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IN THIS ISSUE

A: GENERAL

Enzymatic machinery of the cell

Chlorination of hydrated lime

Asa-catechin — a new antioxidant

B: PHYSICAL SCIENCES

Distribution of radioactivity in the rocks of South India

Crack failure — a structure study

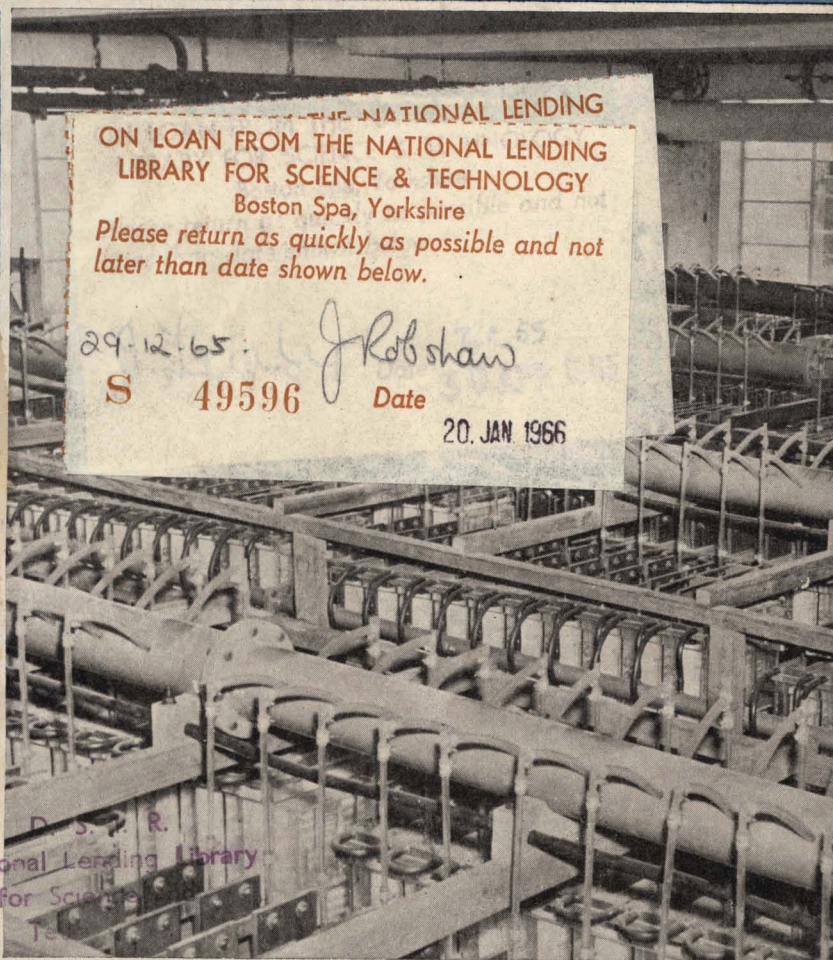
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C: BIOLOGICAL SCIENCES

Synthesis of riboflavin by *Cromothecium ashbyii*

Physico-chemical studies on indigenous seed proteins

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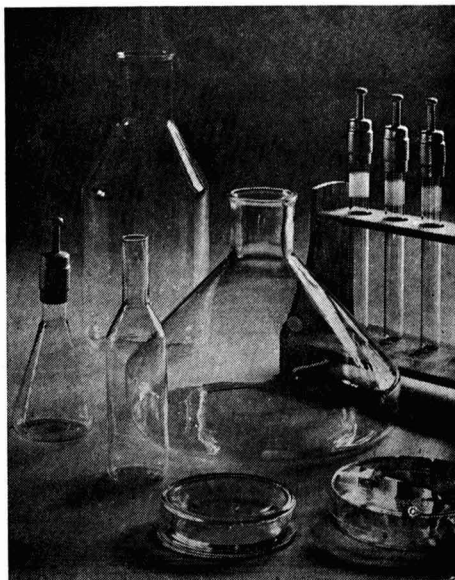


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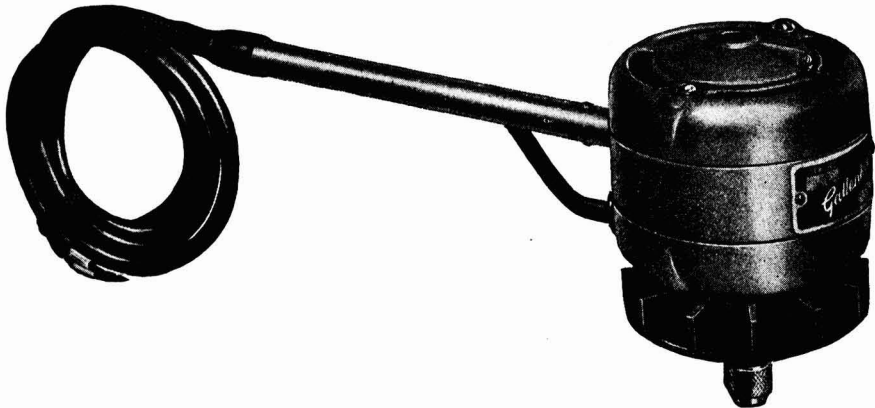
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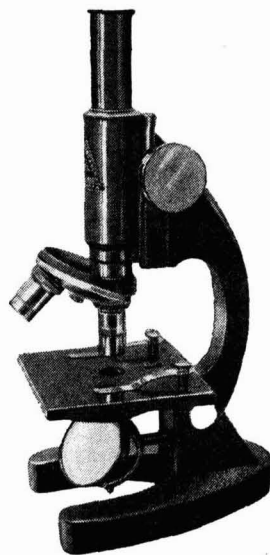
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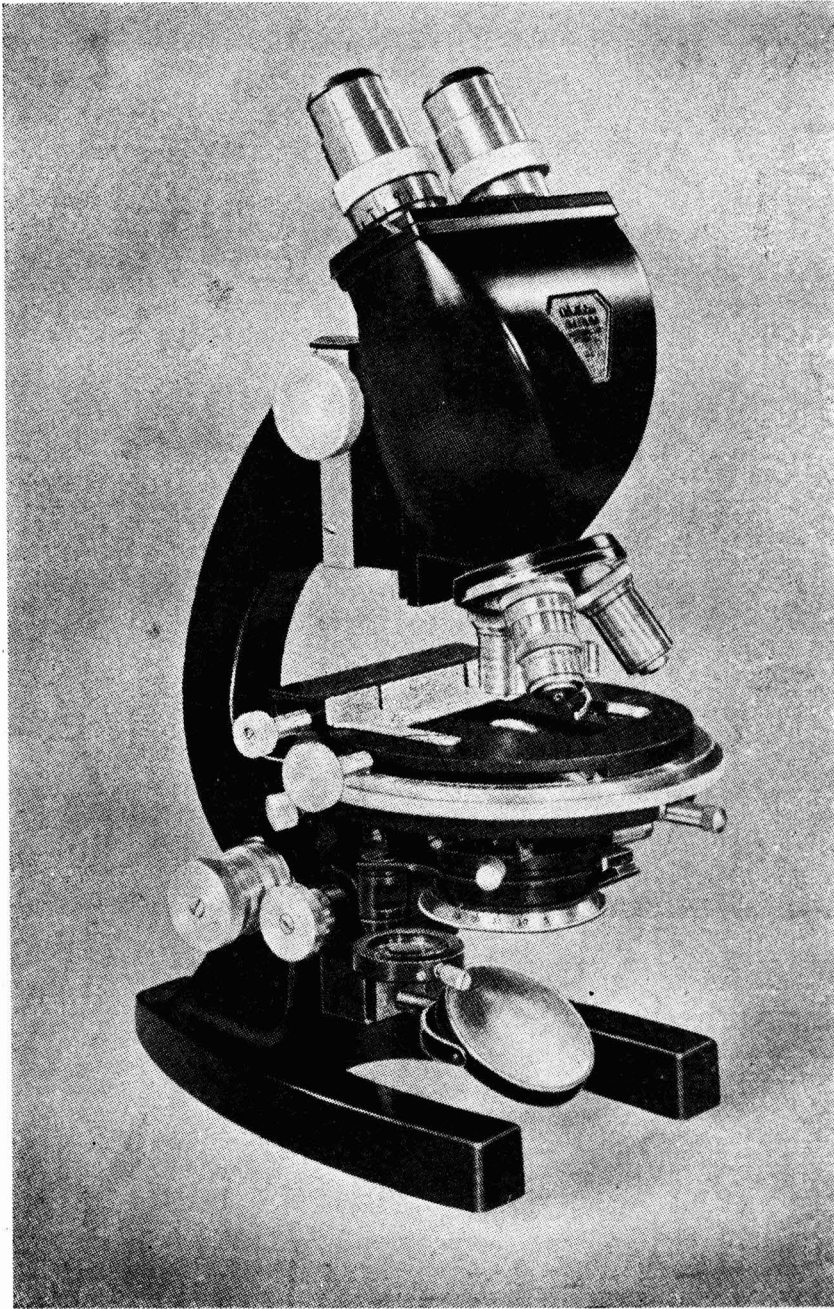
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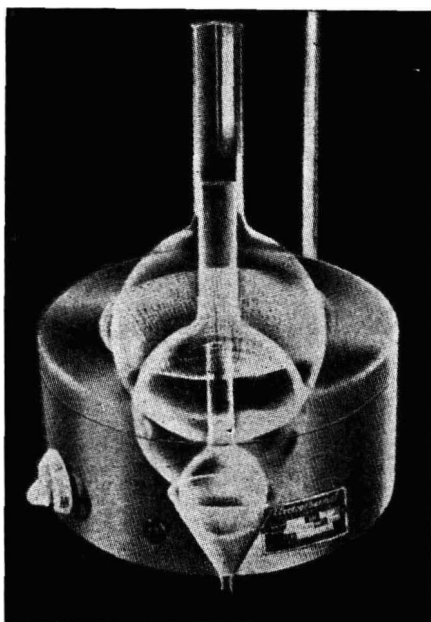
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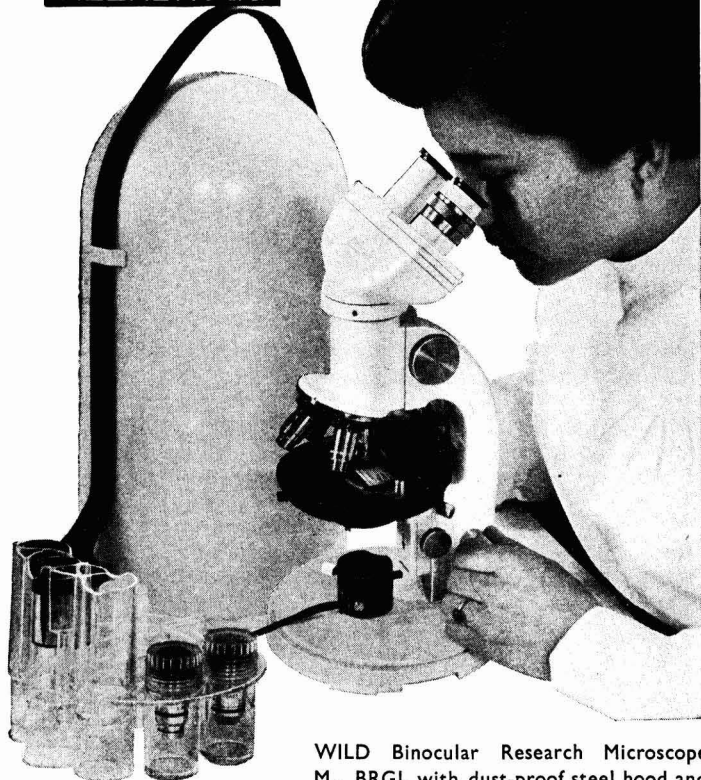
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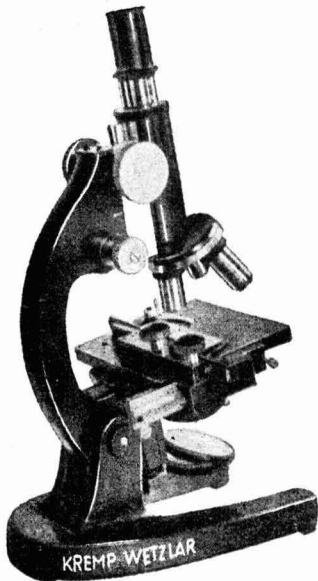
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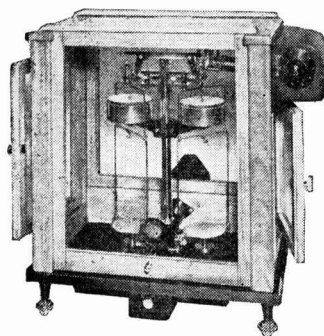
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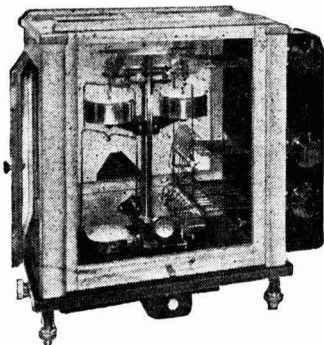
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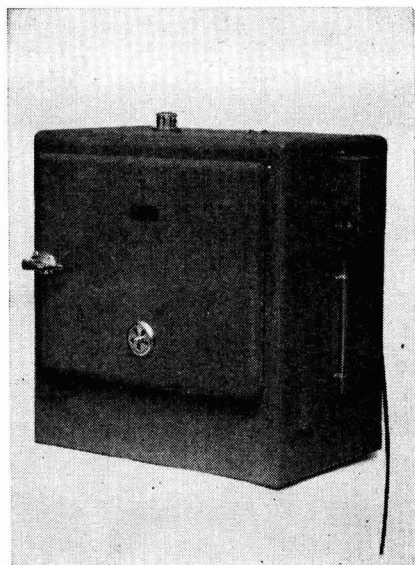
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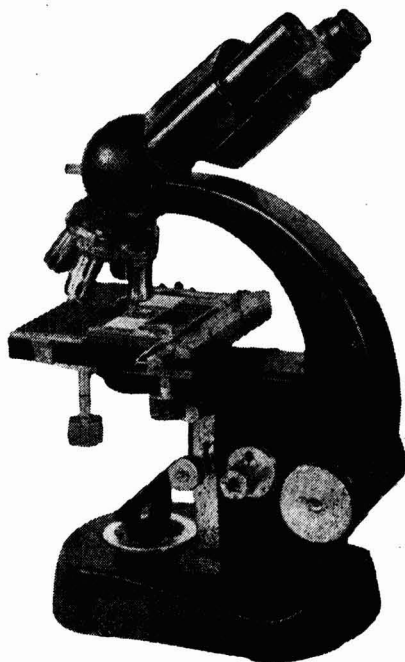
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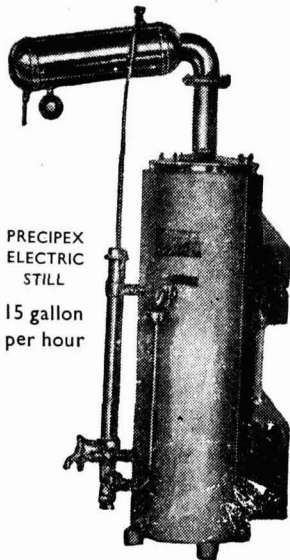
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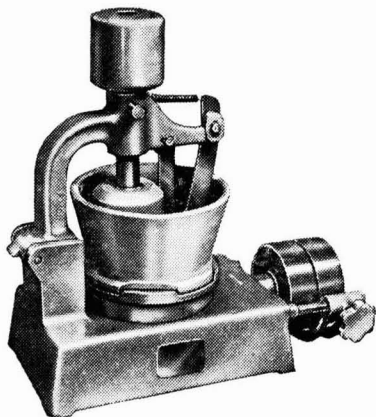
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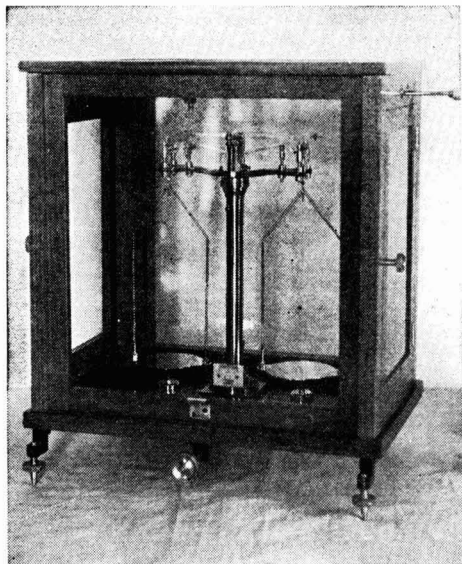
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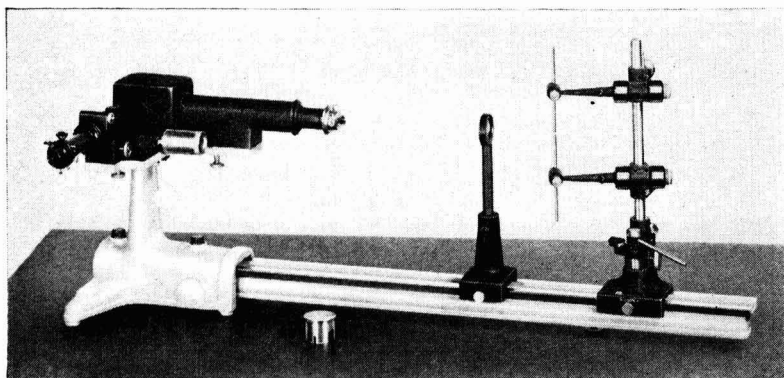
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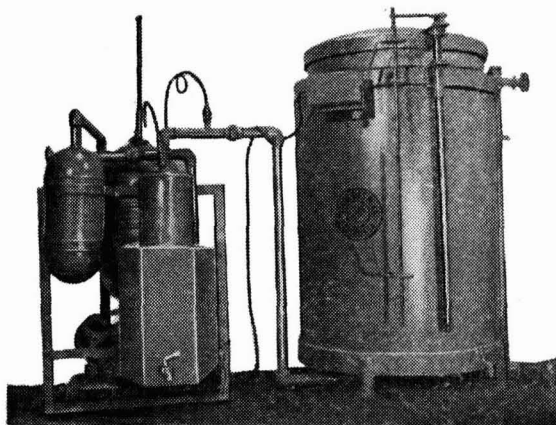
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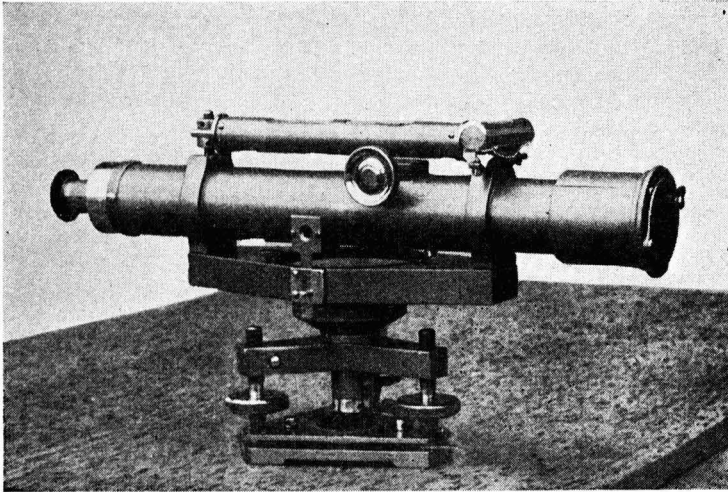
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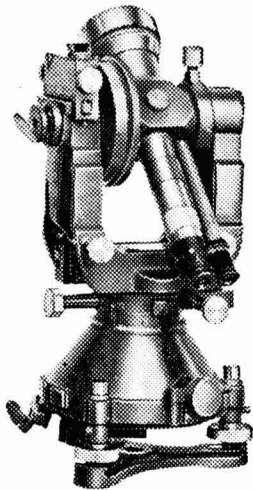
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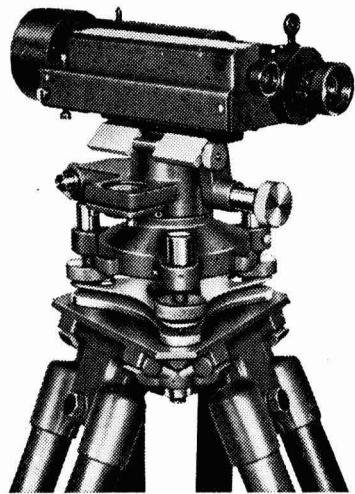
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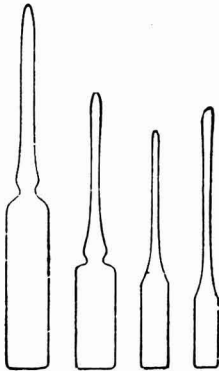
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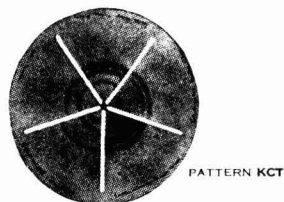
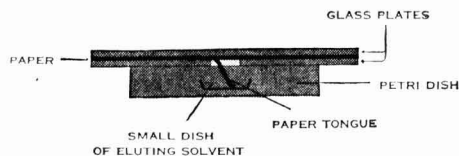
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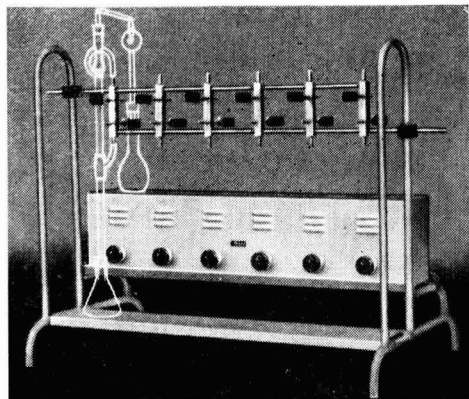
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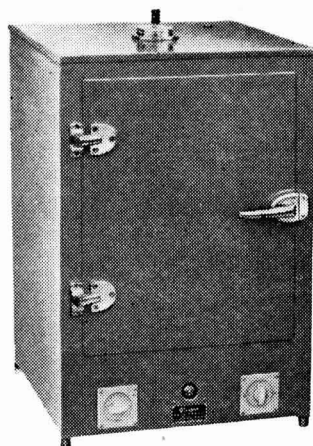
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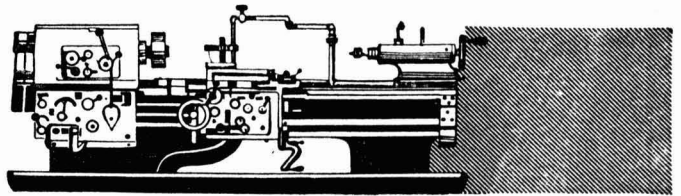
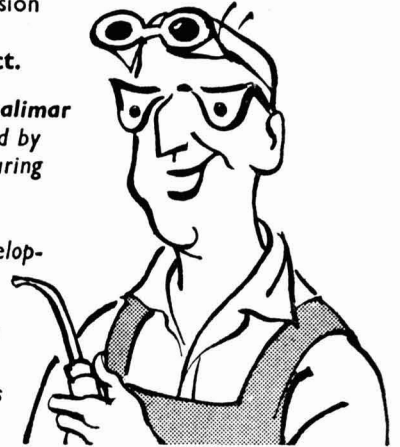
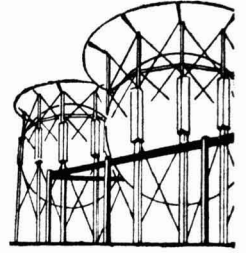
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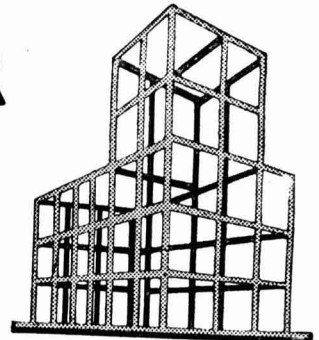
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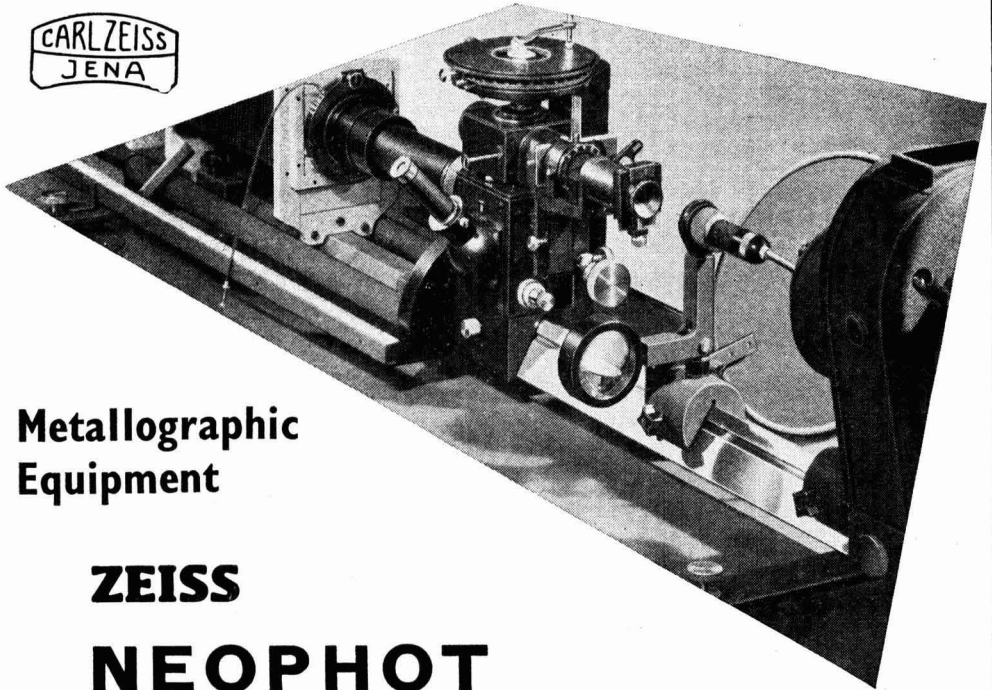
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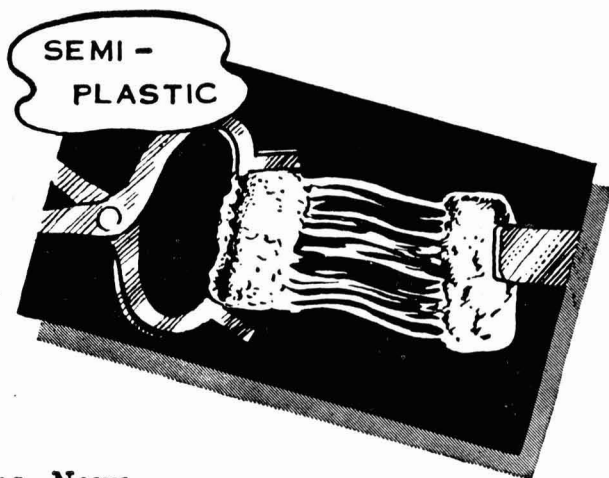
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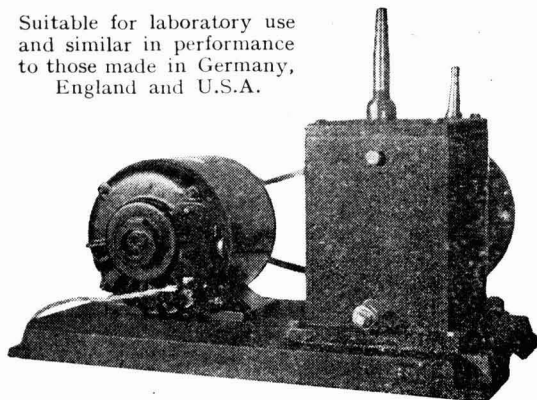
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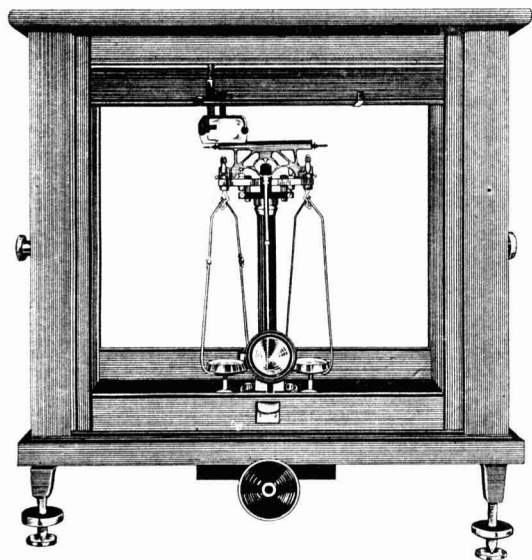
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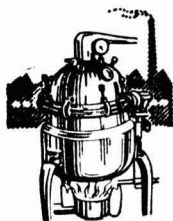
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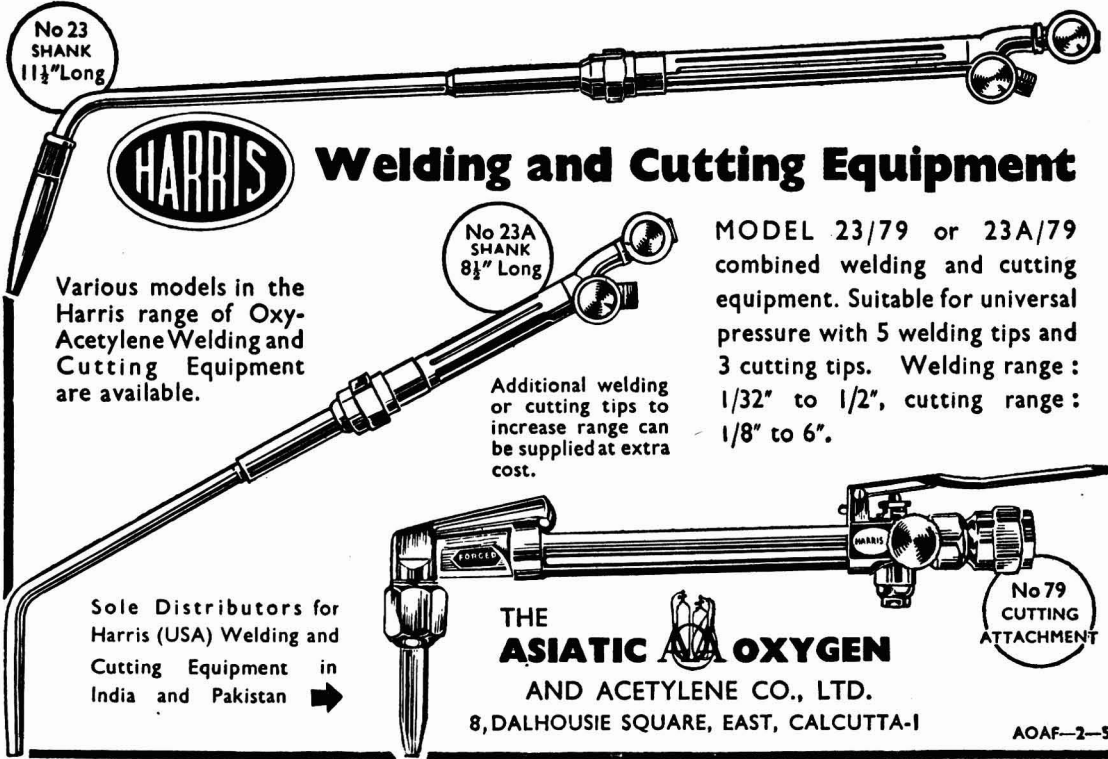
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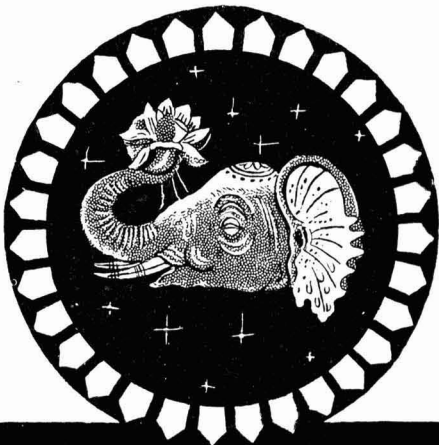


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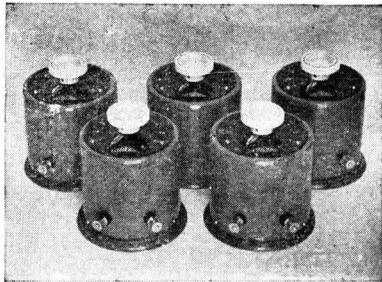


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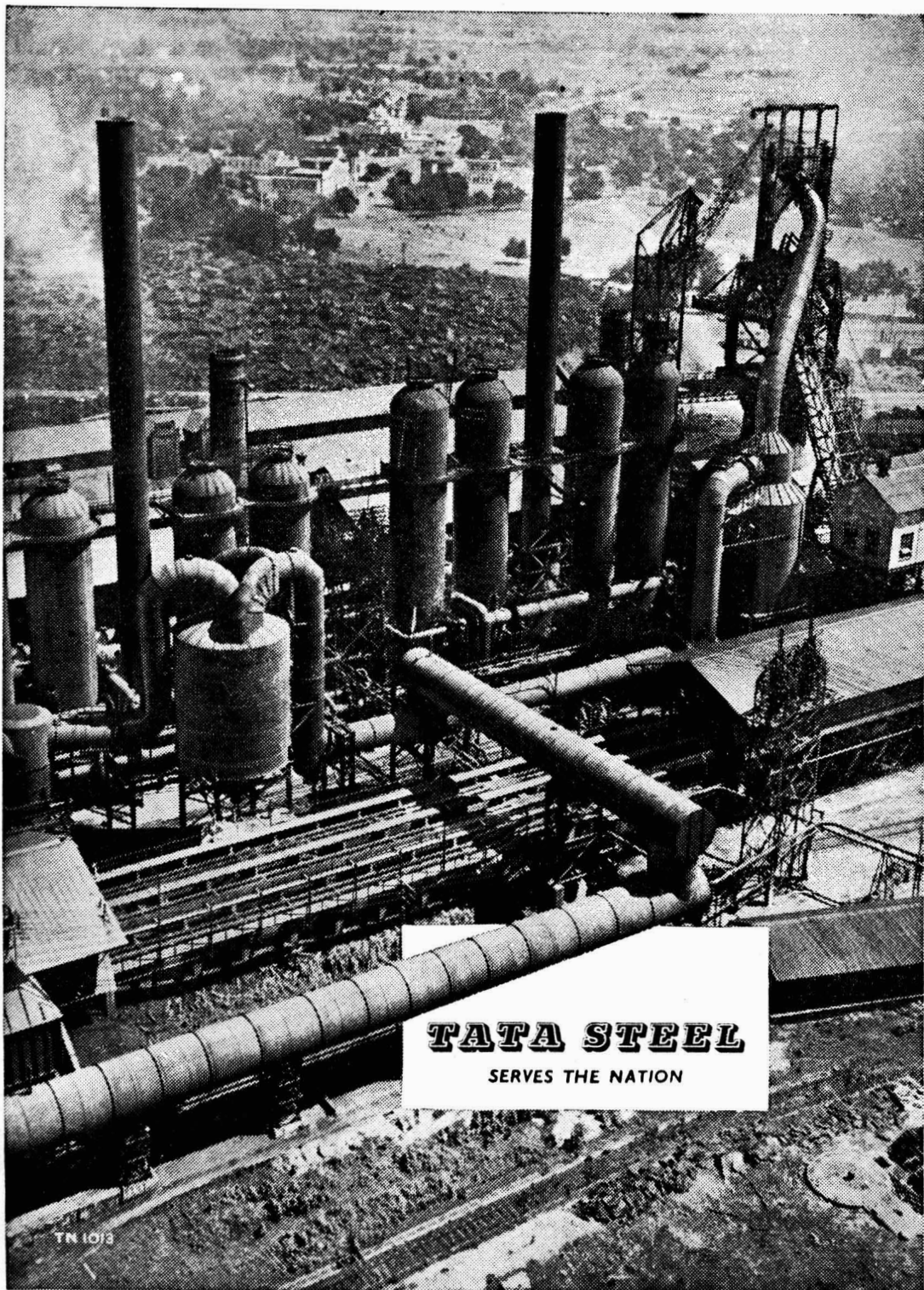
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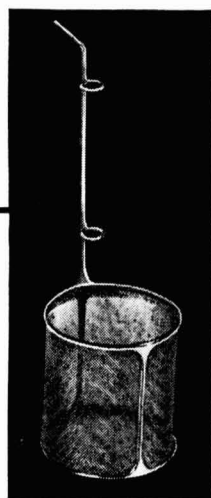
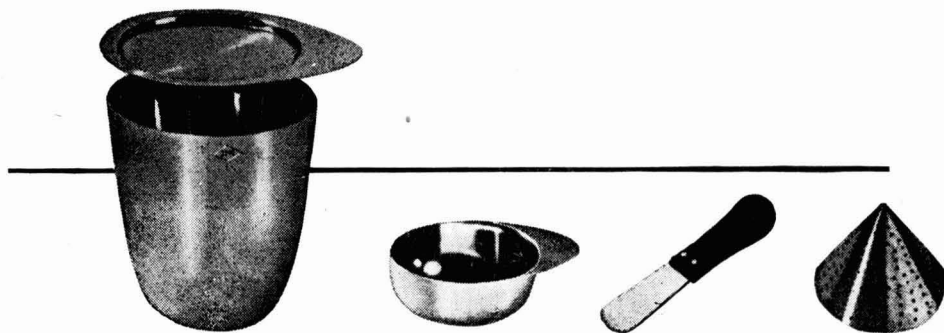
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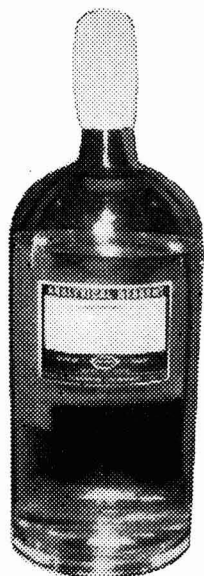
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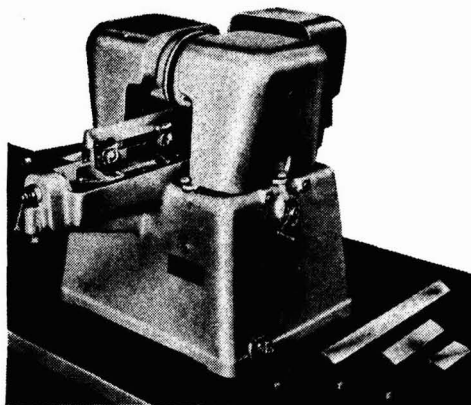
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Enzymatic Machinery of the Cell*

ONE of the most characteristic attributes of living systems as well as one of the most fascinating cellular mysteries is the power of converting energy from one form to another. The muscle or the heart may be looked upon as a machine which converts chemical energy into mechanical energy. The shortening of the muscle fibre is a mechanical process initiated by a chemical trigger. The transmission of a nerve impulse is an instance of the conversion of chemical energy into electrical energy. A special chemical compound elaborated by the nerve cell sets in motion a train of events which leads to the flow of electricity. Practically every organ of the animal body is engaged in one form or another of energy transformation. The kidney and the red blood corpuscle are machines which convert chemical energy into osmotic energy. Salts like potassium salts are concentrated by these machines far beyond the point to which they would be present if no driving forces were at work. We have in the ear a machine which converts sound energy into electrical energy in the form of a nerve impulse. The electric eel owes its invulnerability to its ability of converting chemical energy into electrical energy. The firefly is a remarkable machine for transforming chemical energy into radiant or light energy. The whole of our world economy is based on the capacity of the plant cell to transform the energy of visible light into chemical energy in the form of sugar and other products.

The operational principles of these living energy transformers do not depend on the biological equivalent of pumps, motors, dynamos, storage batteries and photoelectric cells. The raw materials from which the cellular machinery has to be constructed

have nothing in common with anything with which we are familiar in the engineering world. Nature has evolved her own unique engineering devices based on chemical principles which have been imitated in rare instances but never duplicated or equalled.

Biochemists and physiologists have accumulated some knowledge in their understanding of the machines or devices which Nature has evolved for effecting energy transformations. In some areas very substantial progress has been made and we are now very close to a detailed and intimate appreciation of the working principles. In other areas we have a very long way to go.

One can take apart a machine like a watch or a timepiece and disassemble it into a large number of component parts each of which plays a role in the overall operation. Biological machines do not lend themselves to this type of disassembly. Everything is woven together as it were in such an intimate fashion that no separation of parts is either possible or conceivable. In the functional units which carry out the rhythmic beating of a heart, the parts which are engaged in providing the chemical energy are so interwoven with the contractile elements that disassembly in the mechanical sense is impractical. The cellular machines have not been designed to facilitate analysis by the biochemist and biophysicist. More important considerations undoubtedly underlie their design.

We must recognize that Nature rarely constructs one machine to do a particular job of energy transformation. The rule to which there are few exceptions is that large numbers of identical machines are constructed which collaborate in effecting the overall performance. Think of a beating heart for

* Popular lecture delivered by Dr. D. E. Green, Institute of Enzyme Research, University of Wisconsin, U.S.A., at the Forty-fourth Session of the Indian Science Congress, Calcutta, on 14 January 1957.

example. This can be subdivided progressively into smaller and smaller units which still exhibit the capacity for rhythmic contraction. The process of subdivision can be continued down to the microscopic level and eventually to the molecular level which is beyond the reach either of the light or electron microscope. In other words, the unit of the biological machine is a molecular unit and it is thus at the level of molecules that we have to undertake our analysis. This is true whether we study the beating of the heart, the reception of visual impulses, the phenomena of the kidney, the transmission of a nerve impulse, the transformation of radiant energy into chemical energy by the chlorophyll-containing cells of the green plant or the light emission of the firefly. We cannot see how the machine works by direct examination. Indirect and analytical methods have to be relied upon in order to gain insight.

The cellular machines are obliged to work within a narrow range of temperature (0° to 40°) and are, therefore, subjected inexorably to the laws which regulate the well-being and happiness of the cell. If nutrition is inadequate, the cells fail, and by the same token, the cellular machines grind to a halt. All the factors which affect the well-being of the cell like oxygen tension, concentration of salts and nutrients, and temperature obviously must affect to an equal degree the cellular machines.

In the conversion of chemical energy into other forms of energy Nature has elected one special compound, adenosine triphosphate (ATP), to serve as the storage form of chemical energy. This compound has some special features. The purine base adenine is linked to ribose and finally to three phosphate groups in a row. The special properties which make this compound so suitable as a source of chemical energy are: (1) the 'energy-rich' bonds between two phosphorus atoms through the oxygen bridge atom (P-O-P), which can be utilized for energy-requiring reactions and (2) the number of negative charges, four in all, which the molecule carries at the pH of the cell by virtue of the three adjacent charged phosphate groups. There are few biologically important compounds of similar molecular size which carry such a concentrated and high negative charge. In theory other compounds of similar composition could have worked out just as well

as ATP. But the cellular machinery is designed specifically for ATP and so there can be no substitute.

Role of ATP in energy transformation — The contraction of a muscle, a complex and not too well understood process, is initiated or set off by ATP. In this case, the essence of chemical energy is the concentration of a high negative charge on a specific organic molecule. When the contractile elements are exposed to this substance carrying the negative charge, a wave of contraction is propagated through the muscle fibre.

ATP plays an equally key role in the initiation of a nerve impulse but not quite in the same way. It provides the driving force for synthesizing a compound, acetyl choline, from acetic acid and choline. Acetyl choline has the same relation to the initiation of a nerve impulse that ATP has to the initiation of muscular contraction. It sets off a wave of disturbances along the nerve fibre which results in the passage of an electric current and in the transmission of a nerve impulse.

In photosynthesis ATP does not initiate but instead it is formed as the end product of the process. Light energy is absorbed by the chlorophyll system and one of the end results of the whole elaborate sequence of chemical change which follows the absorption of light is the formation of ATP from inorganic phosphate and adenosine diphosphate.

Role of enzymes in energy transformation — In all the energy transformations that we are concerned with in the cell we have come to recognize a universal principle, namely that of enzymes. The machinery of the cell is invariably based on the use and exploitation of enzymes. Every chemical reaction of the cell requires its own enzyme or catalyst. Taking the case of the beating heart in which chemical energy is converted into mechanical energy, the myosin fibres, which are the contractile elements of heart or muscle, interpenetrate small rod-shaped particles, called mitochondria. These mitochondria are at the extreme limit of visibility of the light microscope. Large numbers of them are found in all living cells which take up oxygen. Within these particles is housed the enzymatic machinery by which ATP is produced by the oxidation of a derivative of sugar. ATP produced in the mitochondria then triggers or initiates muscular contraction.

In the process ATP is broken down and then has to be resynthesized in the mitochondrion. The chemical reactions catalysed or facilitated by enzymes are thus interwoven with wondrously constructed materials like myosin of muscle or chlorophyll of green plants or the rods and cones of the eye. These materials then effect the actual energy transformation.

Mitochondrion — A detailed examination of the mitochondrion is important for several reasons. Firstly it is a cell machine about which we know most. Secondly it is perhaps the prototype of all cell machines and lastly it is the most fundamental machine which Nature has elaborated — a machine without which all living cells which depend upon oxygen could not survive. The size of the mitochondrion particle is about that of a small bacterium. Every cell which depends upon oxygen, whether animal, plant or bacterial, contains similar particles with similar, if not identical, enzymatic functions. The mitochondrion appears to consist of an outer membrane with a double layer while throughout the whole of the interior there is a membranous ribbon which twists from one side to the other extending the length of the mitochondrion. The membranous ribbons in the interior are known as the cristae and it is probable that both the external membrane and the internal cristae have the same chemical composition and function.

It is possible to shatter mitochondria into smaller fragments which still exhibit all the enzymatic functions and properties of the original mitochondrion. The mitochondrion is thus an aggregate or polymer of a large number of sub-units, all identical and capable of reproducing any and all of the enzymatic functions of the mitochondrion.

The mitochondrion functions as a cellular power house in which pyruvic acid (derived from carbohydrate) and fatty acids (from fats) are burnt with molecular oxygen to carbon dioxide and water. In the process of this combustion or oxidation ATP is formed.

The oxidation of pyruvic acid to carbon dioxide and water is not a direct oxidative breakdown of the acid, one carbon atom at a time. Rather, Nature has evolved a remarkable cyclical process by which the complete oxidation of pyruvic acid is accomplished — the well-known citric acid cycle, so called because one of the compounds formed in the

cycle is citric acid. The principle of this cyclical oxidation process can be elucidated by the following instance. The substance to be oxidized (No. 1) reacts with another substance (No. 2). In the process a third substance (No. 3) is formed which then goes through a cycle of change and at the end the starting substance (No. 2) is formed again while No. 1 has disappeared in the process. This cycle is met with everywhere in the living world where oxygen is needed — in animals, plants and bacteria. The universality of the citric acid cycle suggests that the mitochondrion was evolved during the earliest development of life and that the emergence of the mitochondrion was one of the earliest triumphs of biochemical evolution.

The citric acid cycle is an enzymatic or catalytic device by which a sugar derivative is burned by oxygen to carbon dioxide and water just as coal is burned in the furnace to carbon dioxide and water. But there the analogy stops. When coal is burned only heat and light are given off. But when sugar is burned in the citric acid cycle useful chemical work is accomplished at the same time.

When sugar is oxidized by molecular oxygen electrons are extracted from the sugar and transferred indirectly to molecular oxygen. Nature has evolved a complex chain along which the electrons are transferred. Each of the members of this chain receives and then passes on electrons to the next in the chain until finally the electrons are handed on to molecular oxygen. Not much can be said with certainty about the chemical composition of the various members of the electron transfer sequence. Some of them contain haeme, the active group of haemoglobin; others contain flavin (vitamin B₂) and still others contain niacin.

Oxidative phosphorylation — It is the structure of the electron transfer system which accounts for the fact that when electrons move through the electron transfer chain, inorganic phosphate becomes linked to adenosine diphosphate to form ATP. For every two electrons which go down the chain, three molecules of ATP are formed. This process is referred to as oxidative phosphorylation — the linking of oxidation with the synthesis of ATP. Although we have some vague ideas as to how electron flow and ATP formation are linked we have yet to under-

stand the process thoroughly. The oxidation process involves transformation of oxidative energy into the energy inherent in the chemical bonds of ATP — which the biochemists call phosphate bond energy. Since ATP is the current of the cell which impels a large number of processes, the conversion of oxidative energy to phosphate bond energy is rightly considered one of the most fundamental processes of the living cell.

Structure of mitochondria — Several hundred different enzymes are involved in the implementation of mitochondrial reactions. These are not separate enzymes in the mitochondrion. Instead, they form an intricate structural pattern like tiles in a mosaic or pieces in a jigsaw puzzle. We have reason to believe that just as the enzymatic reactions take place in a regular sequence or order, so the enzymes which catalyse or facilitate these reactions are attached to one another in just that sequence. There is one bundle of enzymes which carries out the citric acid cycle, another bundle which carries out electron transfer and oxidative phosphorylation and still another which carries out fatty acid oxidation. In turn, these bundles are attached one to the other and an exact overall pattern can be recognized. The interlinking of chemical processes has its counterpart in the interlinking of bundles of enzymes. The regular following of one reaction after another also has its counterpart in the ordered arrangement of enzymes within each bundle.

Recent electron microscopic studies of mitochondria have revealed clearly and unambiguously evidence of ordered arrangement at the molecular level. The cristae are found to consist of alternate light and dark zones. Since it is known that the structural elements of the cristae contain both protein and lipid in about equal amounts we have a basis for postulating an ordered array of proteins and lipids which supplies the framework for mitochondrial organization.

Conclusion

A discussion of any other cellular machine would involve us sooner or later in molecular processes and of a complexity equal to that of the mitochondrion, since all cellular machines are molecular machines.

When we understand fully how life's machines work, we will be close to an understanding of many of the disease processes to which man is still heir. The mitochondrion and the rest of the contractile machine are basic to an understanding of what makes the heart beat and why it fails in disease. Similarly all the other cellular machines are the most fundamental elements in each of the organs in which they are present. We shall have to draw our experimental tools from many disciplines and we shall have to test the ingenuity of scientists to the full before we shall have come close to an understanding of these living machines.

Modern Large Reflecting Telescopes

W. M. VAIDYA

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THE large telescopes described in the previous article¹ are conventional parabolic, mainly used for spectroscopic work. Since spectroscopic observations yield valuable data regarding the physical and chemical constitution of the stars large observatories devote a major part of their time to studies on stellar spectra. However, for another important class of observations, namely studying nebulae, star clusters, galaxies and meteors, a different type of telescope, combining wide angle photography with high speed, is required. This is achieved by the Schmidt telescope. The useful field of large parabolic telescopes is only in minutes of arc; the deterioration of the off axis image in these telescopes is principally due to coma, whereas in Schmidt telescopes the useful field is in matter of degrees, which is achieved by the removal of off axis coma by placing an aspherical correcting plate at the centre of curvature of the spherical mirror (Fig. 1). The correcting plate removes the spherical aberration of the mirror and its location removes the coma. The largest Schmidt telescope is installed at Mt. Palomar. The corrector plate of this telescope has an aperture of 48 in. for a spherical reflector of 72 in. working at $f/2.5$. The telescope is now being

employed for taking photographs of nebulae and stars, which will be used in the compilation of a sky atlas. The atlas should provide valuable information about clusters of nebulae and their relative frequency, since stars down to magnitude 20 can be photographed by this telescope.

To give an idea of the design and construction of a Schmidt telescope a detailed description of the second largest telescope of this type (Fig. 2), installed at Hamburg in 1955, is given below.

The spherical mirror has an aperture of 48 in. with a focal length of 96 in. The mirror is made of 2K7 Schott glass of low thermal expansion. The back of the mirror is convex, so that it is bounded by two concentric spherical surfaces and this is expected to provide better thermal homogeneity. The correcting plate, having an aperture of 32 in., is made from UBK 7 glass, which transmits in the ultraviolet.

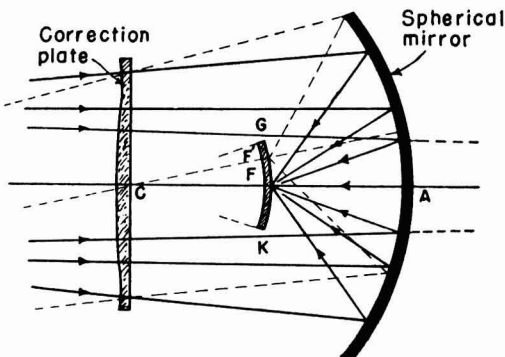


FIG. 1 — OPTICAL ARRANGEMENT OF THE SCHMIDT TELESCOPE

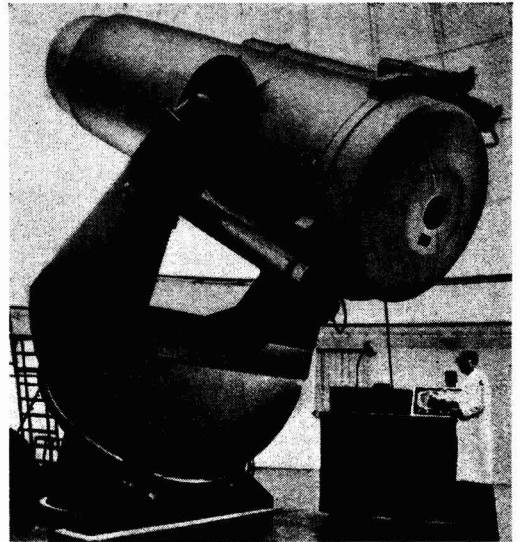


FIG. 2 — SCHMIDT TELESCOPE AT THE HAMBURG OBSERVATORY

The telescope tube is double-walled. For providing automatic compensation of focus changes due to temperature, three rods, whose coefficient of linear thermal expansion corresponds exactly to that of the mirror, are placed between the mirror and the plate-holder assembly. In order that the temperature compensating system may function satisfactorily, it is necessary that rapid changes in temperature do not occur inside the tube. The whole tube is, therefore, covered with felt, over which canvas is stretched and the dome is also cork-lined.

The double-walled externally insulated tube consists of the rear, central and front tubes, tube cap, cradle and dew cap. The rear tube carries the mirror with mount, the mirror ventilators, the mirror covering and its mechanical operating mechanism. Declination pivots and connecting strips for torsion cable are attached to the telescope cradle. Installed in the central tube are the supporting cross (spider) with focussing arrangement, and the plateholder with its various attachments. On the outside of the central tube is fixed the reading telescope for setting the focus, while the corrector plate as well as the objective prism with mount are supported in the front tube. A movable frame carries the plateholder and the colour filters. The frame can be focussed in the supporting cross and accurately adjusted transverse to the declination axis about the centre of curvature of the reflector. A tube-compensating device together with the reflector-compensating device results in excellent stabilization of the focus. The dimensions of the photo plates are 24×24 cm.; they are bent spherically in a special type plateholder.

The declination pivots, attached to the tube cradle are frictionless and are supported in the yoke spars. Power is supplied to the tube by means of the torsion cable through the boring of the pivots. The large driving worm wheel for the movement of the telescope tube is tightly connected with the tube cradle.

The yoke is made of an inherently stable welding construction consisting of northern and southern yoke bases and two attached yoke spars. The declination axis bearings are situated approximately at the middle of the yoke. Drives and gears for the declination movement are housed within the bearing yoke. Fitted to the northern and southern yoke bases are the hour axis bear-

ings. The radial and axial forces are borne by self-aligning ball bearings. Pole and azimuth adjustments are effected between the northern base of the instrument and the base plate of the concrete base. The drive of the hour axis for coarse, fine and micro-motion as well as of the diurnal movement is situated below the south bearing of the hour axis. The hour worm wheel having a diameter of 1200 mm. is precision-gearred, thus reducing the periodical and dividing errors to a minimum.

Position indication in declination and right ascension is effected by electrical long-range transmission and can be read off the switch desk and at the observation points of the telescope.

The mounting of the tube is of the fork type and is based on an interesting new idea as a consequence of which it becomes possible to adjust the polar axis of the telescope without appreciable work against gravity. The arrangement is shown in Fig. 3. An imaginary sphere is drawn with C (the centre of gravity of all the moving parts of the instrument) as the centre. Concentric with the polar axis, a zone (Z) of this sphere has been constructed as a bearing of steel, which rests on the vertical steel pier directly under the centre of gravity. The bearing

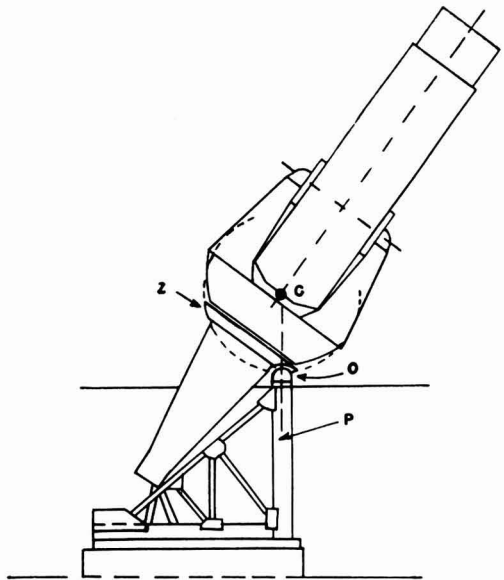


FIG. 3 — MOUNTING OF THE SCHMIDT TELESCOPE AT HAMBURG

turns on two oil pad bearings (*O*) which support the entire weight of the instrument. By this arrangement no weight has to be supported at the lower end of the polar axis, which, however, has to be restrained in position by an adjustable ball bearing assembly. Thus, the telescope turns in hour angle on bearing *Z*, which floats on the film produced by the oil pads.

The driving gear for right ascension is located at the lower end of the polar axis. The whole instrument is electrically operated from one desk. In order to point the telescope at a particular heavenly object, the observer fixes its position on a keyboard to one second of time in right ascension and one-tenth of a minute of arc in declination. By pressing a button, the telescope automatically turns into the desired position. For the observer, there is a portable electro-hydraulic observing platform.

Variants of the Schmidt telescope

In the original Schmidt telescope, the field surface is not flat but spherical and concentric with the mirror. This necessitates the photographic plate being curved. Moreover, the plateholder is located in an inaccessible position in between the mirror and the corrector plate. Another serious drawback is that the overall length of the system is a little more than twice its focal length, which increases considerably the cost of mounting the dome.

The curved field of the Schmidt camera can be flattened by adding a convex secondary mirror to the system (Fig. 4). In this case, the first corrector plate is shifted to the focus which reduces the overall length by half. Such a modified Schmidt telescope, known as Baker-Schmidt telescope, was installed in 1951 at Bloemfontein (S. Africa). The telescope is owned and operated jointly by the Armagh Observatory of the Northern Ireland, the Dunsink Observatory of Eire and the Harvard College Observatory, U.S.A.

The primary mirror, which is spherical, has an aperture of 36 in. The corrector plate,

with an aperture of 33 in., is placed closer to the primary mirror than in the original Schmidt design. The total length of the tube is only 168 in. The light from a star first passes through the correcting plate and is then reflected by a primary mirror to a convex spherical mirror of 17 in. diameter which brings the star light to a focus on the photographic plate, placed only 9 in. from the primary mirror. With this optical system, perfect definition is obtained on the entire photographic plate with a circular diameter of $10\frac{1}{2}$ in.

The programme of work carried out with Baker-Schmidt telescope comprises photography of (1) star clusters, (2) Magellanic clouds and (3) Milky way.

Photography of star clusters — A photograph of the globular cluster Omega Centauri taken with this telescope showed that this cluster consists of 100,000 stars even though to the naked eye it appears as a star of the fourth magnitude. Even large-sized parabolic telescopes are not able to photograph the whole range of this cluster on a single photograph. But the Baker-Schmidt telescope covers with perfection a much larger area of the sky than that of the cluster. Such photographs are required for studies of the star numbers at various distances from the centre of the cluster and the shape of the cluster. They also throw light on the relation of colours of stars to their apparent magnitude at various points in the cluster when comparative studies of photographs on blue sensitive and red sensitive plates are made.

Magellanic clouds — The large Magellanic clouds and the small Magellanic clouds are two stretches of luminosity in the Southern Hemisphere. Fig. 5 shows, in the extreme left region, a section with many star clusters and patches of dark and bright nebulosity. Such photographs are required to obtain a precise knowledge of the varieties of stars, clusters and nebulae in the clouds in order to determine the character of these clouds.

The study of the structure of the Southern Milky way forms the main programme of the Bloemfontein Observatory. The power of this type of telescope is shown by a photograph of Eta Carinae nebula in a portion of the South Milky way (Fig. 6). By studying the nature and distribution of the stars in the nebula, valuable information regarding the galaxy is obtained.

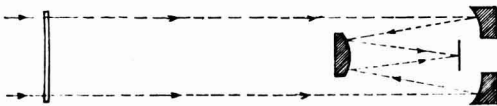


FIG. 4 — OPTICAL ARRANGEMENT OF THE A.D.H. BAKER-SCHMIDT TELESCOPE



FIG. 5 — MAGELLANIC CLOUDS PHOTOGRAPHED WITH A.D.H. BAKER-SCHMIDT TELESCOPE

By placing a large objective prism in front of the corrector plate photographs of the spectra have also been obtained. These have been of great help in identifying the nature of the stars composing the nebulae.

Another variant of the Schmidt telescope is being installed at the University of St. Andrews in Scotland. In this particular case, the final image is made to fall behind the main mirror. This is achieved by locating the secondary convex mirror along with the Schmidt plate in such a way that the focal plane falls behind the central hole of the mirror in an accessible position. Before embarking on the final project of a 37 in. telescope, a pilot model was constructed of half the size and the results obtained with the latter have been very encouraging.

In the pilot model, the primary concave mirror is of 18 $\frac{3}{4}$ in. diameter with a central hole of 6.3 in. and the secondary convex mirror has a diameter of 9.6 in.; both are of Hysil glass. The Schmidt plate is made from Pilkington's white plate of optical purity. The focal surface is flat and accessible. Arrangements are available for squar-

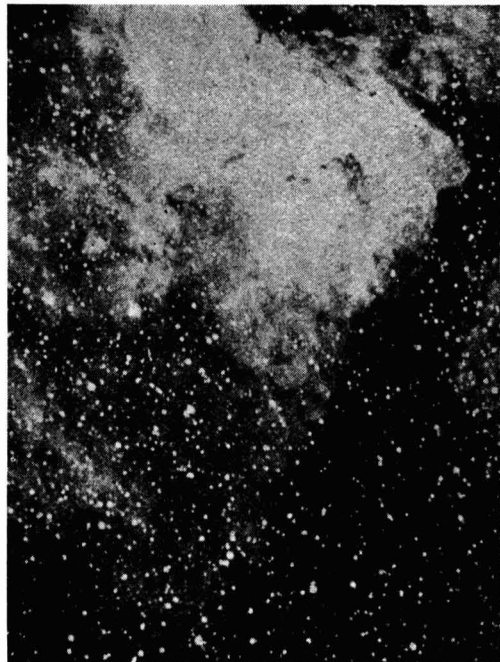


FIG. 6 — ENLARGED PHOTOGRAPH OF ETA CARINAE NEBULA TAKEN WITH A.D.H. BAKER-SCHMIDT TELESCOPE

ing both the mirrors as well as for axial and lateral movement of the Schmidt plate. The axial movement is essential to compensate for the primary coma, while the lateral shift enables stigmatic imaging along the axis.

Acknowledgement

The author is thankful to Mr. Tittlebach and Mr. Heckel of the Export Department of the Zeiss Works, Jena, for making possible his visit to the Zeiss Works. Thanks are also due to Mr. Beck of the Astronomy Section for helpful discussions on the design of the Hamburg Schmidt telescope.

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REVIEWS

RUTIN AND RELATED FLAVONOIDS: CHEMISTRY, PHARMACOLOGY AND CLINICAL APPLICATIONS by Griffith, Krewson & Naghski (Mack Publishing Co., Easton, Pa.). Pp. xiii + 275

BIOFLAVONOIDS AND THE CAPILLARY. Edited by Gustav J. Martin & Albert Szent Gyorgyi [*Annals of the New York Academy of Sciences*, 61 (1955), 1-100]

In recent years there has been considerable advance in the study of the vitamin P-like activity of flavonoids and this progress is fully summed up in two recent and interesting publications. The first book, entitled *Rutin and Related Flavonoids: Chemistry, Pharmacology and Clinical Applications*, presents a concise account of the authors' researches on rutin and quercetin and the extensive clinical trials carried out by them with flavonoids. The first part of the book (6 chapters, 123 pages) is devoted to chemistry and pharmacology and the second part (7 chapters, 120 pages) to the presentation of clinical data and their evaluation. Detailed references to original literature (800) are provided. For evaluating clinical effectiveness of rutin therapy they have utilized mortality statistics based on actuarial data provided by life insurance statisticians. The data representing a nine-year study involve 3140 hypertensive patients. Treatment of capillary fault with rutin prevents 88 out of 100 expected deaths due to apoplexy and causes 65 per cent reduction in deaths due to coronary occlusion.

A three-year study of the clinical effectiveness of quercetin has proved the superiority of this flavonoid over rutin, especially in the treatment of cases refractory to rutin, and these have responded almost 100 per cent to quercetin. This is highly significant and it has an added advantage in that it is more easy to obtain quercetin in a purer form than rutin.

It is remarkable how an intensive study of the subject of capillary fragility and flavonoids has opened out so many possibilities of application. As coming under conditions that can be treated by the administration of flavonoids a large number of vascular abnormalities are listed: retinal haemorrhage, purpura, drug idiosyncrasies, glaucoma, here-

ditary telangiectasia, hemophilia, pemphigus, rheumatic fever, hematuria, proteinuria, edema, hydrocele, idiopathic pulmonary bleeding, toxemia of pregnancy, bleeding gums, thrombophlebitis, scarlet fever, shock, allergy and geriatrics.

The interest of the United States Department of Agriculture in this work has been based on the programme of research on the utilization of farm products. Flavonoids occur in a wide variety of plants and extensive use of these provides opportunity for a new industry based on agriculture.

The second publication, entitled *Bioflavonoids and the Capillary*, edited by Gustav J. Martin and Albert Szent Gyorgyi, is a collection of papers and has been published in the *Annals of the New York Academy of Sciences*. The papers included in this publication were presented at a conference on the "Bioflavonoids and the Capillary" held by the section of Biology of the New York Academy of Sciences in 1955. It consists of two parts. Part I relates to certain papers dealing with the chemistry and biochemistry of bioflavonoids. Some of the more important chemical and physical characteristics of bioflavonoids, which have achieved chemical and pharmaceutical importance, have been discussed along with their availability and economical production. Special mention has been made of the compounds made from citrus fruits. Physiological action of flavonoids particularly as regards their effects on the vascular system have been considered briefly and explanations suggested. The estrogenic activity of some naturally occurring isoflavones has recently attracted considerable attention and a brief discussion of this subject is provided in this part. Probably the most interesting paper in the volume is the one on biogenesis which describes the use of the alga *Chlamydomonas eugametos* in such studies; quercetin has been placed in the centre of the scheme.

Part II deals with clinical studies and discusses observations on the use of bioflavonoids in rheumatic fever, residual bleeding and pregnancy. The concluding paper by Szent Gyorgyi is extremely stimulating. He suggests that flavonoids are normal

constituents of animals and his experiments using thymus glands support this suggestion. He has shown that bioflavonoids are present in the thymus tissue to the extent of 0.1 mg./g. According to him the animal body possibly attaches an amino group to the flavone molecule to make it fit into its machinery.

T. R. SESHADRI

CHEMISTRY OF CARBON COMPOUNDS: VOL. IIIB — AROMATIC COMPOUNDS. Edited by E. H. Rodd (Elsevier Publishing Co., Amsterdam; *Distributors*: Cleaver-Hume Press Ltd., London), 1956. Pp. 687-1670. Price £ 8 10s.

The earlier volumes in this series have already been reviewed in this Journal. The present volume completes the description of important classes of benzene derivatives and covers nearly one thousand pages in twelve chapters (Chapters XI to XXII).

Chapter XI deals with the chemistry of quinones and related compounds of the benzene series. It is followed by three chapters dealing with alcohols, aldehydes, carboxylic acids and their derivatives. Chapter XV gives an account of benzene derivatives with one or more unsaturated side chains. A good account of diphenyl and its derivatives is given in Chapter XVI. The next two chapters are on di-, tri- and polyphenylmethanes and other phenyl substituted paraffins. The modern extended conception of aromaticity has been developed in Chapter XIX on quasi-aromatic compounds in which the chemistry of tropolones and related compounds as well as that of the pseudo-aromatic metal derivatives of cyclopentadiene is discussed. The last three chapters describe aromatic compounds with condensed nuclei, first with two, such as indene and naphthalene, then with three as in anthracene and phenanthrene, fluorene and acenaphthene and finally polycyclic compounds.

The most interesting part of this impressive volume is the treatment of the chemistry of many types of natural products which are presented in their appropriate places. Special mention may be made of tannins and depsides, adrenaline and thyroxine, the eugenol group, cotoin and its derivatives, stilbenes and estrogens, pulvinic acid derivatives, antibiotics (chloromycetin) and azulenes. The index is very comprehensive

and occupies 135 pages. The literature has been brought up to very recent years in most chapters, e.g. pulvinic acid derivatives (1955), brevifolin trimethyl ether (1955), though in some there seems to be a gap of nearly ten years, e.g. in the account of myristicin, elemicin and asarone papers published after 1945 do not seem to have received attention.

Unlike the previous volumes the corrigenda for this particular volume have been sent along with it. Still in a work of this magnitude it is not possible to recognize all of them at the same time. A few of them that have escaped detection are: Page 775, hemipinic acid (4:5-dimethoxy-phthalic acid), Page 782, galloflavin (IV), a yellow dye of the xanthone group; the formula does not correspond to a xanthone. Page 881, old prefixes l and d are used though in other places L and D and (+) and (−) have been used. Page 1008, *o*-methyl coumaric acid is reported to be obtained from coumarin by treatment with methyl iodide; actually sodium methoxide and methanol are necessary besides methyl iodide.

But the errors are only a few and quite minor. The reviewer would like to record his feelings of pleasure in going through the volume and also his conclusion that it is suitable both for reading and for reference. He is sure that all organic chemists will be grateful to the editor for this highly useful publication.

T. R. SESHADRI

PETROLEUM REFINING WITH CHEMICALS by V. A. Kalichevsky & K. A. Kobe (Elsevier Publishing Co., New York; *Distributors*: Cleaver-Hume Press Ltd., London), 1956. Pp. xi + 780. Price 95s.

The refining of petroleum has been receiving increased attention in recent months in this country as a result of the two major oil refineries established already at Bombay, a third large unit due to go on stream at Visakhapatnam sometime this year and the proposed fourth large unit to be established in the eastern portion of the country to refine the new oil finds in Assam. However, the intricacies of chemical refining of petroleum are not generally known in this country since the subject is not covered by any university as a part of its curricula. Knowledge on the subject has been limited almost exclusively to the few experienced foreign petroleum technologists who have come to this country

to set up and operate the refineries or to initiate local blending of additive-type lubricating oils.

The publication of this book is, therefore, particularly timely and should make available most of the knowledge on the subject to the people of this country. The text is fairly comprehensive starting with the 'nature of crude oil and preliminary refining' and ending with 'lubricating oil additives', and covering a wide variety of topics. There is perhaps no other text-book at present which covers adequately this interesting subject.

The chapter on 'evaluation of petroleum products' is of particular interest to the various purchasing authorities and to the various petroleum testing laboratories. 'Additives for non-viscous petroleum fractions' should be of general interest in connection with the additives for gasoline so widely used and advertised in this country. The chapter on 'lubricating oil additives' is most interesting since the largest number of customers for petroleum products are those using detergent oils or lubricating oils containing additives of some sort or the other.

A particularly useful section of the book is the complete review of the literature on the subject and the comprehensive list of references and patents. Four indices have been furnished dealing respectively with authors, subjects, chemicals and patents. This makes the work of reference to any particular topic easy. This is further facilitated by the appropriate chapter headings given at the top of every page.

The format of the book is pleasing and the cloth binding durable and attractive. The book serves a very useful purpose indeed and should be of much use to everyone interested in petroleum. In future editions it may be possible for the authors to include a comparative evaluation and the relative importance of the various methods of refining dealt with. Obviously since this is a controversial aspect the authors have perhaps preferred not to deal with it in the present edition.

T. R. DORASWAMY

PHASE DIAGRAMS FOR CERAMISTS by
McMurdie & F. P. Hall (The American
Ceramic Society Inc., Columbus, Ohio),
1956. Pp. 286. Price \$10.00

The American Ceramic Society had previously compiled and published phase dia-

grams of importance to the ceramic science in 1935, 1938, 1947 and 1949. This book is fifth in succession to bring the matter up to date. In the chapter on general discussion of phase diagrams, glossary of terms used, statement and limitations of the phase rule and interpretation of phase diagrams of one, two, three and multi-component systems have been ably presented. Experimental methods for the study of high temperature heterogeneous equilibrium have also been indicated. A selected bibliography on the theory, methods and technique, mathematical treatment, thermodynamic calculations, and silicate chemistry is included in the book which will be of help to the intending investigators in the field. The book contains 811 diagrams. Author index and system index provided at the end of the book are very convenient for ready reference. The book is of great value to persons interested in the field of glass and ceramics, for whom the book is primarily intended, as also to others like geochemists, mineralogists and petrologists.

R. L. THAKUR

SHELLAC by the Staff of Messrs Angelo Bros.
Ltd., Cossipore, Calcutta (*Distributors:*
Rhodes & Co. Ltd., London and Wil-
liam Zinsser & Co., New York), 1956.
Pp. i + 161

Messrs Angelo Bros. Ltd., Cossipore, Calcutta, one of the oldest and largest manufacturers of shellac, are understandably best-equipped to bring out a publication of the kind under review. This book — in its second edition (the first edition was printed in 1938) — does not claim to be a comprehensive treatise on shellac and sticks to the original conception of offering a practical handbook to the Company's many customers. Naturally it is more objective than comprehensive and has dealt briefly, in its 12 chapters, with all aspects of lac and lac industry including the description of the traditional indigenous process of shellac manufacture as well as the manufacture of machine-made shellac.

The first chapter gives the summary of the book besides elucidating the terms Lac and Shellac both of which are being used quite often synonymously although incorrectly. The second chapter deals with lac insect and its enemies, the parasites and the predators. Chapter III gives the history of lac, informa-

tion for which has been compiled from various sources and has been traced as far back as the *Vedas*.

The story of cultivation of lac and the indigenous method of refining it into seedlac and shellac together with a passing reference to the refining process adopted in foreign countries specially for bleached lac are given in chapters IV and V respectively. Chapter VI is devoted to the history and growth of the organization of Messrs Angelo Bros. Ltd. It is this factory, established over 100 years ago, which first manufactured pure shellac by a solvent process and also introduced new heat processes for its manufacture.

Lac trade is the subject of Chapter VII. Production data for the export of shellac for India, Thailand and Burma are given. It also deals with the organization of lac trade and price fluctuations, etc. Chapter VIII deals with the chemical constitution and physical and chemical properties of lac.

Few products have such wide and varied uses as lac and new uses are continually being developed. It is aptly described as a resin of a thousand and one uses. Chapter IX deals with its numerous uses and also mentions the scientific uses of particular grades of Angelo's lac. Typical compositions are also suggested.

Chapters X, XI and XII deal respectively with lac wax, specifications and analysis, and tests. In the analytical section of the handbook the aim seems to have been to make selection in the methods considered most useful and reliable and to draw attention in appended notes to the practical aspects of the methods, their value, limitations and probable sources of error. The methods themselves have been described in full detail.

The addition of a bibliography at the end of each chapter has made the book particularly valuable. The book is an unpriced publication presumably intended for distribution to the Company's various customers. Its service to the industry will be even more pronounced if it could be made freely available to the general public in the form of a moderately priced edition.

Printed on art paper and profusely illustrated with both coloured and black and white photographs, maps and charts, the book has an excellent get up and will, no doubt, be valued not only by the dealers and consumers, but also by all those who are connected with shellac.

There are a few typographical errors and omissions in the book which are sure to be eliminated in subsequent editions.

S. V. PUNTAMBEKAR

NOTES & NEWS

Genetics and Plant Breeding

A FOUR-DAY SYMPOSIUM ON "Genetics and Plant Breeding in South-east Asia" was held during 21-24 January 1957 at the Indian Agricultural Research Institute, New Delhi, under the joint auspices of the Indian Society of Genetics and Plant Breeding and Unesco South Asia Science Co-operation Office. Plant breeding experts and geneticists from India, Sweden, U.S.A., Australia, Burma, Ceylon and Pakistan participated in the symposium. In his inaugural address, Dr. B. N. Uppal reviewed the work done in India on plant breeding. He pointed out that genetics contributed not only to the conventional methods of plant breeding which aimed at evolving new varieties but it had also helped to devise altogether new techniques which had given spectacular results.

Twenty-four papers were presented for discussion in the following five sections: *Plant Breeding*, *Cytogenetics*, *Plant Introduction*, *Genetics*, and *Plant Physiology*. A popular lecture on the plant breeding and food supply was delivered by Prof. G. L. Stebbins (U.S.A.).

Plant Breeding — Twelve papers were discussed in this section dealing mainly with the problems of breeding improved varieties of crop plants, such as rice, wheat and other cereals, millets, fibres, potato and other tuber crops, oil-seeds and tobacco, with particular reference to South-east Asia. In his paper entitled "Genetics, Evolution and Plant Breeding" Prof. G. L. Stebbins pointed out that a knowledge of the wild relatives of a species of crop plant had become necessary in a modern plant breeding programme. The value of such knowledge had increased markedly owing to the presence of genes for disease resistance and exceedingly efficient methods have been developed for incorporating such genes into the germ plasm of the crop species.

Cytogenetics — The discussion on modern trends in cytogenetics was initiated by Prof. A. Gustafsson (Sweden). He emphasized the indispensability of mutation research for the progress of plant

breeding. High yields could be secured through mutation research which was also helpful for agricultural improvement in general.

Plant Introduction — Three papers were presented in this section including the principles and problems of plant introduction and the scope and importance of plant introduction in S.E. Asia. It was stated that plant migration had provided vast new areas for the evolutionary development of old and new crops. Historical and biological data on this subject were, however, scanty and it was not possible to learn much about the introduction of old plants into the new world.

Three papers were read on *Genetics* covering such topics as linkage studies in rice and jute, genetics of resistance to diseases and pests in crop plants and genetics of quantitative characters in relation to plant breeding. The three contributions in *Plant Physiology* section were devoted to the subjects of recent developments in the use of plant hormones, the problem of assessment of drought resistance in crop plants, and studies in the photoperiodic response of crop plants of S.E. Asia.

Free surface of heated liquids

INTERESTING RESULTS ON THE form of free surface of a liquid which might have an important bearing on various heat transfer problems have been obtained recently by Russian research workers and described in the *Soviet Journal of Academy of Sciences*. Distilled water was made to fall in a fine spray past horizontally mounted polished duralumin tubes which could be electrically heated. Depending upon the rate of flow of the water and the diameter of the cylinder, a thin film of the liquid is formed on the cylindrical surface. At room temperature the thickness varies with the rate of flow, but the thickness varies little around the perimeter of the tube though drops leave the lowest point of the cylinder. As the temperature of the cylinder surface increases, the liquid evaporates at an increased rate. Below 80° the liquid surface

remains smooth and above 80° it changes into the form of a series of waves uniformly distributed along the length of the cylinder. The wavelength is found to be little affected by alterations in the flow rate and temperature (if it is kept above 80°). This form of surface is observed to be stable up to temperatures close to the boiling point of the liquid (when evaporation of the film at the troughs of the waves occurs) and for considerable temperature gradients through the layer.

The wave formation is explained as follows: Due to a temperature difference between two points of the fluid surface, flow takes place along the surface from the point of a higher to that of a lower surface tension. This flow along the curved surface causes a pressure gradient in the layer of fluid adjacent to the cylinder resulting in a movement of fluid along the surface of the cylinder in the opposite direction. The effect of weight of the liquid appears to be negligible as the wave pattern is the same on both the top and bottom surfaces of the cylinder [*Chem. Age*, 76 (1956), 290].

Production and volume determination of droplets

TECHNIQUES FOR THE PRODUCTION and determination of the volume of droplets, useful in the study of the concentration of sub-microscopic particles in colloidal suspensions, have been described [*Chem. Prod.*, 19(11) (1956), 456].

Calibration methods for the determination of droplet volume require the production of droplets of a constant size. The usual atomizer of the scent spray type is capable of providing droplets less than 100 μ in diameter, but there is a wide spread of droplet diameters. An atomizer giving a uniform droplet diameter has been developed in which the liquid falls upon the upper horizontal surface of an inverted solid metal cone kept spinning at constant speed by an air turbine. The liquid is disintegrated and the droplets are thrown off tangentially outwards, travelling horizontally until they are arrested by air resistance.

Determination of the volume of droplets of 1-100 μ size range presents difficulties due to the transient nature of the droplet. A method has been developed in which holes caused by impinging

the droplets on a layer of magnesium oxide, coated over a glass slide, are examined under the microscope. Previous calibration related the observed drop impress diameter to the true droplet diameter and the ratio was found to be 0.86 for all liquid droplets greater than 20 μ in diameter. Other surfaces which have been used for recording droplet impact include layers of lamp black smoked on microscope slides and films of dyes. An alternative technique is to incorporate within the droplet a number of uniformly small particles. The ratio of the number within the droplet to the number in 1 ml. of the original suspension from which it was produced (determined by a pycnometer or a haemocytometer) is an accurate measure of the volume of the droplets.

Physical basis of insect repellency

WITH A VIEW TO GAIN MORE understanding of the physical basis of insect repellency, R. H. Wright of the British Columbia Research Council, Vancouver, Canada, undertook a study of the infrared spectra of a number of commercial insect repellents including dimethyl phthalate, indalone, 2-ethyl hexanediol, benzyl benzoate, *n*-propyl-N, N-diethyl succinamate and butoxy propylene glycol. He recorded fourteen infrared absorption curves for different substances in the region 400-700 cm^{-1} using a Perkin-Elmer infrared spectrophotometer. The results revealed a striking correlation and showed that most of the repellents exhibited an absorption peak near 460 cm^{-1} and pointed to the conclusion that the physical basis of mosquito repellency is the presence of a molecular vibrational mode capable of giving rise to infrared absorption near 460 cm^{-1} . Though it is not yet known whether other insects are repelled by molecules exhibiting this or other characteristic frequency, these results have considerable practical value in the screening of new mosquito repellents. They also support the hypothesis that the low-frequency molecular vibrations provide the physical basis of odours [*Nature, Lond.*, **178** (1956), 638].

Solar flares

DR. T. GOLD OF THE ROYAL Greenwich Observatory, Herst-

monceaux Castle, Sussex, England, has recently suggested that a process closely similar to the 'pinch effect' observed in the recent Russian thermonuclear fusion experiments may be responsible for the solar flares.

Dr. Kurchatov, leading Russian authority on atomic energy, disclosed recently that attempts to produce the unusually high temperatures of the order of a million degrees centigrade for extremely short periods have been successful. This was achieved by passing large discharge currents through gases like deuterium, using a strong magnetic field to keep the gas ions away from the container walls. In these experiments a second constriction of the spark or the 'pinch effect' has been observed to be related to the appearance of a few particles with energies much higher than expected; these have been detected by the neutrons and gamma rays produced. The 'pinch effect' can be used to obtain high temperatures to fuse the light elements into heavier ones with release of energy.

Dr. Gold has pointed out that in sparks constricted in their own magnetic fields there is a conceivable mechanism for accelerating a small fraction of the particles to very high energies, and has suggested the presence of such particles as a probable mechanism for the occurrence of the solar flare. Electric currents, evenly distributed through large volumes, normally flow in the vicinity of sunspots. When the current density becomes too high, instability sets in, causing the currents to become constricted along one or several lines due to their own magnetic field.

If this interpretation were to be correct, the Russian experiments provide an analytical laboratory method to study this important solar phenomenon. Conversely, the phenomenal energy releases known to take place in the sun may also, in due course, be attained artificially on the earth by knowing more about such processes [*Sci. News Lett., Wash.*, **70** (11) (1956), 174].

New geographic features of the Antarctica

AUSTRALIAN PILOTS CARRYING OUT preliminary reconnaissance flights in preparation for the International Geophysical Year start-

ing in July 1957 have sighted two important new features of the Antarctica. They are (1) an uncharted ice-shelf gulf, 100 miles long, near Amundsen Bay in Enderby Land and (2) a gigantic glacier, about 300 miles wide and 150 miles long, flowing down the Antarctic mountains to Prydz Bay. The two discoveries provide fresh data for the new map of Antarctica to be prepared during the International Geophysical Year [*Unesco Feature No. 211* (1956), 2].

Remote-eye radar

THE MARCONI RESEARCH LABORATORIES, England, have developed an equipment which enables complete separation of the radar display from the source of the radar information or the radar head. The development of this equipment known as 'Remote-eye' radar obviates the hitherto inevitable necessity of situating the operation centre in the immediate vicinity of the radar head and permits the two being located miles apart. It also makes possible the routing of 'raw' radar information from a number of remote radar heads to a central operations centre. This is achieved by providing a microwave radar link equipped with high quality repeaters using travelling wave tubes and capable of relaying three radar or television pictures.

The characteristic working of a distant airport can be viewed miles away by using this equipment. At the airport two T.V. cameras are used, one to view the radar head and the other to scan the general scene from the control tower. Selected picture signals and the radio commentary are routed to a microwave link transmitter which is also fed with two sets of P.P.I. radar picture signals, synchronizing and turning information originating from the radar head. This microwave transmission is relayed by a number of repeater stations situated successively at a distance of up to 15 miles (or even 40 miles if the terrain is favourable) with satisfactory signal-to-noise ratio after allowing for normal fading. At the receiving end, the mobile receiving van picks up the signals and re-routes them to their respective display consoles. A video map could be superimposed on either P.P.I. picture permitting, on the tube-face the applicable

grid co-ordinates, together with any topographical features like runways and navigational beacons [*Indian east. Engr.*, **119**(5) (1956), 332].

Radiological measurements

ACCORDING TO THE UNITED NATIONS Scientific Committee on the Effects of Atomic Radiation, diagnostic radiology and radiotherapy now constitute in some countries the principal source of artificial radiation in amounts approximately equal to natural radiation. It has been actually demonstrated in some cases that populations are subjected to more radiation from medical radiology than from 'fall-out' or effects of nuclear waste disposal. It has also been noticed that many countries have no primary standard for X-ray measurement and have no facility of checking them with standards in use in scientifically more advanced countries. To meet this problem the United States National Bureau of Standards has developed an ionization chamber with necessary equipment for checking radiological measurements.

A proposal regarding the world-wide circulation of the ionization chamber has been approved by the General Conference of the Unesco. In co-operation with the World Health Organization and the United States National Bureau of Standards (NBS), the Unesco has formulated a programme of circulating the ionization chamber to various requesting countries for intercomparisons of radiological measurements. The project, it is hoped, will eventually contribute to uniform standards and lead to the reduction to the minimum of the medical irradiation of populations without impairment of its efficient medical use.

The chamber being designed and constructed by the NBS at a cost of \$ 2500, is expected to be available early in 1957. The apparatus with a volume of a few cubic centimeters will be of the guarded type to avoid insulator leakage problems. Its response will be nearly independent of X-ray energy over the range 50-250 kV. medium filtration. It would be used with the same null-type charge measuring system as is employed with the standard free-air chamber, thus avoiding the error due to the shifts in elec-

trometer sensitivity inherent in secondary instruments. Along with the chamber, an X-ray beam defining diaphragm and a calibrated charge-compensating capacitor (1000 $\mu\mu\text{F}$.) will be supplied to various national laboratories to facilitate comparison with their own corresponding equipment [*Unesco Science News No. 39* (1957)].

Fluothane

'FLUOTHANE', 2-BROMO-2-CHLORO-1, 1, 1-trifluoro-ethane, a new volatile anaesthetic agent, has been developed by Imperial Chemical Industries. It is a clear, colourless, heavy liquid with a specific gravity of 1860 (cf. chloroform, 1500), a boiling point of 51°C., and a sweetish odour like chloroform. Induction is smooth, rapid and not unpleasant; recovery also is rapid and unassociated with complications. The range of anaesthetic concentration lies between 1 and 3 per cent fluothane in air and within these limits adequate conditions can be provided for most types of surgery. Fluothane causes respiratory depression which may be sufficient to cause cyanosis and carbon dioxide retention. This and other undesirable features can be overcome by partly assisting or controlling respiration and ensuring that it is handled only by skilled anaesthetists [*Br. med. J.*, (1956), 969].

A new weed control agent

MAY & BAKER LTD. HAVE DEVELOPED a new compound, M.C.P.B. ('Tropotox') γ (4-chloro-2-methylphenoxy butyric acid), for weed control. It introduces a new approach to selective weed control, employing the new principle of using a non-toxic substance which certain plants are able to make toxic. The product can be safely used in crops containing clovers. The resistance of clovers to this compound is such that even at the first trifoliate leaf stage they are unharmed, at the same time controlling a range of common weeds. Furthermore, cereals may be sprayed at growth stage much earlier than hitherto possible without risk of subsequent ear malformation.

Organo-tin compounds

THE HIGH SELECTIVE REACTIVITY of organo-tin hydrides has led to

the production of a series of organo-tin compounds by the Institute of Organic Chemistry, Utrecht. Organo-tin hydride molecule contains at least one tin-hydrogen bond, which can easily enter into an addition reaction with a wide variety of unsaturated carbon-carbon bonds. The reaction $\text{R}_3\text{SnH} + \text{CH}_2 = \text{CH} - \text{R}' \rightarrow \text{R}_3\text{SnCH}_2\text{CH}_2\text{R}'$ can be carried out without difficulty, and yields are over 80 per cent. The functional groups introduced are so firmly attached to the tin atom that they can enter into specific reactions without the remaining part of the molecule being affected [*Chem. Tr. J.*, **139** (1956), 1099].

Rain repellent for jets

A RAIN REPELLENT, COMPOSED essentially of silicones and a combination of natural and synthetic waxes, has been formulated by the U.S. Navy Department's Bureau of Aeronautics to eliminate the need of mechanical wind-shield wipers in high speed jet aircraft. Prior to coating the glass or plastic wind-shields with the repellent, a black bonding paste is applied to the solvent-cleaned surface, followed by an application of wax, which is buffed in with a cloth until it disappears. Each application lasts for several days of heavy rain. The repellent sets up a hard coating on the wind-shield which makes water behave like heavy beads of mercury. The rain is swept off in beady droplet form by the wind and speed of the plane [*Chem. Age*, **75** (1956), 457].

Welded graphite

DR. R. G. BRECKENRIDGE OF THE National Carbon Co., U.S.A., has succeeded in welding pieces of graphite for the first time by heating them to a high temperature under high pressure. The process also yielded new forms of graphite that have the maximum degree of crystalline perfection attained in artificial graphites up to now. Welded graphite is used to prefabricate sheets and panels for the assembly of nuclear reactor moderators [*Sci. News Lett., Wash.*, **70** (1956), 199].

Microwave detection of metallic ions

INVESTIGATIONS CARRIED OUT AT the Duke University, U.S.A., have

indicated the possibility of using microwaves for the detection of specific metallic ions and organic radicals in plant materials.

Materials from some plants or from the ground below, when placed in a microwave absorption cell, gave electron-magnetic resonances corresponding to manganese ions in aqueous solutions showing that the manganese ions found in plants may be present dissolved in their water content. A single sharp line superimposed on the manganese hyperfine structure in the case of pine cones and pine needles, fallen oak leaves, naturally dried ivy stems and dead plant materials, has been attributed to bound or semi-bound oxygen. A third type of broad resonance observed in several plant materials has been interpreted as being due to cupric ions [*Science*, **124** (1956), 22].

Hydrogen and oxygen in germanium

GERMANIUM IS SO SENSITIVE TO the presence of impurities such as gallium and arsenic that a concentration of one part in ten billion is sufficient to produce a measurable change in its conductivity at room temperature. Since there are about 4.4×10^{22} germanium atoms/ml., a concentration of the order of 10^{13} atoms of the impurity/ml. of germanium is significant.

The levels of impurity concentration often defy detection by the usual analytical procedures. Poorly identified impurities which cause resistivity changes in germanium as a result of heat treatment have been called 'thermium' and those which cause electron-hole lifetimes to diminish have been termed 'deathnium'. On the other hand, there are other impurities which, even if present in amounts a hundred thousand times greater than thermium and deathnium, produce no known electrical effects; two of these are hydrogen and oxygen which have recently been found to occur in concentrations greater than 10^{18} atoms/ml.

Special samples of germanium were prepared for these studies by hydrogen reduction of pure germanium oxide in purified graphite crucibles. Single crystals were then grown from these samples in graphite crucibles under hydrogen, and one crystal was grown in vacuum. Tests indi-

cated that all of these crystals were n-type semiconductors with resistivities ranging from 1 to 10 ohm-cm. The lifetime of minority carriers was around 100 μ sec.

These crystals, as well as the polycrystalline germanium from which they were grown, were analysed for hydrogen and oxygen by a refined vacuum fusion technique. The analysis showed no significant variations in hydrogen and oxygen content among the samples prepared under hydrogen, although results on the single crystals were more uniform. In these crystals the hydrogen content was 3.4×10^{18} atoms/ml. and the oxygen was between 1 and 2×10^{18} atoms/ml. In the crystals grown *in vacuo*, hydrogen was not greater than 1 to 2×10^{17} and oxygen about 6×10^{16} atoms/ml. less by a factor of about 15 than in those grown in hydrogen.

These results provide conclusive evidence that oxygen and hydrogen are both present in the interior of germanium single crystals. However, despite amounts greater than 10^{18} atoms/ml. the electronic states of these gases are such that neither holes nor electrons are contributed in adequate numbers to affect the conduction process in germanium. Since about twice as many hydrogen as oxygen atoms are present, it is possible that these two gases react in germanium and exist as water molecules, thus accounting, in part, for their electrical neutrality [*Bell Telephone Lab. News*].

New technique for olefine polymerization

A NEW TECHNIQUE FOR THE POLYMERIZATION of olefines involving the use of sodium hydride for reducing titanium halide employed as an activator or co-catalyst has been developed by Metal Hydrides Inc., Beverly, U.S.A. This process eliminates the use of highly inflammable and costly aluminium trialkyls used in the conventional Ziegler catalysts. For polymerizing ethylene at low or moderate pressures, sodium hydride is dispersed in oil, aluminium chloride and titanium tetrachloride along with an inert diluent, e.g. mineral oil, in a polymerization vessel at 100°. In the presence of a small amount of ethylene, the catalyst is formed and polymerization initiated. More ethylene is added and highly crystalline, Ziegler-type poly-

thenes in the 40,000 to more than 200,000 molecular weight range are formed.

At higher temperatures and pressures (500 lb./sq. in.) aluminium chloride is not necessary sodium hydride-reduced titanium halides are sufficient to catalyse the polymerization [*Chem. Age*, **75** (1956), 540].

Micro technique for catalyst data

GULF RESEARCH & DEVELOPMENT Co., U.S.A., have developed a micro-catalytic chromatographic technique for studying catalytic reactions, which promises to speed up the accumulation of data on new catalysts. This is achieved by combining a catalytic reactor with a gaseous chromatographic column into a single unit. Another technique involving the use of radioactive tracers has also been applied to the system successfully. In this method, the exit products from the reactor pass first through a gaseous chromatographic column, then through a thermal conductivity unit, and finally through a Geiger counter, giving two simultaneous records on a single recorder chart [*Chem. Tr. J.*, **139** (1956), 481].

Electron diffraction in industry

THE ELECTRON DIFFRACTION TECHNIQUE, developed on the basis of the wave properties of electrons, is a valuable new addition to existing methods of determining the structure and composition of materials. In general, X-ray diffraction and electron diffraction are complementary methods in that each has distinct fields of application. While the procedure in interpretation is very similar for both techniques, there are differences in apparatus and the experimental set-up. An important feature which distinguishes electron diffraction from X-ray diffraction is the very small depth of penetration of electrons (less than 50Å when incident at an angle of 2° on the surface) and the consequent ease with which they are scattered by materials, making it a valuable tool for the investigation of surface phenomena or structure of thin films. For obtaining a useful and clear diffraction pattern the sample, in the form of a thin film or fine powder

or even the immediate surface of a massive specimen, should have sufficient regularity of structure to exhibit diffraction effects with fast electrons and must be stable *in vacuo* and under electron bombardment. Some of the technical problems of importance studied by the electron diffraction technique are: oxidation and corrosion of metals and alloys; formation of protective surface coatings; grinding and polishing of surfaces; lubrication; and rectifying contacts.

The essential components of electron diffraction equipment are: (1) a means of producing a beam of electrons of uniform and constant velocity, (2) magnetic lenses mounted axially outside the vacuum chamber, one for focusing the electron beam to a fine spot on the specimen and another to focus the reflected or transmitted beam on to the photographic plate, (3) a device for holding and manipulating the test specimen and (4) a fluorescent screen for observing the diffraction and a camera to obtain a permanent record. All these constituent parts are enclosed in a chamber which can be evacuated to a pressure of 10^{-4} mm. of Hg. Two important services to be provided for the operation of the various parts of the instrument are the stabilized electrical supply for the accelerating high voltage and the energizing current and the high vacuum equipment with accessories.

Specimens easily removable and mountable in a specimen holder, e.g. thin films formed by evaporation and deposition *in vacuo*, thin cleavage slices from single crystals, fine powders, etc., can be examined by the transmission technique in which the resulting diffraction pattern is produced by the incidence, on the photographic plate, of the undiffracted beam and the various diffracted beams of electrons.

Surface layers on a parent substrate, which are of technical and industrial importance but are not readily removable and have to be studied *in situ*, are examined by the reflection method. A beam of electrons is allowed to strike the specimen surface at grazing incidence (*c.* 1°); the electrons pass through the surface excrescences (of about 20-30 atomic diam.) and undergo diffraction. The resulting patterns are similar to the transmission patterns except for that part of the pattern where the

shadow of the bulk of the specimen occupies the viewing screen. Any trace of surface contamination is to be avoided as the method is very sensitive.

With transmission type specimens, when the sample contains a large number of very small crystals randomly oriented with respect to the electron beam, a pattern of continuous rings, each corresponding to diffraction at a particular crystallographic plane, is obtained. If there are only a few crystals, the individual diffracted beams may be insufficient to make up continuous rings and the rings develop a spotty appearance. With reflection type specimens consisting of a continuous layer, the presence of fewer crystals in the path of the electron beam implies that they are larger. Thus differences in crystal growth in two chemically identical samples can be observed from the difference in the degree of spottiness. Strong intensity of the rings at certain positions on their circumference indicates a certain degree of preferred orientation of the individual crystals. As the crystal size progressively decreases the rings become more and more diffuse and no characteristic pattern results with amorphous samples. For single crystals, the patterns usually consist of a number of spots, sometimes accompanied by pairs of parallel lines. Such patterns are more valuable in determining the orientation of the single crystal than in its identification. Special types of characteristic patterns are obtained with particular samples like the surface of a polished metal or thin films of oils or greases. The interpretation is similar to the established procedure in X-ray diffraction work. The diameters of the various rings are measured accurately from which the interplanar spacings are calculated, knowing the geometry of the apparatus and the equivalent wavelength of the electron beam. If the standard data for the substance of the sample is already indexed, it can be identified by comparison with the indexed data.

An idea of the extent to which the electron diffraction method supplements, in a large measure, the analytical facilities in a large industrial organization, may be had from a consideration of a few problems investigated at the Research Laboratory of the General Electric Co. Ltd., England. A few

of the problems studied are considered below.

Visual examination of the cathodes of cathode-ray tubes giving poor emission showed a small darkened area in the centre of the cathode coating. X-ray methods failed to reveal the presence of any crystalline phase other than the normal cathode coating. However, reflection electron diffraction clearly demonstrated the presence of graphite as a contaminant of the coating surface.

In the application of an emissive coating to certain batches of nickel cathodes for radio receiving tubes, after normal processing, the coating flaked away from the nickel base. These batches too complied with the normal acceptance tests and could not otherwise be distinguished from those with satisfactory adhesion. However, samples from each of the batches in which the flaking trouble was observed have given a pattern of hydrated calcium sulphate, while those of the satisfactory nickel did not give it. Thus, the cause of the trouble, not detectable by other means, has been traced by the electron diffraction method.

Due to failure of the metal to amalgamate properly, the recovery of gold by the 'amalgamation' method is incomplete. The 'rusty gold', i.e. the improperly amalgamated gold particles which have a tarnished appearance, has been studied by this technique. The gold particles concerned have been found to be coated with a layer of iron sulphide (pyrite) [*G.E.C.J.*, **23** (1956), 130].

Mauna Loa High-altitude Observatory

A HIGH-ALTITUDE OBSERVATORY located at an altitude of 11,134 ft. on the Hawaiian volcano, Mauna Loa, started functioning on 28 June 1956. Its strategic location for the study of the huge air masses of the tropics which are responsible for most of the weather characteristics in other parts of the world makes it a valuable research centre in improved long-range weather forecasting. Additional knowledge is also expected to be obtained on solar and atmospheric radiation. There is evidence that the ozone content of the lower atmosphere in tropics is associated with the formation of large low-pressure areas

producing typhoons. Continuous ozone measurement may thus assist in the forecasting of typhoons.

The observatory also offers possibilities for the study of cosmic rays, snow crystals, air glow and possibly radioactive fall-out. A study of the moisture content of Mars using spectroscopic techniques is in progress now at the observatory [*Tech. News Bull., Nat. Bur. Stand.*, 40(10) (1956), 137].

Ship-model testing tank at Khadakwasla

A SHIP-MODEL TESTING TANK, 500 ft. long, 12 ft. wide and 9 ft. deep, is now in operation at the Central Water and Power Station, Khadakwasla. It is the first of its kind in South-east Asia and has been installed by Indian engineers with the technical co-operation of a Danish scientist, Dr. H. F. Nordstrom. Models are driven through the tank suspended from a 3-ton carriage, riding on rails, 14 ft. apart. In this tank, reduced scale models of hull designs are tested to obtain the power-wasting resistance from which the horse power required for the engines can be worked out. Experiments conducted at Khadakwasla on models of fishing boats used at Satpati, a port near Bombay, showed that the speed of these boats could be increased by 10 per cent, without supplying any additional power, by changing the design. The significance of this result is being studied by the Bombay State Fisheries Department [*Unesco Feature No. 210* (1956), 2].

Palaeontological Society of India

THE PUBLICATION OF THE INAUGURAL number of the *Journal of the Palaeontological Society of India* provides an indication of the progress palaeontology is making in India and of the importance scientists attach to it. In recent years, palaeontology has become a valuable tool in the prospecting and discovery of natural fuels, especially coal and petroleum.

For a country like India, just embarking on an ambitious programme of industrial development, all knowledge relating to its mineral resources, particularly its

coal, oil and strategic minerals, is valuable. Palaeontology has played an important role in mapping out the structural and stratigraphical sequence of the various regions, indicating where economic exploitation of coal or petroleum is possible. In India, palaeontological studies have been carried out for nearly a century now, under the aegis of the Geological Survey of India and considerable areas have been surveyed. Many of these findings are recorded in the publications emanating from the Geological Survey of India, particularly the series *Palaeontologia Indica*. During the past 3 or 4 decades considerable work has been done on palaeobotany, under the inspiring guidance of Dr. Birbal Sahni, and a new institute for furthering research in this branch has been founded in Lucknow. However, for a country of the vastness of India, there are yet many unsolved problems connected with its geological history, especially of the sedimentary formations, which are a valuable storehouse of fossils of great interest.

The Palaeontological Society of India has been founded with a view to promote and further researches in India on the following: (1) elucidating unsolved problems of Indian Palaeontology (e.g. the age of Vindhyan and Krol systems), (2) search for oil and coal, (3) search for human origins and early man in India, (4) preparation of monographs on Indian fossils and related faunas and (5) establishment of a museum and library to disseminate geological and palaeontological information.

The inaugural number of the journal, which has just been published, is a massive volume of more than 250 pages and contains articles from eminent scientists, not only from India, but all over the world. There are as many as 30 contributions covering many aspects of palaeontology, palaeobotany and palaeohistory. In the opening paper, Dr. M. R. Sahni, who as Founder-President of the Society has inspired this new venture, has given a lucid account of the aims and objectives of the Society and has followed it up with a second article giving a very informative and interesting account of the progress of these branches of science during the past one century in India. The articles have been well edited and printed and profusely illustrated with

photographic plates and line drawings.

The journal is to be published twice a year and will include papers pertaining to original work in various branches of palaeontology, palaeobotany and prehistory and also critical reviews of recent works on several topics. The Palaeontological Society of India has to be warmly congratulated on the commendable effort in bringing out such a valuable publication. The subscription rate or the membership fee of the Society is not mentioned. Considering the size, comprehensiveness and high standard of the inaugural number, the price of Rs. 30 appears to be quite reasonable.

National Institute of Sciences of India

THE FOLLOWING HAVE BEEN elected office-bearers of the Council of the Institute for the year 1957.

Prof. P. C. Mahalanobis (*President*); Prof. S. P. Agharkar and D. S. Kothari (*Vice-Presidents*); Prof. M. S. Thacker and Prof. G. P. Majumdar (*Addl. Vice-Presidents*); Prof. Ram Behari (*Treasurer*); Dr. B. Mukerjee (*Foreign Secretary*); Shri S. Basu and Prof. P. Maheswari (*Secretaries*); Prof. R. C. Majumdar (*Editor of Publications*); Dr. K. N. Bagchi, Prof. K. Banerjee, Dr. U. P. Basu, Dr. S. Bhagavantam, Dr. K. R. Dixit, Dr. B. C. Guha, Dr. V. R. Khanolkar, Prof. P. K. Kichlu, Prof. R. S. Krishnan, Prof. C. Mahadevan, Prof. S. K. Mitra, Dr. B. P. Pal, Dr. Mata Prasad, Prof. B. Sanjiva Rao, Prof. B. R. Seshachar, Prof. N. R. Tawde, Shri Nirmal Kumar Bose, Prof. P. L. Srivastava, Prof. P. S. Gill, Dr. B. N. Prasad, Prof. S. N. Bose, Dr. K. S. Krishnan, and Dr. A. C. Ukil (*Members*).

The following have been elected Fellows of the Institute:

Dr. E. K. Janaki Ammal, Dr. Akshayananda Bose, Dr. S. S. Deb, Dr. K. S. G. Doss, Dr. G. C. Esh, Dr. V. S. Huzurbazar, Dr. S. M. Mehta, Dr. K. R. Nair, Dr. B. R. Nijhawan, Dr. V. Puri, Dr. T. R. Rao, Dr. L. S. Ramaswami, Dr. B. C. Roy, Dr. N. K. Saha, and Dr. P. N. Wahi (*Ordinary Fellows*); Prof. A. H. Compton, Prof. Tomizo Joshida, Prof. Linus Pauling, and Prof. Hideki Yukawa (*Hony. Fellows*).

Indian Botanical Society

THE FOLLOWING HAVE BEEN ELECTED office-bearers of the Society for the year 1957: Dr. S. K. Pande (*President*); Drs. A. C. Joshi and S. Ranjan (*Vice-Presidents*); Dr. J. Venkateswarlu (*Hony. Secretary*); Dr. R. Misra (*Hony. Librarian*); Dr. T. S. Sadasivan (*Hony. Treasurer, Editor-in-chief and Business Manager*); Drs. P. Maheshwari, H. Santapau, E. K. Janaki Ammal, P. N. Mehra, K. A. Chaudhary, B. Samantarai, A. Abraham, J. C. Sen Gupta, R. P. Roy and Shri C. D. Deshmukh (*Councillors*); Drs. S. Ranjan, P. Maheshwari, B. P. Pal and A. C. Joshi (*Members, Editorial Board*).

Institution of Tele-communication Engineers

THE FOLLOWING HAVE BEEN ELECTED office-bearers of the Institution for the year 1957: Prof. K. Sreenivasan (*President*); Shri B. V. Baliga, Dr. Lal C. Verman and Shri D. D. Lakhanpal (*Vice-Presidents*); Shri B. S. Rau (*Hony. Treasurer*); Shri S. S. Aiyar (*Hony. Secretary*); Dr. Ram K. Vepa and Shri N. V. Gadadhar (*Hony. Joint Secretaries*).

Royal Society and Nuffield Foundation Commonwealth Bursaries

DR. S. BASU, READER IN CHEMISTRY, University of Calcutta, and Dr. V. R. Rao, Reader in Physics, Andhra University, have been awarded bursaries for pursuing studies on the 'Application of Quantum Mechanics to the Solution of Problems of Chemical Reactivity' and 'Spectroscopic Techniques in Cytology' respectively. The former will work at Oxford University and the latter at King's College, London.

Award of Doctorate Degrees

THE FOLLOWING PERSONS HAVE recently been awarded Ph.D. degrees by the Poona University: Hari Lal Bhatnagar (*Physico-Chemical Studies on Polymer Solutions*); Moreshwar Bhalchandra Deshmukh (*Some Studies in Joshi Effect*), Mohan Vishwanath Divekar (*Mineral Nutrition of Sugarcane Varieties*); and Chintaman Mahadeo Deshpande (*Dipole Moment and the Nature of the Chemical Bond*).

D. B. Krishna Rao (*Facet Analysis and Depth Classification of Agriculture*); Anand Ram Gupta (*Electrochemical Properties of Some Colloidal Acid Systems*); and Manasi Ghosh (*Morphological and Embryological Studies in the Santalaceae*) have been awarded Ph.D. degrees by the University of Delhi.

Announcements

■ *International Conference on Radio-isotopes* — An international scientific conference on the use of radio-isotopes in research will be held under the auspices of the Unesco in Paris during September 1957. The conference will work in two main sections. The first will deal with the role of radio-isotopes in the field of physical sciences such as geology, geophysics (including meteorology and oceanography) and metallurgical and industrial research, while the second will take up the use of radio-isotopes in biochemistry (including plant biochemistry and photosynthesis), human and animal physiological research, nutrition research, basic medical research and certain branches of agricultural research including soil fertility, plant and animal pathology and the use of insecticides.

■ *Supply of steroid compounds* — The Medical Research Council, England, has issued a revised circular in connection with the supply of reference steroids from the Steroid Reference Collection, formed in 1954 for the use of research workers engaged on steroid metabolism studies [*J. sci. industr. Res.*, **13A** (1954), 542]. The circular includes a new and extended list of 130 compounds, now available. They are mostly obtained as gifts from various British and overseas industrial firms. These compounds have been classified into two categories, those readily available and chiefly in demand (class A) and other steroids for more specialized work (class B).

The circular also announces the starting of a new service for supplying a few selected steroids for analytical use. Compounds of this category available for supply, free of charge, are: Oestradiol-17 β , oestradiol-17 β -methyl ether, oestriol and oestriol methyl ether. Requests for these compounds not exceeding 10-20 mg. should be sent to Dr. R. K. Callow, National Institute for Medical Research, Ridge-way, Mill Hill, London N.W.7.

INSTRUMENTS AND APPLIANCES**COMBINED REFLUX-DISTILLATION CONDENSER**

A distillation condenser has been fabricated at the Prairie Regional Laboratory, National Research Council, Saskatoon, Canada, in which the difficulties normally encountered in routine laboratory distillations regarding change-over from refluxing to distillation have been eliminated.

In the new apparatus, the standard taper joints are connected with a condenser and the distilling and receiving flasks. The change-over from reflux to distillation is carried out merely by turning the 'T' three-way stopcock, thereby avoiding exposure of the contents of the flask to atmosphere. Separate fractions can be collected easily by temporarily switching the stopcock to the reflux position and changing the receiver. The shape of the distilling head is such that the splashing of the liquid into the receiver is avoided [*Canad. J. Tech.*, **34** (1956), 397].

POCKET MICROSCOPE-TELESCOPE

A handy one-piece device incorporating both a 50-power microscope and a 10-power telescope useful in routine observations for plant-operating engineers, workshop and laboratory technicians and design and research personnel has been marketed by Edmund Scientific Corporation, Barrington, N.J. It approximates a fountain pen in size. When used as a microscope it is focussed by tilting, and a metal reflector throws light on the object. It is useful for close-up examinations of small parts and components of plastic, wood or metal. It is also handy for spotting, checking and inspecting machining operations, threads, chambers, wear on cutting tools, for studying insects, crystals, food particles, etc.

For use as a telescope, the reflector is unscrewed and the eye-piece tube and sight are drawn out. It is used for chimney, roof and wire inspections and for distant gauge readings, etc. [*J. Franklin Inst.*, **262**(3) (1956), 245].

ELECTRONICALLY CONTROLLED OIL SEPARATOR

An electronically controlled oil separator has been devised by White's Marine Engineering Co.

Ltd., Durham, for separating mixtures of liquids differing in their densities.

A mixture of the liquids is introduced through the inlet and in due course the lighter liquid rises to the top. In the lighter liquid, a pair of electrodes act as sensitive members in a balanced capacity circuit. One of the liquids acts as the dielectric of a condenser, creating a capacity which differs for the two liquids. The associated circuit sets a motor-driven camshaft in motion and this opens a valve for one of the liquids and closes that of the other. The operation is cyclic, the action being to pump out either of the liquids according to which is between the electrodes [*Overseas Eng.*, (Nov. 1956), 150].

ALTERNATING GRADIENT SYNCHROTRON

An alternating gradient synchrotron capable of producing beams of protons of energies up to 30 BeV. is under construction at the Brookhaven National Laboratory, Upton, N.Y. These high energy particles are to be used for obtaining additional information on the nature of nuclear and sub-nuclear particles.

The machine, estimated to cost \$ 26,000,000, will use a series of alternate, strongly converging and diverging magnetic fields to confine a proton beam in a tube of relatively small cross-section. The focusing effect allows the production of high energy beams with smaller electromagnets and related equipment than would otherwise be possible. The protons are started towards their ultimate energy by means of a 110 ft. long 50 MeV. linear accelerator. The linear accelerator will inject the protons into the circular synchrotron magnet which will not only guide the particles but will also keep the particle beams strongly focused. The overall circumference of the magnet ring is half a mile. About 3500 tons of steel are required for the 240 magnets making up the ring. The protons will make 300,000 revolutions of the doughnut-shaped vacuum chamber, which is also about half a mile long and has a 9×3.5 in. elliptical cross-section. During each revolution the energy of the protons is increased by 100,000 eV. by means of twelve radio-frequency accelerating stations which are periodically located

around the synchrotron ring [*Discovery*, 17(10) (1956), 403].

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Progress Reports

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE ANNUAL REPORT OF THE INDIAN ASSOCIATION for the Cultivation of Science for the year 1955-56 records a number of new fundamental researches in physical and chemical branches of science. A number of modern precision instruments or specially devised apparatus have been designed and calibrated for pursuing particular research problems during the year under review. An account of some of the important researches carried out in various departments is given below:

General physics, X-rays and magnetism — A low temperature bath for working at liquid air temperature and a differential conductivity analyser for measuring diffusion rate have been designed and constructed.

For the determination of potential parameters of unlike molecules from experimental data on thermal diffusion, two methods, one graphical and the other computational, have been developed.

During investigations on 'thermal diffusion and interdiffusion of gases' for isotopic and binary mixtures, the contributions of the second approximation to the thermal diffusion factor and the third approximation to concentration diffusion factor have been computed. The transport property collision integrals for the Lennard-Jones 12:6 model over an extensive range of temperatures have been evaluated. Knowledge of these collision integrals has enabled the calculation of diffusion coefficients to a higher degree of approximation than hitherto possible.

The crystal class and space group of barium oxyfluoroborate have been fixed and its structure has been established by evaluating the atomic co-ordinates from the experimental observations.

A simple method for dealing with the energy density diagrams of graphite obtained from the soft X-ray emission data, enabling easier estimation of various electronic parameters, has been evolved.

Measurements on the magnetic anisotropies of single crystals of a large number of hydrated salts have revealed some anomalies. It has been found that the behaviour of the different salts having the same paramagnetic ion is more or less the same, contrary to the changes observed previously. The existing theories have been observed to be inadequate, particularly at low temperatures, to account for the deviations observed in respect of the temperature variation of ionic anisotropies of these salts.

Optics — An approximate and quick method for the calculation of potential constants of 1, 1, 1-trichloroethane molecule using Wilson's universe kinetic energy matrices has been developed. Studies on the intensities and positions of some new lines which appear in the low-frequency region in the Raman spectra of meta-chlorotoluene, meta-bromotoluene and ortho-, meta- and paracresols in the solid state at different temperatures indicated the formation of virtual bonds among neighbouring

molecules; these bonds are strengthened in the solid state, at low temperatures.

The intensity of some new low-frequency lines appearing in the Raman spectra of frozen solution of carbon disulphide in methyl cyclohexane at -180° has been observed to persist with undiminished intensity in a 50 per cent solution, while they are absent in a spectrum due to a 20 per cent solution. The origin of these lines is traceable to vibrations in dimers. Experiments with solutions of other strengths and in other aliphatic solvents revealed that these new lines cannot be due to any oscillation in the lattice of pure carbon disulphide but are due to oscillation in small groups of carbon disulphide molecules.

In the transition from liquid to vapour phase of ethylene chlorhydrin and *n*-propyl chloride, an abrupt change in the ratio of intensities of prominent Raman lines has been observed. This points to the conclusion that the relative populations of the two types of molecules to which the lines are attributed do not depend much on temperature, but on the nature of the intermolecular field in the state of aggregation.

Theoretical physics — The problem of evaluating theoretically the relative importance of the influence of spin and relativity on the decrease of the scattering cross-section with increasing proton energy has been approached through a semi-relativistic Hamiltonian, enabling a separation of the corrections due to spin and relativity. It has been found that the spin slightly increases the scattering cross-section. The decrease in cross-section, therefore, is due to the predominant influence of relativity effect. The method, however, is not applicable in the region of extreme relativistic energies.

Qualitative agreement with the essential features of the experimental observations on the polarization effects of p-p scattering has been obtained by using a potential of the type $e^{-\alpha r}$ in the Dirac equation. The second order Dirac equation built from the first order Dirac equation gives rise to spin-dependent interactions which accounts for the polarization effect in the scattering, resulting in an improvement in the quantitative agreement with the experimental value.

Physical chemistry — The following interesting relationship has been arrived at between boiling point and other physical properties on the one hand and the effective nuclear charge of the molecule on the other: $P = a\Sigma(Z-S) + b$ where P is the property under consideration, a and b , constants for any particular sequence of molecules, $(Z-S)$, the effective atomic number; Z , atomic number and S a constant characteristic of each element.

During studies on kinetics of vinyl polymerization, an interesting phenomenon has been observed, namely that the polymer (methyl isopropenyl ketone) which is white in the initial stages becomes coloured after some time. With time, the pigmentation increases and finally becomes deep red. The mechanism of this colour formation is being studied.

PROGRESS REPORTS

Organic chemistry — Extensive data have been obtained on the ultraviolet and infrared absorption of organic molecules of polynuclear compounds and alicyclic systems with a view to study their complicated structural features.

A crystalline lactone isolated from costus roots (*Saussurea lappa*) of Kashmir origin has been chemically investigated and a tentative structure assigned.

A number of resins with desirable properties as film formers have been prepared employing the cashewnut shell oil.

Inorganic chemistry — Two new homologues of glycine hydroxamic acid, viz. α - and β -alanine hydroxamic acids, have been synthesized, of which the α variety forms brilliantly coloured crystals of copper and nickel complexes.

A chlorothiosulphato-cobaltic-*bis*-ethylene-diamine in *cis* and *trans* modifications has been prepared.

A number of coloured and stable bi-positive silver complexes with pyridine carboxylic acids have been prepared. They have the magnetic moment of about 174 $\mu\beta$. All the mono-, many of the di- and a few of the tricarboxylic acid derivatives have been found to form bi-positive silver complexes. A few of the complexes when examined by X-ray method showed isomorphism with the corresponding copper complexes.

A number of colorimetric agents have been found suitable for the estimation of different elements. The reagents and the elements that can be estimated with them are given below:

Malon-hydroxamic acid	Iron, molybdenum, uranium and vanadium
Benzo hydroxamic acid	Manganese
Di- <i>p</i> -hydroxymethyl rubeanic acid	Copper, cobalt, nickel and palladium
Benzimidazole (in the presence of ammoniacal ethylenediamine tetra-acetic acid)	Silver
Nicotino-hydroxamic acid	Iron, manganese, molybdenum and vanadium
o-Phenylenediamine	Cobalt

BOSE INSTITUTE

THE ANNUAL REPORT OF THE INSTITUTE FOR THE YEAR 1955-56 gives an account of the important research activities of the different sections.

Physics — An apparatus has been constructed for measuring independently the ultrasonic radiation pressure and the hydrodynamic flow of liquids. The absorption coefficient measurements of a few normally and highly absorbing liquids, like benzene, carbon tetrachloride, etc., have shown large anomalous absorption.

Several cases of decay of unstable particles, both charged and neutral, have been observed. An interesting case of K-meson decay in which there was evidence for direct emission of a pair of γ -rays from the point of decay has been noticed.

A method for the direct determination of photoelectric absorption coefficient has been developed. In the experimental set-up a thin spherical shell of absorber is used, at the centre of which is placed the Co^{60} source in the form of a ball (diam. 0.63 cm.). A Geiger Muller counter is used as the

detector. Pair creation phenomena being a minor factor in the region of 1 MeV. γ -ray energy, this method, by elimination of scattering effect, gives directly the photoelectric cross-section.

A $\text{ZnS} : \text{Ag} - \text{H}_3\text{BO}_3$ scintillation detector has been developed for determining thermal neutron scattering cross-section of compounds containing hydrogen atoms. The detector counts thermal neutrons while eliminating the γ -radiation background by biasing off the γ -pulses.

Chemistry — A survey of the distribution of alkaloids in Indian non-medicinal flora has been undertaken. Of the 18 plants investigated during the year under review, 9 showed the presence of alkaloids in traces, 2 contained appreciable amounts and 2 (*Franciscea latifolia* and *Brunfelsia americana*) were fairly rich in alkaloidal content.

The construction of a Tiselius electrophoresis apparatus was completed. A manual polarographic and a gas chromatographic apparatus were set up.

The radioactive tracer technique has been applied to the study of plant metabolism problems such as role of thioctic acid and malic acid in the mechanism of photosynthesis. Thioctic acid has been shown to play a key role in the Hill reaction in photosynthesis.

Desoxy ribonucleic acid, isolated from the blue green alga *Nostoc muscorum*, was found to consist of two parts, DNA I and DNA II.

Plant biochemistry — A new type of complex polysaccharide, so far unreported, has been isolated from the 5 per cent TCA extract of *Nostoc muscorum*. Prolonged acid hydrolysis of the polysaccharide yielded eight sugars, six of which were identified as glucose, galactose, xylose, arabinose, ribose and rhamnose. The remaining two sugars have not yet been identified.

Plant physiology — Stainable bodies found in the active pulvina cells in *Mimosa pudica* have been shown to be tannin-like bodies present in contractile vaenoles. Studies carried out on the mechanism of contraction of the pulvini of *Mimosa* indicated that the excess of sap contained in the vacuole of the contractile cells was expelled into the connecting tissues during contraction. A close similarity in time sequence was found to exist between the expulsion and re-imbibing of the vacuolar sap with the fall and recovery of the petiole attached to the pulvinus. The expelled sap has been found to contain some potassium salt and some free amino acids like glycine, alanine and glutamic acid. These are supposed to be the main constituents of the irritability substance.

Cytogenetics and plant breeding — *Olitorius R₂₆*, a species of jute, when irradiated by X-ray, undergoes mutation, producing a new variety, the Tall Mutant, which is characterized by 50 per cent increase in fibre bundles in the stem. Treatment of the seeds of *R₂₆* with the radioactive isotope P^{32} resulted in the production of two dominant mutants, one like the 'Tall Mutant' and the other similar to a naturally occurring variety of *olitorius*, Chinsura green.

In the case of sesamum and mustard, X-ray irradiation of the seeds resulted in early flowering and higher yield of oil. In the X_1 generations of sesamum the best plants in types 12 and 20 were found in 40,000 γ treatments giving 118 and 105 fruits respectively, the respective figures in controls being

92 and 68. The selections continued to give higher yields up to the X_6 generation. In X_5 generations of Bengal type of sesamum, earliness in flowering, ranging from 2 to 19 days, has been recorded in almost all types. In the X_6 generations, the irradiated progenies have been found to be as fertile as the parent varieties. The oil content in the irradiated progenies also showed increase over the control, the white-flowered and the small-seeded mutants showing an increase of 2.5 and 10.5 per cent of oil respectively over the control.

The morphology of somatic chromosomes of six varieties of Suttons tomatoes have been studied in detail. They were found to possess one pair of secondary constricted chromosomes and at least two pairs of satellited chromosomes as compared to the lone pair reported earlier.

Microbiology—A mutant of *Aspergillus niger* which gave about 50 per cent increase in the yield of citric acid was isolated.

Polyporus ostreiformis, when grown on 2 per cent malt extract solution, has been found to secrete into the medium a substance which inactivates the antibiotic property of streptomycin and dihydrostreptomycin sulphate. The activity of the culture filtrate is not lost even by free steaming for 1 hr. or autoclaving at 15 lb. pressure for 20 min.

Zoology—Thyroxine has been found to be a more potent means of effecting metamorphosis in retarded tadpoles than vitamin B_{12} .

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

THE FIRST ANNUAL REPORT OF THE EUROPEAN Organization for Nuclear Research (CERN*) reviews its activities during the period 29 September 1954 to 31 December 1955. The organization was inaugurated on 10 June 1955 concurrent with the laying of the foundation-stone of CERN buildings at Meyrin (near Geneva).

The purpose of the organization, supported by 12 European Member States, is "to provide for collaboration among European States in nuclear research of a purely scientific and fundamental character". The results of its researches will be made available without any restrictions. Construction and operation of two accelerators for research on high energy particles; international co-operation, in particular with the Unesco, in research work in theoretical nuclear physics, cosmic rays, etc. and promotion of contacts between scientists from different countries and dissemination of scientific information form the basic programme of the Organization.

*Abbreviation for Conseil Européen pour la Recherche Nucléaire, the name of the Organization in French.

The Organization's programme is directed by a Director-General through three main divisions, namely (1) Proton Synchrotron Division, (2) Synchro-cyclotron Division and (3) Scientific and Technical Services Division. The Organization is assisted, in the purely scientific field, by an Advisory Scientific Policy Committee of eight exceptionally qualified members.

The practical work carried out during the period under review was aimed at making improvements in the design and fixing of parameters of the accelerators. Studies on meson and hyperon theories have been carried out by the Theoretical Study Division. For cosmic-ray investigations an experimental arrangement has been set up to study the lifetime and decay of K-mesons. The set-up consists of two large-sized multiplate cloud chambers and an associated electronic circuitry comprising a combination of scintillation and Cerenkov counters which are selectively sensitive to the fast secondaries arising from the decay of K-mesons. The electronic circuits trigger the photographing equipment as well as register the lifetimes of the mesons.

In the Proton Synchrotron Division, the principles of construction of a high power synchrotron machine are under study. The maximum energy of the machine would be 25 Gev. and the maximum magnetic field for this energy would be 12,000 gauss. On this basis, a set of parameters having 50 magnet periods and 100 magnet units in the circumference has been adopted.

Theoretical studies have been undertaken for developing approximate methods for reducing the unduly high costs of computation of the equations of motion of particles in non-linear fields using perturbation methods employing digital computers for carrying out calculations. The number of starting conditions have been reduced by carefully establishing a few critical conditions which represent possible extreme values. The approximate methods of perturbation evolved have already reduced computation costs by a factor of 10 and a further reduction by a factor of 100 seems possible.

Analytical investigations on the stability of particle oscillations in non-linear fields yielded solutions which are good approximations over longer periods than those derived from the standard perturbation theory and indicated new sub-resonances in addition to those predicted by the linear theory. From these investigations it has been concluded that the non-linearities that could be expected in the machine will not cause dangerous sub-resonances under static conditions.

A low cost mechanical analogue consisting of a quartz fibre pendulum oscillating in vacuum has been constructed and has been found suitable to study experimentally non-linear resonance phenomena and to check the validity of the analytical methods.

Chlorination of Hydrated Lime

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(Manuscript received 31 July 1956)

The effect of moisture content and particle size of hydrated lime, and the temperature of calcination of the parent limestone on the chlorine absorption characteristics of hydrated lime have been studied. Maximum chlorine absorption takes place when dry hydrated lime is used with at least 95 per cent of the hydrate passing through 200 B.S. mesh sieve, and the temperature of calcination of the parent limestone is c. 1000°C.

Bleaching powders possessing good stability and containing 32-38 per cent available chlorine have been prepared from 12 selected Indian limestones.

THE object of the present investigation was to determine the influence of variables such as the particle size and moisture content of hydrated lime and the temperature of calcination of the parent limestone on the chlorine absorption capacity and the rate of chlorine uptake of hydrated lime, and also to evaluate the suitability of some selected Indian limes for use as raw materials in the manufacture of bleaching powder.

Limes obtained by calcining limestones from Gotan (Rajasthan), Katni (Madhya Pradesh) and Sankaridrug (Madras) were used in the studies (Table 1).

Experimental procedure

Preparation of hydrated lime—Freshly prepared quicklime, obtained by calcining limestone ($\frac{1}{4}$ to $\frac{1}{2}$ in. size) in an electrically heated muffle furnace, was taken in a bolt-head flask and water, slightly in excess of that required to hydrate the base, was added slowly while shaking the flask. The flask was kept aside for 30 min. The hydrated lime was dried at 110°C. and transferred to a tightly sealed container.

Hydrated lime of the desired moisture content was prepared by adding the calculated amount of water to dry hydrated lime. The moisture content was determined by measuring the loss in weight on drying.

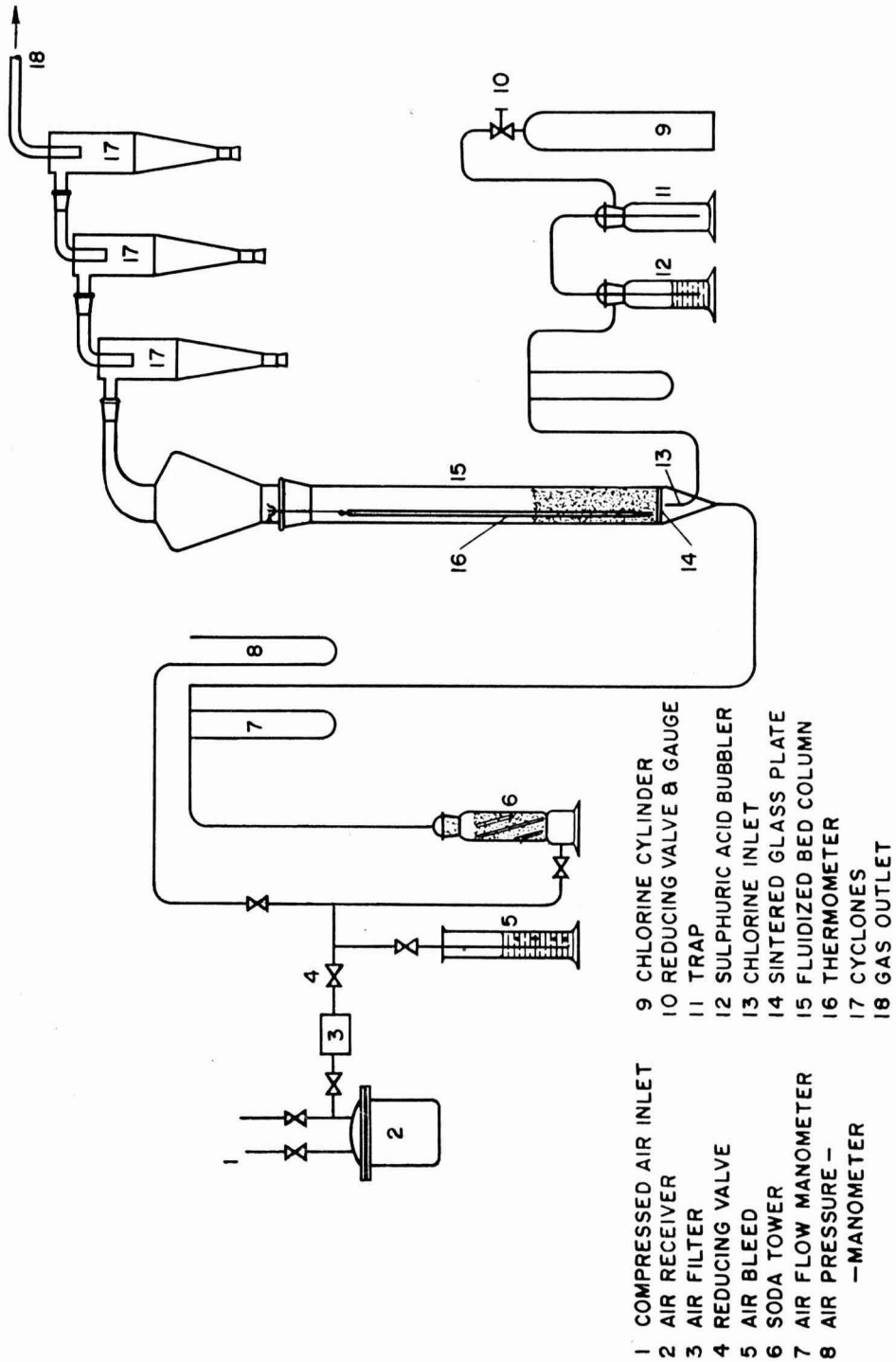
Results of chemical analyses of the limestones used are given in Table 1.

Chlorination of hydrated lime—The fluidized bed technique was employed for chlorination. This method of chlorination was adopted because of its rapidity and the close control it afforded over the chlorination process. The chlorinator (Fig. 1) consisted of a pyrex glass tube, 2.5 in. diam. \times 30 in. long, fitted at the bottom with a sintered glass plate and at the top with an expanded disengaging section and a system of cyclone separators for collecting entrained solid particles. A thermometer was suspended inside the chlorinator. Hydrated lime (100 g.) was charged into the chlorinator and a stream of dry air was fed into the tube at the rate of 14.45 litres/min. Dry chlorine was introduced into the bed at the rate of 0.09 litre/min. Unreacted chlorine was absorbed in a caustic scrubber.

Samples of chlorinated lime were withdrawn from the chlorinator from time to time and analysed for available chlorine. Chlorination was continued till no further chlorine absorption took place.

Analysis of bleaching powder—The moisture content of bleaching powder was determined in the modified apparatus of Golden-son and Danner¹ used in the earlier study². Available chlorine, silica, R_2O_3 , ferric oxide and manganic oxide were estimated by standard methods³; alumina was determined by difference.

Stability—The bleaching powder was stored in clear glass stoppered bottles for 31 days (average daily temperature: max., 37°C.; min., 22°C.; average relative humidity: max., 80 per cent; min., 10 per cent); the available chlorine in the material was determined at the end of this period. An alternative determination of stability was made by heating samples of the material in an electric oven for 2 hr. at 100°C. and estimating the loss of available chlorine.



- 1 COMPRESSED AIR INLET
- 2 AIR RECEIVER
- 3 AIR FILTER
- 4 REDUCING VALVE
- 5 AIR BLEED
- 6 SODA TOWER
- 7 AIR FLOW MANOMETER
- 8 AIR PRESSURE -
-MANOMETER

- 9 CHLORINE CYLINDER
- 10 REDUCING VALVE & GAUGE
- 11 TRAP
- 12 SULPHURIC ACID BUBBLER
- 13 CHLORINE INLET
- 14 SINTERED GLASS COLUMN
- 15 FLUIDIZED BED COLUMN
- 16 THERMOCYCLONES
- 17 CYCLONES
- 18 GAS OUTLET

FIG. 1 — CHLORINATION APPARATUS

TABLE 1 — CHEMICAL ANALYSIS OF LIMESTONES, %⁴

	CaO	Loss on ignition	CO ₂	SiO ₂ and acid insol.	Fe ₂ O ₃	Mn ₂ O ₃	Al ₂ O ₃	R ₂ O ₃	MgO	P ₂ O ₅	S (total)	Cl	Moisture	Available CaO
1 Gotan	55.62	43.80	42.24	0.39	0.02	0.00	0.13	0.15	0.34	0.01	0.02	0.10	0.06	97.27
2 Sojat	55.30	43.50	41.47	0.44	0.03	0.02	0.12	0.15	0.15	0.02	0.05	0.03	0.03	99.25
3 Ghatra	54.80	43.30	42.60	0.96	0.08	0.02	0.35	0.45	0.51	0.03	0.02	0.01	0.08	98.35
4 Katni	55.69	43.45	40.00	0.50	0.08	0.01	0.17	0.26	0.41	0.03	0.02	0.00	0.03	95.65
5 Massive	53.24	44.90	39.85	0.22	0.04	0.00	0.13	0.17	0.18	0.01	0.13	0.44	0.35	93.35
6 Corallite	52.95	45.25	39.13	0.24	0.06	0.00	0.12	0.18	0.26	<0.01	0.18	1.04	0.18	92.75
7 Kona-Rameswara-swami, II	55.70	43.60	42.80	0.19	0.03	0.00	0.11	0.14	0.17	0.01	0.02	<0.01	0.03	97.70
8 Kona-Rameswara-swami, III	55.90	43.90	42.95	0.10	0.02	0.00	0.08	0.10	0.08	0.01	0.02	<0.01	0.03	94.63
9 Palkur	55.40	43.05	42.84	1.09	0.07	0.00	0.23	0.30	0.48	0.01	<0.01	<0.01	0.05	94.14
10 Tuticorin coral	52.85	43.80	39.68	0.98	0.10	0.00	0.47	0.57	0.33	0.02	0.20	0.06	0.65	92.15
11 Sankaridrug white	55.60	43.40	42.20	0.37	0.10	0.02	0.01	0.19	0.13	0.03	0.05	<0.01	0.01	97.78
12 Kottayam shells	55.40	44.10	40.85	0.03	0.07	0.01	0.09	0.27	0.03	0.03	0.05	0.01	0.06	97.36

Results and discussion

Moisture content of hydrate — The effect of moisture content of hydrated lime on chlorine absorption is shown in Table 2 and Fig. 2. The rate of chlorine absorption diminishes as the moisture content increases; the total quantity of chlorine absorbed is also lowered. The absorption of chlorine by the hydrate is accompanied by the formation of water which facilitates further chlorine uptake. A high initial moisture content leads to the formation of a dense mass and also causes particles to stick to the sides of the chamber, thereby reducing the chlorine absorption capacity of the material.

Particle size of hydrated lime — The effect of particle size on chlorine absorption is shown

TABLE 2 — EFFECT OF MOISTURE CONTENT OF HYDRATED LIME ON CHLORINE ABSORPTION

LIME	HYDRATE SIZE B.S. mesh	MOISTURE %	MAXIMUM AVAILABLE CHLORINE %
Gotan	{ -200+240	4.0	34.0
		8.0	30.0
Katni	{ -100+200	0.0	25.6
		2.5	25.0
		4.5	22.0
		4.0	20.0
		8.0	17.4

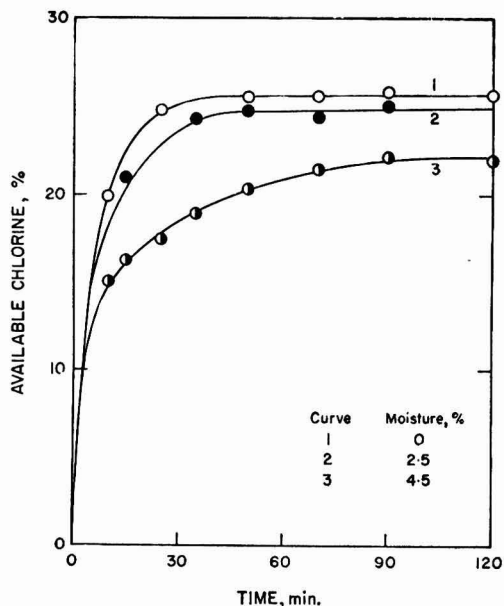


FIG. 2 — EFFECT OF MOISTURE CONTENT ON CHLORINE ABSORPTION FOR KATNI HYDRATED LIME [Temp. of calcination, 900°C., particle size, -100 +200 B.S. mesh]

in Fig. 3. Table 3 gives the maximum chlorine absorption in relation to particle size of the hydrate.

The effect of particle size of hydrated lime on chlorine absorption is much more pronounced than that of moisture content. Thus, the available chlorine in bleaching powder prepared from Sankaridrug limestone rises from 15 to 34 per cent as the particle size of the hydrate is reduced from -36 +72 to -240+300 B.S. mesh. 'Fat' limes, which yield a large proportion of fine particles on slaking, are, therefore, specially suitable for the preparation of bleaching powder.

Table 4 gives the grading analyses of dry hydrates prepared from Gotan, Katni and Sankaridrug white limes. The hydrates of the three limes differ greatly in particle size distribution. Gotan hydrate, as produced, contains a large fraction (79.5 per cent) passing through 200 B.S. mesh sieve, and tends to absorb more chlorine than Sankari-

drug hydrate in which the proportion of -200 mesh particles is only 3.1 per cent. The intrinsic chlorine absorption capacity of

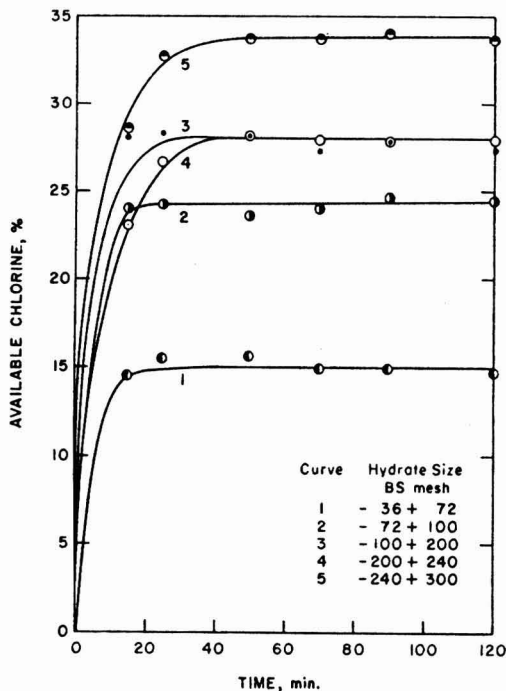


FIG. 3 — EFFECT OF PARTICLE SIZE ON CHLORINE ABSORPTION FOR SANKARIDRUG WHITE HYDRATED LIME [Temp. of calcination, 900°C.; moisture content, nil]

TABLE 3 — EFFECT OF PARTICLE SIZE OF HYDRATED LIME ON CHLORINE ABSORPTION

(Moisture content of hydrate: Katni, 4%; Sankaridrug, 0%)

HYDRATE SIZE B.S. mesh	MAX. AVAILABLE CHLORINE	
	Katni lime %	Sankaridrug lime %
-36+72	18.2	15.0
-72+100	20.0	24.7
-100+200	22.9	28.0
-200+240	28.9	28.0
-240+300	30.2	34.0

TABLE 4 — PHYSICAL CHARACTERISTICS OF SELECTED INDIAN LIMES AND

No.	LIMESTONE	ORIGIN	NATURE OF LIMESTONE	CHARACTERISTICS OF			
				Porosity %	Fatness vol. hydrate/ vol. lime	Sieve analysis B.S.	
						+36 %	-36+72 %
1	Gotan	Rajasthan	Metamorphic, compact, carboniferous	55-60	3.03	2.3	3.0
2	Sojat	do	do	54-56	4.01	7.3	7.7
3	Ghatra	do	Tufaceous, porous	45-51	4.45	21.2	13.3
4	Katni	Madhya Pradesh	Metamorphic, compact, marble	42-49	3.49	25.7	5.5
5	Massive	Saurashtra	Coralline, porous	71-80	—	1.3	2.3
6	Corallite	do	do	—	—	1.0	1.5
7	Kona-Rameswaraswami, II	Andhra	Tufaceous, porous	44-54	4.45	42.7	14.6
8	Kona-Rameswaraswami, III	do	do	42-53	3.47	35.5	14.8
9	Palkur	do	do	41-51	5.12	48.5	6.0
10	Tuticorin coral	Madras	Coralline, porous	—	—	6.0	6.0
11	Sankaridrug white	do	Metamorphic, compact	—	—	55.2	20.9
12	Kottayam shells	Travancore-Cochin	Organic, shell limestone	—	—	7.0	6.0
13	Commercial stable bleaching powder (Indian)	—	—	—	—	—	—
14	Commercial stable bleaching powder (foreign)	—	—	—	—	—	—

*Stability test conducted on bleaching powder after drying for 15 min. at 80°C

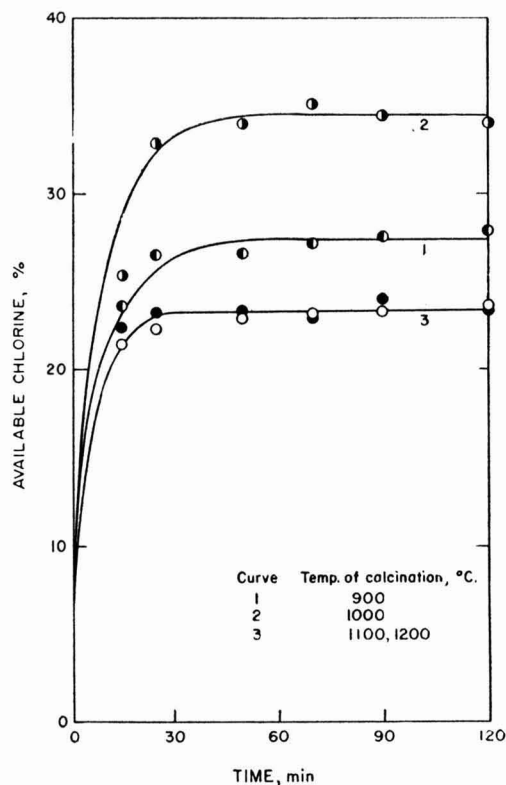


FIG. 4 — EFFECT OF TEMPERATURE OF CALCINATION OF PARENT LIMESTONE ON CHLORINE ABSORPTION FOR KATNI HYDRATED LIME [Particle size, -200 +300 B.S. mesh; moisture content, nil]

Sankaridrug hydrate is, however, slightly greater than that of Gotan hydrate as, under similar conditions of chlorination and particle size distribution, the former absorbs more chlorine than the latter (Table 4).

The grading analysis of hydrated limes given in Table 4 gives an idea of the amount of grinding necessary to obtain a material suitable for chlorination.

For the production of bleaching powder, hydrated lime should first be sieved, and, if necessary, be ground and air-classified so that at least 95 per cent of it passes through 200 B.S. mesh sieve.

Temperature of calcination — The effect of temperature of calcination of Katni limestone on chlorine absorption of the derived lime is shown in Fig. 4. Table 5 gives the maximum available chlorine content of bleaching powders prepared from limes calcined at various temperatures.

The maximum chlorine content and absorption rate rise with increasing calcination temperature up to about 1000°C. beyond which they decrease. Calcination at low temperatures sometimes fails to open up the lime sufficiently, while high temperatures promote the formation of a dense and over-burned lime with low available lime index, due to the reaction of calcium oxide with silica and alumina present in limestone.

Lime used for preparing bleaching powder should be calcined under controlled conditions with a close regulation of kiln tempera-

CHEMICAL COMPOSITION AND STABILITY OF DERIVED BLEACHING POWDERS

LIME AT 1000°C.		PARTIAL CHEMICAL ANALYSIS OF BLEACHING POWDER							LOSS OF AV. Cl ₂ ON STORAGE* %/day	WHITENESS	
of hydrate sieve		Available Cl ₂ %	SiO ₂ %	R ₂ O ₃ %	Fe ₂ O ₃ %	Mn ₂ O ₃ %	MgO %	H ₂ O %		Hydrate %	Bleaching powder %
-72+200 %	-200 %										
15.2	79.5	36.4	0.52	0.09	0.03	0.00	0.33	0.44	0.06	92.0	90.0
42.5	42.5	33.9	0.42	0.08	0.03	0.01	0.46	0.20	0.05	91.2	91.0
35.0	30.5	37.4	0.71	0.28	0.08	0.03	0.38	4.48	0.06	89.5	88.7
22.7	46.1	36.0	0.09	0.06	0.02	0.01	0.57	3.67	0.03	92.0	92.0
12.6	83.8	32.8	0.56	0.08	0.03	0.00	0.29	4.47	0.07	91.5	90.0
11.2	86.3	34.4	0.33	0.11	0.04	0.00	0.21	3.93	0.05	93.3	92.8
22.6	20.1	33.3	0.24	0.05	0.03	0.00	0.17	2.70	0.05	93.0	92.5
23.7	26.0	34.0	0.08	0.02	0.01	0.00	0.21	3.82	0.06	93.2	92.0
7.5	38.0	36.6	1.43	0.23	0.08	0.00	0.40	3.93	0.09	90.0	89.9
74.0	64.0	32.5	1.51	1.15	0.10	0.00	1.23	3.88	0.06	89.3	89.0
20.8	3.1	37.9	0.39	0.12	0.09	0.08	0.21	2.76	0.05	90.0	90.0
18.0	69.0	37.7	0.32	0.17	0.06	0.01	0.11	—	0.06	90.0	90.0
—	—	32.7	0.28	0.24	0.11	0.07	0.68	1.00	0.10	—	82.4
—	—	31.24	0.42	0.52	0.22	0.03	0.14	1.30	0.06	—	87.5

and 27 in. Hg vacuum. The moisture content of the samples was less than 0.5%.

TABLE 5 — EFFECT OF TEMPERATURE OF CALCINATION ON CHLORINE ABSORPTION

(Moisture content of hydrated lime, 0%)

SOURCE OF HYDRATE	MAX. AVAILABLE CHLORINE FROM HYDRATE CALCINED AT (°C.)			
	900	1000	1100	1200
Katni	28.0	34.4	23.2	23.2
Sankaridrug	34.0	37.9	—	—

TABLE 6 — EFFECT OF BED TEMPERATURE ON CHLORINE ABSORPTION

(Lime from Katni was used)

HYDRATE SIZE B.S. mesh	MAX. TEMPERATURE ATTAINED (°C.)		MAX. AVAILABLE CHLORINE (%)	
	Without water jacket	With water jacket	Without water jacket	With water jacket
-100 + 200	61	40	25.6	21.2
-200 + 240	64	30	29.0	39.0

ture. The temperature in the calcination zone of the kiln should be as close as possible to 1000°C.

Temperature variation during chlorination — The temperature variation in the fluidized bed during chlorination is shown in Fig. 5. The temperature rises sharply on the introduction of chlorine, attains a maximum and then rapidly decreases. The maximum temperature is in the range of 55°-65°C., the only exception being hydrated lime from Gotan limestone in the chlorination of which a temperature of c. 80°C. was recorded. The maximum temperature was reached from 2 to 10 min. after the introduction of chlorine. Higher temperatures were attained with decreasing particle size of hydrate.

The lowering of the bed temperature from 64° to 30°C., by surrounding the chlorinator with a water jacket and circulating cold

water, had little effect on total chlorine absorption (Table 6).

Evaluation of limes for bleaching powder manufacture — Bleaching powder was prepared in the fluidized bed apparatus employing optimum conditions from a dozen hydrated limes considered suitable for the purpose by virtue of their purity and whiteness. The chlorinated product was dried under vacuum at 80°C. for 15 min.

The available chlorine content, partial chemical composition, stability and whiteness of the bleaching powders produced are given in Table 4; the composition and stability of two commercial bleaching powders are included for comparison.

Rate of chlorination and chlorine absorption capacity — The chlorine absorption capacities of different hydrated limes are recorded in Table 4 and shown in Figs. 6 and 7. The hydrates derived from coralline limestones, such as massive, corallite and Tuticorin

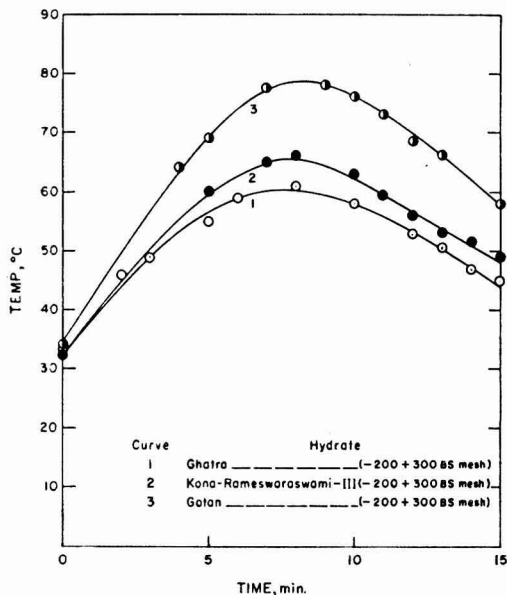


FIG. 5 — TEMPERATURE VARIATION IN THE FLUIDIZED BED DURING CHLORINATION

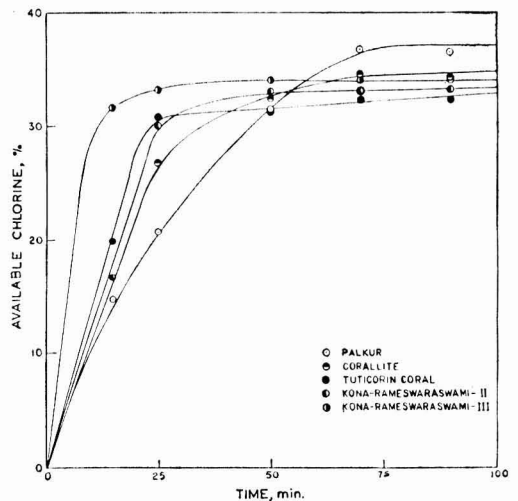


FIG. 6 — CHLORINE ABSORPTION CURVES FOR HYDRATED LIMES

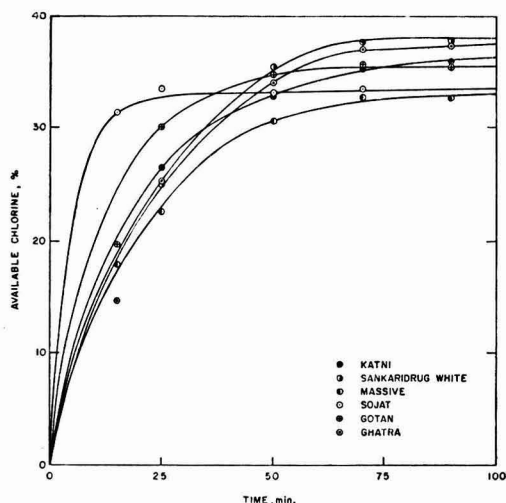


FIG. 7 — CHLORINE ABSORPTION CURVES FOR HYDRATED LIMES

coral, as a class, appear to possess low chlorine absorption capacity. Apart from this, no significant relationship is apparent between the nature of lime and its chlorine absorption characteristics.

The rates of chlorine absorption by hydrated limes can be calculated from Figs. 6 and 7. Table 7 gives the time required to attain an available chlorine content of 30 per cent and the maximum available chlorine content. The results show that the highest chlorine absorption capacity is not necessarily associated with the highest absorption rate. For example, Sojat hydrated lime has the highest rate of absorption, but the total chlorine absorption is relatively low. On the other

TABLE 7 — CHLORINE ABSORPTION RATES OF HYDRATED LIMES

HYDRATE	TIME REQUIRED FOR ATTAINING	
	30% av. Cl ₂ min.	Max. av. Cl ₂ min.
Sojat	15	25 (33.9)*
Kona-Rameswaraswami, III	16	50 (34.0)
Kona-Rameswaraswami, II	25	50 (33.3)
Gotan	25	60 (36.4)
Tuticorin coral	26	55 (32.5)
Sankaridrug white	31	70 (37.9)
Ghatra	35	70 (37.4)
Corallite	35	70 (34.4)
Katni	41	90 (36.0)
Palkur	43	70 (36.6)
Massive	48	70 (32.8)

*Figures in parentheses denote maximum available chlorine content.

TABLE 8 — STABILITY OF BLEACHING POWDERS — COMPARISON OF STORAGE AND HEATING TESTS

BLEACHING POWDER	LOSS OF AVAILABLE CHLORINE	
	Storage test* %/day	Heating test* %
Gotan	0.06	0.32
Sojat	0.05	0.72
Ghatra	0.06	0.33
Katni	0.03	0.16
Massive	0.07	0.79
Corallite	0.05	0.26
Kona-Rameswaraswami, II	0.05	0.62
Kona-Rameswaraswami, III	0.06	0.56
Palkur	0.09	1.77
Tuticorin coral	0.06	0.50
Sankaridrug white	0.05	0.72
Kottayam	0.06	—
Commercial Indian stable bleaching powder	0.10	0.55
Commercial foreign stable bleaching powder	0.06	0.90

*Storage and heating tests were conducted on bleaching powder after drying for 15 min. at 80°C. and 27 in. Hg vacuum. The moisture content was less than 0.5%.

hand, the chlorine absorption rate of Sankaridrug hydrated lime is relatively low although it shows the highest chlorine absorption capacity.

Chemical composition and stability of bleaching powders — Bleaching powders prepared from the selected limes, with the possible exception of Palkur and Tuticorin coral, are of excellent quality and are superior to commercial bleaching powders. Bleaching powders made from Palkur and Tuticorin coral hydrates contain excessive proportions of silica.

The results of heating tests on bleaching powder (for 2 hr. at 100°C.) are reported to correlate with those of storage tests at 45°C. and 20-80 per cent relative humidity⁶. Table 8 gives the results of heating and storage tests on bleaching powders prepared from different hydrated limes. It will be seen that the data obtained by the heating tests do not correlate with those obtained by storage tests. The conditions under which the results of storage and heating tests can be compared require further investigation.

Summary

Bleaching powders were prepared from different hydrated limes by chlorination in a fluidized bed.

Chlorine absorption was facilitated when the hydrated lime was dry and ground to a particle size such that at least 95 per cent

passed through a 200 B.S. mesh sieve; limes obtained by calcining limestones at 1000°C. showed the highest chlorine absorption.

Bleaching powders containing 32-38 per cent available chlorine and possessing good stability were prepared from 12 selected Indian limes. The available chlorine content and the stability of most of them were higher than those of some widely used commercial bleaching powders.

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Aca-catechin—A New Antioxidant: Part II

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Aca-catechin, a constituent of catechu (*katha*), has been shown to be a good antioxidant for fats and oils in spite of its low solubility in them. Addition of 0.05 and 0.1 per cent aca-catechin to ghee increases its shelf storage life from 123 to 240 and 210 days respectively. Its carry-through properties in potato chips and biscuits are promising.

HUSAINI and Saletore have reported aca-catechin to be a good antioxidant for fats and oils¹. They studied the antioxidant behaviour of aca-catechin on raw groundnut oil by accelerated oxidation and shelf storage tests. The present communication reports the results of comparative studies with aca-catechin and some well-known antioxidants.

Experimental procedure

The procedure described in the earlier paper¹ was employed for studying the antioxidant behaviour of aca-catechin. Swift stability tests were conducted with the substrate oil at 95°C. using purified air, and the point of rapid increase of the peroxide value by 30 units or more taken as the end of the induction period. The shelf storage test was carried out in 8 oz. narrow-mouthed, colourless glass bottles held in diffused daylight at room temperature, the bottles being kept half full of fat.

Results and discussion

Accelerated oxidation test—The results of comparative studies with some well-known antioxidants and catechin, using raw groundnut oil as substrate, are given in Table 1. The results obtained with catechin on raw, refined and dried groundnut oil are given in Table 2; the earlier results¹ on raw groundnut oil are included for comparison. Table 3 gives the results with raw mustard oil and a commercial hydrogenated fat obtained fresh from a local manufacturer.

The results show that aca-catechin is effective as an antioxidant in all the fats tried, the protection conferred being of the same order as in the case of other antioxidants. Refined groundnut oil has very low stability, and the protection conferred by aca-catechin, particularly in synergism with

TABLE 1—ANTIOXIDANT CHARACTERISTICS OF DIFFERENT COMPOUNDS IN RAW GROUNDNUT OIL

(Conc. of antioxidant, 0.1% on the wt. of oil)

ANTIOXIDANT	INDUCTION PERIOD hr.	PROTECTION FACTOR
Control	13	—
B.H.A.	64	3.9
Catechin	65	4.0
Propyl gallate	71	4.2
N.D.G.A.	85	5.0

TABLE 2 — ANTIOXIDANT CHARACTERISTICS OF ACA-CATECHIN IN GROUNDNUT OIL

ANTIOXIDANT	INDUCTION PERIOD hr.	PROTECTION FACTOR
Raw groundnut oil		
Control	12	—
Aca-catechin (0.05%)	41	2.4
Aca-catechin (0.10%)	60	4.0
Aca-catechin (0.05%) + phosphoric acid (0.005%)	35	2.0
Aca-catechin (0.10%) + phosphoric acid (0.05%)	91	6.6
Aca-catechin (0.05%) + citric acid (0.005%)	40	2.3
Aca-catechin (0.10%) + oleic acid (0.05%)	83	6.3
Refined groundnut oil		
Control	2	—
Aca-catechin (0.05%)	10	4.0
Aca-catechin (0.05%) + phosphoric acid (0.005%)	17	7.5
Aca-catechin (0.1%) + phosphoric acid (0.05%)	34	16.0
Aca-catechin (0.1%) + citric acid (0.05%)	31	14.5
Aca-catechin (0.1%) + oleic acid (0.05%)	58	28.0
Raw, dried groundnut oil		
Control	11	—
Aca-catechin (0.05%)	44	3.0
Aca-catechin (0.10%)	62	4.6

TABLE 3 — ANTIOXIDANT CHARACTERISTICS OF ACA-CATECHIN IN DIFFERENT FATS

ANTIOXIDANT	CONC. OF ANTIOXIDANT %	INDUCTION PERIOD hr.	PROTECTION FACTOR
Raw mustard oil			
Control	—	10	—
Aca-catechin	0.05	26	1.6
do	0.10	39	2.9
Hydrogenated fat			
Control	—	17	—
Aca-catechin	0.05	66	3.0
do	0.10	92	4.4

oleic acid and phosphoric acid, is very striking. Thus 0.1 per cent aca-catechin with 0.05 per cent oleic acid as synergist gives a protection factor of 28.

Solubility of aca-catechin in groundnut oil — The solubility of aca-catechin in raw groundnut oil is only 0.09 per cent. On drying the oil over sodium sulphate, the solubility falls to 0.005 per cent indicating that the solubility in raw oil is due mostly to the moisture present in it. For studying its antioxidant properties, therefore, aca-catechin was incorporated into the oil in alcohol solution. On evaporating the solvent, the material

settles out as a fine powder. Aca-catechin is effective even when dispersed in perfectly dry oil (Table 2). This is in accord with the finding of Taufel and Rothe² that solubility is not essential for antioxidant effectiveness.

Shelf storage of ghee — To fresh cow ghee (from the Indian Dairy Research Institute, Bangalore) aca-catechin was added in two concentrations, viz. 0.05 and 0.1 per cent, and the samples stored along with a control sample without catechin. While the control sample went rancid in 123 days, the samples containing 0.05 and 0.1 per cent aca-catechin went rancid only after 240 and 210 days respectively, implying protection factors of 1.0 and 0.7.

Carry-through properties — Potato chips (50 g.) fried at 250° in refined groundnut oil, with and without antioxidant, were kept in closed glass jars at room temperature. The fat was extracted from the chips periodically with chloroform and alcohol³. Chips fried in fat containing no aca-catechin went rancid in 5 days, while those fried in fat containing 0.05 and 0.1 per cent aca-catechin could be stored for 18 and 36 days respectively, implying protection factors of 2.6 and 6.2 per cent.

Salted, plain biscuits were made with Polson's kiln-dried flour and Marvo, a commercial hydrogenated fat, at a baking temperature of 220°C. In a typical experiment, the life of biscuits kept in an oven at 63°C. increased from 4.5 days to 9 days when 0.1 per cent aca-catechin was added to the fat. Further laboratory and large-scale commercial trials are in progress.

Katha of the best quality costs about Rs. 6 per lb. yielding about 80 g. of aca-catechin by solvent extraction with ethyl acetate which is mostly recoverable. The residue is suitable for chewing purposes.

Since most of the imported antioxidants cost from Rs. 20 to 50 per lb., it would be economical to use aca-catechin in their place.

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Beneficiation of Gypsum

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A sample of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, 81.28 per cent) from Rajasthan containing quartz and calcite as impurities has been upgraded, using dry methods of beneficiation, to give a product conforming to the specification for making fertilizer ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, 85-87 per cent). Crushing the sample to -8 mesh and screening off the -100 mesh fraction produced a gypsum concentrate assaying 41.83 per cent SO_3 (89.93 per cent gypsum) with a recovery of 82.9 per cent. Treatment of the -100+200 mesh fraction in an electrostatic separator produced a concentrate assaying 37.35 per cent SO_3 , which when mixed with the -8+100 mesh fraction assayed 41.44 per cent SO_3 (89.10 per cent gypsum) with an overall recovery of 89.9 per cent. Screening out the -200 mesh instead of the -100 mesh fraction produced a concentrate assaying 40.33 per cent SO_3 (86.7 per cent gypsum) with a recovery of 92.6 per cent of gypsum.

PURE gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, 100 per cent) contains SO_3 , 46.5; CaO , 32.6; and H_2O , 20.9 per cent. For the manufacture of sulphuric acid, purity of gypsum should not be less than 84 per cent and for making fertilizers it should contain not less than 85 per cent $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

Sindri Fertilizers & Chemicals Ltd. specify gypsum of not less than 87 per cent purity and silica content below 7 per cent for use in the manufacture of fertilizer. The sodium chloride content should be as low as possible, the permissible upper limit being 0.03 per cent.

The present communication reports the results of dry beneficiation of a gypsum sample from Rajasthan.

The sample of 'green gypsum' from Rajasthan (received from Messrs Mecanico, New Delhi) consisted mostly of fines but contained also a few lumps about 3-4 in. in size.

The gypsum was largely of the crystalline variety, dull white to grey in appearance. The principal gangue mineral was quartz, small quantities of calcite, chlorite and traces of a few other minerals were also present.

The lumps were crushed to about 1 in. size in a jaw crusher and thoroughly mixed with the fines. Part of this was roll crushed to -8 mesh for chemical analysis. The chemical composition of the sample is given in Table 1.

The mineralogical composition as computed from the chemical analysis of the sample is given in Table 2.

The sample thus appeared to be of a fairly good grade, though not suitable for fertilizer production. As quartz was the main gangue mineral, the problem of beneficiation consisted in its elimination.

Results and discussion

As the sample was from an area where water is scarce, only dry methods of concentration were attempted. In the absence of any magnetic mineral in the sample, only electrostatic separation was tried.

Sieve analysis — Different sieve fractions of a representative sample crushed to -8

TABLE 1 — CHEMICAL COMPOSITION OF 'GREEN GYPSUM'

CONSTITUENT	%
SO_3	37.83
CaO	30.33
H_2O (combined)	17.25
H_2O (free)	0.24
CO_2	2.67
SiO_2	7.82
Al_2O_3	1.49
Fe_2O_3	0.78
MgO	1.24
NaCl	<0.01
Total insolubles	10.51

TABLE 2 — MINERALOGICAL COMPOSITION

CONSTITUENT	%
Gypsum	81.28
MgCO_3	2.59
CaCO_3	3.00
CaO excess	2.20
$\text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3$	2.27
NaCl	<0.01
Free H_2O	0.24
SiO_2	7.82
Other ingredients	0.60

TABLE 3 — SIEVE ANALYSIS

SIZE mesh B.S.	Wt. %	ASSAY % INSOLUBLES	DISTRIBUTION % INSOLUBLES
-8+10	7.8	4.50	3.5
-10+20	17.3	3.97	6.9
-20+35	21.8	3.30	7.3
-35+48	10.3	2.60	2.7
-48+65	8.0	2.88	2.3
-65+100	8.6	5.40	4.7
-100+150	6.8	19.60	13.4
-150+200	5.6	30.30	17.1
-200	13.8	30.29	42.1
Head (calc.)	100.0	9.93	100.0

TABLE 4 — ELECTROSTATIC SEPARATION OF THE
-35 MESH FRACTION

PRODUCT	Wt. %	ASSAY % SO ₃	DISTRI- BUTION % SO ₃
-35+48 mesh			
Gypsum concentrate	19.7	43.19	23.0
Middling	5.0	41.78	5.6
Tailing	nil	—	—
-48+65 mesh			
Gypsum concentrate	10.6	43.55	12.5
Middling	3.5	42.57	4.0
Tailing	1.9	36.87	1.9
-65+100 mesh			
Gypsum concentrate	11.5	43.28	13.4
Middling	3.2	42.17	3.6
Tailing	1.1	21.98	0.6
-100+200 mesh			
Gypsum concentrate	11.2	38.65	11.7
Middling	5.4	36.98	5.4
Tailing	4.0	17.76	1.9
-200 mesh	22.9	26.58	16.4
Head (calc.)	100.0	37.09	100.0

mesh were analysed for their insoluble contents. The results are given in Table 3.

The insoluble content was quite low in all the +100 mesh fractions, but steeply increased in the -100 mesh fraction and increased further with increasing fineness. When different sieve fractions were treated with a heavy liquid (sp. gr. 2.60) gypsum floated and free quartz being heavier settled down. In fractions coarser than 35 mesh, no free quartz was observed and the small quantity present was found interlocked with gypsum grains. Liberation of quartz from gypsum started at 35 mesh. The -100 mesh fraction, constituting 26.2 per cent by weight, accounted for 72.6 per cent of the insolubles (mostly quartz) contained in the original sample.

Electrostatic separation after grinding to -35 mesh—A portion of the -8 mesh original sample was crushed to -35 mesh in a roll crusher and screened into closely sized fractions. All the fractions except -200 mesh were passed through an electrostatic separator. Quartz was found to collect on the conducting side and gypsum on the non-conducting side. Conditions were adjusted so as to get a clean gypsum concentrate. The results of this test are given in Table 4.

Fairly good separation of gypsum and quartz was effected by electrostatic separation. No tailing was obtained from the -35+48 mesh fraction, as no free quartz was present. All the concentrates and middlings when mixed up assayed 41.88 per cent SO₃, equivalent to a grade of 90.04 per cent gypsum with a recovery of 79.2 per cent.

Electrostatic separation of fines—The previous tests indicated that the coarser fractions were rich in gypsum and quartz was mostly distributed in the -100 mesh fraction.

For improving the recovery of gypsum from the fines a portion of the original -8

mesh sample was screened into two fractions, -8+100 and -100 mesh. The -8+100 mesh fraction constituting 74.8 per cent by weight was kept aside as a gypsum concentrate and the -100 mesh fraction, rich in quartz, was further screened into three fractions, -100+150, -150+200 and -200 mesh. The first two fractions were passed through an electrostatic separator. The -200 mesh fraction could not be treated as it was very fine. The results are recorded in Table 5.

The -8+100 mesh fraction assaying 41.83 per cent SO₃ was equivalent to a gypsum concentrate of grade 89.93 per cent and it contained 82.9 per cent of the total gypsum present in the original sample. Electrostatic separation of the -100+200 mesh fractions produced concentrates which were not of a high grade although some insolubles could be eliminated in the tailing. By mixing the two gypsum concentrates and the middling from the -100+150 mesh fraction, a product could be obtained assaying 37.35 per cent SO₃ and recovering another 7.0 per cent of gypsum. This product when mixed with the -8+100 mesh fraction yielded a gypsum concentrate assaying 41.44 per cent SO₃ and 4.67 per cent insolubles, equivalent to a grade of 89.10 per cent gypsum with an overall recovery of 89.9 per cent.

However, when the -8 mesh sample was screened through a 200 mesh sieve, the -8+200 mesh fraction assayed 40.33 per cent

TABLE 5 — ELECTROSTATIC SEPARATION OF FINES

PRODUCT	Wt. %	ASSAY		DISTRIBUTION	
		SO ₃ %	Insolubles %	SO ₃ %	Insolubles %
-8+100 mesh	74.8	41.83	4.06	82.9	30.6
-100+150 mesh					
Gypsum concentrate	4.1	38.64	9.00	4.2	3.7
Middling	0.6	33.60	20.52	0.5	1.2
Tailing	1.9	23.36	39.13	1.2	7.5
-150+200 mesh					
Gypsum concentrate	2.4	36.08	12.48	2.3	3.0
Middling	1.6	22.22	40.95	0.9	8.2
Tailing	1.3	17.30	51.40	0.6	5.3
-200 mesh	13.3	21.08	30.32	7.4	40.5
Head (calc.)	100.0	37.77	9.94	100.0	100.0

TABLE 6 — CHEMICAL ANALYSIS OF THE CONCENTRATE

CONSTITUENT %	-8+100 MESH	MIXED CONCENTRATE
SO ₃	41.83 (89.93 gypsum)	41.44 (89.10 gypsum)
CaO	31.96	31.80
MgO	0.66	0.67
CO ₂	1.18	1.27
H ₂ O (combined)	19.04	18.87
SiO ₂	3.18	3.70
Fe ₂ O ₃ +Al ₂ O ₃	0.91	1.01
NaCl	<0.01	<0.01

SO₃ and 6.81 per cent insolubles equivalent to a concentrate of grade 86.7 per cent with a recovery of 92.6 per cent gypsum.

The complete chemical analyses of the -8+100 mesh fraction and also of the product obtained by mixing it with the two electrostatic gypsum concentrates and the -100+150 mesh middling obtained from this test are given in Table 6. The concentrates thus satisfy the grade requirements for the production of fertilizer.

Summary

The sample of 'green gypsum' assayed SO₃, 37.83; CaO, 30.33; H₂O (combined), 17.25; CO₂, 2.67; SiO₂, 7.82; Al₂O₃, 1.49; Fe₂O₃, 0.78; MgO, 1.24; and NaCl, <0.01 per cent. It was equivalent to a gypsum of grade 81.28 per cent. The principal gangue mineral was quartz, but the sample contained a little calcite also.

Only dry methods of beneficiation were investigated. Sieve analysis and preliminary sink and float tests indicated that

the fractions coarser than 100 mesh were rich in gypsum and the -100 mesh fraction contained nearly three-fourths of the total insolubles (quartz) present in the sample.

Electrostatic separation after grinding the sample to -35 mesh produced a combined concentrate assaying 41.88 per cent SO₃, equivalent to a grade of 90.04 per cent gypsum with a recovery of 79.2 per cent in the product.

Screening out the -100 mesh fraction after crushing the original sample to -8 mesh yielded an oversize product assaying 41.83 per cent SO₃ (89.93 per cent gypsum) with a recovery of 82.9 per cent. Electrostatic separation of the -100+200 mesh fraction yielded a product assaying 37.35 per cent SO₃ and recovered another 7.0 per cent of the gypsum. This product when mixed with the -8+100 mesh fraction produced a combined concentrate assaying 41.44 per cent SO₃ (89.10 per cent gypsum), with a recovery of 89.9 per cent of the total gypsum in the product.

Even by screening out the -200 mesh fraction from the -8 mesh sample, a fairly good grade of gypsum concentrate assaying 40.33 per cent SO₃ (86.7 per cent gypsum) could be obtained, with a recovery of 92.6 per cent.

The cheapest method of concentrating the sample for fertilizer production (87 per cent purity) would be to crush the run-of-mine gypsum to -8 mesh and air classify it to eliminate approximately the -200 mesh fines; the recovery would be 92.93 per cent.

Acknowledgement

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Studies on Karbogel—a Desiccant from Coal: Effect of Base Exchange on Dry Gas Capacity (D.G.C.)

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(Manuscript received 2 July 1956)

The dry gas capacities of different ionic forms of Karbogel and Nalcite HCR (Dowex 50) have been determined. The moisture sorption property of Karbogel seems to be mainly a function of $-\text{SO}_3\text{H}$ and $-\text{COOH}$ groups and their corresponding salts, which hydrate to different extents.

THE desiccating properties of Karbogel, a product of sulphonation of coal, have been reported in an earlier paper¹. In the present study, the dry gas capacities (D.G.C.) of different ionic forms of Karbogel have been determined and compared with those of the corresponding ionic forms of Nalcite HCR (Dowex 50), a resinous sulphonic acid ion-exchange material.

Experimental procedure

Sulphonated coal was prepared by the process described earlier¹. For preparing different ionic forms of Karbogel, sufficient quantity of 5 per cent hydrochloric acid was passed through a glass column packed with the material to convert it first to the 'H' form. After washing off excess of the acid by passing demineralized water, the material in the column was treated at a slow rate with a solution containing excess of a 15-20 per cent mixture of chloride and hydroxide of the cation desired to be introduced, in the ratio of 1:5. The bed was finally washed free of salts with demineralized water and air-dried. The whole operation was carried out at room temperature. The material was then activated at 100°-110° to a constant weight.

Sulphonated polystyrene—divinyl benzene polymer (Nalcite HCR)—was converted to various cationic forms by the same method.

The dry gas capacities (D.G.C.) of the material were determined with the apparatus

and under conditions described in the previous communication¹.

Results and discussion

Sorption of water vapour by Karbogel may be ascribed to (i) physical adsorption in the capillary system of the material and (ii) the presence of sulphonic and carboxylic groups and the formation of hydrated ions in the case of different ionic forms of the material. The presence of hysteresis, which extends from the lowest to the highest humidity range, in the sorption-isotherm curve of Karbogel indicates adsorption by capillary action (Nandi, S. P. and Puri, R. P., unpublished data). The hysteresis has also been found to decrease with repeated adsorption and desorption cycles, which may be due to the disruption and collapse of the capillaries and intermicellar spaces. The decrease in D.G.C. in the first few drying runs of Karbogel, as reported in the earlier communication¹, may either be due to the collapse of capillaries or to the decomposition of the less stable groups which may be present in Karbogel.

The pore area of Karbogel as determined by low temperature argon adsorption has been found to be very small, indicating very little adsorption due to capillary condensation. Thus, most of the sorption is due to the presence of $-\text{SO}_3\text{H}$ and $-\text{COOH}$ groups, which hydrate to different extents depending upon the particular ion associated with these groups².

The dry gas capacities of different ionic states of Karbogel and Nalcite HCR are given in Table 1. It is clear that replacement of H by a metallic ion produces a depressing effect on the water adsorption capacity of Nalcite HCR. The results are

TABLE 1—DRY GAS CAPACITIES OF DIFFERENT IONIC FORMS OF KARBOGEL AND NALCITE HCR (DOWEX 50)

IONIC STATE	DRY GAS CAPACITY (%)	
	Karbogel	Nalcite HCR
<i>Monovalent</i>		
H	9.1	24.9
Li	14.9	18.9
Na	11.0	15.1
NH ₄	10.7	13.9
K	9.7	13.7
<i>Bivalent</i>		
Mg	11.6	16.6
Ca	11.0	15.1
Ba	9.5	10.0

in agreement with those of Gregor *et al.*², both in the case of monovalent and bivalent ions.

In the case of Karbogel, however, an opposite effect, namely an increase in D.G.C., is observed. During sulphonation of coal, the side chain groups are oxidized to carboxylic groups. The carboxylic groups were found to be present in Karbogel to the extent of 50 m.e./100 g. As carboxylic groups are less likely to dissociate from the hydrogen form of Karbogel than from the cationic form, it results in lower values of D.G.C. of the H form of Karbogel. The replacement of H of the carboxylic groups by a metallic ion makes the resulting groups dissociate to a greater extent, thereby increasing its water sorption capacity. The higher water sorption capacity of the metallic salts of a carboxylic resin, noted by Gregor *et al.*², supports this view.

The variation in D.G.C. of different ionic states of Karbogel and Nalcite HCR is possibly due to the difference in the degree of hydration of the cations in the two. In Fig. 1, the D.G.C. values are plotted against the hydrated ionic radii in the case of forms containing monovalent ions. The D.G.C. of these forms falls in the order of their hydrated ionic radii. Fig. 2 gives the relation for bivalent cations. In this case also the strongly hydrated magnesium ion shows the highest D.G.C. A sharp fall in D.G.C. in the case of barium form is observed with both the materials, this being particularly marked in the case of Nalcite HCR. This may be due to its low activity coefficient as compared to those of magnesium and calcium as well as due to its tendency to form associated ion pairs. The low value of D.G.C. in the case of barium may also be explained on

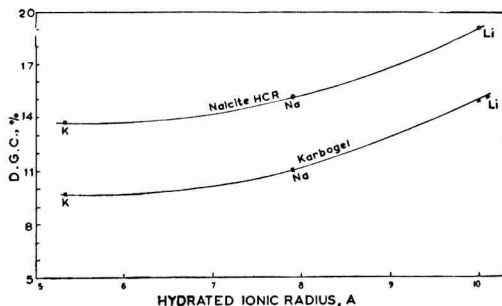


FIG. 1 — DRY GAS CAPACITY VS. HYDRATED IONIC RADII OF MONOVALENT IONS OF KARBOGEL AND NALCITE HCR

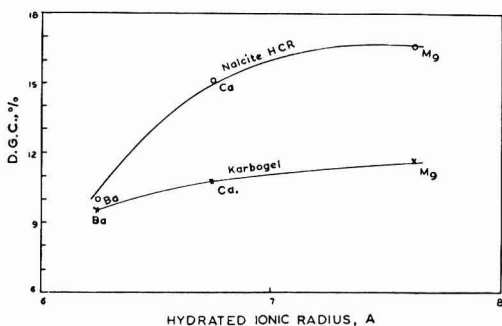


FIG. 2 — DRY GAS CAPACITY VS. HYDRATED IONIC RADII OF BIVALENT IONS OF KARBOGEL AND NALCITE HCR

the basis of its high molecular weight. Since D.G.C. determinations have been carried out on weight basis, the volume through which the gas is allowed to pass is less in the case of the barium form of Karbogel as compared to the volume of an equal weight of calcium or magnesium form, thereby giving the low value of D.G.C.

It is clear from Figs. 1 and 2 that in the case of Karbogel containing bivalent metals, e.g. calcium, the D.G.C. value is comparable to that of the sodium form although hydrated ionic radius of calcium is smaller. This behaviour of the bivalent ions can be explained by assuming that unlike monovalent ions, each bivalent ion is not associated with any particular $-\text{SO}_3\text{H}$ group, but is distributed throughout the matrix in positions of minimum potential energy, i.e. the ions are held in stoichiometric number by electrostatic forces and are, therefore, capable of maximum possible hydration.

Karbogel has been found to be quite stable in the various ionic forms except the magne-

sium form which, in spite of its high initial D.G.C., deteriorates with subsequent sorption and desorption cycles. A fall in the exchange capacity and hence the $-\text{SO}_3\text{H}$ groups was also observed which may naturally affect the D.G.C. Further study is, however, necessary to find out why the magnesium form only exhibits this behaviour.

Conclusion

Moisture adsorption by Karbogel appears to be mainly a function of sulphonic and carboxylic groups and the D.G.C. values of the different ionic forms of Karbogel are functions of the hydrated ionic radii. The

sodium form of Karbogel appears to be sufficiently stable, with D.G.C. comparable to those of other industrial desiccants.

Acknowledgement

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Rot-proofing of Jute by Treatment with Soluble Copper Salt

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(Manuscript received 15 November 1956)

A considerable degree of rot-resistance is imparted to jute materials by dipping them in a bath of a soluble copper salt, such as cupric sulphate or acetate. Copper under these conditions is taken up by jute in appreciable amounts and is fairly resistant to the leaching action of water. Copper, it is suggested, is bound by chemical combination with certain reactive groups, present mainly in the non-cellulosic constituents of jute. In view of the relative cheapness and ease of operation, the treatment appears to offer practical possibilities.

RELATIVELY greater emphasis has been placed by previous workers on the use of copper compounds for the rot-proofing of jute, mainly because of their high antiseptic potency, relative cheapness and ready availability. Among the compounds tried are the naphthenate, oleate, basic carbonate, chromate, oxychloride, oxide and thiocyanate of copper and cuprammonium. Work done in this laboratory with a comprehensive range of rot-proofing agents

also demonstrated the clear superiority of copper treatment¹.

Ordinarily, the rot-proofing methods are based on the deposition of insoluble copper compounds on the fibre and involve the use of several chemicals or baths, or even comparatively expensive organic solvents. Moreover, copper thus deposited cannot be so firmly bound as in chemical combination with the fibre.

Although such techniques may be the only practical ones available for the deposition of toxic metal salts on nearly pure cellulosic fibres like cotton, with jute a different approach seems possible because of its non-cellulosic constituents, which can bind cations under suitable conditions.

Various workers have observed, in the course of the last fifty years or so, that cellulosic materials take up metallic ions from salt solutions². It is now well established that the primary cause is ion exchange between salts and suitable reactive groups present in

cellulosic materials. In cotton, such reactions take place with free carboxyl groups or carboxyl groups (present in pectin and cellulose) already bound with cations. Evidence for the presence of free acidic groups was obtained, for example, from the observation that solutions of sodium chloride, mercuric chloride and some other salts, when filtered through cotton, lost the cations with the accumulation of free mineral acid in the filtrate. Similarly, evidence has also been obtained for ion-exchange reactions with metallic elements present in the cellulose ash.

Such exchange reactions have been found to take place more freely in the case of relatively impure cellulosic materials. Ripley-Duggan³ observed that the retention by wood of copper and zinc from aqueous solutions of their salts results from the replacement by these ions of hydrogen and metal ions attached to hydroxyl and carboxyl groups occurring in the natural constituents of wood. Earlier, Mclean and Wooten⁴ had shown that the exchange capacity of cellulosic materials decreases as they are purified with the removal of uronic acids, pectic acid, lignin, etc., and concluded that these reactions occur mainly with suitable groups present in the β - and γ -cellulose fractions. Raw jute was shown by them to function as a very efficient water softener, after suitable activation with dilute acid and sodium chloride solution, and its acid-neutralizing capacity was among the highest of several cellulosic materials tested by them.

The object of the present investigation was to observe to what extent copper is bound to jute fabrics on impregnation with aqueous solutions of its salts, and also to determine the rot-resisting efficiency of the fabrics so treated.

Experimental procedure

The jute cloth used was a standard 11 \times 12, 40 in. 10 oz./yd. hessian. Tensile strength of the cloth was determined by the process described earlier¹.

The copper salts used were of either B.P. or A.R. quality.

The rot-resistance of the treated fabric was determined by soil incubation test as well as by exposure to the action of selected jute-decomposing fungi¹.

In the soil incubation test, fertile garden soil, cow-dung manure and sand were mixed in the proportion of 2:1:1, the mixture

passed through a 5-6 mesh sieve and the moisture content adjusted to 25-27 per cent. Test strips were incubated at 30° in conical beakers in contact with the prepared soil in accordance with the procedure previously reported⁵. The results have been expressed in terms of the extension of life, which is the ratio between the useful life of treated and untreated strips as determined by the number of days after which these can be torn asunder by hand-pulling; this stage was reached in the case of untreated strips in 7-8 days. The untreated control strips were tested every day until broken, and the treated samples after multiples of the control 'life' period. Strips were used in duplicate, the variation usually not exceeding one day in the control strips, and one control 'life' period in the treated strips.

The multiple culture technique⁵ for testing the rot-resistance of jute materials against fungal damage was also used.

The strips were incubated at 30° for 21 days after inoculation with spores of five specially selected jute-decomposing fungi according to the procedure described earlier⁵. The fungi were: *Chaetomium indicum* Corda, *Curvularia lunata* (Wakkar) Boedijn, *Aspergillus fumigatus* Fresenius, *Penicillium rubrum* Stoll and *Penicillium wortmanni* Klöcker.

Six strips were used for each sample to determine the percentage retention of strength.

In the proofing treatment, jute fabric was boiled with a solution of cupric sulphate or cupric acetate (the solution was acidified with acetic acid to avoid precipitation of copper), when appreciable amounts of metallic copper were found to be retained by the fabric even after three washings with excess of distilled water. As expected, the fabrics so treated also offered a considerable degree of resistance against microbiological attack (Table 1). On the other hand, only traces of copper were found to be retained when a piece of cotton jean was similarly boiled with solutions of the two copper salts. Jute retained appreciable amounts of copper even when treated at room temperature with solutions of these copper salts. The retention of a high percentage of copper even after leaching treatments (Table 2) indicates that copper may have chemically reacted with the constituents of jute fibre. The samples were treated with fairly concentrated solutions of copper salts

TABLE 1 — ROT-RESISTANCE OF JUTE FABRICS TREATED IN SOLUBLE COPPER BATHS

(Fabric-liquor ratio = 1:10)

TREATMENT	COPPER CONTENT %	MEAN INITIAL TENSILE STRENGTH lb.	MULTIPLE CULTURE: TENSILE STRENGTH RETAINED		SOIL INCUBATION	
			lb.	%	Life days	Extension of life (expressed as times the untreated control)
Untreated (control)	—	71.8±3.1	16.6±1.0	23.1	7	1
(A) Boiled for 5 min. with 5% soln. of copper sulphate, followed by washing thrice with excess distilled water	0.474	67.3±3.2	51.6±5.2	76.6	126	18
(B) Boiled for 5 min. with 4% soln. of copper acetate mixed with 0.3 ml. glacial acetic acid/100 ml., followed by washing thrice with excess distilled water	1.225	68.5±3.1	62.5±4.0	91.2	>210	>30

TABLE 2 — LEACH-RESISTANCE OF JUTE FABRICS TREATED IN SOLUBLE COPPER BATHS

TREATMENT	ORIGINAL COPPER CONTENT %	COPPER RETAINED		
		L ₁ %	L ₂ %	L ₃ %
A	0.474	0.404	0.382	0.338
B	1.225	1.209	1.109	1.036

L₁: leached twice with fresh distilled water (pH 6.2) in a rotary shaker (40 r.p.m.), each time for ½ hr., using a fabric-liquor ratio of 1:50; L₂: as in L₁, but leached 6 times; and L₃: as in L₁, but leached 12 times, the fabric being dried in air after the sixth leaching.

in order to bring the copper contents of the fabrics within the limits required for reasonable protection.

Discussion

The binding of copper with jute appears to be due to its chemical combination with the fibre material. About 70 per cent of the ash of jute is cationic (Ca, Mg, Fe, etc.) and these cations appear to be in combination with carboxyl groups which mostly belong to the polyuronic acids⁶. About one-eighth of these carboxyl groups appears to be free, three-eighths combined with the cations and one-half esterified with lignin⁷. It is probable that copper reacts with free and bound carboxyl groups by replacing hydrogen and other cations, as shown by Chatterjee⁶ with silver. The phenolic hydroxyl groups of tannins and lignin also bind copper³. Such

chemically bound copper may manifest toxicity against rotting organisms through the same mechanism as that of the insoluble copper compounds which are deposited on textile materials by the usual proofing treatments. Various factors are believed to be involved, such as slight solubility of the toxic element in water and in the secretions of micro-organisms⁸.

It is apparent that the binding of copper is more a property of the associated non-cellulosic materials than of the cellulose in vegetable fibres. This is in line with the observations of Mclean and Wooten⁴ and would explain the very low uptake of copper by cotton under such conditions. The indications are, therefore, that the non-cellulosic constituents of jute and similar 'impure' fibres may be utilized to some advantage in the rot-proofing of such fibres.

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Tamarind Seed Jellose: A New Class of Neutral Polysaccharides*

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(Manuscript received 28 November 1956)

The position of tamarind seed jellose amongst carbohydrates vis-à-vis the other neutral polysaccharides has been discussed.

NEUTRAL polysaccharides occur widely in plants. They are found in the cell wall, the incrustations around it and also within the cell. They serve either as skeletal substances or as reserve food. Most of them are constituted from the common monosaccharides, namely D-glucose, D-galactose, D-fructose, D-mannose, D-xylose and L-arabinose. In some cases, L-rhamnose and rare sugars are also encountered. Most of the neutral polysaccharides are formed from a single monosaccharide unit and a few from two or more units. These differ not only as regards the constituent sugar units, the nature of the ring (pyranose or furanose), and the nature (α or β) and position of the linkages but also as regards their chain length and micellar structure.

The neutral polysaccharides are not a homogeneous group. They include cellulose, starch and many other intermediate compounds. Cellulose is composed of a mixture of homologous polymers¹, its composition differing with the source. Wood celluloses often contain mannans and xylans and it is not known whether they contain any fraction which is chemically identical with cotton cellulose containing only glucose units².

Starch is a mixture of the two closely related carbohydrates amylose and amylopectin. Glycogen is the counterpart of

starch in animals; it is also found in certain lower plants³.

In between cellulose and starch a large number of compounds having intermediate properties and functions occur. All these are grouped together under the general name of hemicelluloses. They occur as cell-wall constituents and their incrustations and also within the cell. Some of them such as xylan and lichenin are cell-wall constituents like cellulose but none of them approaches cellulose in its insolubility and resistance to hydrolysis. On the other hand, substances such as inulin (in tubers of *Compositae*, such as dahlias), galactoaraban (in peanuts) and konjakmannan (in tubers of *Conophallus konjaku*) are, like starch, reserve carbohydrates¹. Related to inulin are sinistrin, graminin, asparagosin, levan, phlein, poain and secalin¹.

In spite of their importance and even after over 50 years of work since Schulze⁴, there still remains some confusion regarding the exact nature of hemicelluloses. Hemicelluloses have been defined by Norman⁵ as "those cell-wall polysaccharides which may be extracted from plant tissues by treatment with dilute alkalis, either cold or hot, but not with water and which may be hydrolysed to the constituent sugar and sugar acid units by boiling with hot dilute mineral acids". But even this definition does not appear to be satisfactory as hemicelluloses occur not merely as cell-wall constituents but are found within the cell⁶⁻⁸ also. Further, some of the hemi-

*Paper presented at the Anderson Memorial symposium held in Tucson, U.S.A., on 28 and 29 September 1956 under the auspices of the University of Arizona, Tucson and the Southern Arizona Section of the American Chemical Society. After the presentation of the above article a paper by G. R. Savur has appeared in a recent issue of *J. chem. Soc.* (1956, p. 2600), wherein the author has stated that there are more than one jel-forming substances in tamarind kernel powder and has suggested that the material examined by White and Rao was a mixture. Apart from their validity, which is doubtful [Rao, P. S., *Proc. Indian Acad. Sci.*, **42A** (1955), 199], the observations of Savur do not in any way affect the sense of the present article, since even according to Savur the jelling principles are only neutral polysaccharides.

celluloses are soluble in water, and if present in the free condition in the tissues, they are capable of being extracted even with water^{6,9-14}. The extractability by sodium hydroxide need not, therefore, be a criterion for the definition of hemicelluloses, particularly when some of them are known to offer considerable resistance to extraction by dilute alkali, as for example mannan B of ivory nut¹⁵. Solubility in water or sodium hydroxide is a factor that seems to depend on the chain length of the molecule^{11,16} and even cellulose in the degraded form is soluble in sodium hydroxide. Consequently, for evolving a suitable definition for hemicelluloses, their other properties such as chemical nature, solubility or dispersibility in water, lack of mucilaginousness and ease of hydrolysis with dilute acids have to be considered. The first two properties are common to an allied group of naturally occurring polysaccharides, namely mucilages, but not the other two properties. Hemicelluloses may, therefore, be conceived as a group of naturally occurring polysaccharides whose solutions are not mucilaginous and which are completely and readily hydrolysed by boiling dilute mineral acids¹⁷. Some of them contain a uronic acid grouping and are acidic in nature while others being pentosans, hexosans and pento- or hexohexosans are neutral. The chief sugars constituting these are D-xylose, D-glucose, D-mannose, D-fructose and (to a smaller extent) L-arabinose, D-galactose and L-rhamnose².

Closely allied to hemicelluloses are mucilages which also occur in the membrane incrustations and also within the cell. Their main function in plants is to serve either as food reserve or as a water reservoir. As opposed to hemicelluloses, plant mucilages form slimy solutions with water and resist easy hydrolysis. They may be defined as polysaccharide substances occurring in plant tissues, which form slimy solutions with water or merely swell up to form gels and which do not undergo complete hydrolysis with dilute mineral acids easily and readily¹⁸. Like hemicelluloses, some of them are derived from complex uronic acids, while others are neutral polysaccharides. The latter have been reviewed recently by Jones and Smith¹⁹ and Hirst²⁰. Anderson examined the endosperm mucilages of 163 species of legumes²¹. The neutral mucilages are either hexosans or pento- or hexohexosans; simple pentosans,

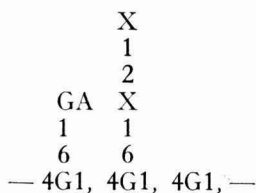
unlike in hemicelluloses, do not seem to occur in this group. Even in the pento-hexosans, xylose, which is so predominantly found in hemicelluloses, is not present in the neutral mucilages, the main constituent sugars being D-mannose, D-galactose and L-arabinose. The occurrence of glucose is rather uncommon.

It may be worth while to note that, though constituted from the same monosaccharide units, one substance falls under the mucilage group while another belongs to the hemicelluloses with different properties. Very likely the differences arise from constitutional factors.

Tamarind seed jellose present in the seed kernels of *Tamarindus indica* Linn. offers a problem regarding its classification. It is the primary neutral polysaccharide occurring in the tamarind seed kernels²² (although two others have also been claimed to be present^{23,24}) and is composed of D-galactose, D-xylose and D-glucose present in the molecular ratio of 1:2:3. It easily gelatinizes even in cold water, forming a thick, viscous, mucilaginous solution; with excess of iodine its aqueous solutions are coloured greenish blue and on dilution with water the colour disappears. A microscopic examination of an iodine-treated section of the seed kernel shows that tamarind seed jellose is present only in the cell-wall incrustation and not within the cell²⁵. A characteristic property of the substance is its ability to form jellies, like fruit pectins, with sugar concentrates under diverse conditions of pH, including neutral medium²⁶. Thus, it is superior to fruit pectins, which can form jellies only in acid medium. On the basis of its origin and also its ability to form mucilaginous solutions with water, the polysaccharide should normally be considered as a member of the mucilage group^{5,19}; in fact it was taken to be a mucilage by some workers²⁷. This classification, however, does not seem to be quite satisfactory, for no neutral mucilage is known to form sugar jellies. Furthermore, the molecule contains a large proportion of glucose and xylose residues, whereas most of the neutral mucilages so far studied appear to be constituted largely of sugar units other than glucose and none of them is known to contain xylose. The property of forming jellies with sugar concentrates under diverse conditions of pH is a characteristic of tamarind seed jellose and is not possessed by

any other class of neutral polysaccharides described earlier. The name 'Jellose' has thus been suggested for this polysaccharide as being descriptive of both the jelly-forming property and its carbohydrate character²⁸. Jellose, like mucilages and hemicelluloses, may form a new group amongst the carbohydrates, though at present represented by only one member.

On account of its availability in abundance and its cheapness, tamarind seed jellose has a great potentiality of replacing fruit pectins in jam, jelly and marmalade industries²⁹. From a study of the products of hydrolysis of the methylated polysaccharide, the following structure for the repeating unit of the jellose molecule has been suggested³⁰:



G = glucose, GA = galactose X = xylose

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Letters to the Editor

PROTEIN HYDROLYSATE FROM FISH

EDIBLE FERMENTED FISHERY PRODUCTS, particularly liquid preparations, are practically unknown in India. Such preparations are very popular in the South-east Asian countries, and products of a more or less similar nature are also used in some Western countries. The *maggi sauce* used in some European countries is analogous in its preparation and properties to the *nam-pla* of Thailand, *patis* of the Philippines and the *nuoc-mam* of Indo-China, the only difference being that in the European preparation meat instead of fish is used as the raw material¹. Analysis of some samples of *nam-pla* has shown that it is essentially a protein hydrolysate². The preparation of a similar product on an experimental scale was attempted in this laboratory and the results are reported here.

The process employed was as follows: local sardines (mainly *Sardinella dayi* Regan) were washed with tap water and 100 lb. were mixed with 35 lb. common salt and placed in a specially constructed wooden barrel. Another 50 lb. of the washed fish were mixed with salt in the proportion 2:1 and placed in the same barrel over the first lot. The surface of the piled fish was covered with a thin layer of salt and a wooden cover which just fits in was placed over the fish. After three days the fluid collecting at the bottom was drained through a tap provided at the bottom of the barrel and returned to the top of the barrel. Heavy stones were then placed on the wooden cover resting on the fish so that the latter was subjected to pressure. The liquid collecting at the bottom of the barrel was tapped at monthly intervals and examined for total, formol and volatile nitrogen contents; the chloride content and acidity of the samples and their bacterial count were also determined.

The total, formol and volatile nitrogen contents of the product increased progressively during the five-month period (Fig. 1). At the end of five months the volatile nitrogen content of the liquid was nearly one-third of the formol nitrogen; a further increase in the

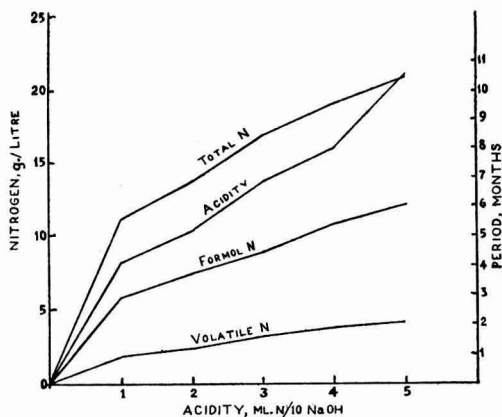


FIG. 1 — PARTITION OF NITROGEN AND ACIDITY IN THE EXPERIMENTAL PRODUCT

TABLE 1 — ANALYSES OF NAM-PLA SAMPLES

EXPERIMENTAL PRODUCT OBTAINED AT THE END OF FIVE MONTHS	Nam-pla MANUFACTURED IN THAILAND				
	Grade I	Grade II	Grade III	Grade IV	
Total nitrogen, g./litre	20.94	21.00	13.50	4.50	1.40
Formol nitrogen, g./litre	12.04	10.25	8.30	2.92	0.42
Volatile nitrogen, g./litre	4.08	3.20	2.40	0.72	0.16
Acidity, ml. of N/10 NaOH required to neutralize 10 ml. of the product	10.50	10.10	8.50	7.80	0.90
Chloride, as % NaCl	29.80	27.60	27.90	30.00	30.07
Bacterial count, No. of colonies per ml.	57	32	61	164	52

volatile nitrogen relative to the formol nitrogen resulted in deterioration of the quality of the product. The liquid collected was, therefore, drained off at the end of five months.

The nitrogen partition data for the product and of *nam-pla* samples (Table 1) show the product to be comparable with the highest grade of *nam-pla*.

The sample obtained at the end of the first month gave a bacterial count of about 500 colonies per ml. and the dominant organisms

present were two *Micrococci* and one *Bacillus* spp. The count decreased rapidly in subsequent samples and *Bacillus* alone was found in the last sample.

About 50 lb. of a clear, amber-coloured liquid, having no fishy or unpleasant odour, were obtained at the end of five months. In appearance the product was indistinguishable from Thailand *nam-pla*. It kept well at room temperature for several months.

Further work is being carried out in order to explore the possibility of applying this procedure for manufacturing fish sauce on a cottage industry scale.

The author is grateful to the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp, for permission to publish this note.

N. K. VELANKAR

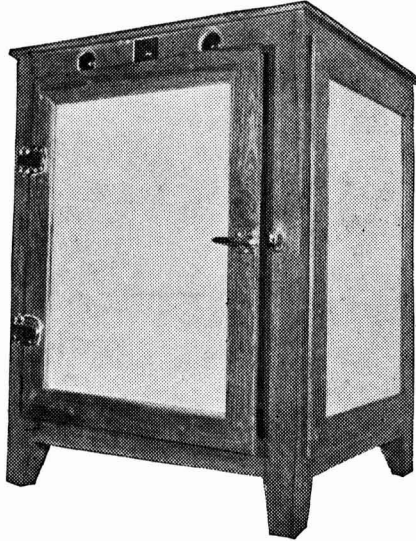
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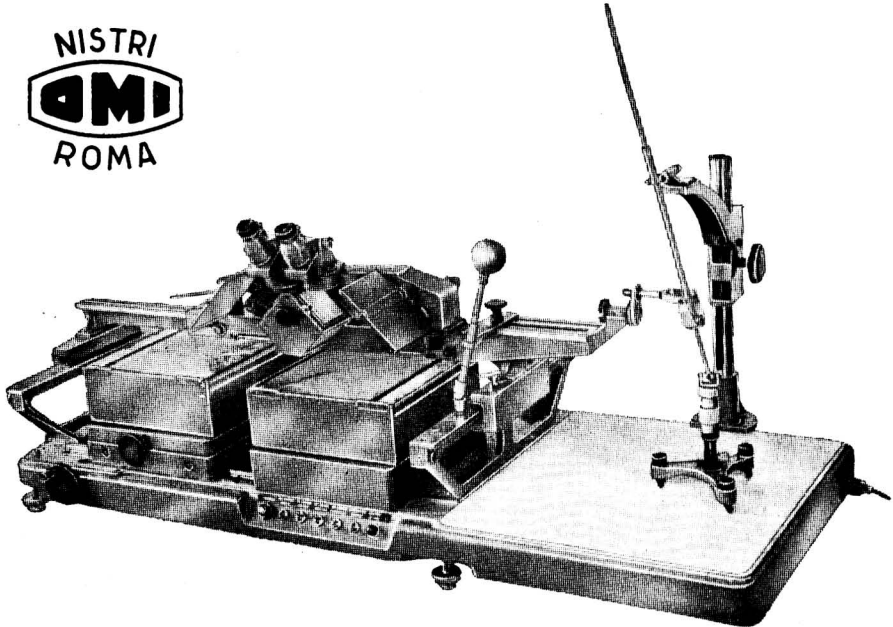
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