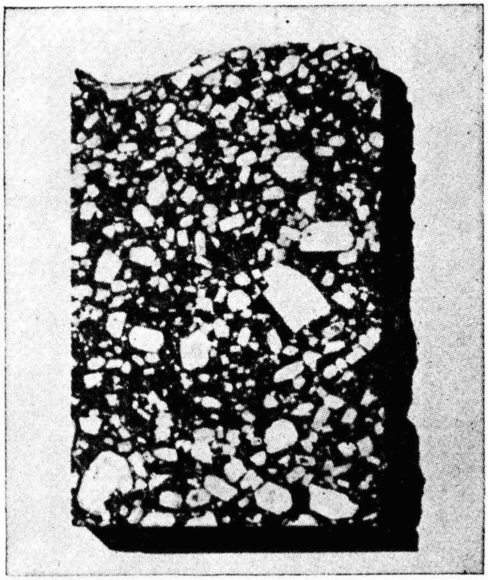

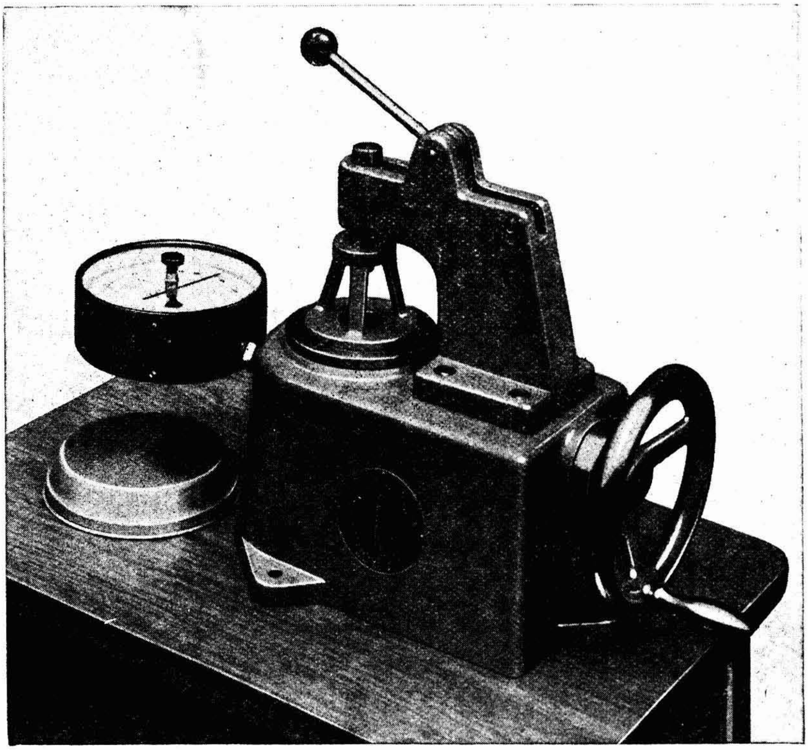

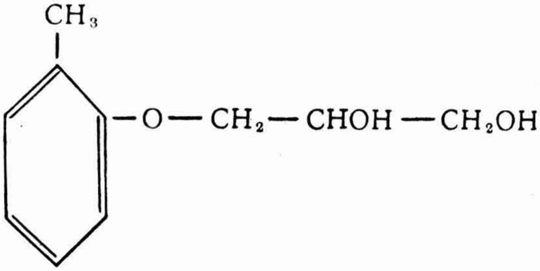

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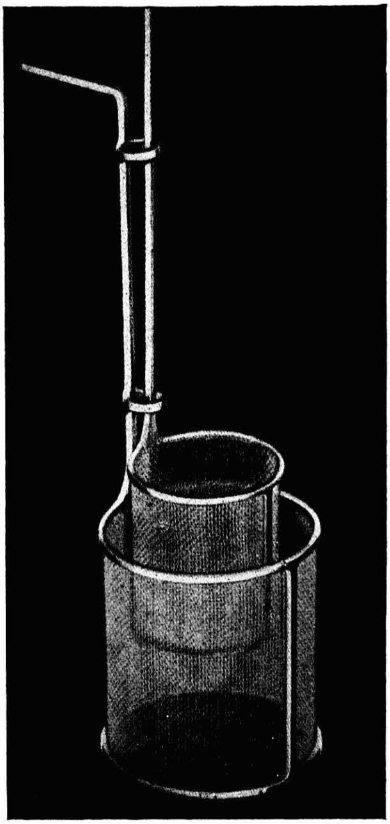

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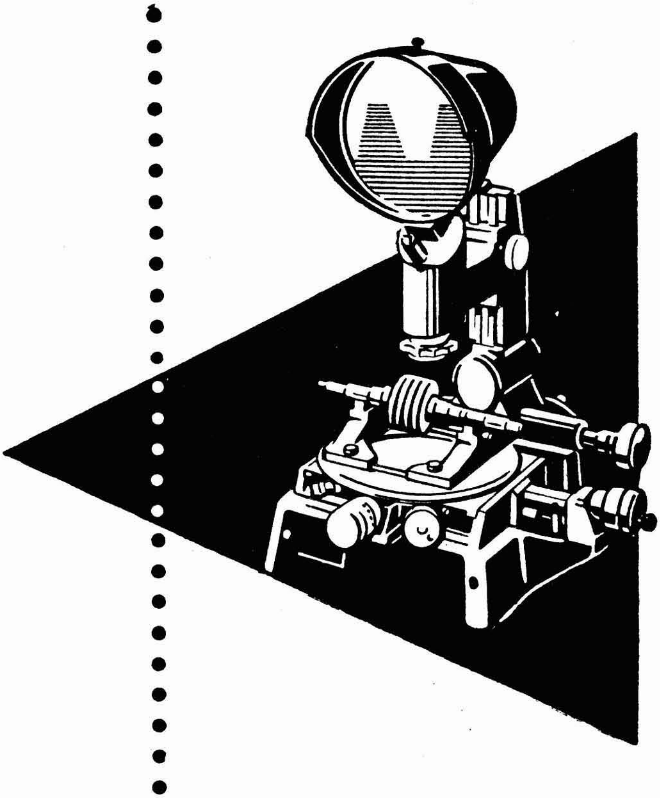

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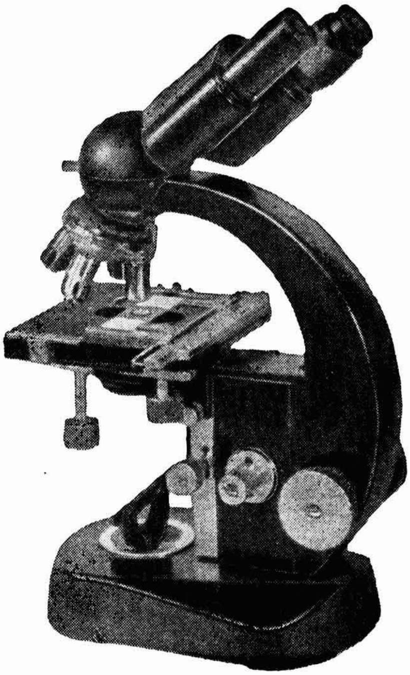

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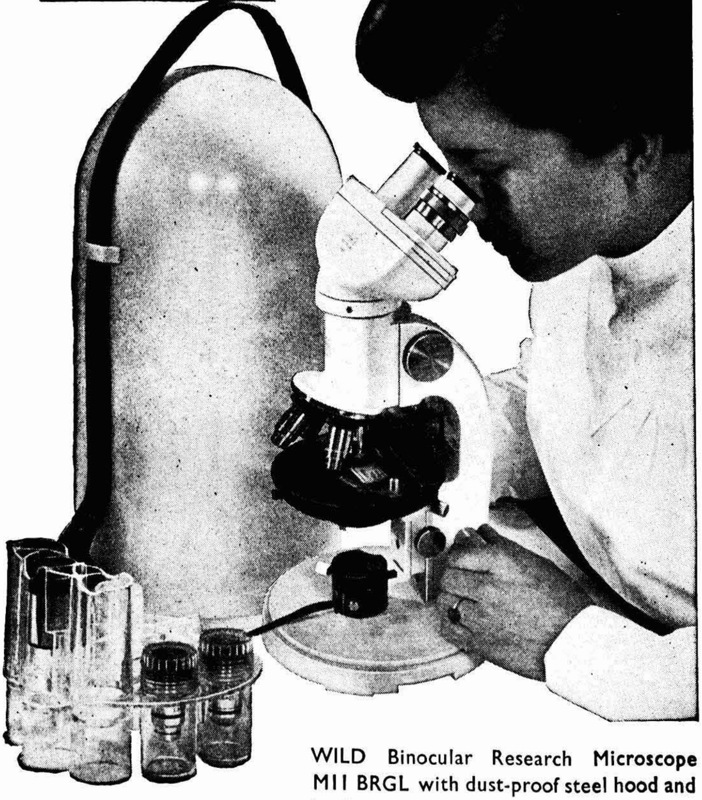

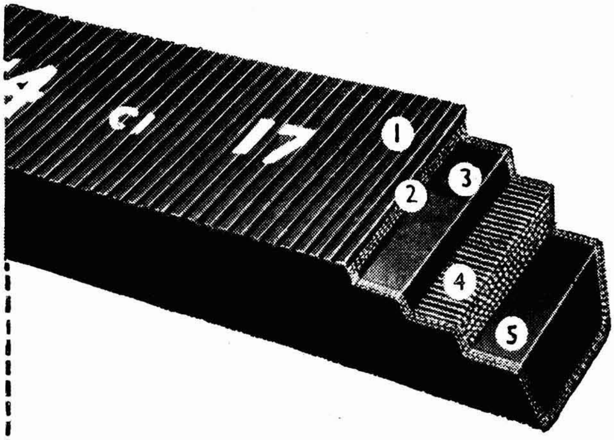
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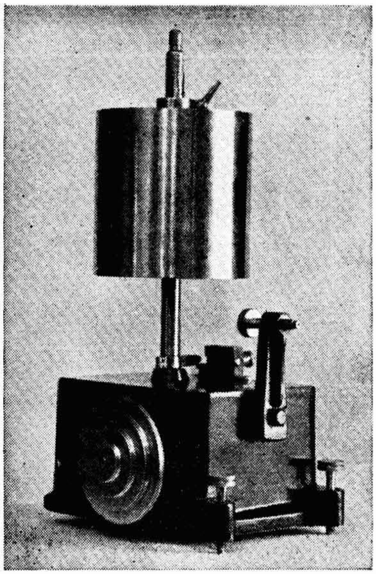

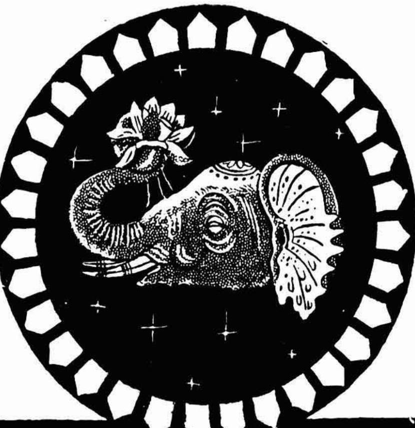

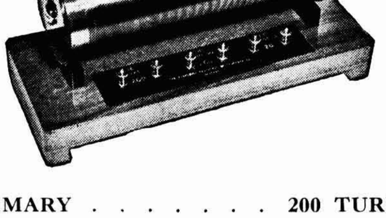

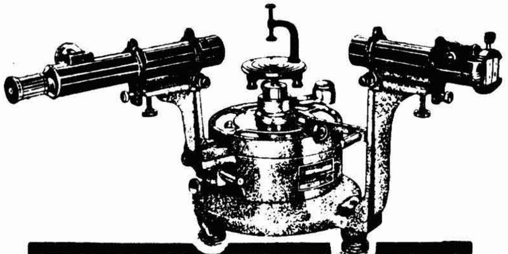

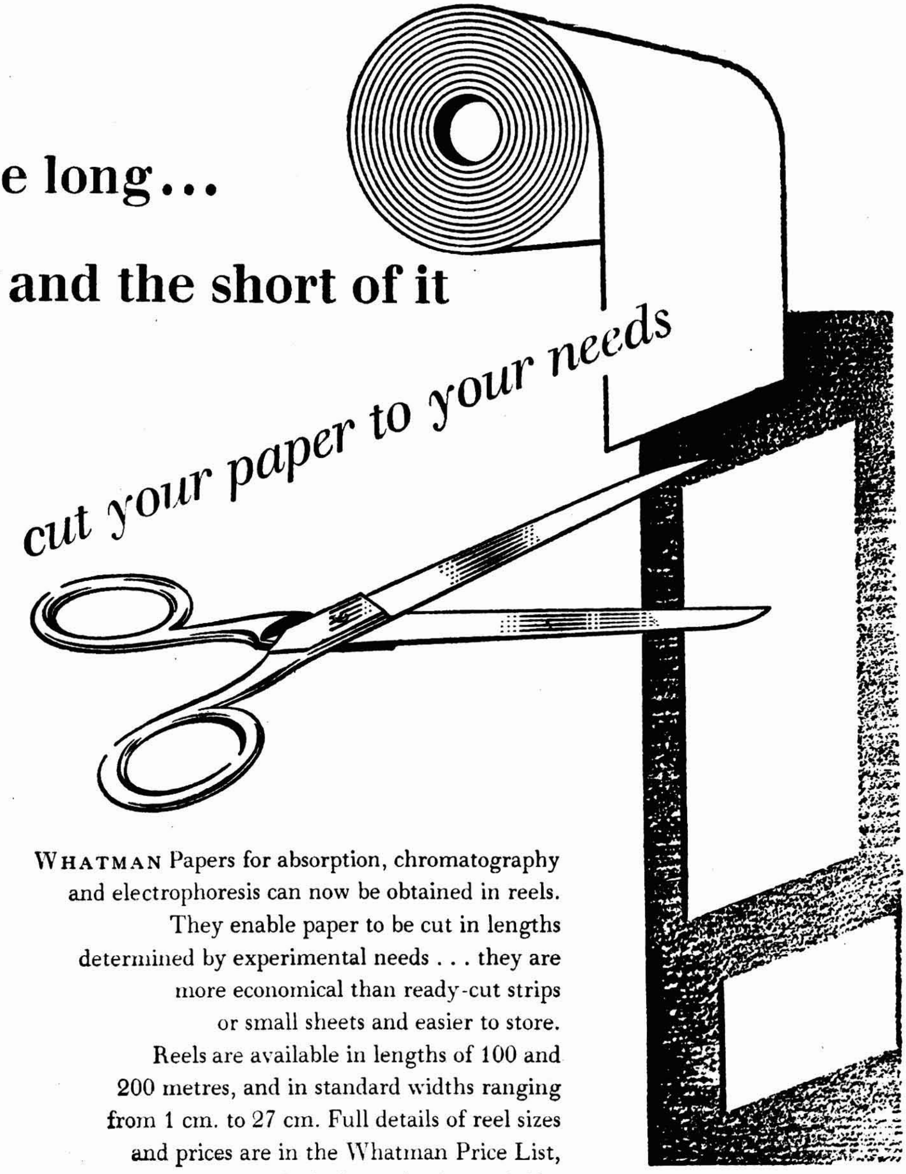
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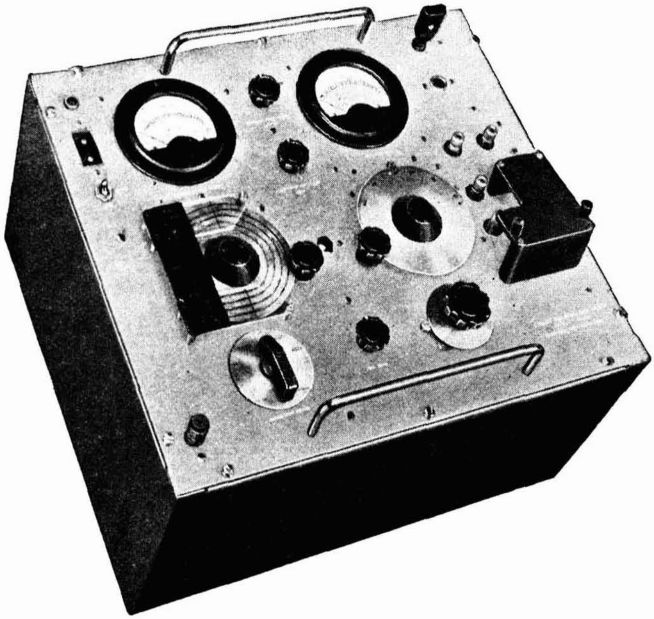

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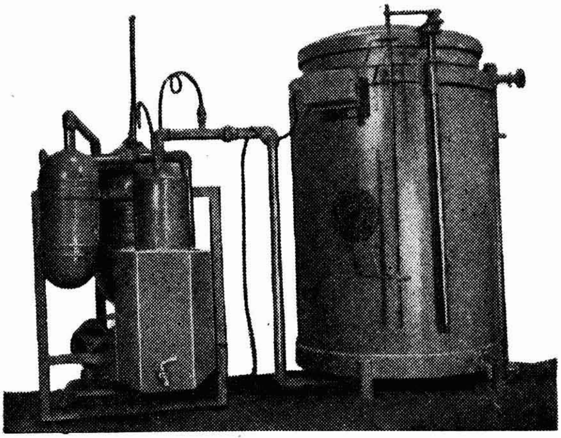

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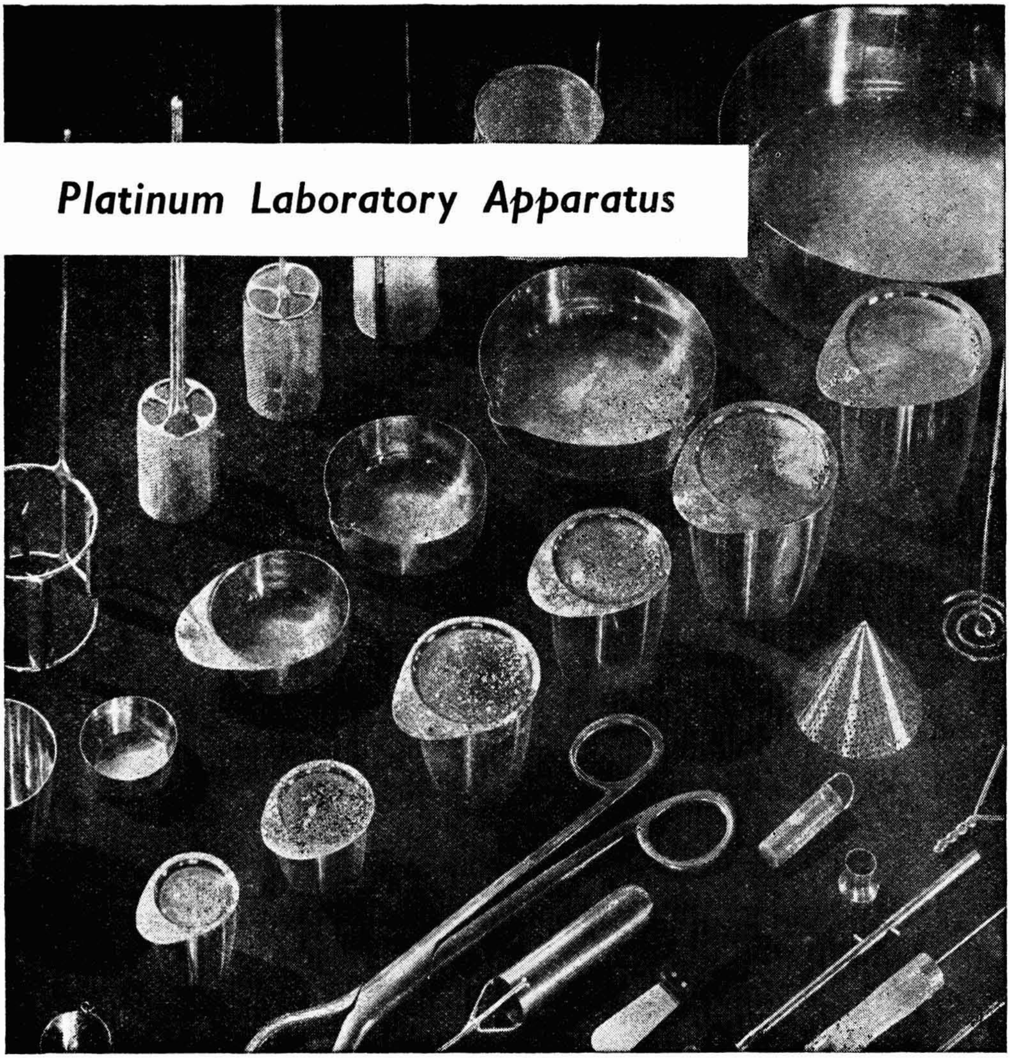

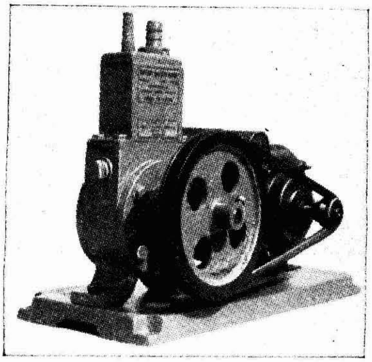

INDEX TO ADVERTISERS


DU MONT

Automation & Society

OUR attitude towards the nineteenth century and especially towards the Victorian Age is still, for many of us, equivocal and undecided. Two or three decades ago, it was fashionable to underrate the achievements of the period and of its great men, a fashion largely set by Lytton Strachey in his amusing and clever caricatures of eminent Victorians. Of recent years, we are beginning to be respectful: we are beginning to recognize that the nineteenth century was a period of remarkably great men and of great advances. Decry as we may some of the values of that age, we are driven to admitting that it was marked by unusual progress, and that it has to its credit the outstanding achievement of grasping the idea of development and evolution in the physical sciences, in the biological world, and in human affairs. The thought of Darwin and Lyell, of Mill and Spencer, of Engels and Marx, is shot through with — is indeed largely based upon — concepts of a world in the process of *becoming* rather than of a world which had *become* or had *arrived*.

No doubt the majority of people did not at the time see the significance of this advance in outlook, and perhaps we may also take leave to doubt whether the quintessence of the Victorian thought has yet reached the man in the street. Nevertheless, all of us have to some degree become more and more impressed by the moving, changing, and dynamic nature of things and ideas. Almost automatically we now interpret geology and biology, history and politics, religion and philosophy with a new awareness — an awareness that history in general does *not* repeat itself, and that ideas and affairs have to be considered in a dynamic setting, as matters of growth rather than of fixedness. Science in particular has felt the impact of evolutionary or developmental views — has in fact been largely responsible for them — and in the nature of things engineering and technology have not lagged behind. Indeed, on occasions they have taken the lead; but there have been similar changes in outlook in economics and social sciences, in ethics and education, in psychology and philosophy.

It is to be noted, however, that our philosophers and thinkers have warned us that in the social sciences, and more especially in the world of ethics and morals, we are lagging dangerously behind: the rate of advance is too slow in relation to that of our science. The question thus poses itself whether some of the difficulties and complications arising in our social and economic life, and also the sense of frustration which often clouds the political horizon have arisen largely because our social development lags behind our technical achievements. The study of automation and its economic and social consequences is a case in point. Of recent years, especially in U.S.A., there have appeared numerous papers and books on the subject, and endless references to conferences on such subjects as man and automation, the automatic factory, technology and human survival and the like. Throughout this literature there runs a division into two major schools of opinion: one regards automation and its consequences as desirable; the other considers the whole movement an enemy to mankind. The first school, the optimists, denies that any major social evils will arise: in fact, they claim that the outcome will be a better life with more and easier jobs and more leisure. The second school, the pessimists, considers that automation will spell *finis* to what remains of the good life — and this not only for the factory workers but also for the vast majority of human beings.

A recent work by Frederick Pollock*, translated from the German, is devoted to the analysis of these problems and opinions. The book is one of a series of enquiries into changes in society which are being made by the Institut Fur Sozialforschung at the University of Frankfurt.

Broadly speaking, automation consists in the employment of machines to control and guide other machines: it is a production technique in which (instead of men) machines are employed to operate and direct other machines and to control the products of the process in respect of quantity and quality. What were formerly separate and unconnected operations in production are changed into a unified process, resulting in a colossal output of goods, often of the highest quality. Automation, however, is not confined to the factory or workshop: it extends to the office, to machines which undertake all calculations, account preparation, and book-keeping; and to machines which produce all the necessary statistics and other office information. Already in America and Europe much of the office work formerly done by men and women is now performed by electronic computers, mechanical shorthand writers, punched cards, sorting machines and the like — in a fraction of the time, and with accuracy.

Several examples are given by Mr. Pollock of the marvellous achievements of automation in respect of reduction of labour and of efficiency of performance. Thus, in U.K. the Lyons Electronic Computer calculates and records the wages for 33,000 employees, and in doing so it takes account of 20 different deductions and extra payments. The computer also shows the number and kinds of notes and coins required, and the insurance stamps needed. In U.S.A: at the General Electric Co.'s works, a computer calculates in 2 hours the wages of 12,000 men and gives information on net payments and the distribution of wage costs. In another 4 hours, it prints the wage cheques for those so paid, and the wage sheets for the pay clerks and the accountant. It performs in 6 seconds work which used to keep many clerks busy for a week. The machine also supplies continuous information concerning the stocks in hand and the new materials required. The possible savings in public administration, insurance offices, banks and the like from the use of computers are obvious.

The indispensable personnel are the engineers who plan and organize the processes, construct the machines, develop new ones, and co-ordinate and integrate the work. Certain engineers and the management are thus still found essential: the craftsman's part practically vanishes — and so does that of the ordinary employee.

Mr. Pollock's main objective, however, is not to describe the marvels of production or other potentialities introduced by automation: it is to forecast the economic and social changes that are likely to result, such as unemployment, the concentration of economic power into a few hands, and the role of management and labour under the new conditions.

The simple problem is: what is going to happen to those who are thrown out of work by the introduction of these new techniques ? It is pointed out that many of the leaders of trade unions consider the situation extremely grave and likely to give rise to social upheavals, strikes and extensive unemployment. Reading between the lines one feels that the author is largely in agreement with this view. But is it true ? The introduction of machinery in numerous countries in the past century was opposed on similar grounds; yet was not greatly increased employment actually provided through such machinery, through factories and workshops, through the whole growth of technology ? Would there have been any such employment *without* the advent of the machine, without technology, without engineering ?

In U.S.A. automation so far has not created any major problem of unemployment: other (often new) industries have been able to absorb readily the superfluous personnel. What therefore are we to conclude ? Does not our fear of this new technique arise from failure to recognize that it will create or generate in due course more employment ? In other words, are most of us still early Victorians in outlook and have we failed to learn the lesson that growth and progress are essential ?

There is of course one all important factor to which attention must be paid, namely the planning of industrial development so that with the advent of these new methods and new machines there is at the same time ade-

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**The Economic and Social Consequences of Automation* by F. Pollock (Basil Blackwell, Oxford), 1957. Pp. 276. Price 25*s*.

quate provision for the transfer or absorption of persons from one form of employment into another. In this respect there is a clear and definite social duty on the shoulders of the industrialists and the State: but the necessary arrangements and provision are unlikely to present any insuperable problem, as industry sooner or later produces *more* industry and *more* employment. It will thus probably be necessary to make special arrangements only for very limited transitional periods.

In a word, our fear to welcome such developments as automation seems to arise largely from failure to appreciate the natural growth of industry which follows upon new ideas and applications; yet the record of history is there to see. No doubt in the past there may have been, for short periods, distress or hardship; but it could surely have been mitigated by proper planning on the part of those responsible. The conclusion to be drawn appears to be that the greater the industrial development, the greater is the tendency to create further industry — with greater employment and a higher standard of living and provided that our social and ethical values are sound, there is little to fear from automation. Can we not make our social values measure up to our technical advances ?

J.W.W.

Mr. V. Cadambe

Mr. V. Cadambe, Assistant Director, National Physical Laboratory of India, New Delhi, who was on deputation with the Ministry of Defence, has been appointed, with effect from 20 February 1958, as Director (Planning), Central Mechanical Engineering Research Institute, which is to be located at Durgapur in West Bengal.

Born on 10 December 1910 in Bangalore, Mr. Cadambe had his education in the University of Mysore and obtained his M.Sc. (Hons.) degree in Mathematics in 1933. He started his career as a lecturer in mathematics in the University of Bombay and was appointed, in 1937, Chief Instructor and Secretary, Technical Training Centre, Air Services of India, at Jamnagar. In 1940 he proceeded to U.S.A. for higher studies and obtained his M.S. degree from the California Institute of Technology. He served the Hughes Aircraft Factory, Los Angeles, as the Structural and Aerodynamic Engineer from 1942 to 1944 and the Douglas Aircraft Factory as Senior Structural Engineer from 1944 to 1946. On his return to India in 1946, Mr. Cadambe joined the Tata Aircraft Ltd., Titaghur. In May 1948 he was appointed Assistant Director (Applied Mechanics Division) in the National Physical Laboratory of India, New Delhi. During the 8 years of his stay in the laboratory, Mr. Cadambe took an active interest in developing and equipping his Division.


MR. V. CADAMBE

Mr. Cadambe has a large number of scientific and technical papers to his credit. They include contributions on elasticity, photoelasticity, vibration and structural engineering, industrial testing and technical education. He is the author of a valuable report entitled *Engineering Research in India*.

Mr. Cadambe is a fellow of many scientific and learned societies in India and abroad. He is an Associate Fellow of the Royal Aeronautical Society, London; the Institute of Aeronautical Sciences Inc., U.S.A.; the Institution of Metallurgists, London; and the National Institute of Sciences of India. He is a member of the Institution of Structural Engineers, London; the Institution of Mechanical Engineers, London; the Institution of Mechanical Engineers, India; the Applied Mechanics Society of India, etc.

Biosynthesis of Alkaloids in the Plants

C. L. MADAN & B. MUKERJI
Central Drug Research Institute, Lucknow

THE object of this review is to present a critical account of the recent findings and some of the earlier work on the biosynthesis of alkaloids in the plants. No attempt has been made in this article to cover other aspects of the physiology of alkaloids, for which reference should also be made to the excellent contributions of Dawson[1], Hegnauer[2], Iljin[3], James[4], and Mothes[5]. The review by Mothes was the last on the subject and covered the literature up to October 1954. The formulation of a general theory of the biosynthesis of alkaloids in the plants is an obviously difficult task; however, a few suggestions have been made in this article which can be taken only as tentative.

There is no doubt that the central problems in the biosynthesis of alkaloids are the characterization of the synthetic mechanisms and other physical and chemical systems within the plant organism, and the manner in which the heterocyclic rings originate in the plant. The great majority of alkaloids are produced by highly evolved plants possessing most complex physiological and structural organization. Uptil now it is not clearly understood whether alkaloid formation in the plant is the result of synthetic or degradative activities, and whether there is some relationship between the alkaloids and the general physiology of the plant.

The theories about the biosynthesis of alkaloids in plants are based chiefly on the relationship between the amino acids of the proteins and the alkaloids occurring in the plants. The impression prevalent is that alkaloids being nitrogenous must be produced parallel with or as a result of some phase of the protein metabolism — either protein synthesis or breakdown of proteins[1,4,6]. Amino acids have long been regarded as the starting point in the synthesis of alkaloids in plants. All amino acids are not considered equally suited for this purpose and speculation has favoured a few as precursors for different types of alkaloids. This has largely been confirmed by the isolation of various amines in the plant extracts, the amines being taken as decarboxylation products of amino acids. Jucker[7] cites a number of such examples. The high merit of work done by Robinson[8-10] and Schoepf[11-13] in the development of theories about the biosynthesis of the alkaloids under 'physiological conditions possible in the cell' is well known. This has provided us with an insight into the possible ways by which alkaloids can originate in the plants, but there is no evidence that the type of reactions suggested by them take place in the plants. Until such time, distinction will have to be made between the biosynthesis under 'physiological conditions', i.e. in the laboratory, and biosynthesis in the plant itself.

Mention may be made here of the chemical relationships envisaged amongst the various alkaloid groups. Chemically, quinoline, *iso*quinoline, phenanthridine, quinuclidine, tropane and lupinane ring structures may be regarded as representing the various modifications of the pyridine ring[1]. Pyridine forms the basic nucleus of the tobacco alkaloids showing serial substitutions in the 3-position by derivatives of pyrrole, pyrrolidine, pyridine and piperidine[14]. The quinuclidine nucleus with variously modified quinoline or even indole rings[15,16] attached through a secondary carbinol bridge would make the framework of the cinchona alkaloids.

An increasing amount of evidence is available which seems to indicate that the simplest pyridine derivative in nature, nicotinic acid, is synthesized in a variety of organisms from the most universally distributed indole derivative, the amino acid tryptophane. Establishment of biosynthetic relationships between tryptophaneand nicotinic acid would thus indicate that similar transformations can account for the origin not only of the pyridine alkaloids, but also those of quinoline, *iso*quinoline, quinuclidine, phenanthridine, tropane, indole alkaloids and trigonelline. The possibility that other nitrogen heterocycles in the plant cells also originate from tryptophane was discussed by Winterstein and Trier[17]. Tryptophane skeleton has been found in several other alkaloid series, viz. hypophorine, yohimbine and strychnine. The imidazole nucleus of histidine is present in pilocarpine alkaloids[18]. Opium alkaloids, with a few exceptions, viz. narcotine[19], papaverine[20] and thebaine[20], are indole or indoline derivatives. Rauvolfia alkaloids containing the indole ring belong either to the yohimbine or to the serpentine and tetrahydroserpentine groups of alkaloids. Ajmaline and ajmalinine are indolinine derivatives but their structure is not yet clearly understood. Stoll *et al.*[21] have assumed that in the biosynthesis of alkaloids of the yohimbine, serpentine and tetrahydroserpentine types, as also those of the indoline type, tryptophane and oxy- or dioxy-phenylalanine are the chief components. Earlier, Woodward[22] had postulated these very amino acids for the formation of strychnos alkaloids. Stoll *et al.*[21] have even assumed a relationship between Rauvolfia and strychnos alkaloids; and this is elucidated by the manner in which the indole system in both these alkaloidal groups gets substituted. Proline and ornithine have been suggested as possible forerunners of the tobacco and tropane alkaloids by various authors.

Mechanisms of biosynthesis

Nicotine — In *Nicotiana tabacum*, Dawson[23-25] demonstrated by grafting experiments that the synthesis of nicotine took place in the root and that upward translocation occurs from it through the xylem. He has also shown that the leaves of *N. glutinosa* possess some mechanism by which nicotine is transmethylated to nor-nicotine and that leaves of *N. tabacum* appeared to be void of it. It has now been shown by Pyriki and Mueller[26] that in the various *Nicotianas*, the alkaloid content shifted from the root to the leaves with the growth of the plant, but there are types in which roots possess the highest alkaloidal content. These authors have found substantial quantities of nor-nicotine in the roots of tobacco plant, and it is assumed that in several tobacco types and varieties demethylation of nicotine takes place in the root. These findings are further supported by the work of Bose *et al.*[27] who found that their results regarding the synthesis of nicotine by the tobacco plant did not reconcile with those of Dawson[1]. Bose *et al.* were able to show that the synthesis of nicotine occurred not only in the roots, but also in the leaf or stem when ammonium sulphate or potassium nitrate was supplied to the leaf and stem pieces. They have also reported that tobacco leaves probably possess some inherent capacity for nicotine synthesis, but only when inorganic nitrogen in the form of ammonium sulphate and potassium nitrate or some amino acid precursor is supplied to the leaves. Nicotine synthesis was also observed to occur when the leaves of the tobacco plant were cultured in the presence of arginine, ornithine, proline, tryptophane and anthranilic acid. Maximum synthesis was observed in the presence of tryptophane, followed by proline, arginine, ornithine and anthranilic acid in the order mentioned.

Bowden[28], by studies involving use of C^{14}-labelled tryptophane, found that this amino-acid was not converted *in toto* into nicotine and stated that the possibility of pyridine ring formation from the indole moiety is not excluded. Leete[29] found that lysine did not act as a precursor in the biosynthesis of nicotine. Bothner-By *et al.*[30] obtained similar results and found that neither L (+) lysine-e-N^{15} nor L (+) lysine with all positions marked with C^{14} were incorporated into nicotine produced by the roots of the Turkish variety of tobacco cultivated under sterile conditions. Tso and Jeffrey[31] did not find any pyridine alkaloids in the seeds of 'Robinson' tobacco (*N. tabacum*) but nicotinic acid and nicotine were both found in the seeds of *N. glutinosa*. In the seedlings, in both the cases, nicotine was found in the root and at the same time it was found in the shoot or earlier. Investigations of Dawson *et al.*[32] seem to indicate that the pyridine ring of nicotinic acid could be the biosynthetic precursor of the pyridine ring of nicotine and other related alkaloids. This is an important finding because condensation of nicotinic acid with pyrrolidine or *N*-methylpyrrolidine gives rise to nicotine. According to Dewey *et al.*[33] ornithine could serve as a specific precursor from which the pyrrolidine ring of nicotine is derived and some symmetrical intermediate like it are formed in the conversion of ornithine to nicotine. Leete[34] has shown that ornithine can only be an indirect precursor in the biosynthesis of nicotine[9].

The origin of the methyl or *N*-methyl group in nicotine has received particular attention.

Byerrum and Wing[35] showed that the methyl carbons of choline and methionine could be donated to nicotine at almost the same rate. Byerrum and Hamill[36] observed that carbon of glycine could serve as the precursor of *N*-methyl group of nicotine. The incorporation into nicotine of glycine was as rapid as in the case of choline or methionine. Later Byerrum *et al.*[37] found that 'active' formaldehyde and serine could also be incorporated into the *N*-methyl of nicotine, and the same was found regarding the α-carbon of the glycolate[38]. The methyl group of betaine could similarly be incorporated into the *N*-methyl of nicotine[39], the extent being the same as in the case of choline or methionine. It was further found that with choline-methyl betaine-dimethylglycine appeared. These findings have been interpreted by the authors as an indication of the presence of a choline-oxidase system and that some choline is oxidized to betaine before methylation of nicotine takes place. As glycolate is produced in photosynthesis, presumably by rupture of the ribose-phosphate, it could be an intermediate in the conversion of carbon dioxide to methyl groups during photosynthesis and thus formate might not be the intermediate in the pathway by which the α-carbon of glycolate is incorporated into the methyl group.

Iljin[40,41] has shown that carbon dioxide is fixed both by the roots and the stem of the tobacco plant. Studies with labelled carbon dioxide have revealed that fixation of carbon dioxide by the root is only partial and carbon dioxide seems to enter through the root in the biosynthesis of nicotine. Iljin[42] further found that seedlings of *N. tabacum* did not synthesize any nicotine in the dark.

Nor-nicotine — Dawson[24] has shown that nor-nicotine arises from nicotine in the leaves of certain species of *Nicotiana*. The overall mechanism involved is taken to be an exchange of a methyl group for a hydrogen atom by transmethylation. There is, however, no direct evidence for the enzyme system involved. The same author[24,25] and Smith and Smith[43] are of the view that the capacity for nor-nicotine synthesis from nicotine by the plant is inherited and demethylation of nicotine appeared to be bound with the presence of some gene in the leaf-cell nuclei. Dawson[44] ascribes the formation of nor-nicotine in the green tobacco leaves as being specific of the *N*-dealkylating activity of the leaf tissues and the process to be dependent on some general property like oxidation-reduction potential of the cell contents. Bose *et al.*[45] have shown that the leaf, stem and roots of nicotine plants, *Nicotiana tabacum* and *N. glauca*, contain an enzyme system which is capable of demethylating nicotine to nor-nicotine. The demethylating enzyme appears to be group specific because it helps in the transfer of methyl group from nicotine to ethanolamine and not to guanido acetic acid. Demethylation takes place not only in the leaves, but also in the root and stem provided sufficient amount of the suitable methyl acceptor was available. The results revealed that the demethylating system is present in *N. tabacum* too, and the lack of the methyl acceptor might be due to some gene. Iljin[42] found that in *N. glutinosa* nor-nicotine was synthesized only when the roots were present; *N. glauca*, however, synthesizes it even in the absence of roots.

Anabasine — Anabasine occurs in traces in most cultivated tobaccos. It occurs in appreciable concentrations in the wild *Nicotiana glauca* and in the Russian weed *Anabis aphylla* (Chenopodiaceae)[6] in which, however, aphylline and lupinine have also been reported[46]. It is quite probable that anabasine is synthesized in both the root as well as the shoot of the intact plant. Dawson[23] has shown that in the excised leaves and roots of *N. glauca*, light was a factor in the increase of anabasine content. The same author[25] found that anabasine was produced by excised leaves of *N. glutinosa* fed with DL-*N*-methylene-anabasine and postulated a biosynthetic link between the two. Recent investigations by Leete[29] have shown that the α-carbon of the piperidine ring attached to the pyridine ring is probably derived from lysine. Earlier Robinson[9] had suggested that alkaloids of the pyridine-piperidine group have their origin from lysine or from a progenitor of lysine. The finding of Aronoff[47] that glucose-U-C^{14} could be used as an ultimate precursor of anabasine is of interest.

Tropane alkaloids — Atropine and hyoscyamine are produced by the solanaceous plants *Atropa, Datura, Hyoscyamus*, etc. Scopolamine is found in *Scopolia*. Van Haga[48] has found that cuscohygrine is a constituent of the roots of *Atropa, Hyoscyamus*, various *Daturas, Scopolia, Physochlaine* and *Mandragora* species. Robinson[10] has postulated that the fused piperidine-pyrrolidine ring system of the coca and belladonna alkaloids arise by a Mannich-type condensation of succinaldehyde methylamine and an acetone derivative. Succinaldehyde is conceived as arising in Nature by the degradation of ornithine. The work of Cromwell[49] in this connection is of theoretical interest only, because Diaper *et al.*[50] found no justification for regarding putrescine as an intermediate in the biosynthesis of hyoscyamine. Evans and Partridge[51] have shown that glycine is not a very efficient starting material for the formation of hyoscine and meteloidine in *Datura ferox*. Glycine has been, however, found to be an efficient carbon source for the tropane ring rather than for tropic acid or tiglic acid. Cromwell's finding that ornithine is an intermediate in the biosynthesis of tropane alkaloids has been partly confirmed by the findings of Leete *et al.*[52,53] in the case of hyoscyamine. They found an indication that ornithine is the precursor of the ring system of tropine, but not of scopine, the base present in hyoscine. Hyoscine is presumed to arise from a hypothetical hydroxyornithine. For the pyrrolidine half of the tropine molecule, ornithine might arise from proline which in turn comes from glutamic acid arising by transamination of α-ketoglutaric acid, an intermediate in the tricarboxylic acid cycle of Krebs[54]. According to Van Haga[55], hyoscine or scopolamine is synthesized first from ornithine at an early stage and soon converted into hyoscyamine. Experiments with sterile root cultures of *Atropa belladonna* seem to indicate that ornithine is a precursor of both the alkaloids. In *Datura stramonium*, Marion and Thomas[56] have found that methionine could serve as the source of the methyl group of hyoscyamine. The earlier suggestion by Trautner[57] that hyoscyamine and hyoscine are produced either by the same or similar pathways, from the same precursor ornithine, or that hyoscine is the base to be formed earlier and gets converted later on into hyoscyamine.

Glutamic acid can also be the common source for a number of other amino acids[58]. Ornithine and arginine have long been looked upon as precursors of hyoscyamine and hyoscine, and both these can arise from glutamic acid[59]. French and Gibson[60] investigated the effect of glutamic acid on three weeks old root cultures of *Datura tatula* and found no support for the above contention. However, there is evidence in support of the suggestion put forth by James[61] that the nitrogen of L-hyoscyamine and allied alkaloids might be derived from the δ-amino group of ornithine and, therefore, arginine. Also, arginine, ornithine, ammonia arginase and succinaldehyde have been found to occur virtually in all plant tissues as a result of the arginine cycle of Krebs and Henseleit[62] and Srb and Horowitz[63], but the formation of putrescine has been suggested to be an alternative pathway of the arginine metabolism[1]. Thus the synthesis of putrescine and hyoscyamine is entirely independent of each other. Jindra[64] found that activity of arginase, converting arginine to ornithine, is influenced by various minerals like Mn^{++}, Co^{++} and Fe^{++}. Andries *et al.*[65] found that in *Datura stramonium*, tryptophane stimulated the formation of nicotinic acid and there was evidence that a direct relationship exists between the nicotinic acid level and the alkaloid content of the plant. Van Haga[66] has shown that in sterile root cultures of *Atropa belladonna*, the addition of ornithine and arginine resulted in increased alkaloid formation. Addition of proline increased the formation of cuscohygrine. There is indication that the ornithine-proline metabolism forming the first step in the biosynthesis of cuscohydrine and tropane alkaloids does not seem to deviate very much from that prevalent in the micro-organisms; the presence of an ornithine transaminase in the root juice of *Atropa belladonna* has been cited in support of this contention.

Trigonelline and damascenine — Trigonelline is the methyl betaine of nicotinic acid while damascenine is a derivative of 3-hydroxyanthranilic acid, both well-known metabolites of tryptophane in animals and moulds. Trigonelline and nicotinic acid are believed to be of general occurrence in the plants. Trier[17] had postulated the synthesis of trigonelline from proline by way of δ-amino-valeric acid and nicotinic acid. Klein and Linser[67,68] found that various hydroxy acids as well as ornithine could be substituted for δ-amino-valeric acid. Zeijlemaker[69] observed that in cut pea plants the nicotinic acid content is normally constant, but above a certain level, it is converted into trigonelline. Additions of tryptophane, ornithine, citrulline, pyridoxine and pyruvic acid did not increase the content of nicotinic acid. Blake[70] found in several varieties of corn that trigonelline concentration was higher in the embryos than in the endosperm and there is quantitative evidence that nicotinic acid present was converted to trigonelline. The proportion of nicotinic acid converted to trigonelline during germination is related to the proportions in which both were originally present.

Leete *et al.*[71] found that feeding pea seedlings with radioactive tryptophane did not result in the formation of active trigonelline. Also Aronoff[47] has shown that in soyabean leaves, in an atmosphere of labelled carbon dioxide, 3-hydroxyanthranilic acid did not act as a precursor of trigonelline. These results are surprising in view of the fact that Tatum *et al.*[72] found in *Neurospora* that tryptophane was produced from anthranilic acid. The evidence provided by Zeijlemaker[69] and Blake[70], however, shows that nicotinic acid bears a direct relationship to trigonelline formation.

In the case of mature *Nigella damascena* plants, Leete *et al.*[71] found that feeding of labelled tryptophane did not result in the formation of radioactive damascenine. From their results with feeding of pea seedlings and *Nigella* plants, these authors have concluded that tryptophane mechanism in the higher plants might be radically different from that in the animals and moulds. This, however, needs further confirmation.

Colchicine — Belleau[73] suggested that trihydroxy phenyl-pyruvic acid might be the precursor of colchicine, and that this alkaloid should be regarded as one belonging to the ethylamine group of alkaloids. Santavy[74] has found that the seeds and bulbs of *Colchicum* contain the highest concentration of this alkaloid, whereas its leaves are very poor in alkaloidal content. No experiments are on record concerning the biosynthesis of colchicine.

Ricinine — Ricinine is synthesized by germinating seeds of the castor oil plant, *Ricinus communis*. Dubeck and Kirkwood[75], by feeding germinating castor seeds with radioactive methionine, found that the methionine methyl could be the precursor of the *N*- as well as *O*-methyl groups of ricinine. Bogdaschewskaja[76] found that infiltration of lysine, often referred to as the starting material for ricinine, resulted in increased ricinine formation, particularly in the roots.

Hordenine and methyltyramine — Hordenine is an alkaloidal amine and its formation is restricted to young barley roots during the first three weeks. After a steady increase, a maximum is attained and within a fortnight it disappears rapidly. Recent investigations on the biosynthesis of hordenine and methyltyramine are based on the suggestion put forth by Raoul[77,78] that hordenine is derived from tyrosine which by undergoing decarboxylation forms tyramine and this on a single methylation gives *N*-methyltyramine and then on a subsequent methylation forms *N*-dimethyltyramine (hordenine). In barley, tyrosine is decarboxylated to tyramine, which is methylated by methionine, first to *N*-methyltyramine and finally to hordenine[79-81]. Leete and Marion[82] found that both D- and L-methionine were equally efficient as sources of the methyl groups of *N*-methyltyramine and hordenine. Earlier, Kirkwood and Marion[83,84] had stated that methylation of tyramine was analogous to the synthesis of choline from ethanolamine and that the synthesis of choline in barley proceeded by a route similar to that used in the synthesis of this substance in the rat[85]. James[86] quoting from unpublished results of Mrs. S. V. Barber states that when choline and methionine are added to excised barley embryos in sterile culture, small amounts of *N*-methyltyramine and hordenine are formed. He suggested that probably hordenine originates from glutamic acid rather from tyrosine. This was in view of the fact that attempts to identify a tyrosine decarboxylase were not successful, and a vigorous glutamic acid decarboxylase had already been shown by Beevers[87] to form γ-aminobutyric acid. In a recent communication, James and Butt[88] have referred to the formation of hordenine by a stepwise methylation from tyramine which itself arises from a first step of a basic or amino acid type contained in the endosperm. They are of the opinion that there is no evidence to prove that tyrosine is the first step in the formation of tyramine. A different approach has, however, been made by Frank and Marion[89]. They found by feeding hordenine-α-C^{14} to sprouting barley that methylation of tyramine to hordenine was only partially reversible and hordenine could not be reverted back to tyrosine or phenylalanine. Later Massicot and Marion[90] obtained radioactive *N*-methyltyramine and hordenine by feeding labelled phenylalanine to sprouting barley. Since it is known that in animals phenylalanine is capable of being transformed into tyrosine[91,92] and on the basis of these findings Massicot and Marion[90] are inclined to accept that tyrosine is derived from phenylalanine in the sprouting barley as well.

Gramine — Gramine found in barley is a member of the indole group of alkaloids and a direct derivative of the amino acid tryptophane. Bowden and Marion[93], by feeding labelled tryptophane to sprouting barley, found that the amino acid was a precursor of gramine which is synthesized in the barley plants in top of the leaf[94]. Leete and Marion[95] have presented evidence to show that tryptophane is converted to gramine without any cleavage of the indole-alanine linkage, and that L-methionine could be a more efficient source than D-methionine for the methyl group of gramine from the leaves[82], while formate was found to be a very poor source for the methyl group of gramine. The work of Massicot and Marion[90] has shown that phenylalanine is not a precursor in the biosynthesis of this alkaloid.

Lupinane alkaloids — By grafting experiments Moshkov and Smirnova[96] have demonstrated that lupinane alkaloids are synthesized in the roots of the plants. Galinovsky[97] has mentioned that the postulations put forth by Schoepf[11,12] that lupinane is formed in the plant by an aldol type condensation of δ-amino-valeric aldehyde derivable from lysine and an imino-aldehyde has been considered to be the intermediate. The synthesis of another lupinane alkaloid, sparteine, was achieved by Anet *et al.*[98] from δ-amino-valeric aldehyde and an acetone dicarbonic acid. Van der Kuy[99] found lupinine to be the chief alkaloid in the seeds of *Lupinus luteus*, and it disappeared on germination and appeared again during flowering and fruiting. This alkaloid was never found in the root. Sparteine was found in all plant organs at all times. Schwanitz[100] has shown by graft experiments that in *L. luteus*, *L. angustifolius* and *L. albus*, the alkaloids are formed by the parts of the plant above the soil, including also the hypocotyl and the cotyledons. Van der Kuy[101] has reported in the 'very bitter' and 'Bipal' varieties of *L. luteus*, the occurrence of lupinane and hydroxy lupinane in addition to sparteine and lupinine. In his opinion lupinine is formed from sparteine or lupinane. However, information about the nitrogen and alkaloidal metabolism, and about the mechanism of biosynthesis of the lupinane alkaloids is very meagre and no attempt seems to have been made to test the validity of Schoepf's postulations by feeding the plants with lysine or its metabolites.

Morphine, benzylisoquinoline and related alkaloids — Besides morphine and codeine, six benzyl*iso*quinoline alkaloids are known to occur in opium. Laudanosine isolated from opium is regarded as a derivative of papaverine - *N* - methyltetrahydropapaverine. Fieser and Fieser[18] have postulated a chemical relationship between the alkaloids of *iso*quinoline and benzyl tetrahydro-*iso*quinoline series. Laudanosine is related to the aporphine series of alkaloids. Glaucine and corydine have been suggested as the intermediates in the general pathways of the biosynthesis of these alkaloids and are even closely related to papaverine. Schoepf[13] has drawn structural analogies between morphine alkaloids and those of the benzyl *iso*quinoline series (e.g. laudanosine). He has postulated that alkaloids of both the series might even have a common precursor. In the case of apomorphine alkaloids, a morphine-apomorphine arrangement seems to exist, and Fieser and Fieser[18] have pointed out that the apomorphine structure is of special interest because it establishes the relationship between morphine and benzyl*iso*quinoline alkaloids. Earlier, Robinson[8,9] had postulated that laudanosine, a companion of morphine, might be the possible biogenetic precursor. No doubt the suggestions of Schoepf and Fieser and Fieser are significant but it has yet to be shown that the type of reactions suggested could also occur in the plants. Wegner[102,103] has studied the distribution of morphine in the poppy plant (*Papaver somniferum*) at various stages of the vegetative period. The ripe capsules have about 70 per cent of the morphine whereas in the seedlings morphine is found to occur only in the roots, but after further growth it is also found in the stem, particularly restricted to the upper third of the stem. Wegner is inclined to assume that the synthesis of morphine takes place only in the root and from there the alkaloid is translocated to other parts of the plant through the latex channels. Since it is not known whether translocation can take place through latex channels, the matter needs further investigation.

Cinchona alkaloids — Dawson[1] concluded from grafting experiments that the synthesis of alkaloids within the cinchona plant is localized, but there is little information as to how quinine synthesis can be related to other vital processes in the living plant. In the cinchona group of alkaloids only quinamine is different from the other members, because like cinchonine, it does not contain the quinoline nucleus along with the usual vinyl quinuclidine group, but has a substituted hydroindole. Goutarel *et al.*[104] have stated that the structures of quinamine and cinchonine are of interest because of their possible biogenetical relationship to alkaloids of the yohimbine series. Prelog *et al.*[105] have demonstrated that corynanthine, a minor yohimbine alkaloid, is structurally a link between cinchonamine and yohimbine. Earlier, Woodward[22] had suggested the fission of catechol ring systems such as could be obtained from 3 : 4-dihydroxy-phenylacetaldehyde (or 3 : 4-dihydroxy-phenylalanine) condensation, and which could give rise to strychnine on the one hand and the cinchona alkaloids on the other. Studies by de Moerloose and Ruyssen[106] on the biosynthesis of alkaloids in cinchona plants in an atmosphere of labelled carbon dioxide have shown that the synthesis of alkaloids in the root and bark is independent of that in the leaves, and that the cinchona alkaloids are synthesized in the root and bark and only stored in the leaves.

Stachydrine — This alkaloid is the methyl betaine of proline and can be regarded as the simplest of pyrrolidine alkaloids which includes hygrine and cuscohygrine amongst the other important ones. Klein and Linser[107] have suggested two schemes for the biogenesis of proline, one from ornithine and the other from glutamic acid via pyrrolidine carboxylic acid. Stetten[108] has, however, found that in animals, glutamic semi-aldehyde, an intermediate in the major pathways of proline biogenesis, arises chiefly by a reduction of glutamic acid and only to a very small extent by the δ-transamination of ornithine. The route from ornithine by α-transamination via α-keto-δ-amino-valeric acid is of minor importance in animals, but in the higher plants, this is the only route which has so far been experimentally demonstrated. The work of James[60], and of Leete and Marion[51,52] on the biogenesis of the pyrrolidine ring of the tropine part of hyoscyamine being derived from ornithine, supports this contention. In *Medico sativa* and alfalfa, Leete and Marion[109] found that ornithine was not a precursor of stachydrine or proline. They are of the opinion that in this case the minor pathways in the scheme put forth by Stetten appeared to be blocked and thus for the biosynthesis of proline and, therefore, stachydrine, the precursors might be glutamic acid and glutamic semi-aldehyde. However, Morgan and Marion[110], on the basis of repeated experiments about the role of ornithine in the biogenesis of stachydrine in alfalfa plants, are inclined to believe that ornithine might still be the precursor of stachydrine assuming that the transformation to proline and methylation to the alkaloid occurs at a later stage of growth, possibly at seed formation.

Ergot alkaloids — Jacobs and Craig[111] have pointed out that a combination of lysergic acid, proline, phenylalanine, ammonia and *iso*butyryl formic acid with the loss of four molecules of water would constitute ergotinine, one of the ergot alkaloids. They even isolated L-phenylalanine and D-proline from the non-lysergic acid portion of the ergotinine. It is noteworthy that two amino acids enter into composition to constitute the product of the ergot mycelium; it is also interesting to note that D- and not L-proline was isolated. Sim and Youngken[112] studied the effect of nitrogen provided by supplementary feedings with tryptophane, ornithine, indole, arginine and ammonium sulphate on the growth and biosynthesis of alkaloids in ergot mycelium. They found that the three first mentioned compounds supported alkaloid biosynthesis, but markedly inhibited growth while the two last mentioned did not have any significant effect on growth or alkaloid biosynthesis. Gjerstad and Ramstad[113] have suggested that ergot alkaloids arise either by the biosynthesis of lysergic acid or a related pyridine derivative, or by the fusion of tryptophane with citric, citraconic or some similar acid. Groeger[114] found that the various host plants of ergot did not show any differences in compositions of their amino acid fractions. He observed that by injecting various amino acids or mixtures of amino acids in the internodes of rye, these could be detected in increased quantities in the sclerotia, but in general no effect on the alkaloid content was noticeable, although a slight increase was recorded when the mixture of amino acids used contained tryptophane. Heath and Wildy[115] have reported that there are similarities in the pathways of histidine and ergothionine biosynthesis because labelled acetate was incorporated by the latter too but the glutamate derived from acetate via the citric acid cycle was not incorporated. Wildy and Heath[116] showed that sulphur was taken up by the fungus direct from sulphate itself and did not necessarily derive its sulphur requirements from the labelled methionine. Also histamine, though a constituent of ergothionine, was not utilized in the biosynthesis of the same. Whatever relationship ergothionine might have with the ergot alkaloids is not clear.

Conclusion

Considering the present status of our knowledge about the mechanisms of biosynthesis of alkaloids in plants it may be observed that uptil now it has not been possible for the botanist, plant physiologist or the biochemist to give an answer to the very simple question as to why do the plants produce alkaloids, keeping in view that about 90 per cent of the known plants seem to get along very well without them. As regards the possible relationship between the production of alkaloids and protein metabolism in plants, it must be pointed out that a great variety of plants which also produce and consume proteins are seemingly devoid of the mechanisms for the biosynthesis of alkaloids. Recent work has shown that the production of alkaloids may not be specific for a particular plant. The example of nicotine occurring even in the pteridophytes, *Lycopodium* and *Equisetum* must be considered as sufficient evidence. The concept that alkaloids are produced mainly by the roots or underground parts of the plants from where it is translocated to other parts needs further experimental confirmation as experiments with excised and isolated plant parts have at times yielded results quite in contrast to those achieved by grafting experiments. It might perhaps be best to regard that the formation of alkaloids results from a series of chemical chain reactions, and that alkaloids might be products of complex synthesis rather than products of catabolic breakdown. The biogenetic schemes put forth by Robinson[8,9], Schoepf[13], Fieser and Fieser[18], Stoll *et al.*[21] no doubt add greatly to our knowledge of the subject, but it still remains to be shown that such type of reactions, ' physiologically possible in the cell ', do really take place in the plant cells producing the alkaloids. Most of the precursors have been taken to be the amino acids, about the origin of which also we are not very clear. In connection with some other work, Madan[117] has brought out the fact that in the plants, principally three amino acids, viz. α-alanine, aspartic acid and glutamic acid, are important and these should be looked upon as the primary amino acids which arise directly from α-keto acids via the tricarboxylic acid cycle of Krebs[54]. The other amino acids can be derived from these three in some form or the other as pointed out by Virtanen[118]. It would be of interest to devote attention to the elucidation of the origin of the *N*-group in the various alkaloids. Through recent work some information has been obtained about the methylation processes at work in the plant (cf. also Mothes[5]) but we still do not know about the origin of the amino groups. Since processes like carboxylation-decarboxylation, amination, transamination and deamination, oxidation-reduction, hydration-dehydration are of general occurrence in the plant, it would be of interest to know something about the biosynthesis of alkaloids in the context of these general processes. Special attention should be paid to the role of phenylalanine, tyrosine, tryptophane, arginine and lysine in the biosynthesis of the various alkaloid groups. References have already been made elsewhere in this work about the biosynthesis of various alkaloid groups with these amino acids as the prime intermediates. It will perhaps be advantageous to use mixtures of two or three amino acids with radioactive labels at different positions, rather than use amino acids labelled only at the carbon of the methyl group. Mothes[5] has referred to biosynthesis of melanin and ommochromes from tryptophane and has laid great stress on this amino acid alone. In this connection, it is perhaps better to study the metabolism of this amino acid in the plant in general and see how it deviates from that observed in micro-organisms like *Neurospora*. In young plants, the seat of active protein synthesis are the tips of the root and the shoot, and it should be seen in the alkaloid producing plants, if these also are the zones for the synthesis of the alkaloids. Reference might also be made to the relationships which Reti[119] has drawn for the cactus alkaloids. The cactus alkaloids and some natural bases are biogenetically linked to such aromatic amino acids as phenylalanine, tyrosine and 3:4-dihydroxyphenylalanine. Oxidation of phenylalanine to tyrosine and its conversion to 3:4-dihydroxy derivatives have been experimentally demonstrated in the case of animals[91]. Bernheim and Bernheimer[120] postulated that this conversion could be regarded as a step in normal intermediary metabolism and is probably dependent upon some specific enzyme system. The general occurrence of decarboxylases and tyrosinases as well as the melanization phenomena indicate that biosynthesis of β-phenylalanine in plant tissues might follow a pattern shown to occur in the mammalian tissue by Gurin and Delluva[121]. There is evidently a biochemical relationship between tyrosine derivatives and some substances of the indole type. Thus, it is clear that the problem of alkaloid biosynthesis is particularly linked with the origin of the aliphatic, aromatic and cyclic amino acids in the plants, as well as to the processes of amination, deamination and transamination. Guggenheim[122] is of the view that the alkaloids, amino acids and nitrogen-free substances probably arise in the plant from some common initial materials and then their elaboration proceeds along parallel pathways. The alkaloids or their precursors might even originate first as *N*-free substances and the amino acids might come to be associated with them somewhat later. New isotope techniques being employed in biochemistry and plant physiology might throw light some day on these aspects. To conclude it can be said that the theories put forward on the biogenesis of alkaloids have greatly prompted synthetic approaches that have proved successful under conditions ' physiologically possible in the cell ', and there are a number of examples cited by Jucker[7] where the speculations about *in vitro* synthesis of various alkaloids have resulted in the synthesis of newer and more specific drugs. This in itself is a fine contribution to modern drug research. As for the biosynthesis of the various alkaloids by the plants themselves, it must be admitted that our knowledge is rather limited. It is hoped that modern tracer and other improved analytical techniques, particularly in the field of enzymology, would help to solve this fascinating biochemical problem.

Summary

The recent literature on the biosynthesis of alkaloids in plants is reviewed. The relationships between the various alkaloids and the mechanisms of their biosynthesis are discussed. The significance of the biosynthetic mechanisms under conditions ' physiologically possible in the cell ' and the synthesis of alkaloids in the plants have been considered and a few suggestions have been put forward for further investigations in this field.

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Size Spectrum of Cloud Particles in Monsoon Clouds over Khandala on the Western Ghats

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The results of measurements made on cloud particle sizes in ground-based monsoon clouds at Khandala on the Western Ghats are presented. In normally raining clouds the size distribution of cloud particles even at a small height above the cloud base is wide enough to initiate cloud droplet growth by collision-cum-coalescence mechanism. On the other hand, shallow and relatively stable clouds are associated with a narrow spectrum.

ACCORDING to the present accepted theory of rain formation in 'warm' clouds, a certain degree of heterogeneity of particle sizes is essential for precipitation growth to take place. Under such conditions the bigger amongst the cloud particles fall relative to the smaller ones and, on collision with the latter, grow by association or coalescence. To understand clearly how the required inhomogeneity in particle sizes develops in naturally raining clouds in different meteorological situations and to find out how far precipitation failure in certain areas is due to non-fulfilment of this basic microphysical element in clouds theoretical and laboratory studies alone are not enough. A complete survey of different types of clouds, both raining and non-raining, in regard to their particle size spectrum at various heights and at different stages of their development is also important. Though some data, based on observations from aircraft, have been collected at a few centres, available information is too meagre. Hardly any data are available representing the conditions obtaining in clouds over tropical regions, such as India (a large proportion of total rainfall in these areas is now definitely known to occur from 'warm' clouds) and measurements in this respect are of particular interest.

In the absence of facilities for such measurements by aircraft in India, some preliminary measurements have been made in ground-based monsoon clouds from a hill top on the west coast of India. The data collected are presented in this paper.

Site of observation

The studies were made during a monsoon month (August 1956) at Khandala, a station situated on the Western Ghats — a chain of hills about 500 miles long forming the western boundary of the Deccan plateau and serving as the main watershed for the rivers of peninsular India. Running roughly north to south and parallel to the west coast of India *c*. 20-50 miles away from the sea, the Ghats rising to an average height of about 3000 ft. above mean sea level present an effective barrier in the path of the direct monsoon current during the entire monsoon season (June-September). Khandala, located on the windward side of the Ghats at a height of about 1900 ft. above sea level, is favourably placed for steady development of low clouds and almost daily rainfall during the monsoon months.

To facilitate measurements in freely moving clouds and under conditions as nearly natural as possible, an open site on one of the highest accessible spots in Khandala town, known as Sunset Point, was chosen as the observation site. Two ridges forming a deep valley to the south-west meet at a narrow point very near this site, from where one gets a full and unobstructed view of banks of low clouds forming farther to the west and drifting steadily towards the station. During the greater part of the day time and in relatively fair weather the base of the cloud over the station is generally about 100 ft. above the ground, but descends frequently down to the surface or even lower into the valley below during early morning and late evening or night. Measurements of cloud particle sizes were made mostly during morning and evening hours; many of the measurements related to clouds of a relatively stable or subsiding nature. When a large convective type cloud, in an active stage of development, was seen growing over the observation site, the cloud base often remained higher than the station level, or when such a cloud with a very low base moved over to the place of observation from the west, rain or showers had started already at the site, preventing accurate measurement of cloud particle sizes by the technique employed. Also, under the conditions stated, measurements made pertained to cloud conditions at or very near the base of the cloud and provided little or no clue to changes in size distribution picture as cloud particles moved up with the ascending air.

Experimental technique

Two methods are usually adopted for cloud particle size measurements. The corona method allows determinations being made without disturbing the environment, while the other, based on method of impaction of particles on a treated surface, involves their removal from normal suspension. The corona method, however, is applicable strictly to monodisperse clouds, as it gives only average diameter of particles and not the entire spectrum. In the second method, a suitably coated surface is exposed to the natural or artificially induced stream of cloud particles. The impressions left by the impinging droplets are then measured suitably and related to cloud particle radii, by means of calibrations carried out earlier. Different materials have been used by workers for coating the slides, one of which is a thin film of MgO deposited on a glass slide. The details of the technique used for the preparation of the slide and of the calibration which was followed by us, have been discussed fully by May[1]. Slides coated with magnesium oxide are easy to prepare and keep without undergoing any change for a reasonable length of time. Prolonged exposure to atmosphere, however, brings about a gradual transformation of the oxide to the corresponding carbonate. Only freshly prepared slides were, therefore, used, and photomicrographs were obtained soon after the samples were taken.

Apparatus — A simple camera-like arrangement, consisting of a box, about 5 in. cube, made of bakelite sheet, was used for giving the desired short-time exposure to MgO slides. On one side of the box, at the centre, is an opening, about $\frac{3}{4}$ in. diameter, through which the stream of cloud particles enters the box and impinges on the coated slide within. A camera shutter with adjustable aperture is fitted on this opening, permitting accurate control of exposure time. The slide (3×1 in.) is held vertically with two clips, with the treated surface facing the shutter. With this arrangement, the distance between the slide and the shutter is about $\frac{3}{4}$ in. A toy motor operated by dry cells and working a small exhaust fan fitted behind the slide at the back of the cloud box helps adequate inflow of cloud particles, especially under conditions of weak wind. On the rear side of the box, there is another circular opening, about 3 in. diameter, to help proper circulation of cloud air through the box during exposure of a slide, but it is otherwise kept closed.

The equipment is light and can be conveniently operated by holding in hand. During our measurements, however, this was generally placed on a stand, with the camera shutter normal to the direction of the wind. Photomicrographs of slides were taken at a magnification of 100 mostly on 35 mm. films, each photograph covering approximately 0·7 sq. mm. of the slide. The subsequent measurement of the crater diameters from the photographs was carried out with the help of a suitable projector or microfilm reader.

A total of 183 slides were exposed at different times on different dates spread over a period of 15 days (9-19 and 21-24 August 1956) and the particle sizes were determined from the crater diameters.

Results and discussion

Microscope examination of the exposed slides showed that the number of craters formed on central portions was much larger usually than that in the peripheral regions. Photomicrographs were, therefore, mostly taken of the central parts of the slides. In a few instances when a number of slides had been exposed in quick succession in one and the same cloud, it was seen that the numbers of particles caught on different slides differed appreciably, suggesting variations in concentration of droplets in different portions of the cloud. The same feature has been observed by workers carrying out aircraft measurements within a cloud by flying through it at the same level. Table 1 gives the total number of particles, together with their size distribution, caught on different slides exposed successively between 12.35 and 12.40 hours on 17 August 1956, when the observed mean wind speed was 2 ft./sec. Exposures in these cases were made without applying any suction. Differences in the number of particles as shown may also have been due partly to fluctuations in wind speed and, consequently, in the rate of flow of cloud through the box.

Cloud particle sizes have been determined on the basis of measurements of crater diameters, multiplied by a constant factor of 0·86. Application of a uniform correction factor over all size ranges is not strictly correct. However, considering the order of accuracy aimed at in the present series of measurements, this does not materially affect the results.

Tabulations of sizes of the particles and their distribution under various size groups have been made in respect of those slides on which about 100 cloud particles or more were caught over an area of 0·7 sq. mm. in their central portions, on exposure for 3 sec. From a study of the size distribution curves obtained in different cloud situations it is seen that the nature of particle size sepctrum may be broadly classified under three main categories: (a) narrow spectrum with particle diameter ranging from 6 to 24 μ and peak concentration at or near 12-14 μ; (b) relatively broad spectrum with particle sizes extending up to 36 μ or more, showing rather a flat maximum instead of a peaked distribution; and (c) spectrum of an intermediate type. Representative examples of each of the three types of spectra are presented in the form of histograms, showing the percentage number of cloud droplets in each 2 μ diameter interval. The three patterns are discussed below.

Narrow spectrum (*a type*) — This type of distribution is shown by the histograms (A-D) shown in Fig. 1. The striking feature of this type, apart from the narrowness of the spectrum, is the occurrence of a peak, mostly at 12-14 μ diameter. Of these, histograms A and B (Fig. 1) are representative of situations in which stratus type cloud of small depth continued to drift over the station for a time, but there was no rain within three-quarters of an hour before or after the observation. Histograms C and D (Fig. 1), on the other hand, relate to an occasion when, following a heavy shower for 10 min., clouds lowered down to the ground. The cloud sampled in this case was apparently freshly formed fracto-nimbus below the main raining cloud which had its base originally at a height of 100-200 ft. above the ground. Both the histograms C and D present practically the same distribution picture, although the latter representing conditions 3 min. later shows a tendency of a slight increase in concentration of particles with diameter 14 μ and more, and a decrease in number of particles smaller than 12 μ.

Broad spectrum (*b type*) — One example of this type of distribution is shown in Fig. 2 (histogram E). Observations in this case were made shortly after the cessation of rain which was in progress for about 50 min. Even after rain stopped the station remained engulfed in a heavy cloud, whose base apparently was well below the level of the observation site. A few minutes later rain showers started again. This was one of the very few occasions when cloud particle size

TABLE 1 — SIZE SPECTRUM ANALYSIS OF THE PARTICLES COLLECTED ON DIFFERENT SLIDES

(*Date of observation*, 17 *August* 1956; *mean wind velocity*, 2 *ft./sec.*)

TIME	TOTAL NUMBER OF PARTICLES	NUMBER OF PARTICLES IN THE SIZE RANGE										
		8-10 μ	10-12 μ	12-14 μ	14-16 μ	16-18 μ	18-20 μ	20-22 μ	22-24 μ	24-26 μ	26-28 μ	28-30 μ
12-35 hr.	61	1	—	10	16	11	19	1	3	—	—	—
	69	—	—	13	15	16	9	14	1	—	1	—
12-40 hr.	78	1	19	46	6	4	2	—	—	—	—	—
	130	1	28	87	7	6	1	—	—	—	—	—
	144	2	12	88	25	12	4	1	—	—	—	—

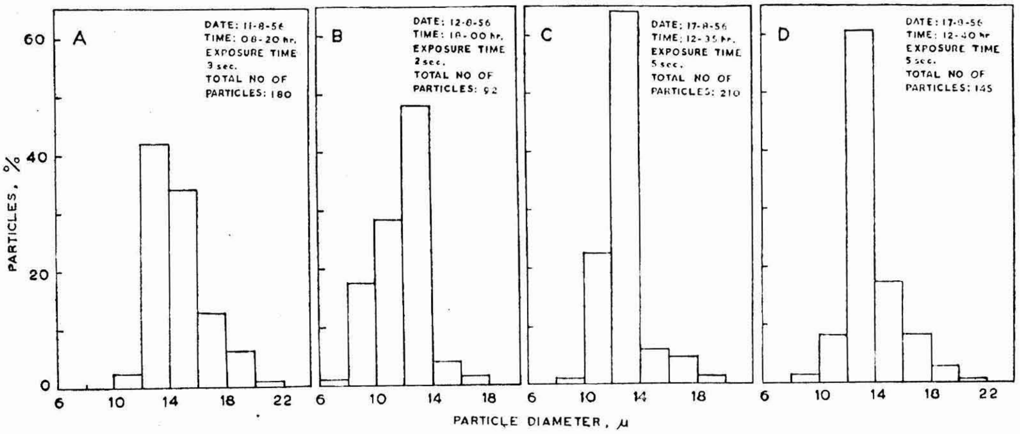

FIG. 1 — HISTOGRAMS SHOWING THE NARROW SPECTRUM TYPE OF PARTICLE SIZE DISTRIBUTION

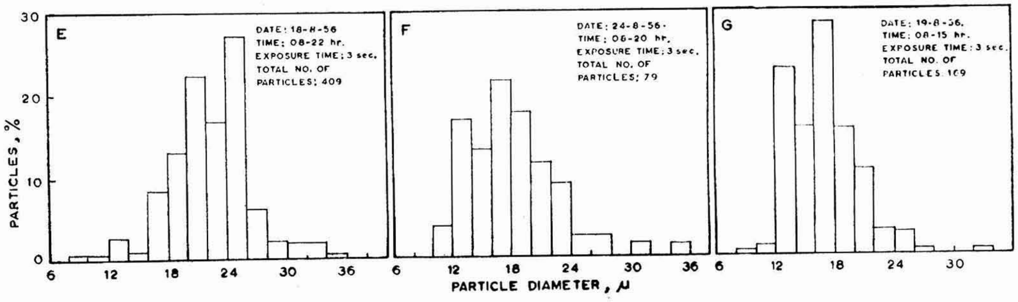

FIG. 2 — HISTOGRAMS SHOWING THE BROAD SPECTRUM TYPE OF PARTICLE SIZE DISTRIBUTION

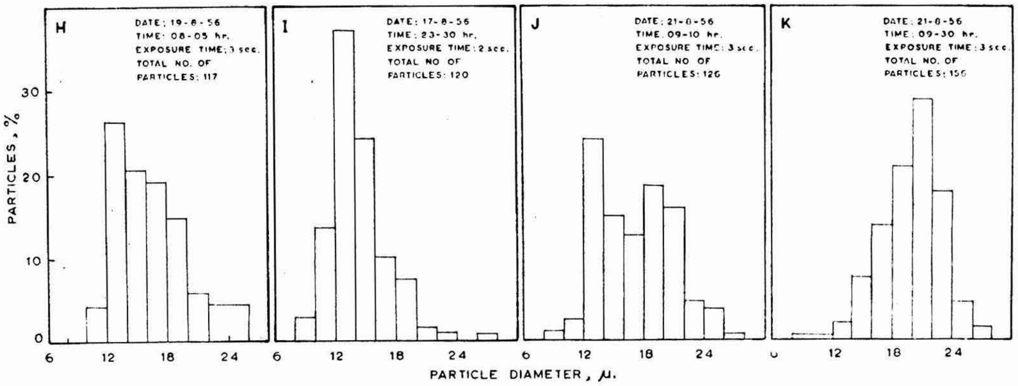

FIG. 3 — HISTOGRAMS SHOWING THE INTERMEDIATE SPECTRUM TYPE OF PARTICLE SIZE DISTRIBUTION

measurements were possible distinctly above the cloud base, and in a cloud which at the time appeared to be in an active stage of vertical development. The histogram (E) in this case covers a fairly wide size range from 8 to 38 μ, and has no pronounced peak but a flat top over the interval 20-26 μ. Histograms F and G (Fig. 2) are two other examples of this type of spectrum.

Intermediate type spectrum (*c type*) — The four histograms H, I, J, K in Fig. 3 are representative of the spectrum of this type. Size spectrum is not as broad as in type *b*, but is slightly wider than in type *a*. Also, in most cases, maximum concentration tends to occur at or near 12-14 μ, although the histograms do not show a sharp peak but rather a flat top as in *b*-type spectrum.

The histograms J and K shown in Fig. 3 relate to measurements in the same cloud, the latter representing conditions about 20 min. later. During this period the cloud drifted very slowly over the observation site and shortly after exposure of the latter slide, rain started at the station. A comparison of the two histograms shows a relative shift of the spectrum towards higher size group, and a change from a flat top distribution with a weak maximum at 12-14 μ, to a somewhat peaked distribution with a peak at 20-22 μ.

In none of the samples discussed above was collected any cloud particle smaller than 6 μ. The smallest particle shown by any sample was in the diameter range 6-8 μ. Failure to detect very small cloud particles has been due apparently to low collection efficiency of our impaction arrangement relative to particles of such sizes. The largest size detected by us is *c.* 40 μ, there being only two cases in the whole series of measurements in which a droplet of diameter 48-50 μ was collected on a slide. Judging from the trend for the large size range, and considering that our measurements related mostly to conditions very near the cloud base, the observed size limit of largest droplet may be taken as reasonably correct. Measurements made by Weickmann and Aufm Kampe[2] have shown that, even well within a cumulus cloud at heights of 500-900 m. above base, concentration of droplets of diameter 60 μ or more is of the order of only 1 particle per 10 cc. of air. Also, Murgatroyd[3] has found that at 300 m. above base in a cumulus cloud mean droplet radius is of the order of 10 μ only, and that only at heights above this one finds a very small proportion of droplets as large as 50 μ in radius. In the measurements reported by Squires and Gillespie[4], which were made in a cumulus cloud at 400 ft. above the base, maximum size of cloud particle caught on most slides was limited to about 60 μ. Considering the small height above the base where our measurements were carried out, and the limited volume of air sampled in each case, our not being able to detect any cloud particle larger than 50 μ, even if these were present in small concentration, is understandable.

The exact rate of flow of cloud air through the sampling box being not known, no attempt has been made to estimate liquid water content, in clouds, on the basis of number and sizes of cloud particles. However, from calculations made relating to one sample (histogram C in Fig. 1), in which sampling was done without any suction by the small exhaust fan, and for which speed of impaction was taken as half the observed speed of wind outside (4 ft./sec.), the value of estimated liquid water (w) comes to about 0·12 g./cu. m., which appears to be of the right order. Zaitsev[5], from his observations in cumulus congestus, found the mean value of w to be less than 0·1 g./cu. m. near cloud base, about 0·5 g. at 600 m., about 0·9 g. at 1000 m., decreasing to less than 0·9 g. at higher levels.

Conclusion

Despite limitations, due mainly to measurements being restricted to conditions at or very near the cloud base only, and that low collection efficiency of the impaction arrangement did not allow correct determinations of size and concentration of cloud particle smaller than 8 μ in diameter, some useful information has been obtained in regard to the nature of particle size spectrum of clouds of different types. It appears that in the normally raining monsoon clouds over Khandala, the particle size spectrum even at a short height of some 100-200 ft. above the cloud base is wide enough to enable the collision-cum-coalescence mechanism to come into operation for the growth of giant cloud droplets to raindrop size. On the other hand, relatively shallow and stable type stratus or fracto-stratus clouds are associated with a narrow spectrum, with few cloud particles larger than 25 μ in diameter.

Acknowledgement

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Electrolytic Recovery of Antimony from Battery Wastes

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A method for the electrolytic recovery of antimony from battery wastes is described. The lead-antimony alloy obtained by melting battery wastes is first subjected to electro-refining in a fluoborate bath to yield anode mud containing 85-90 per cent antimony and 10-15 per cent lead. The anode mud is then treated with sulphuric acid to remove lead as lead sulphate. The insoluble basic antimony sulphate produced is dissolved in a mixture of hydrofluoric and sulphuric acids to give the electrolyte.

Electrolysis is carried out with the addition of clove oil and β-naphthol to the electrolyte and using monel metal cathodes and Acheson graphite as anode. Best deposit was obtained by carrying out the electrolysis at a current density of 10 amp./sq. ft. and at a voltage of 1·6 V. for 4 hr.; the current efficiency was 89 per cent. Under optimum conditions, energy consumption is 0·58 kWh./lb. of antimony. The deposits obtained under these conditions are bright, adherent and of high purity.

THE two important secondary sources of antimony in India are (1) battery wastes containing 8-12 per cent antimony and (2) cable sheaths, containing up to 1 per cent antimony. The antimony recovered from these sources can be reused but the recovered product should be pure and the cost of recovery should not be excessive.

An efficient method for the extraction of antimony employing suitable mixtures of sulphuric and hydrofluoric acids has been developed and found to be suitable for the recovery of the metal from battery wastes on a large scale. By this procedure lead is eliminated as insoluble lead sulphate and could subsequently be processed to obtain high purity lead or lead monoxide by an electrolytic method. The antimony in the wastes is completely extracted and the regeneration of the solvent by subsequent electrolysis is also possible, so that the extraction can be carried out in a cyclic process. The cell voltage for obtaining very pure antimony from this mixed antimony fluoride-sulphuric acid solution is low (1·7 V.).

Raw material

The lead-antimony alloy, obtained by melting battery wastes at low temperatures, was subjected to electro-refining in a fluoborate bath, when an anode ' mud ' containing *c.* 85-90 per cent antimony, 10-15 per cent lead and its oxides and other impurities was obtained. This anode mud was employed as the starting material.

The preparation of electrolyte from the anode mud is not a one-stage process in the sense that the requisite electrolyte composition cannot be obtained by simply reacting the anode mud with the spent electrolyte (mixture of sulphuric and hydrofluoric acids) at the ordinary temperatures. For preparing the electrolyte, the lead in the mud is first converted into lead sulphate, insoluble basic antimony sulphate being formed simultaneously. The insoluble mixture is then treated with a mixture of hydrofluoric and sulphuric acids (spent electrolyte), for the production of soluble antimony fluoride containing sulphuric acid, which is suitable for use as the electrolyte for the deposition of antimony. For the elimination of lead, a minimum of 0·27 lb. of concentrated sulphuric acid per pound of anode mud was found necessary.

Electrolytic cell — A lead-lined wooden tank of 7 × 6 × 6 in. (internal dimensions) constituted the cell. Two anodes (6 × 4 × $\frac{1}{4}$ in.) were hung from copper busbars. The single cathode (5 × 4$\frac{1}{2}$ × $\frac{1}{16}$ in.) was suspended between the anodes. The cathode was well polished and degreased with trichlorethylene. It was also given a dip in a solution of 2 per cent sodium silicate prior to its introduction into the electrolytic cell. The inter-electrode distance (which was maintained at 1·5 in. in all the experiments) did not affect the cell voltage since the electrolyte contains a large excess of sulphuric acid. Power was drawn from a 12 V. accumulator.

Using the above experimental set-up, the influence of various factors on the efficiency of deposition was studied.

Composition of electrolyte

Two compositions of electrolyte were tried. The composition of the electrolyte in the first bath was: antimony, 60; free hydrofluoric acid, 20 and sulphuric acid, 300 g./litre. In the second bath the concentrations of the different ingredients were doubled.

Since the amount of sulphuric acid used was in large excess, the cell voltage was not affected by changes in current density for antimony concentrations above a critical value. The critical concentration of antimony under the experimental conditions adopted was found to lie between 45 and 50 g./litre, and in all the experiments, deposition was carried out at antimony concentration at or above 50 g./litre.

Addition agents

Antimony deposition is influenced by the presence of addition agents in the bath. In the present study, clove oil (0·3 ml.) and β-naphthol (0·05 g.) were employed as addition agents for 3·5 litres of the electrolyte. Excess of clove oil was avoided since it has a deleterious effect on the deposit (dark coloured deposits are produced).

Choice of insoluble anode

Of the many insoluble anodes available, Acheson graphite gave the most satisfactory performance. In the case of lead-antimony alloy (5 per cent antimony), there was some gas evolution and a white film was formed on the anode accompanied by a sharp increase in voltage.

Selection of cathode

Since the electrolyte is a mixture of hydrofluoric and sulphuric acids, the selection of a suitable material for the cathode is difficult. Several single metal and alloy cathodes were tried and monel metal was found to be the most suitable.

In Germany, copper sheet has been employed for antimony refining. Copper sheets have also been employed in the present study, but they were not found satisfactory as the electrolyte used by us attacked them. Moreover, copper did not withstand many strippings.

Good deposits were obtained with stainless steel (18/8) sheets as cathode but its corrosion resistance was rather poor. In the case of electrolytic lead, antimony got plated with the result that the stripping efficiency was very low.

Monel (k) does not get corroded by the electrolyte and has good tensile strength. Hence, a monel cathode and two Acheson graphite anodes were employed in all experiments.

Current density

At current densities greater than 15 amp./sq. ft., only dendritic, black powder was obtained. Hence the experiments have been conducted at current densities below 15 amp./sq. ft. The initial concentration of antimony was 60-120 g./litre and the final concentration was 50 g./litre in both the cases. The electrolysis was carried out at room temperature and the volume of the electrolyte varied from 3 to 4 litres. The results are given in Table 1.

Duration of electrolysis

Continuous electrolysis for more than 5 hr. was found to be unfavourable. This is mainly because there is no circulation of leach

TABLE 1 — ELECTRO-DEPOSITION OF ANTIMONY UNDER DIFFERENT CONDITIONS

CURRENT DENSITY *amp./sq. ft.*	DURATION OF ELECTROLYSIS *hr.*	VOLTAGE *V.*	CURRENT EFFICIENCY %	NATURE OF DEPOSIT
14·4	4	1·8	88	Black dendritic loosely adherent powder
12·0	5	1·7	87	Adherent and bright deposits
12·0	5	1·7	84	do
12·0	6	1·7	77	do
10·0	4	1·6	89	do

liquor and deposition cannot be continued at concentrations of antimony below 50 g./litre.

Under the optimum conditions, the energy consumption was found to be 0·58 kWh./lb. of antimony.

The samples of electrolytic antimony prepared under these conditions were spectroscopically analysed by the National Physical Laboratory and found to be of very high purity; they were also free from traces of lead.

Col. Amin Chand Trust Prizes, 1958

THE INDIAN COUNCIL OF MEDICAL RESEARCH, on behalf of the Col. Amin Chand Trust, has decided to award in 1958 four prizes of the value of Rs. 300 each, to graduates of not more than ten years' standing (counting from the date of graduation) for the best published research work in any subject pertaining to medical sciences including clinical research. The last date for submission of papers (10 reprints) is 1 August 1958. Full details can be had from the Director, Indian Council of Medical Research, C-II Type Flat Nos. 14, 15 and 16, Medical Enclave, P.O. Box 494, New Delhi.

REVIEWS

THE PHYSIOLOGY OF FISHES: Vol. I — METABOLISM. Edited by Margaret E. Brown (Academic Press Inc., New York), 1957. Pp. xiii + 447. Price $ 12.00

While extensive investigations on the physiology of higher vertebrates, particularly mammals, have been undertaken, our knowledge of fish physiology is deplorably poor. Though fishes are of great economic importance, numerous technical difficulties have proved a stumbling block in pursuing this aspect of fish life. We, therefore, welcome the metabolism volume of fish physiology, comprising reviews compiled by competent authorities. Judging by the titles and authors of the volume on Behaviour to come, we expect that it will also be analytically as comprehensive as the volume under review.

Aquatic respiration of fish has been described in a very elementary manner in most text-books; that the cyclostomes do not conform to the respiratory mechanism noticed in other fish is well known. Even in teleosts, as discussed by F. E. J. Fry, many a time the operculum may be put out of action without impairing normal branchial respiration. In discussing the respiratory surface, it is recorded that the vascular fins of *Lepidosiren* allow oxygen to escape to the eggs in the burrow where its content is low. The body surface in the incubating male *Symbranchus* (*Synbranchus*) behaves similarly. In the gills also the flow of blood is always opposite the current of water and thus maximum oxygenation is ensured. Increase of temperature appears to have a deleterious effect on growth; the embryo does not appear to get its quota of oxygen and the development is slowed down.

Some fish go on short excursions on land, leaving temporarily their natural habitat; there are others who on account of depleted oxygen in the water are unable to use their branchiae. These adventurers have developed the faculty of breathing air and this aspect has been admirably described by C. S. Carter. Among marine fish, air-breathing is rare; *Achirus* and two species of *Chiloscyllium* are known to indulge in this method. Fishes frequenting tropical pools and puddles where oxygen content falls considerably have developed this accessory mode. In *Anguilla* (eel), *Periophthalmus* and *Boleophthalmus* the vascular skin aids in respiration. In *Gymnarchus*, it is noted by the author that the arterial supply to the lung-like air-bladder is from the fifth and sixth aortic arches. This probably is not so. In the early stages of *Gymnarchus*, the gas-bladder receives not only from the aortic arches (posterior) but also from the caeliac artery; in the adult, it is from the aorta.

J. C. Mott reviews the cardiovascular system. The veins of fish do not have any valves in them and could be easily drained of its blood if the tail is cut and is held with the head upwards. In some antarctic species there is no haemoglobin in blood. Discussing the alimentary canal and digestion in fishes, E. J. W. Barrington notes that the development of stomach in fishes was dependent on the evolution of jaws and the consequential macrophagous habit. Excretion and osmoregulation form the subject matter of Chapter IV by V. S. Black. Among the dipnoi, no excretion of urine takes place during aestivation and uremia is overcome after the return to water. Ability of fresh-water fish to survive in sea water depends on a number of factors like structure of gills, permeability, oxygen consumption, etc. In the marine fish, glomeruli of the kidneys have no function so that they may degenerate or completely disappear (*Myxocephalus*, *Lophius*, *Opsanus*). In these fish the arterial supply to the glomerulus is also poor. The skin and scales are reviewed by J. Van Oosten. In this connection, the dual origin of the placoid scale is emphasized which is rather debatable. A good account of the usefulness of scales in systematics and life-history studies is given.

Chapters VI and VII are devoted to the endocrine glands, and gonads and reproduction in fishes respectively by W. S. Hoar. It would be no exaggeration to say that of all the vertebrates, we know the least about the piscine endocrine organs and their physiology. While mammals have received most attention, literature discloses a few accounts on fish endocrinology. The mutual gonadotrophic actions of the fish and mammal groups are even today controversial; Hoar states in two places (pp. 249 and 271) that fish do not react to mammalian gonadotrophins and, therefore, the futility of using them for spawning fish. It has been now found, however, that the catfish react successfully to mammalian chorionic and pituitary gonadotrophins. The existence of a corpus luteum in fish is another vexed problem; while in the viviparous cartilaginous fish, a structure simulating the mammalian corpus luteum has been described, whether it also functions in the same way is not yet established. A growth hormone in fish is now definitely known; hypophysectomized fish do not increase in size, and scales and otoliths also stop their growth characteristics. The fish thyroid is not a growth-promoting hormone and probably functions along with somatotrophin. However, thyroid treatment brought about an amphibious life in the blenny which started breathing air.

In describing the appetite of fishes being one aspect of the cause of growth, M. E. Brown notes that environmental factors like temperature and crowding also play a part and that they could be taught to expect food at regular intervals. R. M. Love tells that the biochemical composition of fish is a vexed problem and the results that are available at present should be taken *cum grano salis*.

There is a singular printer's devil on page 66 where crossopterygian has missed a vowel. The volume under review is a mine of information on different aspects of fish physiology and the reviewer gladly recommends the book to every student of fishery biology not only because it furnishes critical reviews but also for the relevant literature at the end of each chapter. The volume is moderately priced.

L.S.R.

REPORTS ON THE PROGRESS OF APPLIED CHEMISTRY — Vol. XLI: 1956. Edited by H. S. Rooke (Society of Chemical Industry, London), 1957. Pp. 795

No single reviewer can critically assess all the contents of a volume covering the entire field of applied chemistry. However, no review of individual chapters of these Annual Reports, which provide a comprehensive coverage of the year's literature and are written by specialists chosen largely from industry and from appropriate Government organizations, is really necessary. With few exceptions the contributors have made no attempt to produce readable stories, and the general object, fulfilled adequately, has been to present briefly a summary of most of the applied chemical work published during the year. The Review of Textile Progress is planned differently and is easier to read; incidentally the chapters on Textiles in the Applied Chemistry Reports might well be omitted in future, since the Review of Textile Progress gives a much more satisfactory account of every aspect of textile chemistry and technology. A similar suggestion may be made regarding the chapter on Colouring Matters in the Review of Textile Progress.

The thirty-eight articles in the volume are grouped into (1) Fuel and Fuel Products, (2) Inorganic Chemistry, (3) Metals, (4) Organic Chemistry, (5) Biological Products, (6) Textiles, Plastics, Adhesives and Paints, (7) Chemical Engineering and Hazards, and (8) Agriculture and Food. The classification and arrangement are not particularly logical; examples are the treatment of leather and antibiotics in neighbouring chapters, the grouping together of Chemical Engineering and Hazards and the inclusion of industrial uses of radio-isotopes in this group, and the treatment of enzymes under Agriculture and Food rather than Biological Products.

Perhaps the time has come for a complete reappraisal of the scope and contents of the *Reports on the Progress of Applied Chemistry*. The present compilation may be replaced, at least in part, by a critical and readable survey of the major advances in chemical technology made during a period of three to five years. In their present form the Reports undoubtedly fulfil a very useful purpose, but it is becoming increasingly difficult to see the wood for the trees. Thus one may fail to note the importance of the Ziegler catalysts or the Procion dyes or the cumene-hydroperoxide process for the production of phenols and ketones; the 1955 Report drew attention to Natta's work on isotactic or stereospecific polymerization as a major contribution to the prospects for polyhydrocarbons, and a fuller account in the 1956 Report would have been valuable.

K.V.

THE MEASUREMENT OF COLOUR by W. D. Wright (Hilger & Watts Ltd., London), Second Edition, 1958. Pp. ix + 263. Price 52*s*.

This is the second edition of the well-known book by Prof. Wright on the measurement of colour. Even though several books on this subject are now available, a second edition of the earlier book by an author who has contributed much to the development of the principle of colour measurement is welcome. Owing to the increase in the range of application of the C.I.E. system of colour measurement, the author has taken the opportunity of enlarging the book by rewriting several chapters.

The first chapter consisting of 24 pages describes the properties of radiation in the visible range. This is followed by a chapter on the functions of the eye. Chapters III and IV discuss in considerable detail the principles of photometry and colorimetry. Full account is given of the earlier work by Guild and also by Prof. Wright himself on the determination of the relative amounts of three specified radiations required to match the colours of the spectrum. The manner in which this data and the concept of the standard observer have been incorporated in the evolution of the present C.I.E. system of colour measurement is described in detail. The background of the principles of the C.I.E. system of colour measurement is discussed in a language which can be understood by a reader with average knowledge of physics and mathematics.

In Chapter V are described various instruments available for colour measurement, both visual and photoelectric.

Among the important fields in which principles of colorimetry have been applied are three-colour reproduction and colour television. Though there are several methods of reconstituting a picture in colour television, the basis essentially remains the same — utilization of three primary colours. An interesting account is given of the present position in the development of colour television in U.S.A.

The last chapter is on practical applications. Some of the industries discussed are lighting, food and agriculture, chemical and pharmaceutical, paint, paper and signal glasses. One of the recent applications is the study of the colour of aurora. There is a concluding section on a new determination of colour matching functions. In a subject of so wide a scope as colour, it is inevitable that emphasis varies and that some topics receive less attention than the others. One would have liked more information about the photometric properties of the eye, such as recognition of colours at low levels of illumination, dynamic visual acuity and colour blindness. In the section on railway signal glasses, there is no reference to the work of McNicholas at the National Bureau of Standards, U.S.A., in 1936. Nor is there any discussion of the principles laying down the limits for signal colours. Measurement of whiteness is another omission even though it is of importance in many industries such as textiles, laundry, cement and sugar. In the section on lighting, measurement of colour of fluorescent tubes is not described. Moreover, descriptions of instruments available for automatic evaluation of colour, such as Nickerson-Hunter cotton colorimeter or colorimeter manufactured by American Optical Co., appear to be rather brief.

W. M. VAIDYA

WORK SAMPLING by Robert E. Heiland & Wallace J. Richardson (McGraw-Hill Book Co. Inc., New York), 1957. Pp. x + 243. Price $ 6.00

Work sampling is defined by the authors as a measurement technique for the quantitative analysis, in terms of time, of the activity of men, machines or of any observable state or condition of operation. This technique consists in observing the different parts of the system at random points of time. This may be used, among other things, to aid in economic analysis of equipment needs, in planning manpower requirements and in determination of time standards and allowances. This will be of much help in providing basic data for effectively solving executive problems.

This book is descriptive in nature and is written in non-technical language. The various stages of work sampling have been discussed in detail and practical hints for a number of situations have been given. The exposition of the p and c control charts is so lucid that even a beginner in statistics can easily understand the implication of these charts. The chapters on preparing for and performance of work sampling are expository and make interesting reading. A number of case studies dealing with the problems like 'office activity in preparation of data processing', 'plant maintenance and construction' and 'loom utilization' are presented in a systematic manner. These case studies should go a long way in selling this technique to the management.

As the authors rightly point out, work sampling is particularly useful in the analysis of non-repetitive or irregularly occurring activity where no complete methods and frequency description are available. In a case study dealing with engineering design and drafting, this technique has been successfully applied to such a situation. The problem was whether to stick to the plan of having the design section grouped into 12 functional units like architectural unit, equipment unit, etc., or to reorganize the section with a view to increase its output. Work sampling revealed that a large percentage of time of each of the groups was spent in consulting another group. On the evidence of this result, the design section was reorganized to form composite groups to reduce the travel to special groups.

It has been repeatedly stressed in the book that the workers should be informed of the objective of the study beforehand and that they should be taken into confidence. This, no doubt, would be the best approach if one is sure that this would not influence their performance. But, in practice, this approach is likely to lead to a study of the situation as it is supposed to be and not as it exists.

In the chapter entitled 'Some Theory of Sampling in General', some statements have been made which are likely to mislead the uninitiated in the field of sample surveys. It is difficult to agree with the authors when they imply simple random sampling or equal probability sampling by 'random sampling', and when they state that stratified or selective sampling consists in drawing a sample from a portion or portions of the entire mass of items. Usually by random sampling is meant probability sampling and it is more general than equal probability sampling. Further the term 'selective sampling' is generally used to denote 'purposive sampling'.

While discussing sampling for estimating proportions, it is stated that the standard deviation of the sample proportion is

$$\sqrt{\frac{p'(1-p')}{n-1}}$$

where p' is the population proportion and n the sample size. But, in fact, the standard error of the sample proportion is

$$\sqrt{\frac{p'(1-p')}{n}}$$

In Appendix 2, Table B, it would have been better if values of $1/\sqrt{n}$ instead of those of $\sqrt{n}$ corresponding to different values of n were tabulated.

On the whole the book makes interesting reading and should be read by all persons interested in analysis of systems or operational research problems.

M. N. MURTHY

FUNDAMENTALS OF ELECTRON DEVICES — McGraw-Hill Electrical and Electronic Engineering Series by Karl R. Spangenberg (McGraw-Hill Book Co. Inc., New York), 1957. Pp. xii + 505. Price $ 10.00

The advent of transistors has led to a rapid expansion of horizons in the field of electron devices. It is important to the research worker, the designer as well as the user of these devices to have an overall picture that covers both vacuum tubes and transistors. This book gives an integrated treatment of the basic theories, the manner of functioning and the applications of transistors as well as vacuum tubes.

The first five chapters give a résumé of the behaviour of electrons in electric and magnetic fields, and inside the atoms. The fundamentals of electromagnetic, atomic and quantum theories are also given, but the treatment of these is necessarily rather sketchy.

The next three chapters deal with conduction in solids, junction effects and electron emission. Topics such as energy band structure, energy distribution of electrons, nature of equilibrium phenomena between carriers across a junction, and various types of emitters, are very clearly explained.

The operation of diodes, multi-electrode tubes and transistors is described in the following three chapters. The value of treating solid state devices and vacuum devices side by side, in giving an integrated picture, is strikingly obvious here.

The following five chapters briefly discuss small and large signal applications and the methods of analysis. In the circuits given as examples, vacuum tubes figure more prominently than transistors, just as the reverse is true in the rest of the book.

A chapter on photoelectric devices and another on noise in electron devices conclude the book. The main text is followed by problems for each chapter, and a combined bibliography. The latter is exhaustive and ingeniously indexed, but is not as easy to consult as when the references are given as footnotes, or at the end of each chapter.

The introductory chapter, as well as the introduction to most topics, give the historical background. In many cases the treatment leads up to very recent developments, such as in cathodes and in transistors. The text thus provides a continuous link between theoretical interpretation of natural phenomena, and development of practical devices, which is conducive to a proper understanding of their interrelationship. Interrelations are further brought out by mentioning devices, which, though outside the field of electron devices, perform similar functions, such as rectification or amplification.

All this provides a panoramic effect. However, the picture is not quite complete, as a large gap is left by the exclusion of gas-type electron devices and the phenomena of electrical discharge in gases. Another group of devices not mentioned is microwave tubes.

The text is lucid and easy to follow. The book is made all the more readable by the fact that there is an emphasis on physical explanation of phenomena, and that most of the mathematics has been put in appendices. However, in some cases, for example regarding injection of minority carriers into semiconductors, the brief descriptive explanation is inadequate to convey a clear impression. The phenomenon is so basic that at least an appendix, dealing with the ratio of currents carried by the two types of carrier at a junction, would have been desirable.

All in all, this is an excellent text-book for students starting a study of electron devices, and a refreshing review for more advanced workers in the field.

AMARJIT SINGH

CELLULOSE RESEARCH (Council of Scientific & Industrial Research, New Delhi), 1958. Pp. vi + 150. Price Rs. 6.00

Cellulose industries are of great importance to India's economy. The annual contribution of these industries to the national income is about a thousand crores of rupees. Recognizing the importance of research aimed at improving the utilization of cellulosic raw materials, the efficiency of processing industry and the quality of the end-products, the Cellulose Research Committee of the Council of Scientific & Industrial Research, during its existence of 17 years, has been sponsoring a number of valuable research schemes at different research centres in the country. With a view to reviewing the current status of knowledge in important branches of cellulose research and affording an opportunity to research workers to present the results of their investigations, it was decided to hold annually a symposium on cellulose research. The present publication records the proceedings of the first symposium held at ATIRA, Ahmedabad, during 4-6 February 1957.

Nineteen papers presented at the symposium are published in this volume. In the introductory paper, the progress of cellulose research in India is traced, with particular reference to research sponsored by the Cellulose Research Committee. Suggestions for promoting research in certain defined fields have been made and the present position of cellulose industries in India and the possibilities for their development discussed. The technical papers are arranged under the following heads: Structure and mechanical properties of cellulose (3); Chemistry of cellulose (7); Pulp and paper (3); Rayon (3); and Jute (2).

LA DIFFUSION DANS LES METAUX — Proceedings of the Symposium on Diffusion in Metals held at Eindhoven on 10 and 11 September 1956. Edited by J. D. Fast, H. G. Van Bueren & J. Philibert (Bibliotheque Technique Philips, Eindhoven), 1957. Pp. x + 124. Price 37*s*. 6*d*.

The eleven papers on diffusion presented at the symposium highlight the important advances that have been made in this field in recent years. The proceedings begin with an introductory paper by Le Claire on theoretical aspects of diffusion illustrated by examples from multi-component systems and including discussion on diffusion mechanism and experimental techniques. The second paper by Compaan and Haven deals with diffusion in ionic crystals exemplified by the diffusion of radioactive silver in silver chloride. In the subsequent paper, Lacombe has dealt exhaustively with the role of grain boundaries in diffusion and has included a critical evaluation of various experimental methods, both direct and indirect. The paper by Leymonie and Lacombe describes an autoradiographic technique which they have adopted for the study of inter-granular self-diffusion in alpha iron at low temperatures. Heumann in his paper has made very interesting observations on the role of vacancies in the diffusion process and he goes on to verify his conclusions taking examples both from systems exhibiting complete miscibility and others exhibiting intermetallic compound formation. The paper by Philibert emphasizes the special advantages of the Electron Probe Microanalyser for studies in segregation and diffusion. This instrument recently developed in France enables quantitative estimations at sites as close as 2 microns apart and this can be achieved in a matter of few minutes. Adda and Philibert have presented details of their findings on inter-diffusion of uranium-zirconium in the gamma phase. The paper by Bolk and Tiedema deals with diffusion in the gold-platinum system. Meijering in his paper has given a critical appraisal of the diffusion of interstitials while Van Wieringen has reported the diffusion of helium in semiconductors such as silicon and germanium. The concluding paper by Berghout deals with the effect of elastic deformations on the mobility of vacancies in copper.

The compilation has special significance for those engaged on diffusion research, specially of the basic phenomena involved. It would have added to the value of the book if the editors had found it possible to include discussions on the papers presented.

The get-up of the book is neat and pleasing.

BRAHM PRAKASH

SMALL APPLIANCE SERVICING by P. T. Brockwell (Jr.) (McGraw-Hill Book Co. Inc., New York), 1957. Pp. ix + 180. Price $ 4.50

This publication deals with the operating principles, construction, testing and servicing techniques of basic household appliances such as irons, toasters, mixers, coffee-makers, waffle-grills, etc. The book embodies the results of the author's long experience in the trade and its practical utility need not be stressed. The author has explained the techniques in clear and simple language, so that one having elementary knowledge of electricity would have no difficulty in understanding them. The set of questions at the end of each chapter adds to the value of the book as they would help the student to think and understand the fundamentals of the techniques better. Numerous photographs and circuit diagrams included in the book make for easy understanding. However, in some cases these are not quite clear and further improvement and possibly different approach is called for. These minor defects, however, do not minimize the utility of the book, for it is, on the whole, well written.

The small appliances' dealer and the servicemen will find the book useful not only for the technical information it contains but also for the clues it provides to make the business a paying one. The book may be used with benefit as an appliance service primer in vocational schools; the book is equally well suited as a self-instruction manual.

S. K. DASGUPTA

PUBLICATIONS RECEIVED

CONFERENCE TERMINOLOGY by Jean Herbert (Elsevier Publishing Co., Amsterdam-London-New York-Princeton; *Distributors*: Cleaver-Hume Press Ltd., London), 1957. Pp. xiv + 147. Price 12*s*. 6*d*.

ELECTRONIC SEMICONDUCTORS by Eberhard Spenke. Translated by Drs. D. Jenny, H. Kroemer, E. G. Ramberg & A. H. Sommer (McGraw-Hill Book Co. Inc., New York), 1958. Pp. xxvi + 402. Price $ 11.00

NUCLEAR CHEMICAL ENGINEERING by Manson Benedict & Thomas H. Pigford (McGraw-Hill Book Co. Inc., New York-Toronto-London), 1957. Pp. xiv + 594. Price $ 9.50

PROCEEDINGS OF THE INTERNATIONAL GENETICS SYMPOSIA, 1956 (Science Council of Japan, Tokyo), 1957. Pp. xxiii + 680

RECENT ADVANCES IN GELATIN AND GLUE RESEARCH. Edited by G. Stainsby (Symposium Publications Division, Pergamon Press, New York), 1958. Pp. 277. Price 70*s*. net

RAILWAY TRACK by K. F. Antia (The New Book Co. Private Ltd., Bombay), Fourth Edition, 1957. Pp. xx + 447. Price Rs. 16.00

NOTES & NEWS

Earth's structure — A new geochemical hypothesis

A NEW GEOCHEMICAL HYPOTHESIS of the structure of the earth based on the new findings relating to the behaviour of matter under very high pressures has been put forward by A. F. Kapustinsky of the Institute of General and Inorganic Chemistry, Moscow. The hypothesis is expected to stimulate further research on the structure of the earth and lead to new concepts of Nature.

Goldschmidt's concept of the earth's interior as zonal in structure, with each zone characterized by certain dominant elements, has recently been found untenable by many scientists who consider the earth as a chemically homogeneous, non-zonal globe. Neither of these views could be accepted on the basis of new findings relating to the behaviour of matter under very high pressures and a more fundamental approach is called for.

The properties of matter and the properties of atoms remain constant only in the crust of the earth, whereas under pressure of hundreds of thousands of atmospheres, the properties of matter change so much that the nature and direction of physical and chemical processes become quite different. With increasing pressure the outer electrons of the atoms are forced into the lower quantum levels ultimately leading to the occupation by the electrons of all the unfilled positions in quantum levels.

Calculations indicate that a depth of 60-120 km. marks the lower boundary of a geo-zone — the ' perisphere ' — in which the outer electrons are pushed into the lower level. This is followed by the ' intersphere ' to a depth of 2900 km., which is made of atoms with ' degenerate chemical properties '. At the centre of the earth is the ' centrisphere ', which is the region of ' squashed ' atoms.

The concept, termed ' periodicity function ', which is based on empirical data, shows that at a pressure of 1,400,000 atm., corresponding to a depth of 2900 km., all the elements are modified to such a degree as to lose their property of periodicity, i.e. all atoms will become identical in respect of their chemical properties. At the high pressure prevailing in the centrisphere all atoms will be in a ' metallized ' state, in which matter will be made of atomic nuclei immersed in a homogeneous electronic ' plasma '. Having no specific electrons attached to them, atoms will cease to be separate elements with definite atomic numbers, definite chemical properties and reactions in this region of ' zero chemistry '. On the other hand, in this state matter will be characterized by such a high electrical and thermal conductivity that the temperature of the whole of the ' centrisphere ' will remain constant.

The hypothesis outlined is also supported by certain thermodynamical considerations and seismological data [*Nature, Lond.*, **180** (1957), 1245].

New particle models

TWO NEW MATHEMATICAL PARticle models based on Einstein's general theory of relativity. have been proposed by two groups of mathematical physicists at the Syracuse University and the Aeronautical Research Laboratory, Dayton. Detailed analysis of the models has indicated, besides the many hitherto known particles, the probable existence of some more undetected particles which differ completely from those so far discovered.

One model analyses particles in terms of the curvature of space-time in the surrounding region. The other model relates the usual observational astronomical data to the individual quantities that can be constructed within the general theory of relativity. The above new models and concepts provide for the first time a complete set of quantities which are independent of the observer and which together uniquely characterize a physical situation in general relativity [*Sci. Newslett., Wash.*, **73** (1958), 99].

Physics of water and ice

THE PHYSICAL PROPERTIES OF water and ice have an important bearing on a number of fields like glaciology, aeronautics, meteorology, etc. A discussion on ' Physics of water and ice ' held recently at the Royal Society, London, reflects the interest that is being evinced in the subject. The discussion covered such aspects as the structure of water and ice, the nature of hydrogen bonds in water and ice, ice-water and water-vapour transitions, etc., as deduced from studies on neutron diffraction, infrared absorption spectra, relaxation processes, electrical conductivities of ice and water, etc.

The result of X-ray, electron, and neutron diffraction experiments with ordinary and heavy ice have shown that both the forms show some degree of differential contraction along the *a*- and *c*-axes on cooling, tending to make the intermolecular distances of the water molecules in ice more nearly equal at lower temperatures.

Neutron diffraction studies indicate an almost completely random position for the protons along the hydrogen bonds. Infrared absorption studies of single crystals of ice also favour an almost isotropic random hydrogen bond structure for ice. Infrared absorption studies of water adsorbed on alkali halides were also reported. Observed shifts in the frequencies of the 3000 $cm.^{-1}$ band were interpreted in terms of water molecules attached by hydrogen bonds to the negative ions. With thicker layers of adsorbed water, bands were found to appear in the 2000 $cm.^{-1}$ region, corresponding to molecular deformation plus a libration of the molecule against the forces of association with other molecules. Body-centred alkali halides show additional bands which suggest attachment of water molecules to positive ions.

Studies on the relaxation processes, particularly dielectric relaxation in ice, revealed that only a part of the phenomenon is attributable to the presence of hydrogen ions in the form of oxonium and hydroxyl ions. The presence of L- and D-protonic defects in ice, in which the oxygen atoms are only slightly displaced, is postulated. L-Defects consist of two neighbouring oxygen atoms between which there is no proton; in D-defects two protons are more or less collinearly arranged between oxygen atoms.

X-ray diffraction patterns and infrared absorption of water show that in the structure of water there are approximately six molecular neighbours at distances varying from 3·0 to 3·4A. from any given molecule.

It has been observed that temperature alone determines the particular habit adopted by ice crystals, except at high supersaturation when dendritic growth occurs. In the temperature ranges from 0° to −3°C., −8° to −12°C. and −16° to −25°C., the crystals generally are hexagonal plates. From −3° to −8°C., and below −25°C., the predominant form is either the elongated hexagonal prism or the hollow prism which sometimes has a spiral structure. The fern-like dendritic crystals occur only between −12° and −16°C. Experiments on the supercooling and freezing of water drops show that in the absence of nuclei, supercooling of drops as small as 1 μ in diameter can be effected down to −41°C. and for 1 mm. drops down to −33°C. Crystallization at these temperatures is almost explosive [*Nature, Lond.*, **181** (1958), 380].

Energy spectrum of cosmic radiation

A MECHANISM TO SATISFACTORILY explain the observed remarkable characteristic of the spectrum of cosmic radiation, viz. that the energy of the radiation is given by a function involving a power (higher than unity) of the momentum, has been proposed by Prof. H. Alfvén and Ernst Aström of the Kungl Tekniska Högskolan, Stockholm. This new hypothesis combines the consequences of the betatron effect with the assumption of scattering or diffusion of the particles to explain the nature of the energy spectrum ($E = C.p^{-n}$ where E is the energy, C, a constant, p the momentum and n, a constant value of about 2·5 for several powers of ten of p). Fermi's theory to explain this type of relation between energy and the momentum requires that the time of acceleration τ and the time of absorption (T) should be of the same order of magnitude and their ratio ($\tau/T = n$) should be constant over a wide range of the momentum. These premises are considered improbable.

To derive the power law Alfvén assumes that particles which are injected at low energies are pumped up to higher energies by a pump, the speed of which is a power function of the momentum, there being no considerable loss of particles during acceleration. However, it is supposed that when the particles have reached the maximum energy which can be stored in the accelerator, they leave the accelerator. Thus, the time of dissipation being determined by the time of acceleration, all the particles move up through the energy spectrum in a systematic way. The time they spend in any energy range is inversely proportional to the speed of the pump.

If the magnetic field H in a certain volume U' increases, the momentum p of charged particles in the volume increases by Δp, which is proportional to p. If the particles are scattered or diffused out of U' to an adjacent volume where H is constant and later the field in U' returns to its initial value, the net result would be that a number of particles fU' have increased their momenta by

$$\Delta p = \alpha p$$

where α is constant. If the process is iterated and low-energy particles are injected at a constant rate, this leads to a power spectrum with $n = 1$.

In the neighbourhood of the sun under the influence of varying magnetic fields produced by solar activity the value of n may be changed for geometrical reasons. Particles that have gained enough energy diffuse away from the environment of the sun and fill a volume U which may be put equal to $U = \beta.p^b$ where β is a constant and $b = 2$ or 3 depending on the properties of the trapping field. The rate of acceleration of of the diffused particles would be slower as α decreases with increasing distance from the sun. Hence α depends implicitly on U and may be connected by the relation

$$\alpha = a.U^{\nu}$$

When an equilibrium is attained the number dn of particles possessing a certain momentum p should be independent of p, and thus $Uf\Delta p = \text{constant}$. From the above interrelations it can be shown that $f = \text{constant}.p^{-n}$, where $n = b(1-\nu)+1$. For the observed value of $n = 2{\cdot}5\nu$ comes out as 0·25 for $b = 2$ and 0·5 for $b = 3$ [*Nature, Lond.*, **181** (1958), 330].

Spatial asymmetry in π-μ decay

RECENT OBSERVATIONS BY A group of physicists at the Institute of Atomic Physics, Bucharest, on the decay of pions at rest in nuclear emulsions have revealed large asymmetries in π-μ decay phenomena. Nuclear emulsions were exposed to pions produced by the large synchro-cyclotron at the Institute of Nuclear Research near Moscow. The π-μ decay events were classified into two groups depending on whether the muon momentum was directed forwards or backwards with respect to the pion momentum immediately before stopping. Out of 3595 events, 2199 backward and 1396 forward decays were observed. Assuming the angular distribution to be of the type $(1+b\cos\theta)$, θ being the angle between the two momenta, the asymmetry parameter, b, was found to be $-0{\cdot}447 \pm 0{\cdot}032$, which, differing from zero by more than 14 standard deviations, could not be ascribed to a statistical fluctuation. Also, the longitudinal polarization of the pion beam would mean non-conservation of parity hard to reconcile with the observed conservation of parity in nuclear forces.

Various kinds of anisotropy in π-μ decay have also been reported by a few other groups of workers in this field. In each case, however, the experiment has been extended to the electrons afterwards emitted in μ-e decay. The angular correlation in the μ-e decay is well known and comparatively small in nuclear emulsion (asymmetry parameter, numerically smaller than $-0{\cdot}20$). It follows that the π-e correlation, through two decay processes, should be much smaller than the simple π-μ correlations. This was not found to be true, indicating that the effects observed were not physical but due rather to hitherto unsuspected distortions or scanning biases in nuclear emulsion work.

An asymmetry in the π-μ decay could mean that the pion has a finite spin, most probably

2 units of $h/2\pi$. This contradicts previous concepts about pion phenomena interpreted on the basis of zero spin for the pion. Alternatively the effect could mean that present ideas about space which lead to connections between angular momenta and spatial probability distributions are not true [*Nature, Lond.*, **180** (1957), 1245].

Direct determination of velocity of sound

THE U.S. NATIONAL BUREAU OF Standards has developed a simple, quick and precise method for determining the velocity of sound in non-dispersible liquids and solid media. The high accuracy of the method is of significance in the calibration of field velocimeters used in underwater sound research because of the large discrepancies (exceeding the accuracy of the measuring methods), in the existing data obtainable by these instruments. The new method gives useful data on the smooth variation of velocity in liquids and solids with temperature over considerable ranges of temperature which is not available now. The velocity values combined with density data also enable determination of the adiabatic compressibility and ratio of specific heats.

Velocity measurements are made in a confined tube the ends of which are plane parallel quartz crystals which serve as electro-acoustic transducers. An extremely short electrical pulse is impressed on a transmitting crystal; an oscilloscope connected to a receiving crystal shows a series of received pulses arising from the reflection of the impressed sound pulse between the two transducers. The received pulses are separated by the travel time of the pulse over twice the length of the tank. The travel time divided by the total path length is the velocity of sound.

A sine-wave oscillator generates the exciting pulses and applies repetitively to the transmitting crystal by a blocking oscillator. By varying the frequency of the sine-wave oscillator, a coincidence is obtained between the first received pulse corresponding to a particular electrical pulse and the first echo of the preceding pulse. After amplification, this coincidence is observed on an oscillograph screen. At coincidence, the frequency, which can be measured with an electronic counter, is the reciprocal of the travel time. Knowing the travel time and the path length from the dimensions of the tube, the velocity of sound is easily calculable.

The method has been used to calculate the values of velocity of sound in water at 83 temperatures between 0° and 100°C. with an accuracy of 1 in 30,000. The values are fitted into a fifth-degree polynomial [*Tech. News Bull., U.S. Bur. Stand.*, **42** (1958), 38].

Extension of kinetic theory of gases

A WIDE-RANGE INVESTIGATION ON the statistical mechanics of time-dependent phenomena undertaken at the thermodynamics laboratory of the U.S. National Bureau of Standards has led to an extension of the kinetic theory of gases to imperfect gases.

Though Boltzmann's hypothesis, derived with the help of a statistical postulate, is highly plausible and a number of its consequences were supported by experimental verifications, there had not been available a simple way of deriving the hypothesis from the principles of statistical mechanics. The recent efforts of Kirkwood, Green, Bogolyubov and other workers to provide a more satisfactory treatment are limited to the domain of non-quantum dynamics. The present study represents a significant conceptual difference from any of the earlier treatments which took into account only the effects of collisions involving a pair of particles. The new treatment introduces additional terms which take account of simultaneous collisions among three or more particles.

In the case of time-dependent phenomena, the motion of an isolated system of mass points, i.e. a statistical mechanical model, is explained by means of dynamical equations whose solutions are known to have a repetitive if not periodic character. On the other hand, time-dependent processes in bulk matter, e.g. fluid motion, chemical reactions, heat conduction, diffusion, etc., lead, through a series of ever-decreasing oscillations to an equilibrium state from which there is no tendency to repeat the initial state. Thus, an apparent paradox presents itself, viz. how time-dependent phenomena in the statistical-mechanical model of an imperfect gas, which is of the same type as the solar system, can nevertheless exhibit the approach to equilibrium, characteristic of all kinds of bulk matter including imperfect gases. One of the most promising and satisfactory solutions offered by various mathematicians and physicists is as follows: Irreversible behaviour, like many of the laws of equilibrium statistical mechanics, is an approximation that holds strictly only in the limit of large volumes and numbers of particles. When the number of isolated mass points is as large as it is in bulk matter (i.e. in portions large enough to be conveniently observed) the times of repetition are extremely long. For a system containing as many particles as a drop of water, the time intervals between recurrences of similar states are enormously longer than the time scales of ordinary experience. Thus, the statistical-mechanical model of an imperfect gas need not exhibit repetitive processes for all practical purposes. The consequences of the derivation of the Boltzmann equation evolved at the Bureau's laboratory support the above interpretation.

Having thus rationalized the situation, it becomes possible to employ concepts used in treating states of equilibrium in gases in the case of time-dependent phenomena. For instance, in such phenomena, the virial expansion of the equation of state can be obtained by working out the successive coefficients of the power series of the expansion employing statistical-mechanical methods from the interaction energy of groups of 2, 3 or more molecules.

Similarly, in the time-dependent theory of imperfect gases, expansions in powers of density can be set up for properties like molecular velocity distribution and ultimately the transport properties like viscosity, heat conduction, etc. In this case, the successive coefficients are determined not only from the energy of interaction but also from an analysis of collisions involving 2, 3 or more molecules. This procedure is inherently more difficult than the analogous problem for the equation of state. The effect of increased pressure (or density) on the transport properties of monatomic gases is being carried out at present on the above basis.

The results of such an investigation have applications to the theory of other effects in gases brought about by or involving intermolecular collisions, e.g. the pressure broadening of lines in microwave and other spectra, particularly in the pressure range extending up to a few hundred atmospheres. At still higher pressures such an analysis is not possible in terms of multiple simultaneous collisions [*Tech. News Bull., U.S. Bur. Stand.*, **41** (1957), 145].

Samples for infrared spectroscopy

A SIMPLE TECHNIQUE IS DEScribed by which mulls of a wide variety of materials like textile fibres, viscous, plastic and rubbery substances can be quickly prepared for infrared spectroscopic examination. The material is ground between ground glass plates. Pairs of glass plates are ground together with 220 mesh carborundum powder until uniformly rough and then rubbed together using a few drops of paraffin as lubricant until no further glass powder is produced. Most materials in powder or crystalline form can be mulled in *c.* 30 seconds by placing a small quantity of the material between the plates, together with a few drops of paraffin or hexachlorobutadiene, and rubbing manually with a circular motion. Textile yarns cut to short lengths (*c.* 0·5-2 mm.) and fabrics cut diagonally across the weave to produce similar short lengths of yarn are mulled a little at a time, adding more yarn and paraffin at intervals. Plastic and rubbery materials require the addition of sodium chloride to the mull to act as a mild abrasive and diluent. The glass plates are cleaned by mulling a small quantity of sodium carbonate and water, and washing them under a tap and drying. This technique has enabled a satisfactory infrared spectrum to be made of any material [*Chem. & Ind.*, (1958), 95].

A new phospholipid

A NEW PHOSPHOLIPID, PHOSPHAtidyl glycerol, has been identified by research workers at the Department of Agricultural and Biological Chemistry, University of Pennsylvania. This phospholipid is reported to occur in a wide variety of plants (leaves), in animal liver fats and in algae. Because of its simple structure, this phospholipid eluded identification for the past thirty years and a clue to its identity was finally obtained in green algae employing radiocarbon and radiophosphorus-labelled nutrients. The identification of this phospholipid is expected to resolve many unexplained facts about phospholipids and is already reported to have provided an explanation to some unusual experimental observations regarding synthesis of sugar by plants.

Phosphotidyl glycerol has in its molecule two glycerol molecules in contrast to normal fats. It has two fatty acids and one molecule of phosphoric acid which holds the two glycerol molecules together. Although these components are the usual components of fats, they exist in such simple and symmetrical arrangement that their identification by the usual chemical methods was not possible [*Chem. Age*, **79** (1958), 388].

Cell-free yeast homogenate

A SIMPLE METHOD FOR THE PREparation of cell-free yeast homogenate has been developed at Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts. Cell-free yeast preparations have been recently used in the study of biogenesis of sterols. The homogenate is responsible for the conversion of acetate to sterols.

Twenty g. of dry baker's yeast (Fleischmann) is suspended in 80 ml. of 5 per cent aqueous glycerol solution and stirred vigorously for 2 hr. at room temperature with a Herschberg wire stirrer. The suspension is then centrifuged 'at 1000 g. for 30 min. in the cold, and the supernatant is dialysed against four changes of distilled water over a 24-hr. period at 7°C. to remove the glycerol. The homogenate (approximately 60 ml.) contains particulate material but no whole cells or cell-wall debris.

The homogenate remains active for a long time. In several experiments a small increase in incorporation of C^{14} into sterols was found even after a 96-hr. incubation. Since the homogenate is apparently not a good growth-supporting medium, proper care during its preparation is sufficient to prevent contamination in 90 per cent of the cases. Passing it through a Seitz filter into sterile flasks prior to incubation eliminates the remaining contaminants [*Science*, **126** (1957), 1065].

Protein analysis

TWO RAPID, RELIABLE AND EASY methods for measuring true protein content of food products have been developed. These two methods replace the expensive, time-consuming Kjeldahl's method.

The first method is based on biuret reaction. Protein in alkaline solution also reacts with copper ions in the same way as does biuret to form a violet copper salt. The reagent consists of alkali copper and small amounts of glycerine. Glycerine stabilizes the copper so that it does not precipitate as the hydroxide. Freshly ground wheat or flour samples when treated with this reagent results in the formation of the violet colour as a result of the reaction between the protein and copper ions of the reagent. The intensity of the colour is read in a colorimeter and the readings are converted to protein values by means of charts that relate colour intensity to protein content.

The second method is based on a reaction between Orange G dye (a water-soluble disulphonic acid dye) and proteins forming an insoluble complex. A known amount of the Orange G dye is mixed with the protein in tubes. Tubes are stoppered and then agitated to allow complete reaction between protein and dye molecules. The insoluble complex and other insoluble flour components are separated from the solution by centrifuging or filtering. The concentration of the unbound dye in the clear filtrate is measured in a colorimeter. The protein content of the flour or wheat sample is related to the concentration of the unbound dye. Protein content can, therefore, be read directly from a table previously prepared.

A single protein analysis can be made within 5 min. when the agitation step is carried out in a semi-micro electric blender container. It is adaptable to automatic techniques and it measures native protein and not nitrogen as in the Kjeldahl's method [*Chem. Age*, **79** (1958), 286].

Determination of tungsten in steel

A DIRECT PHOTOMETRIC METHOD has been developed at the National Bureau of Standards for the precise determination of minute quantities of tungsten in steel. The method offers several advantages over other chemical methods for the determination of tungsten in the presence of other elements normally encountered in iron metallurgy. The method involves the use of dithiol reagent (1, 2-dithiol-4-methylbenzene). With this reagent interference due to other metals is eliminated as it forms complexes with metals.

In practice the steel sample is dissolved in aqua regia. A sulphuric-phosphoric-perchloric acid mixture is then added. The resulting mixture is heated until some sulphuric acid fumes are given off, signifying complete solution of the steel. When dithiol is added to the solution, it combines with any molybdenum present to form a complex which is removed by chloroform extraction. Copper also combines with dithiol, forming a black precipitate and preventing complete molybdenum extraction by chloroform. Since this copper precipitate apparently occludes some of the molybdenum, the solution is filtered through glass wool to remove the interfering precipitate. If there is molybdenum in the original sample, treatment with dithiol and chloroform is repeated. Molybdenum present must be removed completely, otherwise it imparts a green colour to the final blue solution. The solution is then heated to remove sulphur dioxide, which inhibits tungsten colour development, and to eliminate any remaining chloroform.

Before the tungsten-dithiol complex is formed, tungsten is reduced with stannous chloride in the presence of hydrochloric acid. After this step, dithiol is again added, this time to form the bright blue tungsten-dithiol complex, which is extracted in butyl acetate. To check for the possible incomplete extraction of molybdenum, the optical absorbency of the tungsten-dithiol complex in the butyl acetate layer is measured in a colorimeter at two wavelengths, 635 and 720 mμ. Any change in the ratio of the 635 to 720 mμ absorbency values indicates this contaminant. The actual tungsten content of the sample is then determined by reference to a chart or table. Experiments using a second extraction with the acetate show that more than 99 per cent of the tungsten-dithiol complex is removed by one separation.

Fifteen elements — antimony, arsenic, bismuth, chromium, cobalt, lead, manganese, mercury, nickel, platinum, rhenium, selenium, silver, tin and vanadium — were investigated as potential interfering agents in the determination of tungsten; they neither hindered molybdenum elimination nor blocked tungsten colour development.

An accuracy of 0·005 per cent was obtained for samples containing between 0·5 and 0·05 per cent tungsten while an accuracy of 0·001 per cent was indicated for samples with less than 0·05 per cent tungsten. However, as the absorbency of the tungsten-dithiol complex varies with temperature (about 0·2 per cent per degree), measurements should be taken within a 5 degree range to obtain this accuracy [*Tech. News Bull., U.S. Bur. Stand.*, **42** (1958), 36].

Disposal of fission products

IN A PAPER PRESENTED AT THE Symposium on Nuclear Energy organized by the Institution of Chemical Engineers for the British Nuclear Energy Conference, the problem of the safe disposal of fission products was discussed.

The available methods of radioactive waste disposal fall into two categories: (a) complete containment (storage of effluent under conditions completely safe to the public until all or most of the activity has decayed); and (b) dispersion of the activity so that it is greatly diluted. Highly active waste is given complete containment in leak-proof, shielded storage. Because of the high cost of storage (a) this type of waste is segregated to avoid dilution by less active waste which would increase the bulk to be stored and (b) waste is concentrated to the maximum prior to storage.

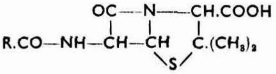
The separation and separate storage of the most long-lived fission products, caesium and strontium, have been achieved. Addition of nickel ferrocyanide to the solution gives a decontamination factor for caesium of 300-1000. Similarly additional decontamination from radiostrontium is obtained by the addition of calcium phosphate. The sludge formed during the scavenging operation settles in the storage tank and decantation in cascade permits separation of a clear supernatant of such reduced activity that it can be dealt with by 'cribbing'. Further chemical treatment of the effluent removes other elements having long half-lives. The Windscale process for medium-active effluents depends on the adsorption of the active materials on alumina floc. The method removes 92-95 per cent of β-γ activity and 98 per cent of the plutonium [*Chem. & Ind.*, (1958), 182].

Antibiotics — structure and activity

THE ANTIBIOTICS WHOSE STRUCTURES have been established represent a large variety of diverse chemical compounds and it is difficult to evolve any guiding principle useful to the synthetic chemist in the development of new drugs. From simple cyclic compounds like sarkomycin containing only carbon, hydrogen and oxygen, the range extends to cyclic polypeptides like the micrococcins containing nitrogen and sulphur in addition. The variety presumably derives from the multitude of ways in which a drug may interfere with bacterial metabolism. The polypeptide antibiotics probably act as surface-active agents on bacteria, whereas the simpler compounds block various stages of bacterial metabolism. Moulds, mostly *Penicillium* species, produce the antibiotics of the penicillin group.

The majority of other antibiotics come from actinomycetes; among others, streptomycin, neomycin, the tetracycline group, erythromycin, viomycin and nystatin. Lichens provide a few antibacterial compounds like usnic acid. Basidiomycetes tend to elaborate highly toxic antibiotics; grifolin is an exception. Both usnic acid and grifolin are comparatively simple compounds without nitrogen or sulphur. Usnic acid, from which a number of experimental chemotherapeutic agents have been made by condensation with various amino compounds, is a diphenyl oxide derivative which can be greatly simplified without sacrifice of antibacterial potency.

The penicillins have a thiazolidine-beta-lactam nucleus:



in which the radical R can be modified and the carboxylic group used for salt or ester formation. By using various precursors in the culture medium, other radicals can be introduced into the penicillin structure, some of the resulting penicillins losing the power to provoke allergic reactions in patients, sensitized to benzylpenicillin. The desire to avoid frequent injections of soluble penicillins led to the manufacture of depot preparations, for example the procaine salt of benzylpenicillin in oily or aqueous suspension. The N, N′-dibenzylethylenediamine salt (benzathine penicillin) serves the same purpose. Preparations intended to reduce the inactivation of soluble penicillin salts in the stomach include the aluminium and N, N′-*bis*-(dehydroabietyl) ethylenediamine salts. The latest addition to this group is phenoxymethyl penicillin (penicillin-V).

Cephalosporin N has an alpha-aminoadipic side-chain in place of the penicillin side-chain R.CO—. This compound, also called synnematin B, is sensitive to bacterial penicillinase, but its relative, cephalosporin C, is comparatively resistant, and would exert a more prolonged activity. Cephalosporin P is a tetracyclic compound with two reactive hydroxyls, and is a monobasic carboxylic acid.

Another sulphur-containing antibiotic, micrococcin P, produced by *B. pumilus*, contains eleven sulphur atoms. It has no reactive sulphydryl groups but the presence of a thiazolidine ring is essential. A similar structure may be assumed for bacitracin (a complex of compounds), with one sulphur atom per molecule and no free sulphydryl group. Bacitracin is rather toxic, like all polypeptide antibiotics, particularly towards the kidney tubules, and its main use is in local applications, where it has low sensitizing potential. It seems fairly well established that antibiotics with the thiazolidine ring structure come within the clinical group of bactericidal compounds, as opposed to bacteriostatic ones.

Streptomycin is a glycoside elaborated by *Streptomyces griseus* and other species. Its basic portion, streptidine, is 1, 3-diguanidino-2, 4, 5, 6-tetrahydroxycyclohexane, which is linked to a disaccharide, streptobiosamine or streptose-2-(methylamino)-L-glucose. Its products of hydrolysis are all inactive against bacteria. The aldehyde group of the streptose moiety, however, can be reduced to the alcohol without appreciable loss of potency or change in toxicity, the resulting compound being dihydrostreptomycin. The main shortcoming of the streptomycin compounds is their dual power to sensitize the patient and provoke resistance in the bacterium. Another effective anti-tuberculous antibiotic, viomycin (from *S. puniceus*) is a strongly basic polypeptide with, like streptomycin, a guanidine moiety. It is more toxic than streptomycin. Viomycin has one primary amino group, but no reactive alpha-aminocarboxyl.

The characteristic of the erythromycin group of antibiotics is a many-membered lactone ring with glycosidally linked sugar residues. Erythromycin, the most active and important member, has a 14-membered ring, while carbomycin (magnamycin) has a 17-membered and methymycin a 12-membered ring. The antibacterial spectra of all these compounds are similar, and resistance to one carries cross-resistance to the others.

Erythromycin has one nitrogen atom, probably as dimethylamino. Oleandomycin, picromycin and hygromycin are other members of the series. None is likely to become important in medicine except as carefully reserved last-ditch remedies for resistant staphylococcal infections. Here they may be life-saving.

Tetracyclines — The tetracyclines form a compact trio of four six-membered carbocyclic rings, differing only in chlorine atom at position 7 (chlortetracycline) and hydroxyl at position 5 (oxytetracycline). The three known compounds differ little in their antibacterial effect; chlortetracycline is appreciably more toxic than others, and its stability is less. These compounds are amphoteric, and their complexing power on metals explain their bacteriostatic effect.

Of the four known stereoisomers, chloramphenicol D-(-)-threo-2-dichloroacetamido-1-*p*-nitrophenyl-1, 3-propanediol is the only one with antibacterial potency. Interference with the dichloroacetyl group, variations in the length of the side-chain, substitution in the phenyl moiety and variation of the nitrophenyl group reduce the potency to less than one-fifth. The nitro group is recognized as undesirable, for it is responsible for the destruction of bone-marrow and anaemia.

The simple antibiotic molecules seem to be associated with anti-tubercular and anti-tumour activity rather than with common antibacterial effect. Sarkomycin, a feeble antibacterial but marked anti-tumour drug, is 2-methylene-3-oxocyclopentane carboxylic acid. Hydrogenation to the 2-methyl acid destroys the antibacterial but not the anti-tumour effect, while rearrangement of the oxocyclic double bond destroys both activities [*Chem. Age*, **79** (1958), 285].

Symposium on photosynthesis

A SYMPOSIUM ON PHOTOSYNTHESIS organized by British Association was held in Dublin on 10 September 1957. The papers presented discussed the actual and potential yields of carbohydrates, etc., in photosynthesis, the chemical nature of photosynthesis, and the photosynthetic bacteria. Conversion of the sun's energy reaching the earth's surface to potential energy is most effectively carried out by photosynthesis in the green plants. If the radiation of utilizable wavelengths alone is considered, then a total yearly fixation of $5{\cdot}6 \times 10^{10}$ tons of carbon as carbohydrates corresponds to an efficiency of energy conversion over the earth's surface as a whole of approximately 0·2 per cent. To obtain higher efficiencies under natural conditions it is necessary to find new varieties or new crop plants which are capable of utilizing efficiently the natural radiation. Unicellular algae offer the possibility of higher yields.

Considerable insight into the biochemistry of photosynthesis has been made possible by the application of paper chromatography and tracer carbon techniques and information has been obtained on the nature of intermediates formed during the synthesis of carbohydrates.

Attempts have recently been made to study the structure of the chloroplast and relate it to its photochemical activity. The electron microscope has revealed a multi-layered structure with areas of high degree of organization, tentatively identified with 'grana' seen in the light microscope. Changes in the structure of chloroplasts occurring during greening of etiolated maize seedlings have been noticed. In the etiolated plant the chloroplasts have an irregular granular appearance but as greening occurred, the development and organization of a layered structure are observed concomitant with the development of photosynthetic activity. The extensive interfacial area produced by a multilayered structure offers a surface suitable for the orientation of chlorophyll molecules. This would result in a concentration of pigment within the interface, thus facilitating energy transfer both between accessory pigment molecules and between chlorophyll molecules. Tentative calculations show a permissible transfer of excitation energy from an absorbing molecule through several hundred other molecules before dissipation. It has been shown long ago that not every chlorophyll molecule, but about only one in every five hundred, was capable of producing oxygen from a brief intense light flash. This would be consistent with a unit of 500-1000 chlorophyll molecules associated with each energy conversion centre. Such a unit is much smaller than the chloroplast or the granum and might be identified with a portion of lamellar interface. The nature of the energy conversion centre at which excitation energy is converted to chemical bond energy is still not clear. Some consider it to be an enzymic link between intermediates of the carbon path and certain individual chlorophyll molecules. Others favour the view that it is a physical structure with polar character analogous to a *p-n* junction. Excitation results in a supply of electrons to one surface and depletion from the other; the electrons and 'positive holes' then initiate respectively the carbon reduction process and oxidation of water to molecular oxygen.

Work on photosynthetic bacteria has yielded many interesting results. Photosynthesis in all three major groups of bacteria, the Chlorobacteriaceae, the Thiorhodaceae and Athiorhodaceae, differs from that in the green plant in that no oxygen is produced and an additional substate — more or less specific to the group — is required. There are a number of features common to photosynthesis in bacteria and the green plant.

All three groups of bacteria contain both chlorophyll and carotenoid pigments and these are located in small spherical particles, the chromatophores. The chlorophyll of the Chlorobacteriaceae appears to be very closely related to the chlorophyll *a* of the green plant; the Thiorhodaceae and Athiorhodaceae have a different chlorophyll which is a tetrahydroporphin derivative. The action spectra for growth and for photosynthesis are similar to the *in vivo* absorption spectrum of the chlorophylls, indicating that the chlorophylls are the primary photosynthetic pigments as in green plants.

Specific cytochromes have been found in the photosynthetic bacteria and are presumed to play a similar part to that of the cytochromes found associated with the chloroplast of the green plant. The bacterial cytochromes are of the *c* class with absorption maxima for the α-band between 550-555 mμ. They are not autoxidizable and differ in oxidation-reduction potential from organism to organism, varying, for example, from −100 mV. for a compound isolated from the green bacterium *Chlorobium thiosulphatophilum* to +340 mV. for a compound from *Rhodospirillum rubrum*. A close similarity is observed in the photochemical activity of chloroplasts isolated from the green plant and chromatophores isolated from the photosynthetic bacteria.

The elucidation of the reactions involving carbon dioxide using isotopes and the comparative studies of photosynthesis in bacteria and green plants emphasize that the basic biochemical pattern is essentially similar to that of the dark metabolism of other organisms, both plant and animal [*Nature, Lond.*, **180** (1957), 1083].

Large-scale production of arginine

SEPARATION OF ARGININE FROM other amino acids in protein hydrolysates has always been a difficult problem and has hindered the large-scale production of the amino acid. A new ion-exchange process developed for effecting the separation of arginine has facilitated the large-scale production of the amino acid. The process has also been successfully applied for the production of L-lysine and can be adapted for several other amino acids.

The basic steps in the process are the hydrolysis of proteins such as gelatin, blood meal or soyabean meal and separation of arginine from the mixture of amino acids in the hydrolysate. Arginine of 99 per cent purity is reported to have been obtained by this process [*Chem. Age*, **79** (1958), 388].

Recent advances in polymer technology

SOME OF THE RECENT TECHNIQUES being employed in polymer technology were discussed at a conference on the Advances in Polymer Technology organized jointly by the Institution of the Rubber Industry and the Plastics Institute in London on 27 February 1958. These include the methods of controlling the internal molecular geometry of many polymers by new kinds of catalysts, methods of controlling molecular weight distribution, new methods for the production of graft copolymers and linear block copolymers. The use of high energy radiation in inducing polymerization and in modifying the structure has passed the laboratory stage and is now ready for commercial exploitation.

A variety of modified masterbatching techniques specially suited to plastics, resin or elastomer have been developed. The modified method has produced significant improvements in tyre tread wear and shortened processing time in the factory. It has brought the two components, rubber and carbon black, together as colloids with minimum physical and chemical interference with their ultimate union.

Expanded polyvinyl chloride (p.v.c.) products (both unicellular and open cell) produced either by chemical blowing agents or carbon dioxide gas are finding many uses. By varying the p.v.c. plasticizer ratio, the hardness of the expanded product can be varied over a wide range. This leads to the production of diverse commercial outfits varying from upholstery to marine and buoyancy materials. The papers presented at the conference will be published in the *Transactions of the Plastics Institute* and in the *Transactions of the Institution of Rubber Industry* [*Chem. Age*, **79** (1958), 449].

Leather auxiliaries — a symposium

A SYMPOSIUM ON LEATHER AUXILIARIES was held at the Central Leather Research Institute, Madras, during 14-17 March 1958. The symposium was inaugurated by Prof. M. S. Thacker, Director-General, Scientific & Industrial Research. Over 180 delegates from all over India representing technologists, traders, tanners, and manufacturers attended the symposium. Delegates from U.S.S.R. and the Philippines also attended the symposium.

Sixty two papers were presented and discussed in the course of five technical sessions: (1) Auxiliaries for pre-tanning, (2) Tanning agents, (3) Tanning extracts, (4) Post-tanning auxiliaries, and (5) Leather finishes. [For detailed report *see Res & Ind.*, **3** (1958), 123.]

Bioclimatology

THE INTERNATIONAL SOCIETY OF Bioclimatology and Biometeorology (ISBB) held its first scientific congress in Vienna during 23-27 September 1957. The meeting was attended by 137 delegates from 33 countries. The papers read at the congress depicted the scope of bioclimatology, its methods, its concepts, and its problems.

A positive achievement of the congress was the demonstration that, in a multi-disciplinary science such as bioclimatology there was a common ground for discussion which would ultimately make possible an integrated approach to the significant problems of human and animal health and welfare. The scope of bioclimatology has to be enlarged so that it not only deals with the physical environmental factors affecting living organisms but also deals with the physiological and pathophysiological mechanisms underlying the responses of the organism [*Science*, **127** (1958), 155].

Geophysical Journal

THIS NEW QUARTERLY JOURNAL published by the Royal Astronomical Society, England, commenced publication in March 1958. The need for a separate journal arose from the inadequacy of the *Geophysical Supplement* to the *Monthly Notices* of the Royal Astronomical Society to provide an adequate medium for quick publication and wider circulation of the rapidly increasing amount of research work being done in geophysics and related subjects. The new journal is intended to replace the *Geophysical Supplement* as well as to widen its scope by including other aspects such as the researches in the upper atmosphere.

The new journal contains original papers, short notes and letters and articles on the progress of geophysics together with book reviews and reports of geophysical discussions.

The annual subscription for the journal is £ 3 or $ 9 or its equivalent in other currencies. Details can be obtained from the Assistant Secretary, Royal Astronomical Society, Burlington House, London W-1.

Announcement

▪ *Award of Doctorate Degrees* — The following have been recently awarded the Ph.D. degree of the Poona University for the theses noted in brackets against their names: Shri Vinayak Narsinha Athavale (*A study of atmospherics in the long wave region*); Shri Chandrakant Gopalrao Khot (*Atmospheric noise interference in the standard broadcast band at Poona*); and Shri Sharad Chandra Dattatraya Ambegaokar (*Chronic dietary protein deficiency in experimental animals*).

INSTRUMENTS AND APPLIANCES

FLAME IONIZATION DETECTOR FOR GAS CHROMATOGRAPHY

A sensitive detector for gas chromatography has been developed which depends on the ionization of the effluent in a hydrogen flame. The gases from a column in a suitable inert carrier are mixed with hydrogen, and burned in air at the tip of a glass jet. If hydrogen is used as the carrier gas, mixing is unnecessary. Two platinum electrodes are arranged to be in contact with the flame, the spacing being not very critical, forming part of an electrical circuit consisting of a balanced cathode-follower impedance transformer. With a 0-1 milliampere meter or recorder connected to the output terminals, full-scale deflection was produced with an injected sample of 1 μl., with a signal-to-noise ratio of better than 1000 to 1, and little base-line drift over a wide range of operating conditions has been observed. The electrical output appears to depend linearly on the sample size (tested up to 10 μl.). As the detector is constructed entirely of glass and metal, it is well suited to the detection of fractions from high-temperature columns [*Nature, Lond.*, **181** (1958), 177].

ELECTRONIC HYGROMETER

A new hygrometer with rapid response, stable characteristics and provision for easy checking, standardizing and remote reading has been developed by Messrs J. C. Shaw Electronics Ltd., Bradford, Yorkshire, England. The device has a small detecting element consisting of a capacitor with a hygroscopic dielectric, a few microns thick, with a 24 carat gold electrode. The detector is contained in a tiny but strong fine wire gauze protector, plugging into a coaxial cable connecting it to the recorder. An important use for the instrument is in quick estimation of moisture content in hygroscopic materials like urea moulding powders correct to one part in a thousand [*Chem. Tr. J.*, **142** (1958), 436].

Progress Reports

THE BOSE INSTITUTE

THE ANNUAL REPORT OF THE BOSE INSTITUTE FOR the year 1956-57 records some significant achievements in the fields of plant chemistry and physiology, and radiation genetics. The Institute is participating in the Cosmic Ray Programme of the IGY and for this purpose two sets of neutron monitoring equipment using enriched BF_3 proportional counters have been set up.

A survey of the saponin-bearing plants of India has been undertaken with the object of finding out new sapogenins which might be utilized for the manufacture of cortisone and sex hormones. During the year, 8 plants, viz. *Barringtonia acutangula* Gaertn., *Luffa cylindrica* Roem., *L. acutangula*, *Albizzia lebbeck*, *Vigna catiang*, *Polianthes tuberosa*, *Phaseolus radiatus* and *Lens culinaris*, were found to contain saponin. Under a programme of surveying the alkaloidal potentialities of the local flora, including non-medicinal plants, a large number of plants were screened. The following plants showed the presence of alkaloids: *Amoora rohituka*, *Beaumontia grandiflora*, *Beilschmidia roxburghiana*, *Canthium parviflorum*, *Clitoria ternatia*, *Diplospora singularia*, *Hunteria corymbosa*, *Jatropha gossipifolia*, *Michelia champaca* and *Pterocarpus indicus*.

A résumé of the main research activities of the different sections during the year is presented below.

Cosmic rays — Analysis of the pictures obtained with the square cloud chamber installed at Darjeeling has yielded interesting results regarding the nuclear diameters of Al, Cu and Pb atoms. The equivalent square well radii determined from the cross-section for nuclear disintegrations (high energy transfers) were found to agree well with the equation $R_c = 1{\cdot}19 \times A^{\frac{1}{3}} \times 10^{-13}$ cm. where A is the mass number of the material. This indicates the same matter distribution in Al, Cu and Pb nuclei as that determined from high energy electron scattering, mu-mesonic X-ray data and high energy neutron absorption data. But the radii corresponding to the total cross-sections follow the equation $R_N = 1{\cdot}34 \times A^{\frac{1}{3}} \times 10^{-13}$ cm. Thus each nucleus appears to be surrounded by an equivalent spherical shell of thickness $0{\cdot}15 \times A^{\frac{1}{3}} \times 10^{-13}$ cm., which is chiefly responsible for the nuclear scattering.

Nuclear physics — Using a flexible neutron howitzer, the scattering cross-sections of protons in liquid hydrogenous molecules have been measured and applying the Sachs and Teller theory of neutron scattering by bound protons to the experimental data, structures of the scattering molecules determined. From the measured cross-section for water, it has been found that water is not a linear molecule. Experiments on glacial orthophosphoric acid have indicated that unlike other oxyacids, hydrogen in this acid is loosely bound to the rest of the molecule.

Chemistry — A colorimetric method has been evolved for the estimation of compounds containing $-CH_2-CO-CHOH$ or $-CH(OH)CHO$ groups. The method is based on the fact that a violet colouration is obtained when compounds containing these groups are warmed with 1:2-dinitrobenzene in the presence of alkali; the colour turns yellow on keeping. The colour intensity can be determined using varying amounts of glucose with the help of a Beckmann spectrophotometer.

Radiochemistry — The path of sulphate reduction by green plants has been studied using S^{35}. The results indicate the initial incorporation of sulphate-S^{35} into taurine-S^{35} to be non-enzymatic. The SO_4^{--} ion is reduced to SH through several steps. The following tentative scheme has been suggested: $SO_4 \longrightarrow HSO_3$ (taurine) $\longrightarrow HSO_2$ (hypotaurine) $\longrightarrow HSO \longrightarrow SH$.

The phosphorus metabolism of higher plants has been studied using radioactive P^{32} as tracer. Incorporation of fluoride into the phospho-intermediates inhibited the rate of total incorporation of P^{32} by *c.* 40 per cent indicating that the fluoride ion suppresses the utilization of glycolytic breakdown along Krebs tricarboxylic acid cycle and results in the diversion of glucose breakdown more towards the pentose phosphate pathway.

Plant physiology — Studies on the problem of spontaneous random falling of mimosa leaflets even when the plants are kept under constant conditions of light, temperature and humidity have indicated that the falls are caused by the flow of plant hormones from the growing stem to the young leaf systems of the plant, especially during rains. The diurnal movement of the mimosa leaflet with the spontaneous evening fall has been found to be related to the change in the volume of the pulvinus accompanying the leaf fall, the diurnal record of the changes of the pulvinus being a replica of the diurnal record of the petiolar movement. This indicates that the evening fall is brought about by the increased mechanical movement of the sub-petiole.

Radiation genetics — A long-range programme on the mutagenic action of different radiations on seeds of economic importance has resulted in mutants with improved characteristics. The following general conclusions were arrived at regarding oil yield from X-ray irradiation studies on sesamum seeds: (1) the best selections giving higher yields than the control in the first generations continue to do so in subsequent generations; (2) the best selections giving a higher yield than the control in the first generation may in any subsequent generation give lower yield than the control, only to give again a higher yield in the subsequent generation; (3) the best selections giving lower yield than the control in the first generation may in a later generation give higher yield, which continues in subsequent generations; and (4) the selections giving lower yield than the control in the first generation continue to do so in the subsequent generations.

The maximum increase in yield (75·0 per cent) was obtained in X_2 generation of sesamum type

10 of 140 ma./hr. treatment. In 200 ma./hr. treatment *c.* 50 per cent higher yields than from the control were obtained.

Irradiation was also found to affect pollen sterility and size. In sesamum types 12 and 16, treatments 36 and 50 ma./hr. gave greater pollen sterility, but bigger grains as compared to controls.

A significant achievement was the *Rai* selection D19/1/3 of 250 ma./hr. treatment which is 25 days earlier in flowering than the control, *c.* 4½ times higher in fruit yield and *c.* 7 times higher in seed weight than the control. In *Rai* (brassica) and brown mustard, the oils of the irradiated progenies were found to contain greater amount of essential fatty acids than the controls and hence their nutritive value is better.

In the case of paddy, best results were obtained from treatment of *Patnai*, a variety of *aman* paddy with S^{35}. A red husked and a small variant were obtained; the former segregated into plants with deep red and light red husks, both with or without awns and with red or green tillers. The small seeded variant segregated into small seeded and normal seeded grains, with or without awns.

Weed control — Studies have been conducted on the destruction of weeds like *Cyperus rotundus* L., *Vicia sativa* L., *Imperata arundinacea* Cyrill, *Ludwigia parviflora* Roxb., *Rottboelia compressa* L. and *Eichornia crassipes* Solms using chemicals such as 2,4-D, Cornox-D, Dicotox, Fernoxone, Crag Herbicide 1, 2, 4, 5-T, M.C.P.A., Cornox-M, Agroxone, Na-T.C.A. The following general conclusions have been drawn: (1) the herbicidal chemicals show greater lethal or injurious action when sprayed in the morning than when sprayed in the evening; heat and bright light cause an enhancement of the herbicidal action in the plants sprayed in the morning; (2) narrow leaved weeds such as *Imperata*, *Rottboelia* are more susceptible to herbicidal attack at the seedling stage than when mature.

INDIAN CENTRAL COTTON COMMITTEE

THE ANNUAL REPORT OF THE DIRECTOR, TECHNOlogical Laboratory, Indian Central Cotton Committee, for the year ending 31 May 1957 records considerable increase in its routine testing work. The number of samples received for testing was 3808 as against 3699 samples tested during the previous year. The Economic and Technical Survey of the existing gins in India undertaken by the Committee has been completed and the results found very useful by the Indian Central Cotton Committee. The results of the survey are being published as a report.

For facilitating routine testing work, two modified apparatuses were developed. The first one based on the torsional oscillation method determines the rigidity of fibre bundles in considerably shorter time than that required in the conventional method in which rigidity of single fibres has to be determined. The second apparatus developed is useful for measuring the frictional force between cotton fibres and studying the relationships between frictional force and fibre properties.

In order to enhance the usefulness of the technological bulletins issued from time to time incorporating the results of ginning qualities of representative *kapas* samples obtained from different sources, it has been decided to include the results of fibre tests such as fibre weight and Pressley strength index.

A number of improved varieties of cotton were evolved which are suitable for cultivation in different regions. Six improved strains, viz. 7036 × V, Dh2 Sel 1-2-1-2, Y1 (old bulk), 2205, 1494 and M 980, have been found to yield finer staple and give significantly better spinning performance. The results of studies on spacing, sowing date and manurial treatments on two varieties, viz. *desi* and Buri 0394, at Amravati showed that normal sowing gives better results than pre-monsoon sowing. Manuring also improved the yarn strength. Post-monsoon irrigation had no effect on yarn strength.

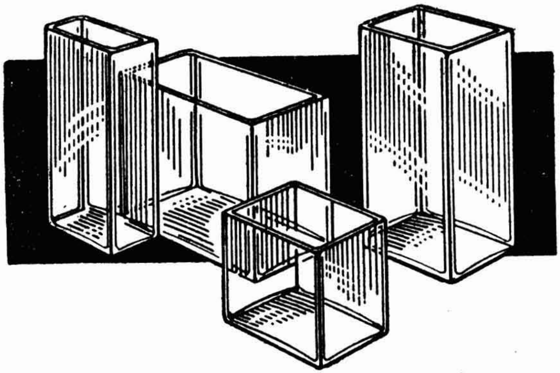
Ginning — Tests on lint samples obtained by large-scale ginning in a saw gin and in a double roller gin have led to the following conclusions: (1) The saw gin gives *c.* 2 per cent lower ginning percentage than the roller gin; (2) the saw ginned lint is more regular than roller ginned lint; (3) the saw ginned lint gives about 3 per cent lower waste losses during spinning than roller ginned lint; and (4) both saw ginned and roller ginned lint give yarns having practically the same lea strength, though the former tends to produce slightly more neppy yarns.

Fibre properties — With a view to correlate the strength of attachment with fibre immaturity, detailed tests on the work of pulling fibres from the seeds and on the fibre maturity on 50 single seeds of Jarila cotton were undertaken using the ballistic tester. The fibre maturity was fairly high (maturity coefficient, 0·95) at the side of the seed and did not vary much. The maturity coefficient at the chalazal end varied from 0·42 to 0·98 and the coefficient between the work of pulling fibres and maturity index was 0·41 which is significant. The mean work for pulling fibres from the chalazal end for 16 seeds in which seed-coat fragments were removed from the chalazal end was 64·2 ergs whereas from the other seeds it was 63·9 ergs. This indicates that this factor is not associated with fibre immaturity.

Studies on fibrillar orientation of 38 cottons by X-ray diffraction showed a significant correlation of −0·67 between the 40 per cent X-ray angle and the Pressley strength index.

Comparison of results on fibre-length irregularity by different methods indicates that values of the Balls sorter mean lengths and the upper half mean by the fibrograph are close to each other for Indian cottons (upper half mean values are to be preferred to the fibrograph mean). The coefficient of fibre-length variation is strongly correlated with the fibre-length irregularity, both these parameters are not associated to any considerable extent with the uniformity ratio. Hence the uniformity ratio is not a dependable statistic for Indian cottons.

Studies on the fibre properties of 55 cottons have led to the conclusion that the mean fibre length, the gravimetric fineness and the intrinsic strength contribute most to the single thread strength for both the 20s and 30s counts. The maturity coefficient and the fibre-length irregularity have very little effect on the yarn strength. The Pressley strength index could advantageously replace the intrinsic fibre strength in the estimation of yarn strength, thus saving considerable time and labour.



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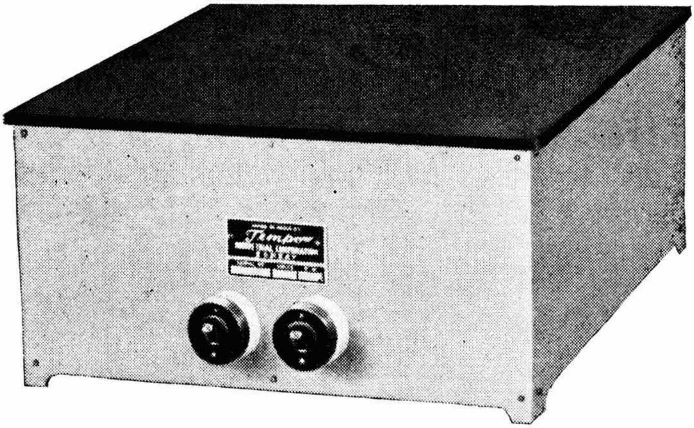

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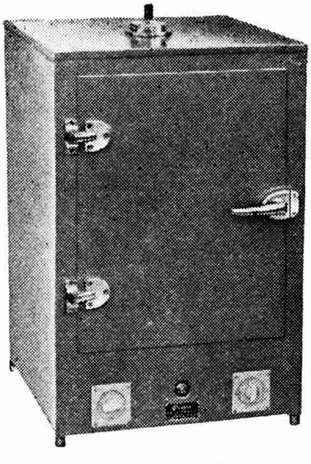

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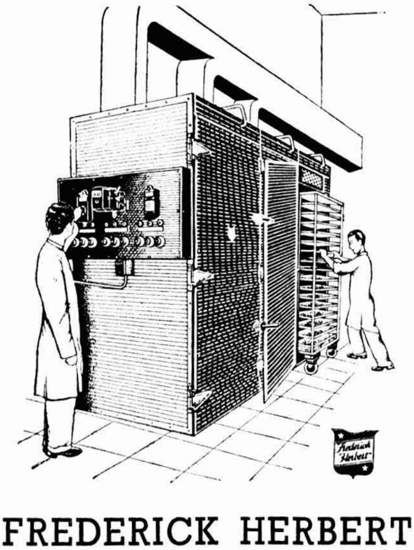
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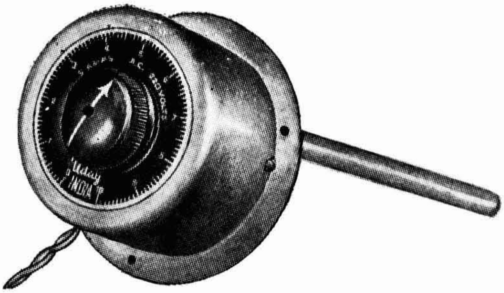

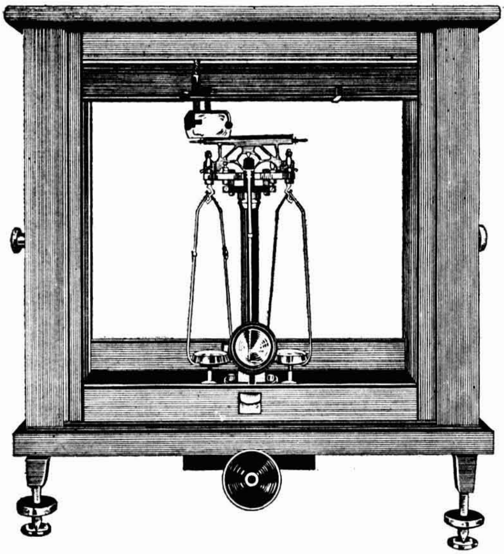

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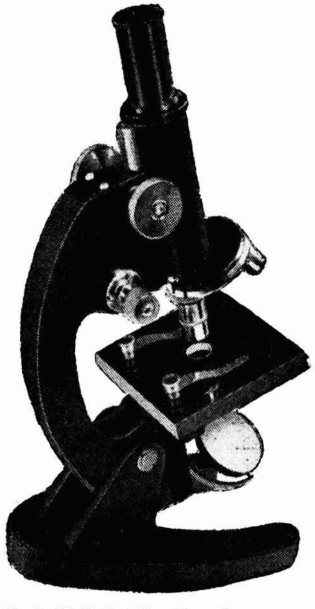

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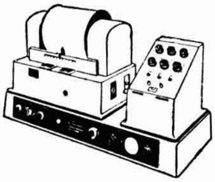

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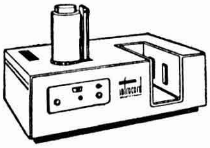

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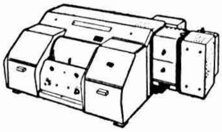

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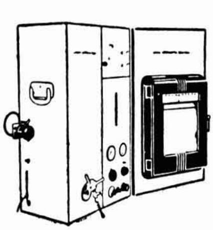

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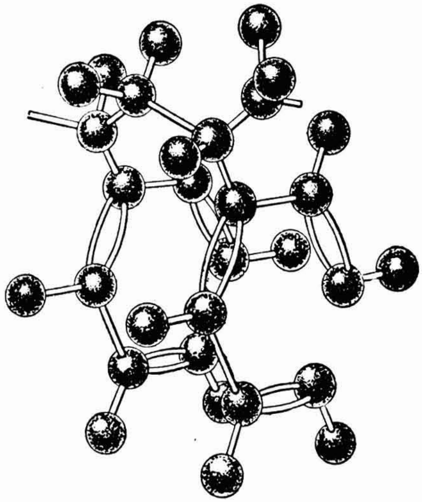

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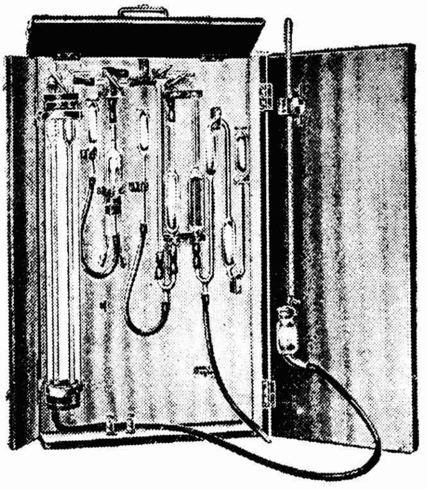

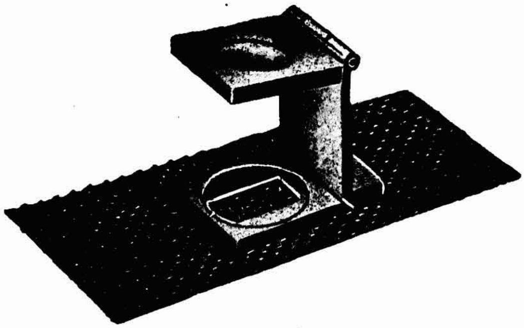

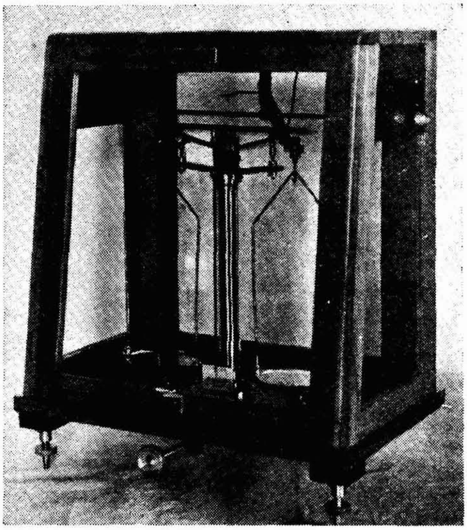

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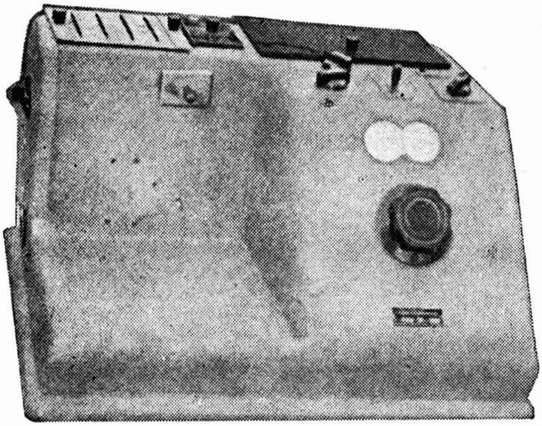

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