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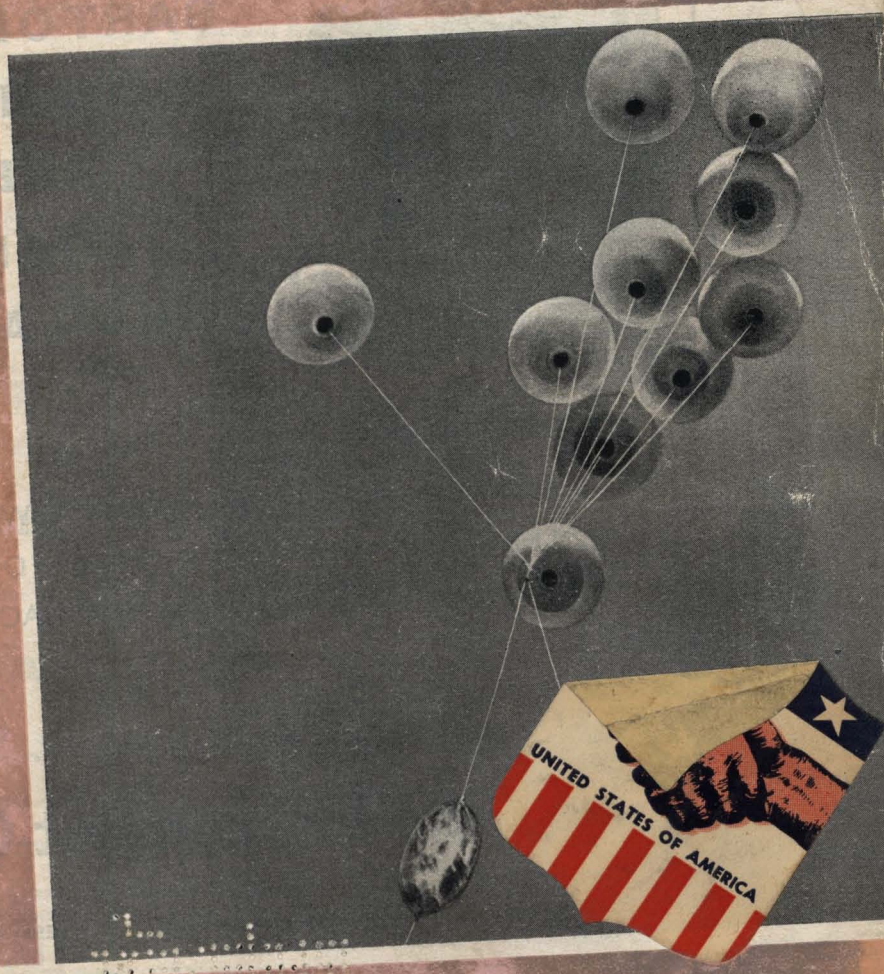

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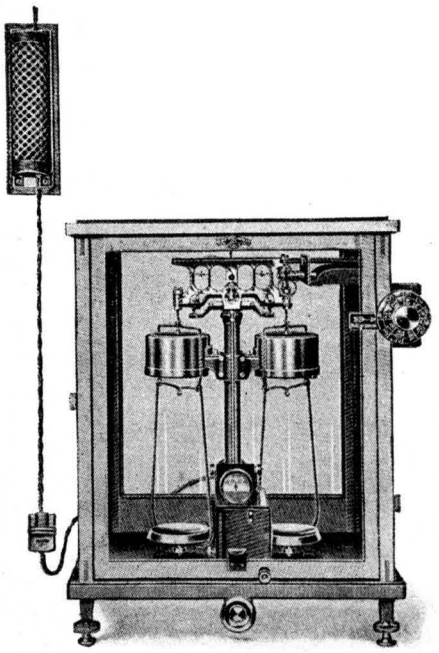

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COVER PICTURE

Significant developments in the application of radio sonde technique to high altitude cosmic ray investigations by unmanned balloons have been made at the *Tata Institute of Fundamental Research*. Picture on the cover page shows a cluster of ten balloons, carrying temperature-controlled cosmic ray precision equipment specially designed for these investigations. (*See* page 259.)

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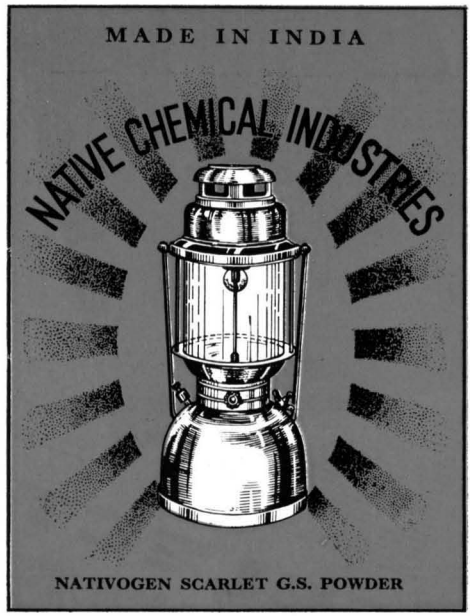

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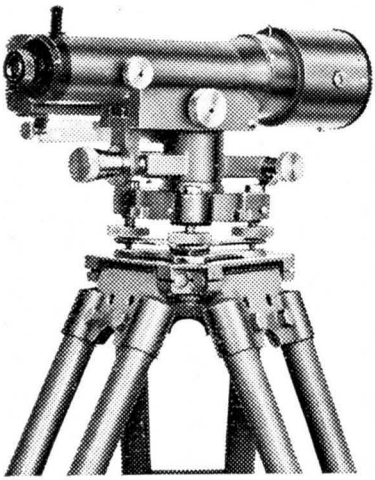

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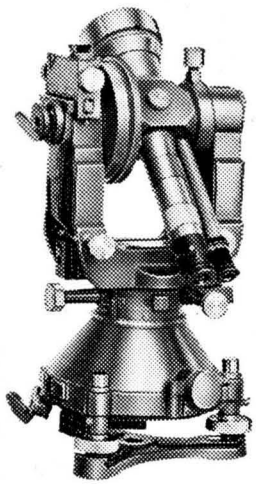

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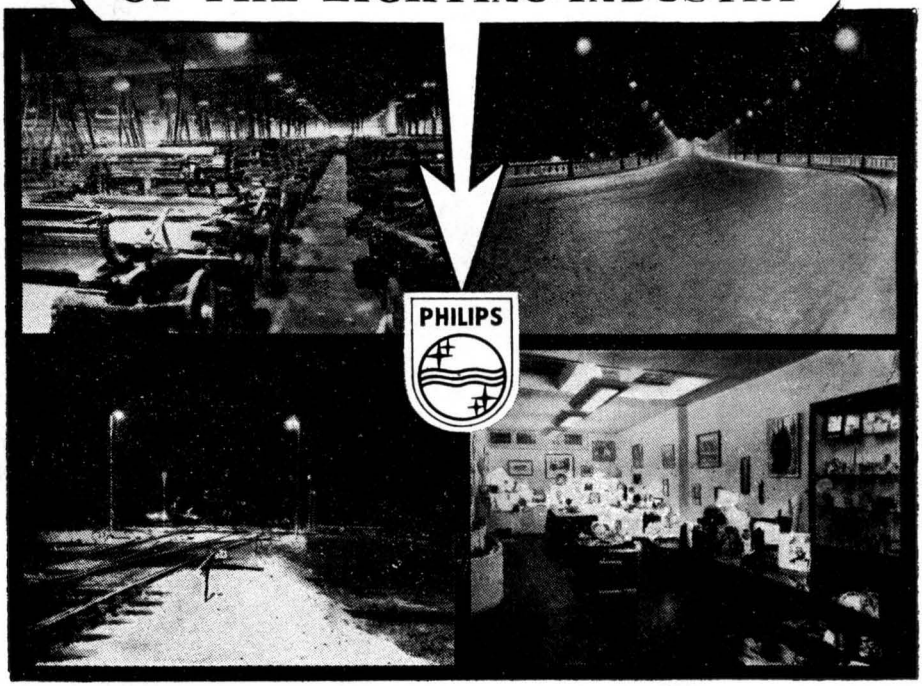

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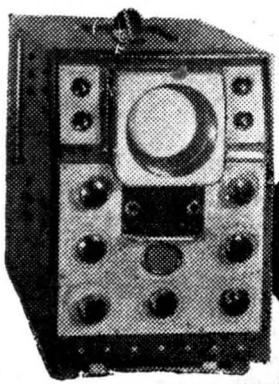

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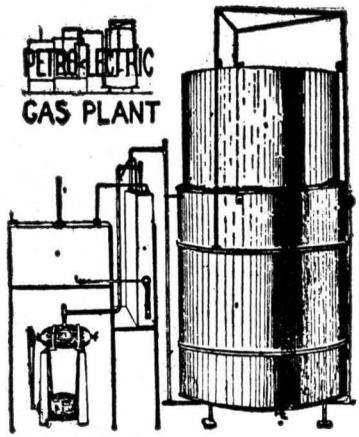

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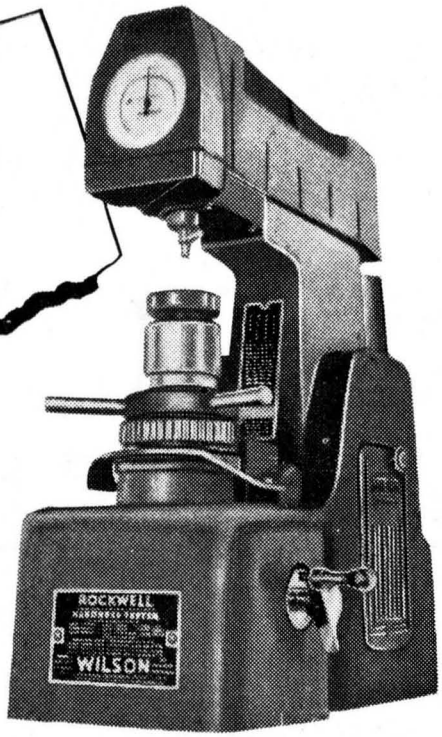

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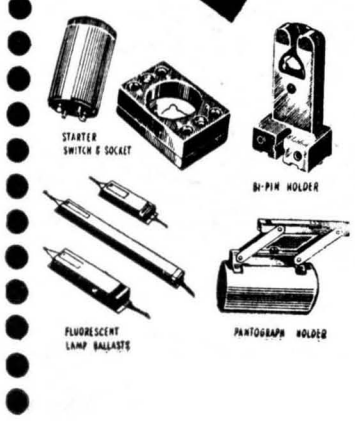

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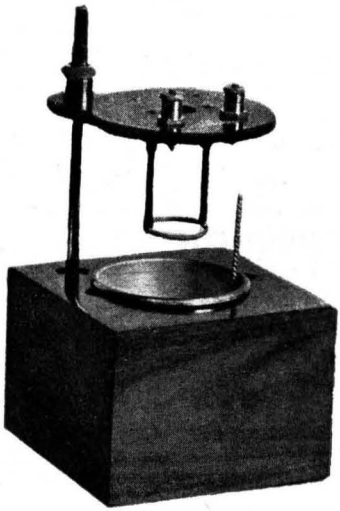

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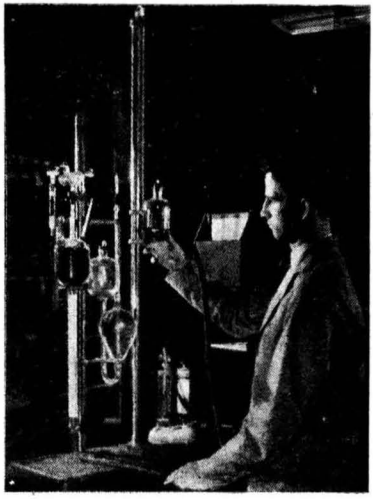

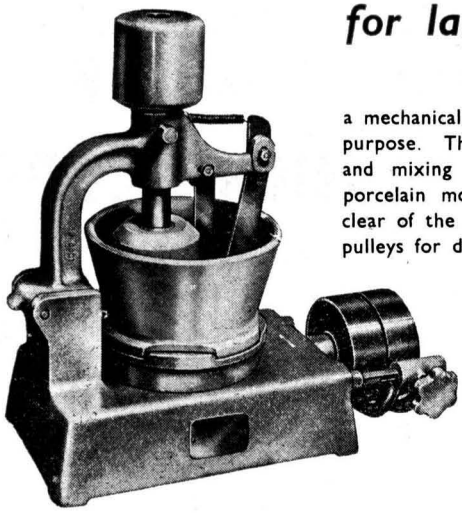

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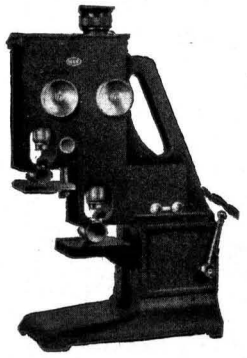

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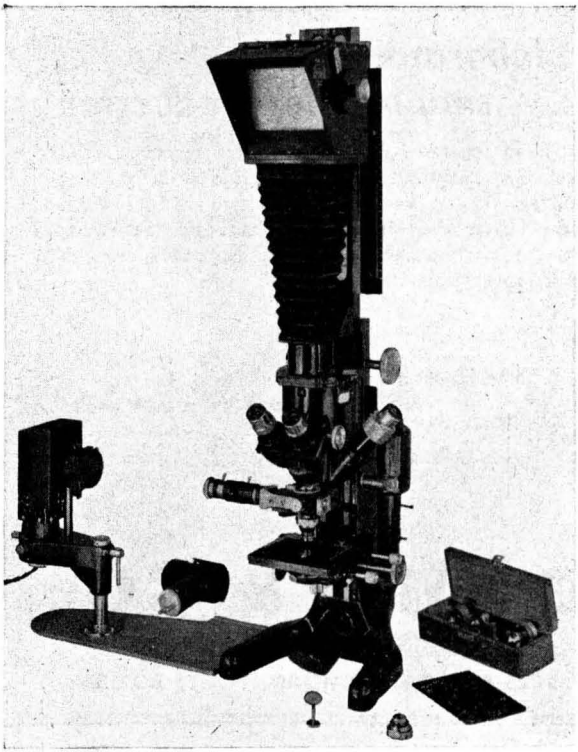

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Natural Resources & Human Welfare

RECENT discussions on the utilization of natural resources among scientists and economists reveal a refreshing shift of emphasis from " exploitation " to " conservation ". Exploitation was the dominant feature of resources utilization during the war years when " working plans " were discarded and " slaughter tapping " was resorted to. The very ruthlessness of the exploitation led the thinking section of the people — among them scientists, technologists and economists — to pause and consider the consequences of current practices on the life and productivity of resources which foster and sustain life. It was indeed appropriate that the Secretary General of the *United Nations Organization*, following the discussions of the Economic and Social Council (March 28, 1947), decided to call, in August 1949, a Scientific Conference on the Conservation and Utilization of Resources with a view to enable all those who have given thought to the subject to exchange information on techniques in the field, their economic costs and benefits, and their inter-relations. The problem has rightly assumed international importance, for it transcends national and group interests and affects the welfare of mankind as a whole. Concern has been expressed in various quarters that the lack of balance between growing populations and waning resources is attaining increasingly alarming proportions, and that such lack of balance would lead to widespread starvation and famine. Since the decision to hold the international conference was taken, an Inter-American Conference on Conservation of Renewable Natural Resources was convened at Denver, Colorado (September 7-20, 1948), at which representatives of 21 nations examined the conservation problem at the technical level. The papers discussed at the working sessions of the Conference emphasized the magnitude of the problem and the need for continuing co-operation among nations to ensure effective action towards the solution of a problem of such vital concern to the human race.

The Declaration of the Inter-American Conference indicates the importance of the problem. " The crucial problem of our generation ", it states , " is to safeguard, maintain, develop, increase, and wisely use for the common benefit of mankind the natural resources of the earth... The catastrophe that threatens civilization results from man's failure to live in harmony with the principles that govern his environment."

For the effective handling of the problem, it is necessary to understand the " principles that govern man's environment ". History furnishes many examples of civilizations which flourished for a time and then decayed largely as a result of a lack of harmony between the people and the environment. A historical study of the systems of resources utilization at various chronological epochs of man's evolution should prove instructive and helpful to the proper appreciation of the factors that determine man's prosperity and decay. It is important to recognize that man lives in " an environment of many facets, related to each other, not as single pieces but as a mosaic, the pattern of which is not easily discerned at first glance. It must be seen in different lights before we appreciate its full design and real worth." * For his very existence man must interfere with nature and in this act he disturbs one or more pieces of the mosaic whose consequences, if not foreseen and promptly remedied, may lead to disastrous consequences. Resources utilization, therefore, must be based on a clear understanding of the ecological factors constituting the environment.

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* *Nature*, Ecology in Service of Man (*Rev.*), 1945, **156**, 675.

Unified Resources Development

In the past, when populations were sparsely distributed, nomadic existence was the rule, and resources were relatively abundant, there was little urgency for resorting to conservation practices. With the growth of population and the coming into existence of settled life, the pressure on resources necessarily increased. The resources problem was aggravated by a perceptible diminution in the productivity of the land and the sea. Industrialization and urbanization gave rise to vested interests and pressure groups with pronounced tendencies to exploit resources oblivious to consequences. It became clear that resources utilization must receive prior attention if the productivity of what was left is to be sustained and the needs of future generations are to be provided for. Specific short-term corrective devices were inadequate and ineffective, and a scientific approach to the management problem, which took into account the ecological factors, was called for. Long-term programmes of a constructive and restorative character provided an effective safeguard against permanent damage to productivity. Water, soil, woods, forage, and wild life comprise a "biotic whole" in relative equilibrium, the loss of which may result in the ruin of any or all of its constituents.* Unified resources development, which takes into cognizance the complex nature of the biotic balance, offered a plausible solution. How this can be achieved on a regional basis was amply demonstrated under the leadership of the late United States' President, Theodore Roosevelt, in the Tennessee Valley. This successful experiment stands out as an object lesson to the nations of the world, and as an example of the tactics and strategy of resources conservation and management.

Planning on a National Basis

In considering national economic programmes, it is necessary to examine current utilization practices in terms of their effect on future resources capacities. The questions that demand consideration are: Are we using our national wealth faster than it is being renewed? What are the principles of management which ensure sustained productivity of renewable resources? Scientists in their approach to the conservation problem are inspired by the faith that the world's resources could be developed to take care of the economic needs of the people to a greater extent than in the past. Every nation is concerned with maximizing production, and programmes for so doing have received the highest priority. How this can be done even in countries with limited *per capita* resources is a problem which should receive the earnest consideration of scientists and administrators alike. In post-war Japan, for instance, some of the most intricate problems of occupation by Allied Forces involved the technology of resources utilization. The National Resources Section, which was established in Tokyo immediately after the cessation of the war as a special Staff Section of the G.HQ. of the Supreme Commander for the Allied Forces, has tackled the problem of Nippon's shattered economy with conspicuous ability. At the time the National Resources Section was set up, the position appeared somewhat gloomy. Farm lands had been intensely cultivated for centuries and their fertility had greatly diminished. Fisheries and forests had been over-exploited. The wealth of the land and the sea was concentrated in the hands of a relatively few individuals. Sweeping reforms in ownership were introduced. Reconnaissance surveys were made and a general inventory of resources was taken. Statistics were collected. Japan's science and technology were built on European and American foundations but the liaison between them was poor. Research and development had to be reorganized to produce practical results. Economic planning had to be considered on a national scale, and the National Resources Section, with vision and knowledge and armed with reliable factual data, evolved working plans for the utilization of both renewable and non-renewable resources. "What is being done in Japan to build a good society, economically, socially, and politically may, if it is successful, serve to justify the efforts and sacrifices of millions of people in fighting this part of World War II."*

Conservation must be made Effective

The success of utilization planning in the Tennessee Valley and in Japan are significant, and serve as pointers to what is possible to achieve in other regions of the world. No country can afford to be complacent about

* Cf. H. P. SALAZAR: *Woods and Pastures*, Inter-American Conference on Conservation, p. 61.

* *Science*, 1948, **108**, 367.

its natural resources, and no country has yet formulated or adopted a national policy of resources management for maintaining their productive potential to perpetuity. What has been done only shows what remains yet to be done. It is fortunate that in India poverty and ignorance in the past had stood in the way of exploiting, or even mapping, of *all* her resources, and there is every hope that a planned utilization of the resources would lead to increased prosperity and a higher living standard for her people. The initiative taken by the Government for the multi-purpose development of water resources gives hope that the problem of constructive management is beginning to receive attention. Scientists have the responsibility of not only taking a full inventory of renewable and exhaustible resources, but also of evolving sound standards of resources management, and of influencing national policies. They have the even greater responsibility of educating the public and making it conservation-conscious, for no plan, however sound, has any chance of becoming effective unless the people are receptive and responsive to its principles and techniques. Conservation should become a part of the social philosophy of the people.

It is often said that the most serious catastrophe facing humanity is slow starvation. This catastrophe can be averted if resources utilization is managed on a sustained yield basis. Science provides the basis for such plans and programmes. What is needed is the determination to apply the results and methods of science for promoting human welfare. By enabling the leading scientists and science administrators from all parts of the world to meet in conference* and discuss conservation programmes and policies, the *United Nations Organization* has rendered a momentous service to the cause of peace and prosperity of mankind.

* A scientific delegation led by Dr. Shanti Swarup Bhatnagar and composed of the following members has been sponsored by the Government of India to take part in the forthcoming conference to be held at Lake Success: Dr. S. S. Bhatnagar, Dr. J. C. Ghosh, Dr. J. N. Mukherjee, Dr. P. C. Mahalanobis, Dr. M. S. Krishnan, Dr. S. L. Hora and Mr. A. N. Khosla.

Characteristics of the Ionosphere over Calcutta (April 1949)

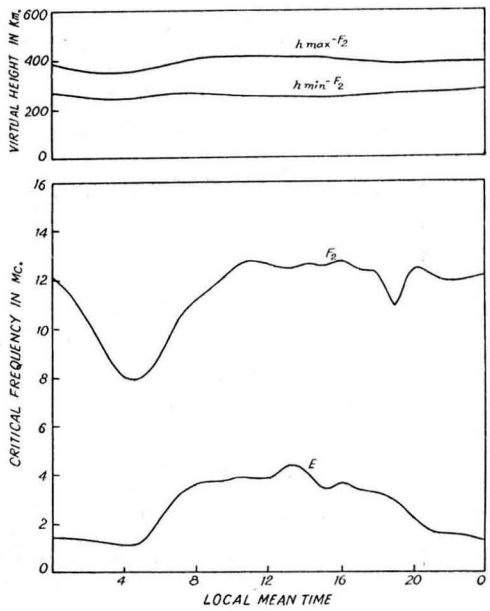
S. S. BARAL, R. K. MITRA, D. C. CHOUDHURY, (MISS) T. K. PAL & A. P. MITRA

Wireless Laboratory, University College of Science, Calcutta

THE following are the ionospheric data observed at Calcutta for the month of April 1949. The observations were made at each hour of the day for 5 days a week.

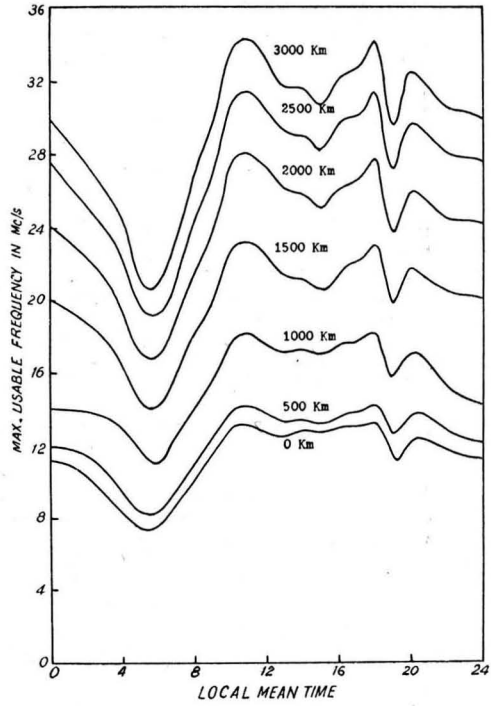
Fig. 1 represents the mean hourly values of the virtual heights and critical frequencies of the F_2 layer and the critical frequency of the E layer in graphical form. The figure represents the mean of both normal and abnormal values. The special feature of the F_2 region during the month is that the ionization maintains a high value from about 10 a.m. till midnight.

Fig. 2 gives the predictions of maximum usable frequencies which can be used for different distances of transmission during July 1949 by reflection at the F region over Calcutta. Table I gives the list of occasions when the E region ionization was found to be abnormal and the corresponding penetration frequencies and heights.



(5 HOURS 54 MINUTES AHEAD OF G.M.T.)

FIG. 1 — APRIL 1949.



AT POINT OF REFLECTION.

FIG. 2 — PREDICTED M.U.F. VIA F_2 LAYER, JULY 1949.

TABLE I

MONTH & YEAR	DATE	HOUR	$f°E_s$ Mc.	h_{E_s} Km.
April 1949	*11	21.00	5·25	105
		22.00	4·25	105
		23.00	6·00	105
	12	08.00	5·75	120
		09.00	6·60	135
		23.00	2·65	90
	13	00.00	2·60	90
		06.00	3·50	105
		07.00	3·85	105
		08.00	4·65	120
		10.00	5·20	120
	*14	13.00	5·20	150
		15.00	5·00	150
		16.00	5·70	150
		17.00	4·00	135
		20.00	6·75	135
		21.00	4·00	120
		22.00	4·00	120
	*15	07.00	6·50	150
		08.00	9·60	150
		09.00	6·65	150
		11.00	6·00	150
		12.00	6·65	150
		13.00	6·25	150
		14.00	5·80	150
	*16	09.00	7·15	150
		10.00	7·00	150
		11.00	5·80	150
	18	21.00	2·50	105
		22.00	4·00	105
		23.00	3·25	105
	19	00.00	3·00	90
		01.00	3·00	90
		02.00	2·80	90
		07.00	4·25	105
		08.00	5·75	120
		09.00	5·25	120
		20.00	5·00	120
		21.00	4·25	120
		22.00	3·50	120
		23.00	3·30	105
	20	00.00	3·00	90
		06.00	6·00	120
		07.00	3·50	120
		09.00	5·00	135
		10.00	4·25	135
		11.00	5·00	135
	*21	09.00	4·20	135
		11.00	5·20	150
		12.00	5·50	150
		19.00	6·45	135
	25	18.00	3·40	105
		19.00	3·50	105
		20.00	3·00	90
		22.00	3·50	90
		23.00	2·75	90
	*26	07.00	3·50	120
		08.00	4·25	120
		09.00	5·25	135
		10.00	6·00	150
		11.00	6·25	150
	*27	07.00	5·25	135
		09.00	5·15	135
		10.00	5·25	135
	28	09.00	11·00	150
		10.00	8·70	150
		20.00	3·25	105
		21.00	2·70	105
	*30	08.00	4·75	120
		09.00	9·75	135

* Local thunderstorm.

A Cosmic Ray Radio Sonde

R. P. THATTE
Tata Institute of Fundamental Research, Bombay

MILLIKAN, Neher and Pickering[1], in 1939-40, investigated total cosmic ray intensity in India by using radio sonde technique, and G-M counters singly or in coincidence telescopes. They made a latitude survey extending from Madras, 3°N., to Peshawar, 25°N. geomagnetic latitude. The geometry of their coincidence telescopes was such that their data can be compared only with great difficulty with any other high altitude data using telescopes of different geometry. At the *Tata Institute of Fundamental Research*, a programme was, therefore, undertaken to carry out an accurate high altitude survey with telescopes of standardized geometry, both with and without lead absorber, at several different latitudes varying from the magnetic equator northwards. In August and September 1948, seven high altitude soundings were made at New Delhi, 19°N. magnetic latitude, as a preliminary to standardizing the technique. The results obtained will be published separately by Messrs A. S. Rao and G. S. Gokhale. The purpose of this paper is to describe the apparatus used in these flights.

The Equipment

Generally speaking, the radio sonde technique, when applied to high altitude cosmic ray investigations by unmanned balloons, consists essentially in transmitting the cosmic ray data, along with the pressure-temperature data, over an ultra-high frequency carrier from the balloon-borne equipment to the ground station where it is received and recorded. The equipment used, therefore, will be described in two parts, namely the equipment that goes up and the equipment on the ground.

The Balloon-borne Equipment

This consists of a telescope of chosen geometry using G-M counters in coincidence ; the coincidence circuit ; the transmitting circuit ; the meteorograph, which sends the pressure-temperature data, from which the height of the apparatus above ground at any instant during the flight can be computed ; the necessary H.T. and L.T. supplies for the electronic circuits, and the H.T. supply for the G-M counters.

The Counter Telescope — It was decided to use four counters in quadruple coincidence instead of the triple coincidence generally used, to reduce the relative count due to side showers. Fig. 1 is the coincidence circuit of the conventional Rossi type. The four, 1-N-5-GT-G, 1·5 volt filament, sharp cut-off R.F. pentodes form the four Rossi coincidence tubes. The centre wire of the G-M counter is directly connected to the grid of the coincidence tube, its 1 megohm grid leak forming the load resistance of the self-quenching counter. The coincidence anode load resistance is 1 megohm. All the screens of the coincidence tubes are connected together and connected to the 90 volt H.T. anode supply through a 220K ohm resistor. Although this direct connection to the coincidence valve grid and the unconventionally high anode load resistance are rather unorthodox, they were found to give large discrimination ratios of the true to false coincidences. For example, using a pulse generator with three tubes receiving a common pulse and the fourth having no input, a 140 volt pulse was required on the three grids to give a coincidence pulse of the same height as obtained with only a 4 volt pulse in a true quadruple coincidence. Similarly, it was found that the ratio of pulse input for only two tubes, the others floating, to the true quadruple coincidence pulse input was still higher than above.

Fig. 2 is a photograph, showing the coincidence circuit mounted on the counter telescope frame.

The Resolving Time of the Coincidence Circuit — The resolving time of a coincidence circuit has to be low to reduce the accidental error. Using the data of Neher and Pickering[2] obtained at Agra, 17°N., the total intensity of a single counter will be approximately 50 times the ground intensity at the maximum at high altitudes. Also, the

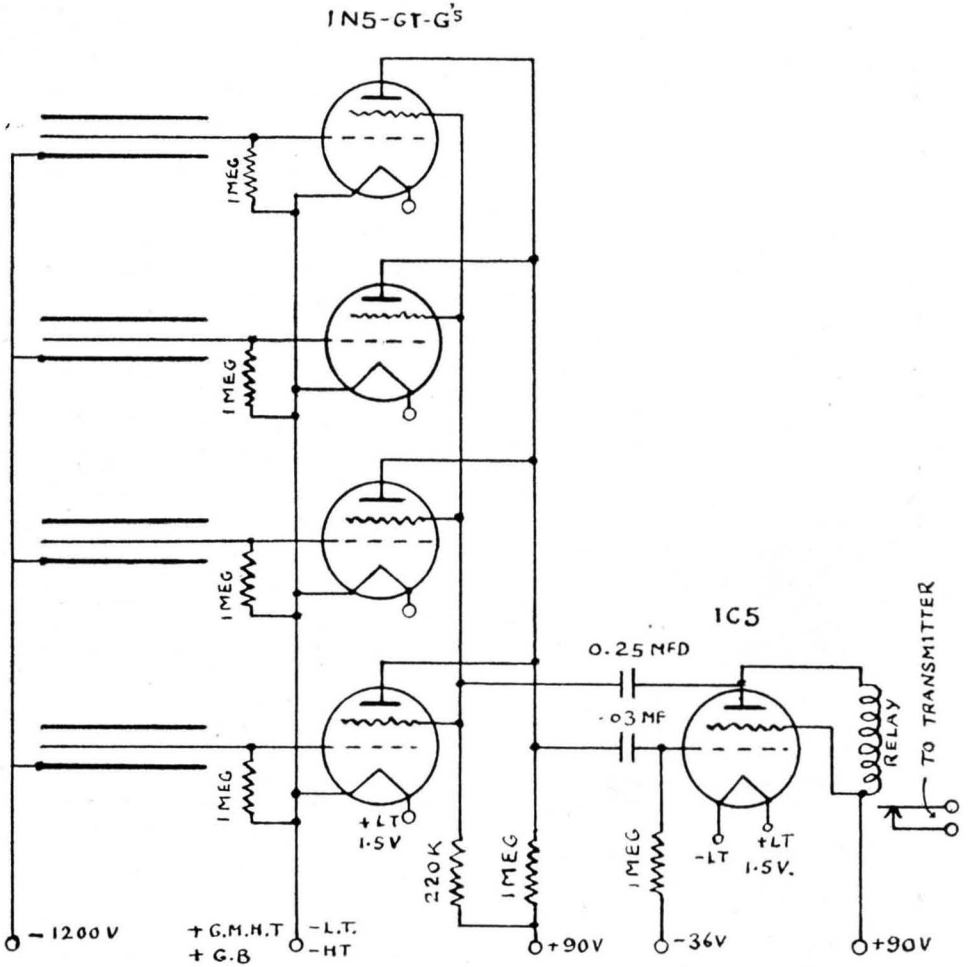


FIG. 1 — THE COINCIDENCE CIRCUIT.

intensity of a quadruple coincidence telescope will be approximately 20 times the ground intensity at the maximum. For the counters used by us, this would give the rate for a single counter of 150 counts per second, and 0·25 per second for the quadruples at the maximum.

The resolving time for the above coincidence circuit was measured by the usual method of measuring the accidental rate and using the formula

$A = 4N_1N_2N_3N_4\tau^3$ — for quadruple coincidence,

where A is the accidental rate and N_1 to N_4 are the counting rates of the four individual counters placed in such a way that no single particle can pass through all of them. The value of τ, the resolving time, was $7{\cdot}3\times10^{-5}$ sec.

Thus, at the maximum counting rate of a single counter, the accidental rate, calculated from the same formula for the above resolving time, would be $7{\cdot}87\times10^{-4}$ counts/sec., which would give an error of only 0·31 per cent at the maximum expected quadruple rate of 0·25/sec. The error would be much lower for lower counting rates and, therefore, negligible.

The output circuit of the coincidence unit is similar to that used by Neher and Pickering[3] with screen feed-back. With the time constants of the feed-back circuit as shown, the width of the output pulse is 0·05 second. The output stage has in its

anode circuit a high-speed sensitive relay. This valve is normally kept at plate current cut-off by the 36 volt grid bias ; the relay is in an unenergized state, and the normally closed pair of its contacts is inserted in the plate H.T. circuit of the coincidence transmitter. The transmitter, therefore, gives a continuous carrier when there is no coincidence pulse. When the shaped pulse opens the relay contacts for 0·05 sec., the transmitter is switched off for this duration. Since the counting rate of our telescope was low, this method of having the carrier continuously on, except for the duration of the coincidence pulse, was found to be a great help in keeping the receiver sharply tuned to the carrier.

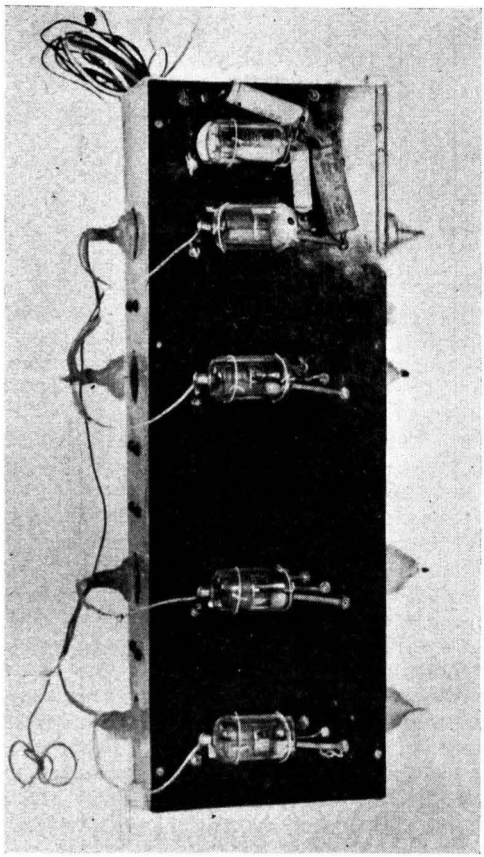


FIG. 2 — THE COINCIDENCE TELESCOPE — THE COINCIDENCE CIRCUIT IS WIRED ON A BAKELITE PANEL FORMING ONE SIDE OF THE TELESCOPE FRAME. NOTE THE SHORT CONNECTIONS FROM THE COUNTER ANODES TO THE VALVE GRIDS. THE VALVES ARE DEBASED AND WIRED ON THE PANEL.

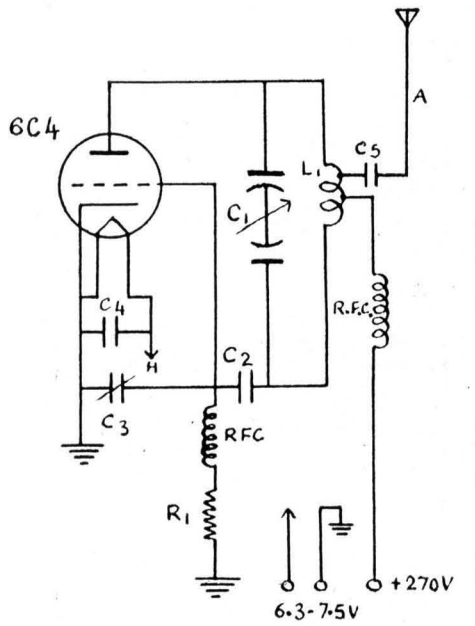


FIG. 3 — THE U.H.F. TRANSMITTER CIRCUIT — THE VALUES OF THE DIFFERENT COMPONENTS USED ARE AS UNDER : C_1 — Split stator tuning condenser. C_2 — 50 mmfd. midget mica. C_3 — 3-30 mmfd. ceramic trimmer. C_4 — 500 mmfd. midget mica. C_5 — 50 mmfd. silver mica. R_1 — 10,000 ohms grid leak. L_1 — 2 turns, 10 swg 0·7″ — 151 mc. ; 2 turns, 10 swg 1·0″ — 141 mc. RFC — 1 inch winding, 24 swg enamelled on ¼″ diameter polystyrene rod. A — half wavelength aerial.

Errors Due to the Resolving Time of the Carrier Pulse — For the duration of the carrier pulse of 0·05 sec., the relative error introduced at the maximum counting rate of 0·25/sec. is only 1·2 per cent, as shown by Neher[4]. For the resolving time of the relay, which is also 0·02 sec., the percentage error is only one half per cent.

The Transmitter — The transmitters used in these flights were designed and made by Mr. A. S. Rao. Since the counting rate expected in these flights would be very low, the loss of a few counts would seriously affect the statistical accuracy of the observations. It was, therefore, decided to use a more powerful carrier than generally used in radio-meteorography. The choice of the wavelength was also made to make the man-made interference negligible. 144-150 mc. band was, therefore, chosen. Ordinarily used battery valves such as type 1G4, 19, etc., were found to be very poor at these wavelengths. The 958 type triode of 1·5

filament volt rating as used by Pickering[5] was not obtainable here and, therefore, a type 6C4, U.H.F. miniature triode, having 6·3 volt filament was chosen. Using an ultra-audion circuit as given in *A.R.R.L.* handbook[6], with an input of 15 to 20 ma. at 270 volts on the anode, an R.F. output of approximately 1·5 watts was obtained in the half-wave antenna, capacitively coupled. With this carrier output, the signal strength during the flights was found to be good. In fact, in one of the trial flights, strong signals were obtained even at an altitude of 100,000′. There was not a single count missed due to fading in any of the cosmic ray flights, though, once or twice, data were lost while retuning the receiver to the carrier which drifted slightly. Fig. 3 shows the circuit of the transmitter and Fig. 4 is a photograph.

The Meteorograph — To determine the pressure corresponding to the position of the apparatus, at any instant during its flight, a meteorograph was needed. It was also necessary to know the temperature of the apparatus to know whether the change of temperature, if any, was such as to affect the counters, batteries and other equipment, sensitive to temperature.

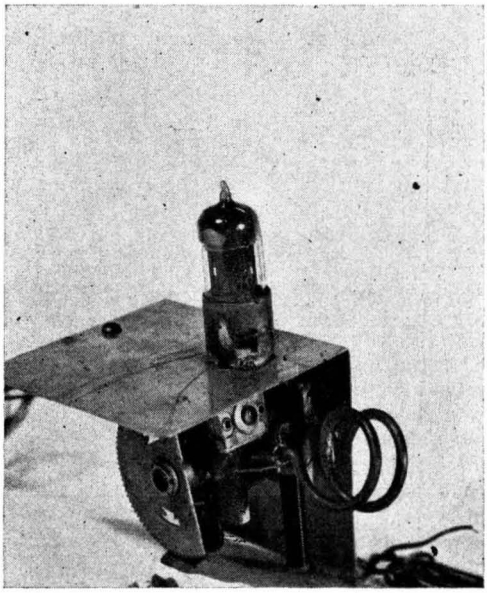


FIG. 4 — THE TRANSMITTER, SHOWING THE TRANSMITTER ASSEMBLED ON A L-SHAPED CHASSIS. IT IS MOUNTED ON THE TELESCOPE FRAME DURING THE FLIGHT.

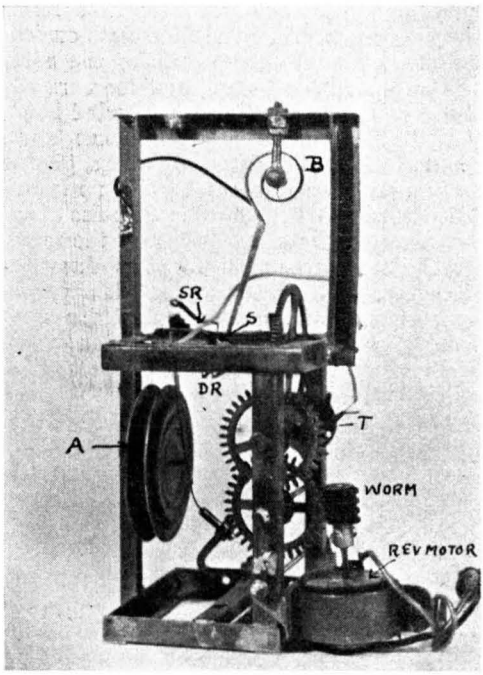


FIG. 5 — THE METEOROGRAPH WITH MOTOR DRIVE — THE SMALL REV MOTOR IS SEEN COUPLED BY A 36 : 1 WORM.

A — Aneroid. B — Bimetal thermometer. S — Silver wire spiral. SR — Single reference for temperature. DR — Double reference for pressure. T — Ten teeth wheel with spring contact.

The coincidence unit, the transmitter, the H.T. and L.T. power supplies were enclosed in a bamboo cage, the whole of which was then enclosed in a double covering of violet and clear cellophane. The temperature regulation achieved by this will be described elsewhere.

A suitable meteorograph was available in the *India Meteorological Department*[7]. The original meteorograph is driven by a fan, operated by the downward wind as the meteorograph ascends with the balloon. Since, in these flights, the apparatus was enclosed, there was no air to drive the fan. The fan was, therefore, replaced by a midget motor operating on 4 to 6 volts battery. (These motors are manufactured by *Messrs Rev Motors Ltd.*, Bolton, England, and the radically new principle on which they work is described[8].) The motor is only 1″ in diameter and 0·5″ long, and weighs only 22 gm. At 4·5 volts, it runs at 4,000 to 5,000 r.p.m. and the torque, after 36 : 1 worm

reduction, was found to be adequate to drive the meteorograph. Fig. 5 shows the meteorograph adapted for the motor drive.

The principle on which this meteorograph works is the same as in Bureau's[9] meteorograph. The working of the I.M.D. meteorograph and the method of evaluating the pressure-temperature data have already been described[10].

Because of the design of this meteorograph, it was not possible to utilize the same carrier to transmit the cosmic ray and the meteorological data simultaneously as done by Neher and Pickering[5]. A separate transmitter was, therefore, used for the meteorograph channel similar to that used for the cosmic ray channel, but on a wavelength separated by a few megacycles. The meteorograph transmitter worked near 141 mc. and the cosmic ray transmitter near 151 mc.

It was, however, found that with such small separation between the two carrier frequencies, the receiver could discriminate between the two from the point of view of the receiver selectivity when the two transmitters were separated from each other at some distance. When both the transmitters were put in the same enclosure, the two resonating, half-wave aerials of very nearly equal lengths induced strong currents mutually, resulting in cross modulation. Since it was not possible to do radical design changes, either in the transmitter or the receivers, at the field station where the difficulty was observed without upsetting the time schedule of the flights, the only remedy was to separate the two transmitters to a minimum distance where the cross modulation was zero. The cosmic ray telescope, its transmitter and the necessary power supplies were, therefore, put in an enclosure covered with cellophane. The meteorograph, its transmitter and power supply were then put in another similar enclosure, and during the ascent it was hung 25′ below the cosmic ray enclosure. Fig. 6 shows the two enclosures ready for ascent on the ground, and Fig. 7 shows the apparatus immediately after the release with the two enclosures hung one below the other.

The H.T., L.T. & the Counter H.T. Power Supplies — The apparatus was intended to work for 3 to 4 hours' maximum during the flights. Small, light-weight H.T. and L.T. batteries of adequately small capacities were not available to us. The smallest 1·5 volt cell commercially available

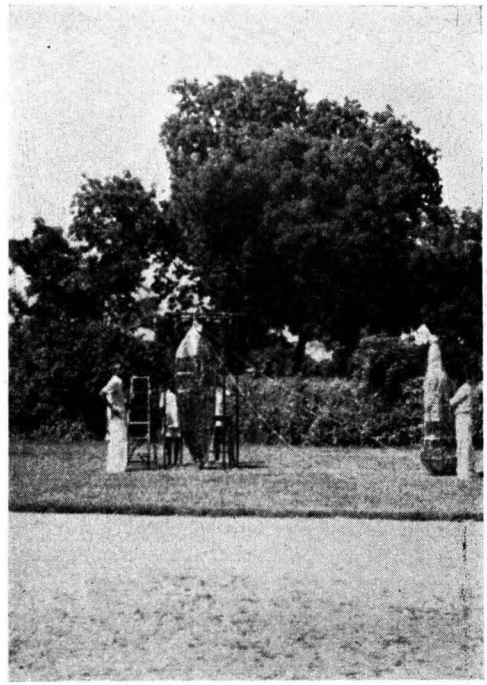


FIG. 6 — THE TWO ENCLOSURES READY FOR ASCENT. THE COSMIC RAY ENCLOSURE, BECAUSE OF ITS HEAVINESS, IS HUNG IN A PIPE FRAME TO FACILITATE THE ASSEMBLY OF THE VARIOUS UNITS IN THE BAMBOO CAGE. THE MAN ON THE RIGHT IS HOLDING THE METEOROGRAPH ENCLOSURE.

Photo by courtesy of Dr. L. S. Mathur

was the *Eveready* pencil torch, type 915, weighing 15 gm. each. H.T. and G.B. blocks were, therefore, made using these unit cells for the coincidence circuit and the transmitters. The capacity of these was found to be more than adequate for the current drain of these units, but the weight was excessive. The current drains of the various circuits were as under.

TABLE I

UNIT	H.T.		G.B.	L.T.	
	Volts	Amps.	Volts	Volts	Amps.
Coincidence	90	0·003	36	1·5	0·3
Transmitter	270	0·02	...	7·5	0·180
Meteorograph motor	...	...	...	4·5	0·400

The L.T. units were made out of *Eveready* type 950 cells, two or more being connected in parallel to meet the current drain

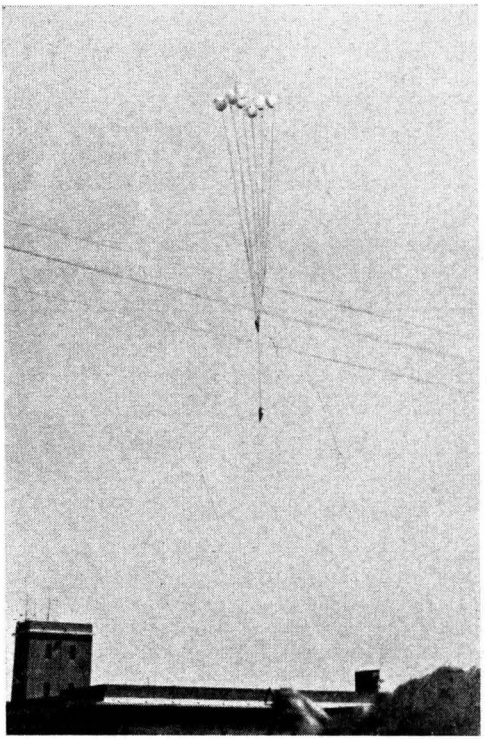


FIG. 7 — PHOTO SHOWS A FLIGHT AFTER RELEASE, WITH A CLUSTER OF EIGHT BALLOONS. THE TWO ENCLOSURES ARE CLEARLY VISIBLE HANGING BELOW THE BALLOONS. THE BOTTOM IS THE METEOROGRAPH ENCLOSURE.

Photo by courtesy of Dr. L. S. Mathur

requirements. Table II gives the total weights of the prepared H.T. and L.T. batteries.

TABLE II

TYPE		WEIGHTS	
		lb. oz.	gm.
Coincidence	H.T.	2 3	922·23
,,	L.T.	0 10	283·54
,,	G.B.	0 14	396·89
Transmitter	H.T.	7 2	3,231·83
,,	L.T.	2 3	992·23
Motor		1 4	566·99

The Geiger Counter H.T. Supply — Light-weight H.T. batteries were also not available commercially to make the 1,200-volt H.T. supply needed for the G-M counters. However, a technique was developed for preparing light-weight H.T. batteries for radio-meteorography[10] while the author was employed in the radio-meteorograph development project of the *India Meteorological Department*. The technique was adopted for developing a suitable G-M H.T. supply. Smaller carbon cups similar to *I.M.D.* H.T. battery were supplied to us by *Messrs Helium Products Ltd.*, Poona. These cups were 0·5″ in diameter and $\frac{7}{32}$ high. A unit cell, after filling these cups with the depolarizing mixture, also supplied by the company, and putting a blotting paper disc saturated with electrolyte, on which a zinc disc was placed, gave 1·5 volts and weighed 1·6 gm. An adequate number of these cells were assembled in a "Volta Pile" fashion in a bakelite box having suitable compartments to give 1,200 to 1,300 volts H.T. as required. Since the current drain from the four counters on this H.T. was only a few micro-amperes, the only load on this battery was the leakage current in the assembled box. The battery was found to keep its terminal voltage within the range of the counter plateau for 2 hours after the complete battery was assembled. The assembly of these small cells, though simple, was rather tedious, and required about 10·5 man-hours. The assembly time was, therefore, brought down to 1·5 hours with a team of six to seven people. The complete H.T. battery after assembly weighed 6 lb. 4 oz. (2,835 gm.).

The Weight of the Apparatus — As mentioned above, the heaviness of the battery blocks contributed to the total weight of our equipment. Table III gives the weight of the different units in the balloon-borne equipment.

TABLE III

UNIT	COSMIC RAY ENCLOSURE		METEOROGRAPH ENCLOSURE	
	lb. oz.	gm.	lb. oz.	gm.
Bamboo cage	4 0	1,814·37	3 8	1,587·56
Cellophane bag	1 8	680·39	1 8	680·39
Coincidence unit with transmitter	4 0	1,814·37	...	...
Meteorograph with transmitter	...	...	2 6	1,077·28
Batteries for the transmitter	9 5	4,224·08	9 5	4,224·06
Batteries for the coincidence unit	3 11	1,672·61	...	...
TOTAL	22 8	10,205·82	16 11	7,569·29

Gross weight of the whole equipment: 48 lb. 2 oz. (21,857·37 gm.) with suspension rigging.

These weights are somewhat unconventional. Yet, using 10 to 15 balloons with 3,000 to 3,500 gm. free lift each, heights of about 40,000′ were consistently reached;

in a few instances the flights reached up to 60,000′. In one flight, 10 cm. of lead was interposed between the counters of the telescope to measure the hard component of the cosmic ray intensity. The gross weight of the equipment in this flight was 64 lb. 6 oz. (29·2 kg.). This flight reached a height of 60,000′, though the cosmic ray data were lost after 24,000′, when the cosmic ray carrier drifted in frequency beyond the tuning range of the receiver.

The Balloons

Latex balloons, manufactured by the *Nagpur Rubber Industries*, were used for these flights. Their *NR*-220 type, which is equivalent to *Dewey Almy Chemical Co.'s* (U.S.A.) neoprene balloon, *Darex* J-800, was used throughout. In previous ascents their performance was found to be comparable to the American equivalent. Like the American neoprene balloons, their life period for an afternoon flight was found to be 1·5 to 2 hours, irrespective of the rate of ascent or the height reached. The experience in these flights shows that it is desirable to use as few balloons as possible with the maximum permissible free lift to each, since the larger the number used, the greater is the probability of one or two bursting, limiting the maximum height reached. As many as 15 balloons were used in one of the flights with a smaller free lift than the maximum permissible lift when only 10 balloons were used. As mentioned before, heights of 40,000′ have been consistently reached.

Figs. 8 and 8a show the balloons after release.

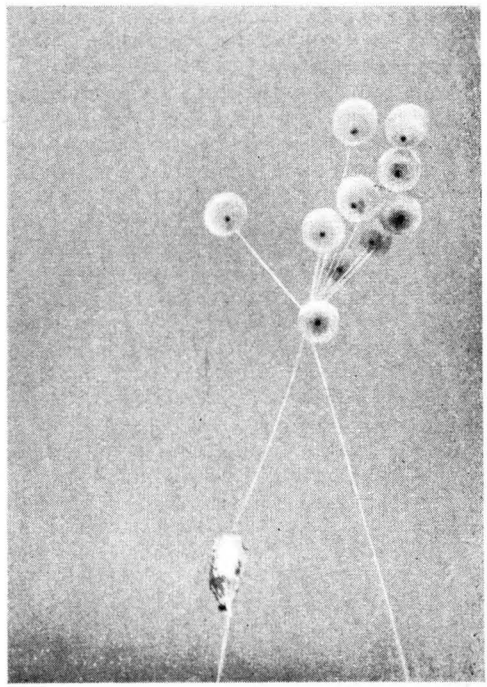


FIG. 8a — A CLUSTER OF TEN BALLOONS USED IN ONE OF THE FLIGHTS. THE CELLOPHANE WRAPPED COINCIDENCE ENCLOSURE IS ALSO VISIBLE.
Photo by courtesy of Dr. L. S. Mathur

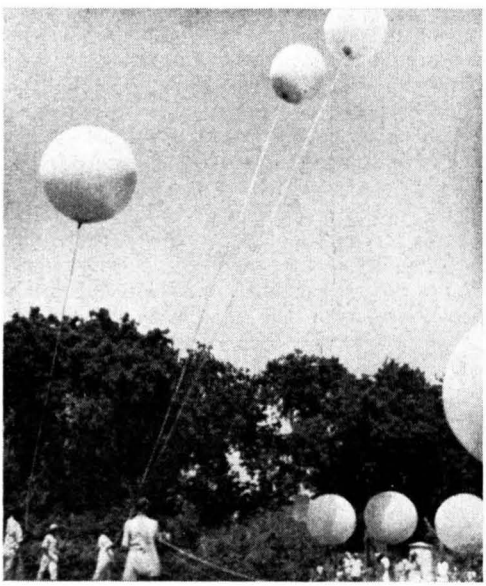


FIG. 8 — SHOWS INDIAN MADE LATEX BALLOONS USED IN THESE FLIGHTS. NOTE THE PERFECT SPHERICAL SHAPE OF THESE BALLOONS.
Photo by courtesy of Dr. L. S. Mathur

The Ground Equipment

The Receiver — Neher and Pickering have used in their later balloon flights a super-heterodyne receiver for these U.H.F. carriers. This choice was made because, for the counting rate encountered in their experiments, the transmitter pulse was only a few micro-seconds long[3, 11]. Because of its inherent a.v.c. action, a super-regenerative receiver is unable to respond to such sharp pulses. In our flights the transmitted pulse was 0·05 second long, and hence could be recorded by a super-regenerative receiver. The additional advantage of the super-regenerative

receiver is that it does not respond to auto-ignition interference, and hence the choice of the receiving site is not as critical as when a superhet is used. Further, the meteorograph used requires a D.C. amplifier coupled to the recorder. This requirement is easily met by a super-regenerative receiver, since the hiss quenching of the receiver can be converted into a D.C. pulse of the same duration as the carrier pulse, which can be further amplified by a D.C. amplifier before being fed to the recorder.

Two super-regenerative receivers were, therefore, chosen to receive the two carriers from the cosmic ray equipment and the meteorograph. Commercially built *Mac-Murdo Silver Model* 800 receivers were chosen. These receivers have only two tuning ranges of 144 to 148 mc./s. and 235 to 240 mc./s. The 144 to 148 mc. bands in the two receivers were slightly modified to cover 141 mc. and 151 mc. bands for our two channels. Because of this short tuning range and the broad tuning feature inherent in the super-regeneration principle and the design of the receivers, it was rather difficult to adjust our carrier sharply in the centre of the receiver band when the signal strength of the transmitter was very strong, although the transmitter was far away from the receiving location. Because of this difficulty, in one flight the cosmic ray carrier drifted beyond the tuning range of the corresponding receiver after the flight reached 24,000′ although the maximum height reached by the flight was 60,000′, as indicated by the pressure-temperature carrier, which was recorded up to this height.

The D.C. Amplifier — The D.C. amplifier used in conjunction with the above receivers is of the neon-coupled type[10]. Since the carrier for the cosmic ray channel is continuously on, except when a count is transmitted, the super-regeneration hiss in the corresponding receiver is normally quenched, except for the duration of the pulse. For the desired sensitivity, the number of stages in the neon-coupled amplifier is so chosen that, with the hiss quenched, the final stage in the amplifier is non-conducting. The recorder in its anode circuit is, therefore, normally not excited, and the pen attached to it is undeflected. When a pulse arrives, the hiss of the receiver comes on and the recorder marks a pulse. Fig. 9 is a circuit diagram giving the circuit of the super-regenerative receiver, the neon-coupled D.C. amplifier, and the voltage-regulated power supply furnishing the H.T. and L.T. voltages, both for the receiver and the amplifier.

The complete system, therefore, consists of two such receivers coupled to D.C. amplifiers feeding the recorders with their separate power supplies.

The Recorder — The recorder is made out of a G.P.O., high speed, S.P.D.T. relay, with the coil rewound for lower impedance to work in the anode circuit of triode-connected 6F6 pentode in the final stage of the D.C. amplifier of Fig. 9. The relay contacts are removed to reduce the load on the armature and an extension is fitted to the armature arm, the other end of which carries a light-weight holder in which a " crow-quill " nib can be fitted. Two of such recorders are fixed opposite each other and write on a paper tape which is pulled by a tape-pulling arrangement made out of a variable speed, governor-controlled, gramophone induction motor, with a 9 : 1 reduction from its 78 r.p.m. spindle. The whole recorder is assembled on the front panel of the D.C. amplifier. The paper-tape stock spool, the idling rollers, the two recording pens with their vertical and lateral adjustments and the variable speed control knob of the tape puller drive, are thus always under view. Any adjustment of the recording nibs, their pen pressures, the ink feed, and the adjustments on the paper tape, if any fouling occurs, can thus be immediately made without stopping the recording, and thus no data are lost. The nibs of the recording pens are fed by cotton wicks from a small ink reservoir by capillary action.

Though the cosmic ray counts are continuously recorded, the pressure and temperature data are recorded once in one Olland cycle, the duration of which is from 2 to 4 minutes. To be able to interpolate the cosmic ray data with pressure corresponding to chosen height intervals, a continuous time trace is also put on the paper tape by a third pen. To reduce the complication of the ink-feed problem for a third pen, an ink refill, complete with the ball point, commercially available for an American made ball-point pen, was used for the third pen. This pen puts a continuous trace between the cosmic ray and the meteorograph traces. The time pen is lifted for a short duration every 15 seconds by an additional relay, similar to the recording relays, by the help of a synchronous clock. At every full minute there is a double interruption.

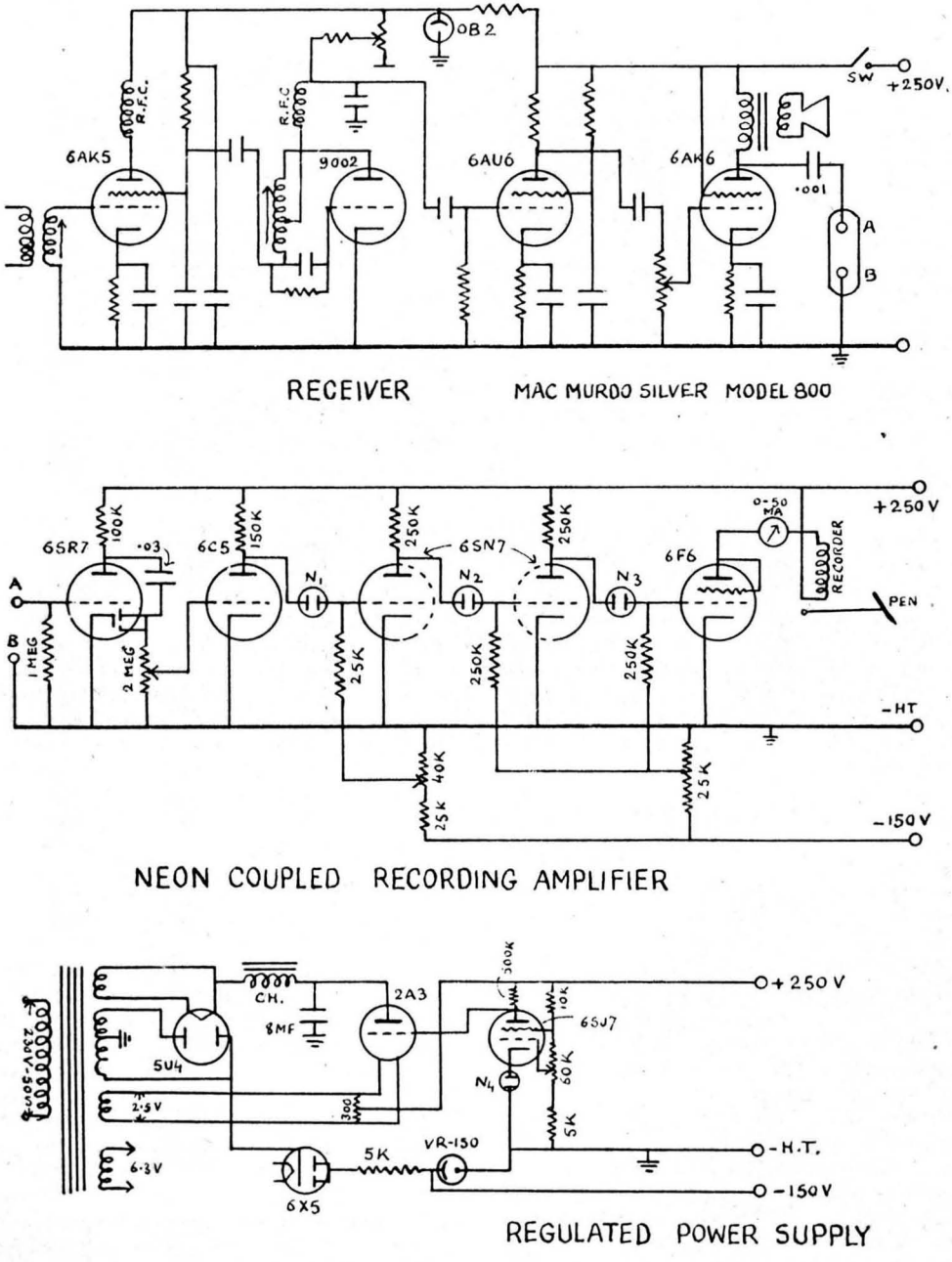


FIG. 9 — THE CIRCUIT OF THE U.H.F. SUPER-REGENERATIVE RECEIVER, THE NEON-COUPLED D.C. AMPLIFIER AND THE VOLTAGE-REGULATED POWER SUPPLY. TWO SUCH IDENTICAL UNITS WERE USED.

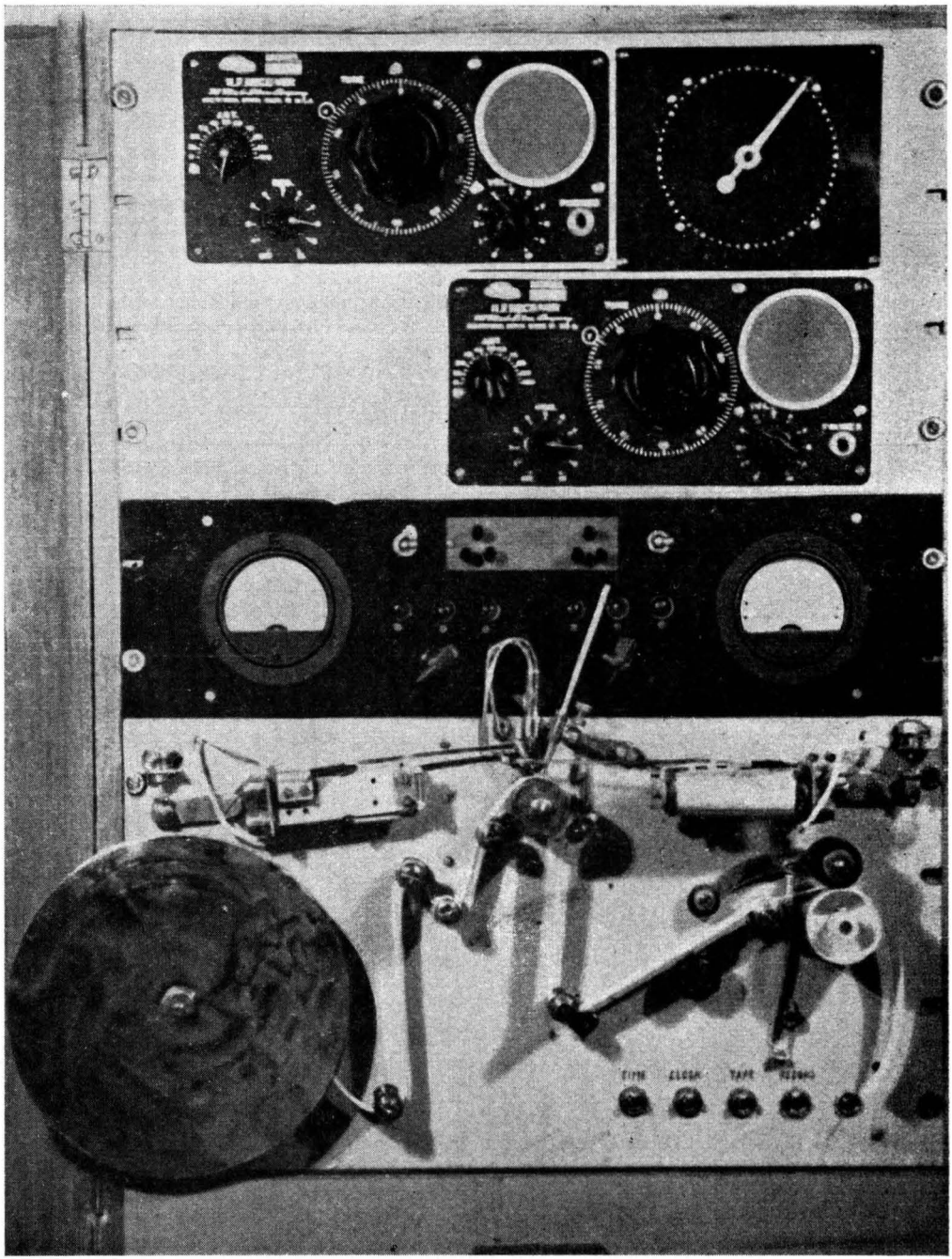


FIG. 10 — THE COMPLETE RECEIVING UNIT — THE TOP PANEL SHOWS THE TWO RECEIVERS AND THE TIME MARKING CLOCK. THE BLACK PANEL SHOWS THE TWO TUNING METERS AND THE SIX NEONS VISIBLE THROUGH CIRCULAR WINDOWS. ON THE BOTTOM PANEL ARE MOUNTED THE WRITING RELAYS AND THE TAPE-FEEDING AND PULLING ARRANGEMENT.

Thus, there is a continuous time recording synoptic with the two data records, and an accurate measurement of time to 0·01 minute can be made. From the pressure data a time-pressure curve is drawn. Having chosen a pressure interval corresponding to the desired height interval, the cosmic ray counts are measured from the tape for the corresponding time interval and the counting rate determined.

Fig. 10 shows the complete receiving set, rack mounted in a cabinet. The top panel carries the two receivers. The time marking clock is also visible in the right top corner. The next panel carries the six neons of the two D.C. amplifiers visible through windows. The two meters are 0 to 50 ma. meters in series with the recorder coils. These meters also serve as tuning indicators for the receivers, since the recorder current is zero for a perfectly tuned carrier, the strength of which is above the threshold for positive operation of the recorder. The neon bulbs of the amplifier, which are visible, also help to keep a check on the satisfactory operation of the various stages of the D.C. amplifiers. The bottom panel shows the recording relays with the pens attached, the ink feed, the tape feed and the pulling arrangement. At the bottom is a small drawer carrying the accessories required for the recorder.

Fig. 11 is a photograph of a length of tape recording. The top trace shows the random cosmic ray counts, the middle is the time trace and the lowest is the meteorograph recording.

The Receiving Aerial — The receiving aerial is of the same type as designed by the author for radio-meteorography[10] in the *India Meteorological Department.* It has been found to be very successful in overcoming the periodic fading encountered because of

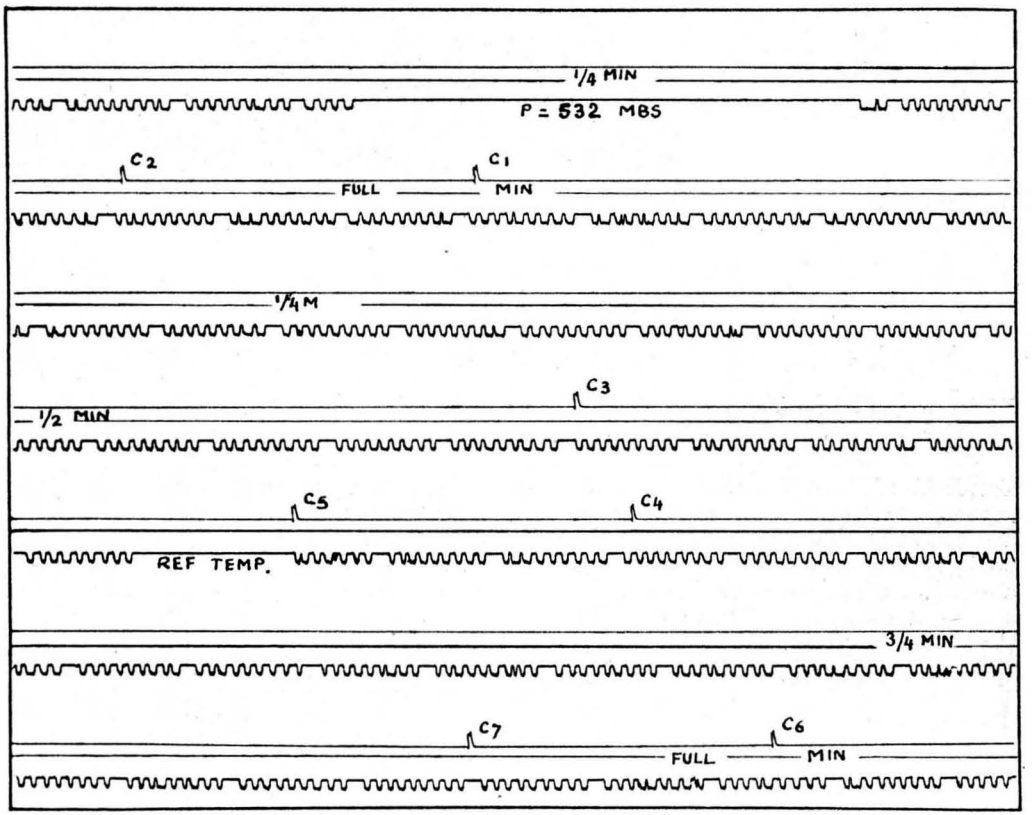


FIG. 11 — SAMPLE OF TAPE RECORD OBTAINED DURING ONE OF THE FLIGHTS AT ABOUT 5 KM. ALTITUDE. TOP TRACE IS FOR THE COINCIDENCE PULSES, THE MIDDLE FOR TIME, AND THE BOTTOM FOR METEOROGRAPH. THE DOUBLE INTERRUPTION AT EVERY FULL MINUTE AND SINGLE AT EVERY QUARTER MINUTE IS SEEN. SIX COINCIDENCE PULSES HAVE BEEN RECORDED FOR A ONE MINUTE INTERVAL.

swinging vertical antenna of the balloon-borne transmitter, which results in a change of the carrier polarization from the vertical.

Summary

Using radio sonde technique, cosmic ray vertical intensity up to 40,000′ was recently measured at New Delhi. The radio sonde equipment used in these flights is described. It consists of the coincidence unit with a pulse lengthening circuit ; a meteorograph for the pressure-temperature data ; and two U.H.F. light-weight transmitters to transmit the two data separately. The receiving unit consists of a super-regenerative receiver coupled to a neon-coupled amplifier feeding a high-speed tape recorder for each of the channels. Using Indian made balloons, heights of 40,000′ were consistently reached, though the weight of the equipment was about 22 kg. In one flight, 10 cm. lead absorber was used, the total weight then being 30 kg., yet the flight reached a height of 60,000′.

Acknowledgement

I would like to record my thanks to Messrs A. S. Rao and G. S. Gokhale in collaboration with whom the experiment was carried out. As mentioned in the body of the paper, the transmitters were made by Mr. A. S. Rao who also duplicated the coincidence circuits. I also take the opportunity to thank Dr. Roy and Mr. S. P. Venkiteswaran of the *India Meteorological Department* for the use and supply of the Fan type meteorographs. Thanks are also due to Mr. Kalyansundaram of the *I.M.D's.* Poona office, and Mr. Gokhale of this *Institute* for calibrating the meteorographs for these flights. I also wish to acknowledge with gratitude the encouragement received from Professor Bhaba during the course of this work. Finally, thanks are due to the *Council of Scientific & Industrial Research* for financial assistance for the scheme.

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Micro-filming of Manuscripts

THE *Indian Library Association* IS CONSIDERING steps to be taken for filming perishing and perishable manuscripts and out-of-print books in India's libraries. The UNESCO is also interested in this work. It may be necessary, it is stated, to approach the UNESCO to provide micro-film laboratories in India in the light of information regarding the micro-filming resources at the disposal of Government departments, research institutions and libraries in India. Such information about existing apparatus may be sent to Dr. S. R. Ranganathan, President, *Indian Library Association*, Delhi University, Delhi 2.

Some Scientific Aspects of High-Polymers*

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NATURAL products such as cellulose (in cotton, wood and vegetable fibres), protein (in silk and wool), and rubber (in *Hevea* latex) have, for a long time, been recognized as high-polymeric substances, that is, compounds made up of many (poly) identical, simpler units (mer) linked together by primary (covalent or homopolar) bonds. In cellulose molecule, the repeating unit (mer) is anhydrous glucose ($C_6H_{10}O_5$); in silk-fibroin, glycylalanine residue ($-NH-CH_2-CONH-CH(CH_3)-CO-$), and in rubber, isoprene ($-CH_2-C(CH_3)=CH-CH_2-$). In recent years, a large number of synthetic high-polymers with valuable properties and of great practical utility has come into existence in the shape of textile fibres (rayons, nylons, vinyons, etc.), rubbers (Buna S, Buna N, Butyl, Neoprene, etc.), and plastics of a bewildering variety. Scientific research carried out particularly during the last 20 or 25 years, both on natural and synthetic high-polymers, has brought to light certain fundamental characteristics common to all these substances and also some specific differences which are responsible for their division into fibres, plastics and rubbers. A knowledge of these similarities and differences, a critical survey of which is proposed to be given in the present article, is necessary not only to understand the nature of high-polymeric substances, but also to be able to synthesize new materials possessing better and more useful properties; in short, to synthesize the so-called tailor-made molecules.

Molecular Weight

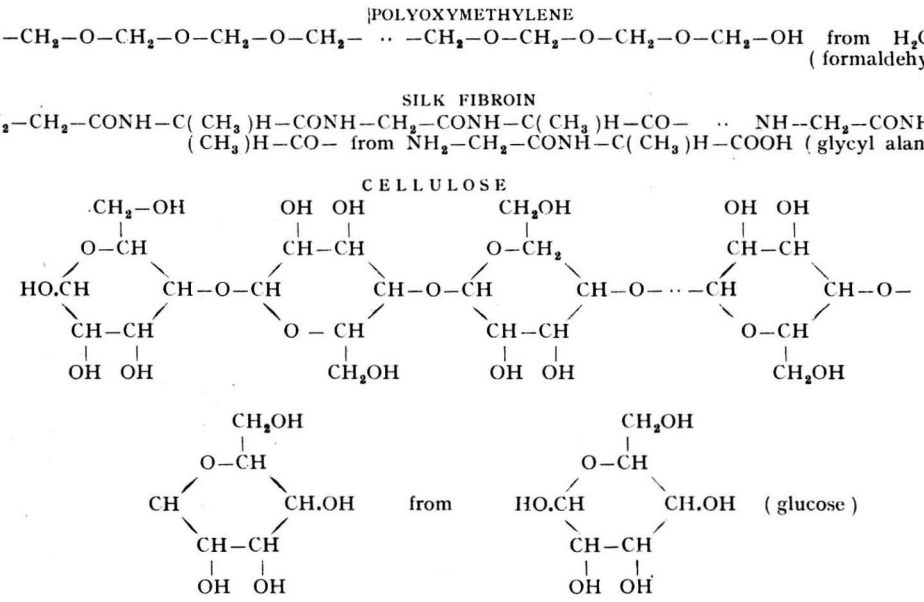
The first characteristic of all high-polymers is their molecular weight. Classical organic chemistry deals with substances whose molecular weights rarely exceed a thousand. The molecular weights of high-polymers run into tens and hundreds of thousands as may be seen from Table I. They have been determined by osmotic pressure[2], viscosity[3], ultra-centrifuge[4] and, more recently, light-scattering[5] methods. But there is a certain indefiniteness about them. When we speak of sugar having a molecular weight, 342, we understand that each sugar molecule in a given sample has the same number of carbon, hydrogen and oxygen atoms, and hence has the same size and shape. But, in the case of a high-polymer, all the molecules in a given sample do not appear to have the same number of fundamental units, nor the same size and shape; some are longer, some more branched than others. In fact, there seems to be a regular distribution of size and shape among the molecules of a given sample so that we can speak only of an average molecular weight.

TABLE I — MOLECULAR WEIGHTS & DEGREE OF POLYMERIZATION (D.P.) OF SOME HIGH-POLYMERS

Material investigated	Mol. wt.	D.P.
Native cellulose in cotton, ramie, or wood	800,000—500,000	2,000—3,000
Cellulose in bleached cotton linters	150,000—230,000	1,000—1,500
Cellulose in purified wood pulp	120,000—200,000	800—1,200
Regenerated cellulose in rayon	75,000—100,000	500—600
Regenerated cellulose in staple fibre	60,000—75,000	400—500
Regenerated cellulose in cellophane	50,000—60,000	300—400
Native rubber in *Hevea* latex	140,000—210,000	2,000—3,000
Rubber after being milled in air	55,000—70,000	800—1,000
Nitrocellulose used for moulding	400,000—700,000	1,500—2,500
Nitrocellulose used for extrusion	150,000—300,000	600—1,200
Nitrocellulose used for coatings	50,000—100,000	200—400
Polystyrene for plate casting	250,000—400,000	2,500—4,000
Polystyrene for injection moulding	120,000—180,000	1,200—1,800
Polystyrene for coatings	80,000—120,000	800—1,200
Polyvinyl chloride (Koroseal)	250,000	3,000
Polyisobutylene (Vistanex)	120,000—200,000	2,000—3,000
Polyhexamethylene adipamate (Nylon)	16,000—32,000	150—300

* Based on a paper read at the High-Polymer Symposium, Chemistry Section, Allahabad Session of the *Indian Science Congress Association*, 1949.

Experimental justification for this statement has amply been provided by fractional precipitation, first of rubber by Caspari[6], later of nitro-cellulose by Duclaux and Wollman[7], and by the work done on cellulose balta and many synthetic polymers by Staudinger and coworkers[8] from 1927 onwards, and on rubber by Midgley and coworkers[8] from 1931. The influence of molecular weight distribution curve on the mechanical properties of high-polymers will be discussed later.



Polymerization

Whatever be the manner in which high-polymeric materials are synthesized by nature in plant and animal organisms, the process by which they have been produced from simpler molecules in the laboratory or in industry is known as polymerization. Classical organic chemistry, interpreting Berzelius' definition of a polymer in a rather narrow sense, restricted the capacity to polymerize to molecules containing an unsaturated bond, such as $-C=C-$, $-C=O$, $-C=N-$, so that the polymer would have the same chemical composition as the simple molecule from which it was built up. The inadequacy of such a definition of a polymer and of polymerization was first pointed out by W. H. Carothers[9] from a critical examination of the structures of such admittedly high-polymeric substances as cellulose, silk-fibroin, polypeptides, polyoxymethylene, polyethylene glycol, in which, though the repeating unit (mer) in a particular high-polymer is the same, the chemical composition of the latter is not identical with that of the starting simple molecule, as illustrated in the following structures:

He showed from these examples that the characteristic feature of a high-polymer is the structural unit, the repetition of which leads to the large molecule. He proposed, therefore, as a more logical and comprehensive definition of polymerization any chemical union of similar molecules to form a single large, i.e. high-polymeric molecule. Such a chemical combination may be effected either by mere self-addition, or by condensation involving the elimination of simple molecules such as water, ammonia, hydrochloric acid, etc., so that one can speak of addition or A-polymerization, and condensation or C-polymerization.

Addition polymerization[10] is undergone essentially by molecules containing an unsaturated linkage. Thus, ethylene can be polymerized into the technically valuable polyethylene[11], known for its excellent insulating properties:

$$CH_2=CH_2+CH_2=CH_2 \longrightarrow -CH_2-CH_2-CH_2-CH_2-$$

which, with further addition of ethylene molecules, results in a large molecule. But the reaction requires high temperature,

200° to 300°C. and high pressures up to 1,200 atm., though lower degrees of polymerization can be easily achieved[12]. On the other hand, substituted ethylenes, of the type $CH_2=CHX$[13], where X is a phenyl or carboxylic ester group or a halogen atom, undergo polymerization much more readily. Examples are: polystyrene from styrene, polyvinyl acetate from vinyl acetate, polyacrylates from acrylic esters, polyvinyl and polyvinylidene chlorides from vinyl and vinylidene chlorides respectively.

This type of polymerization, also known as vinyl polymerization because of the compounds involved, is generally carried out with the help of a catalyst[14] such as free radicals, and free radical yielding organic peroxides (benzoyl peroxide, diazo-compounds, etc.), and metal halides like BF_3, $AlCl_3$, $SnCl_4$. The chemical process appears to be a chain reaction involving :

(a) activation of the monomer by a catalyst leading to an activated state having the character of a free radical,

$$\underset{\text{catalyst}}{K} + \underset{\text{monomer}}{CH_2=CHX} \longrightarrow \underset{\text{active radical}}{KCH_2-CHX-}$$

(b) followed by successive additions of monomer molecules,

$$\underset{\text{active radical}}{KCH_2-CHX} + \underset{\text{monomer}}{CH_2-CHX} \longrightarrow \underset{\text{growing chain}}{KCH_2-CHX-CH_2}$$
$$-CHX- \longrightarrow K-(CH_2-CHX-)_n$$

(c) until the polymer is stabilized either :

(i) by chain termination or cessation,

$$\underset{\text{growing chain}}{K(CH_2-CHX-)_n} + \underset{\text{growing chain}}{(-XHC-CH_2)_mK} \longrightarrow$$
$$\underset{\text{stabilized chains}}{K(CH_2-CHX)_n - (XHC-CH_2)_mK}$$

or (ii) by chain transfer in which the activity is transferred to some other polymer or solvent molecule,

$$\underset{\text{growing chain}}{K(CH_2-CHK-)_n} + \underset{\text{monomer}}{CH_2-CHX} \longrightarrow$$
$$\underset{\text{deactivated chain}}{K(CH_2-CHX)_{n-1}-CH_2=CHX} + \underset{\text{active radical}}{CH_2-CHX-}$$

or (iii) by chain branching,

$$\underset{\text{growing chain}}{KCH_2-CHX-} + \underset{\text{growing chain}}{-XHC-CH_2K} \longrightarrow$$
$$\underset{\text{terminated chain}}{KCH_2-CH_2X} + \underset{\text{branching chain}}{>XC-CH_2K}$$

It appears that process (b), having a low activation energy, is frequently repeated, about a thousand times or more in a fraction of a second, so that the chain grows to a fair size in a comparatively short period of time before it is terminated by a cessation process. Consequently the average chain length (or degree of polymerization, D.P., indicating the number of monomeric units in the chain) and consequently the average molecular weight will be independent of time or extent of the reaction, unlike in the case of the other type of polymerization, as will presently be seen.

Condensation polymerization[9,15] consists of a stepwise combination of the reactive groups of monomer molecules with the elimination of simple molecules like water, etc. Thus,

$$\underset{\text{glycol}}{HO-CH_2-CH_2-OH} + \underset{\text{adipic acid}}{HOOC(CH_2)_4COOH}$$
$$\underset{\text{condensate}}{HO-CH_2-CH_2-OOC(CH_2)_4COOH} + \underset{\text{water}}{H_2O}$$

The OH and COOH groups of the resulting molecule can further react with COOH and OH groups of other monomeric molecules respectively to give, after successive condensations, a long chain molecule. Similarly diamines, such as hexamethylene diamine, can react with adipic acid to yield polyamides like nylon. The same type of polymerization is involved in the industrial preparation of plastic as well as varnish and adhesive resins from phenol and formaldehyde, urea or melamine and formaldehyde, glycerol and phthalic anhydride, and of polysulphide rubbers (Thiokol) from alkyl dihalides and alkali polysulphides, with the elimination of alkali halide molecules. Because of the stepwise character of the reaction, the average chain length (even if branched) and the average molecular weight of the resulting polymer (leaving aside for the moment cross-linked polymers) will depend on the extent of the reaction.

It may not be out of place to point out here a variation of the simple addition polymerization, known as copolymerization, first discovered by Klatte in 1914, now extensively employed in industrial practice, and still being actively investigated in some of its fundamental aspects[16]. It consists in the simultaneous polymerization of 2 or more vinyl compounds such as vinyl acetate and vinyl chloride to get a polyvinyl acetate chloride copolymer (vinyon). Buna S, a copolymer of butadiene and styrene, was successfully substituted for natural rubber on a large scale by U.S.A. during the last war. Buna N is a copolymer of butadiene and acrylonitrile and has excellent resistance to hydrocarbon and other organic solvents.*

* Regarding the manner of addition polymerization, bulk polymerization was the common practice until some years ago ; now, emulsion, employed by U.S.A. for Buna S and more recently, suspension polymerization are becoming more important[18].

Shape of High-polymers, Linear & Cross-linked

The second characteristic of a high-polymer resulting from either of the above type of polymerization is the shape of its molecules which may be a straight, linear, or a cross-linked, 2 or 3-dimensional structure. There is, of course, the possibility of branched chains as is suggested by the mechanism of addition polymerization already described above. But, for the present discussion, a linear chain with only some degree of branching may be approximated to a straight linear type, and one with a high degree of branching may be regarded as equivalent to a cross-linked molecule. The production of these 2 widely differing molecular structures depends primarily on the number of reactive, functional groups in the monomeric molecule or molecules[9]. If the monomer is bifunctional, that is, has only 2 reactive groups or a single double bond, the polymer resulting from it by either type of polymerization will be essentially a linear chain as is clear from the examples already adduced. Polyesters from glycols and dicarboxylic acids, polyamides from similar acids and diamines, and even phenolic resins (Novolak) from *para* cresol with only two reactive hydrogen atoms in the *ortho*-positions to the phenolic OH and formaldehyde, will contain mainly linear molecules. That there is possibility of some degree of branching in the case of vinyl polymers is evident from the mechanism of the process already outlined and from indications supplied by viscosity measurements[17].

If the monomers are polyfunctional, that is, having more than 2 reactive groups in each molecule, there is definite possibility of growth of the polymer in more than 2 directions in space leading to a complex net and 3-dimensional structures. Thus, if glycerol, instead of glycol, is condensed with adipic acid, the resulting compound may be represented by the following equation:

$$HO\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}OH + 2\ HOOC(CH_2)_4COOH \longrightarrow HOOC(CH_2)_4COOCH_2\text{-}CH(OH)\text{-}CH_2OOC(CH_2)_4COOH$$

The secondary OH of glycerol can next react with the —COOH of another acid molecule, whereas the —COOH groups can react with OH groups of other glycerol molecules. As the reaction proceeds, further condensations not only in 2 but in 3 directions can take place to give finally a complex cross-linked, space polymer. Similarly, glycerol and phthalic anhydride react to yield Alkyds or Glyptals used as varnish resins. Phenol, which has 3 reactive hydrogens in the nucleus, condenses with formaldehyde to give phenolic resins (Bakelite), urea with 4 reactive hydrogens and melamine with a still higher number of reactive hydrogen atoms combine with formaldehyde to yield complex polymers, ureas and melamines.

It is of interest to note that the above division of synthetic high-polymers into linear and cross-linked molecular structures corresponds to what obtains in natural high-polymers such as cellulose, chitin, rubber, which are mainly long-chain, thread-like molecules, and keratin (with S-S cross links), lignin, etc., which are cross-linked, complex structures.

Physical & Chemical Properties

The physical and chemical properties of these 2 types of polymers are quite distinct and of technical importance[19]. The chain polymers have an indefinite capacity to swell in suitable solvents and eventually pass into solution in molecular state, since there are no strong chemical bonds between adjacent chains to hold them together. In the swollen state they are capable of undergoing exchange reactions such as esterification, chlorination, saponification, etc., without apparently changing their average size or shape. Thus polyvinyl acetate can be hydrolysed into the corresponding alcohol which in turn can be condensed with aldehydes to give polyvinyl acetals, as is done in industrial practice; polyvinyl butyral, for instance, being used as self-sealing inner lining of gasoline tanks of fighter planes. The temperature effect on chain polymers (of the plastic type to distinguish them from the fibre type) is very characteristic and of technical value. With temperature, they pass from the amorphous or quasi-crystalline state through a softening or plastic zone into a viscous, liquid condition. This change with temperature is indefinitely reversible and is characteristic of what are called thermoplastic high-polymers. This behaviour with temperature has recently been explained by Mark[20] in terms of micro- (irregular motion of segments of chains) and macro- (displacement of chains as a whole) Brownian movements, originally introduced by Kuhn. Only thermoplastic materials can be utilized for the rapid methods of fabrication, such as injection

moulding and extrusion processes, in the place of the time-consuming compression moulding.

The net and space polymers, on the other hand, show only a limited capacity to swell in solvents. Because of the chemical cross-links between the chains, the material does not go into solution at all. Phenolics, ureas, certain polyesters are typical examples. They do not undergo permutoid reactions like the chain polymers and are, therefore, chemically more inert than the latter. They show no definite zone of softening with temperature and at relatively high temperatures they suffer chemical decomposition and are known as thermosetting plastics. Because of their thermosetting character, special procedure has to be employed in moulding operations. For instance, in the case of phenol-formaldehyde resins, the polymerization is first carried only to the thermoplastic stage (A and B stages) in which there are few cross-links between the long chains and, in the mould, along with fillers, plasticizers and catalyst, the material is made, under pressure and temperature, to react to the final thermosetting condition. A similar procedure is adopted in the case of urea resins, for otherwise fully reacted thermosetting resin is incapable of the plastic flow necessary to take the shape of the mould. The compactness of molecular structure of thermosetting plastics is responsible for their chemical inertness, electrical properties and resistance to mechanical abrasion and also for their brittle character. Plasticizers and fillers are, therefore, necessary to give them toughness and impact and tensile strength. A fully cured thermosetting plastic material is something like a giant molecule or an aggregate of such molecules, so that it is not possible to evaluate their molecular weight or exact shape and size. Hence the following discussion is limited to thermoplastic and, in general, to chain polymers.

Molecular Weight & Mechanical Strength

The dependence of mechanical strength of chain polymers on the average molecular weight or average chain length was first investigated by Rocha, Ohl and Carothers, and later by several authors, particularly, Harris, Sookne, Spurlin, Mark and Meyer. It appears[21] that for a high-polymer to begin to manifest any mechanical strength at all, it must have a certain critical chain length or D.P. (around 40 for polyamides, and 80 for polyhydrocarbons) above which the strength increases with increasing D.P. up to a limiting value (around a D.P. of 600 to 700) beyond which further increase in chain length does not seem to affect sensibly the mechanical strength, as can be seen from Fig. 1 (after Mark)[21]. The upper curve, with circles, refers to polyamides and the lower curve, with crosses, to polyhydrocarbons. The minimum and maximum D.P. limits for polyamides are lower than the corresponding values for hydrocarbons, because of the additional contribution made to mechanical strength by the cohesive forces between the chains coming from the polar groups along the polyamide chains. When the chains are sufficiently long for their ends to be effectively entangled so as to avoid slipping under tension, tensile strength or tanacity will become independent of further increase in D.P. The shaded region between the two curves refers to all other high-polymers such as cellulose esters, polyvinyl derivatives, etc. (FIGS. 1 and 2).

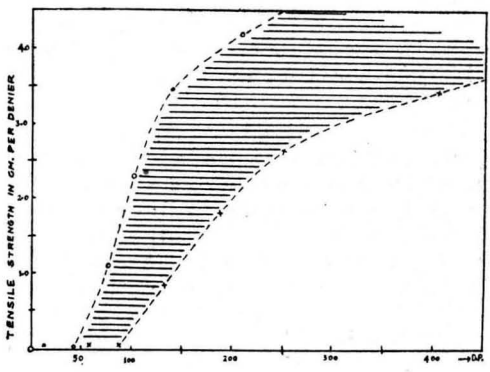


FIG. 1 — SCHEMATIC REPRESENTATION OF THE RELATION OF THE TENSILE STRENGTH WITH AVERAGE DEGREE OF POLYMERIZATION.

In this connection a less well-understood relation is the influence of the range of distribution of chain length or D.P. on the mechanical strength, in spite of the researches carried out by various authors, especially Mark, Harris, Sookne and Spurlin. According to Mark, "the shape of the distribution curve seems to have no effect on the ultimate strength except that a comparatively small amount (between 10 to 15 per cent by weight) of constituents having a polymerization degree below 150 is definitely detrimental to the mechanical properties of the

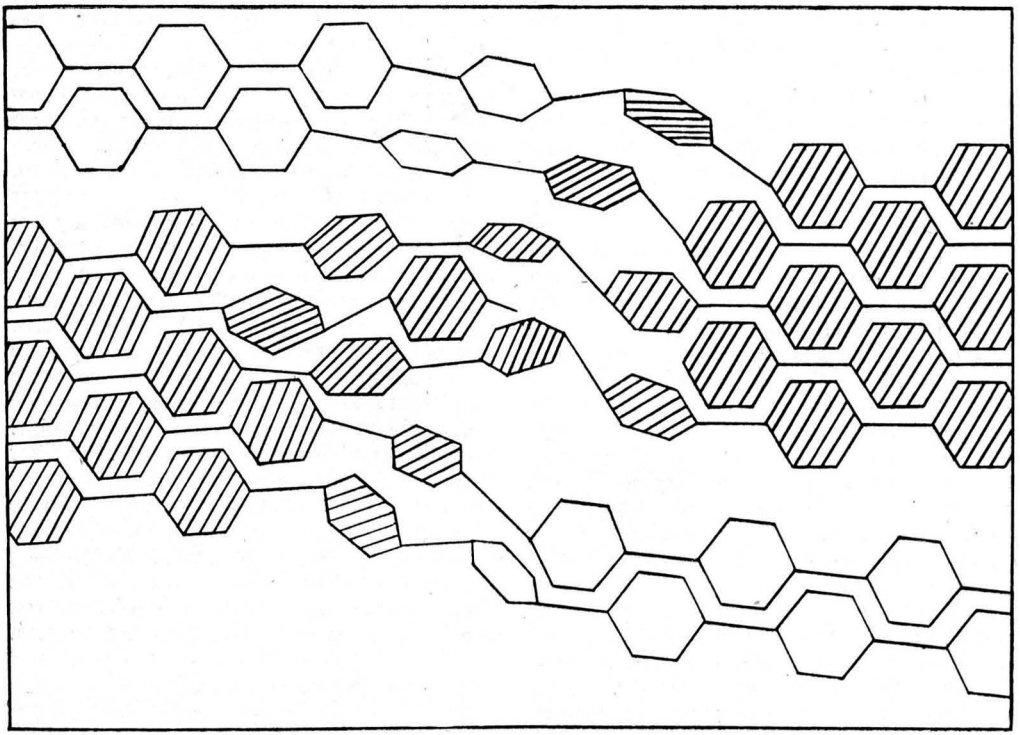


FIG. 2 — DIAGRAMMATIC REPRESENTATION OF CELLULOSE CHAINS WHICH ARE PARTLY BELONGING TO CRYSTALLITES AND PARTLY TO A DISORDERED AREA.

sample."[22] A more comprehensive statement based on the work of the other authors cited above is presented by Alfrey[23], though it does not contradict the general conclusion of Mark. It may be added that in general the more uniform the chain lengths, provided the limiting D.P. is attained, the better would be the mechanical properties of the sample.

Molecular Texture & Mechanical Properties

It is the molecular architecture which is ultimately responsible for a high-polymeric material being a fibre, plastic or rubber. In the study of this molecular geometry, the X-ray method of Debye and Scherrer has been of particular value. Well-known organic crystals, in powder form, give an X-ray pattern known as powder diagram, consisting of bright spots of varying intensity and sharpness from which the elements of symmetry of the crystalline material can be evaluated. An amorphous material, on the other hand, yields an X-ray pattern of diffuse rings or halos, commonly known as diffuse ring diagram, revealing the absence of crystalline order in the diffracting material. Natural rubber in its unstretched condition gives such a diffuse ring diagram as was first reported by Scherrer[24]. Cotton fibre[25] gives a diffraction pattern, known as fibre diagram, of a certain intensity and sharpness, intermediate between that of a regular crystal and of an amorphous material. This has been interpreted to mean that cotton fibre contains ordered regions of a certain degree of crystallinity (crystallites) which are separated from one another by disordered (amorphous) regions, the crystallites being so oriented that the molecules from which they are built are parallel to the fibre axis. Also there is no sudden, but only gradual, transition from the ordered to the disordered regions. One and the same chain is supposed to find itself partly in the crystalline and partly in the amorphous domains of the fibre, as illustrated in Fig. 2 (after Mark)[26]. An interesting discovery was first made by Katz[27] on rubber that, when stretched, it gives a fibre X-ray diagram indicating the presence of a certain degree of crystallinity brought about by the mechanical process of

stretching. In this stretched state, rubber acquires its tensile strength. It is natural, therefore, to associate tensile strength with crystalline structure both in stretched rubber and ordinary cotton fibre. The increased tensile strength of strong rayons (regenerated cellulose) is to be ascribed to the better alignment of chains in the crystalline regions induced by the mechanical stretching during spinning, as shown by an enhanced fibre diagram. R. O. Herzhog[28] was one of the first to study the quantitative relationship between the tensile strength of viscose and cuprammonium rayons and the improved orientation of crystallites parallel to the fibre axis as revealed by X-ray diagrams. Further studies on the subject led to the common industrial practice of stretch-spinning and to the discovery by Carothers[29] of the cold-drawing process of nylon as well as, in recent years, of vinyon and other polyvinyl fibres and filaments.

An interesting feature to be noted about the cold-drawing of nylon and the other fibres is that the fibre retains, unlike rubber, the impressed elongation after the removal of the stretching force. Even in the unstretched condition, nylon, like natural proteins, is supposed to have its chains folded in some regular fashion, and on being stretched by external force, as the chains become parallelized, the polar side groups in the chains, CO and NH groups, by their hydrogen bonding, maintain the chains in the stretched state. As Mark has put it, in the case of nylon, internal crystallization is converted into external crystallization by the cold-drawing process. In the case of rubber, on the other hand, such strong polar group forces do not exist between the hydrocarbon chains. Further, the methyl groups arranged in *cis*-position along the chains tend naturally to bring the chains, once the external stretching force is removed, into the thermodynamically stable position of maximum entropy, which accounts for the elasticity of rubber. When unvulcanized rubber is subjected, however, to a prolonged tension or stretching, it begins to creep, that is, the chains tend to slip past one another, since there are no strong cohesive forces between the chains, and it does not snap back quickly. But vulcanized rubber does not suffer creep, and snaps back quite effectively, because vulcanization introduces, here and there along the chains, sulphur links at the place of the double bonds which prevent slippage of the chains and pull back the chains to their natural curled-up state on the removal of the stretching force. It may be noted that if the sulphur cross-links between the chains are closely spaced by the incorporation, into rubber, of a large amount of sulphur, a rather compact molecular structure is obtained which is hard rubber or ebonite.

From the foregoing discussion, certain general conclusions[1] can be deduced regarding the relation between the mechanical properties and molecular structure of high-polymers. Once the required chain length and fair uniformity of chain length are secured, it is the nature of the chain structure and the cohesive forces between chains which determine whether the material is a typical fibre, plastic or a rubber. If the chains easily fit into some regular geometrical pattern and retain that pattern by virtue of strong intermolecular forces arising from the presence, along the chains, of dipole or polarizable groups or hydrogen bonds, the material will be a typical fibre. On the other hand, if the chains do not fit well into a regular geometrical pattern, either because of bulky side chains (as in the case of Buna S) or because of unsymmetrical disposition of side groups (as in the case of *cis* arrangement of methyl side groups in natural rubber), and if there are no strong cohesive forces between the chains, the material would behave as a typical rubber. Between these two extremes are to be found plastic materials with intermediate geometrical structures and intermolecular cohesive forces ; given the possible combination of the relative magnitudes of these two factors, a great variety of plastics is possible. Table II (after Mark)[30] illustrates the type of cohesive forces between chain molecules of the 3 categories of high-polymers. The values for the cohesive forces, presented in the last column of the table, are in cals. per mol. for a chain length of 5 Angstrom units on the assumption that each chain is surrounded by 4 others, as suggested by the X-ray structure of these polymers. For rubbery materials the forces have an energy value around 1,000 cal. per mol., and for fibres, a value around 6,000 cal. That the intermolecular forces alone are not sufficient to explain the mechanical properties of the polymers is clearly indicated by some of the listed substances. Thus, polyethylene with only 1,000 cal. intermolecular forces tends to show rather fibre than rubbery properties, because, in spite of the weak

TABLE II — INTERMOLECULAR FORCES OF SOME HIGH-POLYMERS & THEIR INFLUENCE ON MECHANICAL BEHAVIOUR

SUBSTANCE	COVALENT BOND ENERGY ALONG THE CHAINS, IN CAL. PER MOLE		MOLAR COHESION PRO 5 Å CHAIN LENGTH WITH CO-ORDINATION NUMBER FOUR, IN CAL. PER MOLE	
Polyethylene	—C—C—	70—80,000	(CH_2)	1,000
Polyisobutylene	—C—C—	70—80,000	(CH_2), (CH_2)	1,200
Polybutadiene	—C=C—	70—120,000	(CH_2), (CH=CH)	1,100
Rubber	—C=C—	70—120,000	(CH_2), (CH=C—CH_3)	1,300
Polystyrene	—C—C—	70—80,000	(CH_2), (C_6H_5)	4,000
Polychloroprene	—C=C—	70—120,000	(CH_2), (CH=CCl)	1,600
Polyvinyl chloride	—C—C—	70—80,000	(CH_2), (CHCl)	2,600
Polyvinyl acetate	—C—C—	70—80,000	(CH_2), ($COOCH_3$)	3,200
Polyvinyl alcohol	—C—C—	70—80,000	(CH_2), (CHOH)	4,200
Cellulose	—C—O—C—	80—90,000	(OH), (—O—)	6,200
Cellulose acetate	—C—O—C—	80—90,000	($OOCCH_3$), (—O—)	4,800
Polyamides	—C—N—C—	70—90,000	(CH_2), (CONH)	5,800
Silk fibroin	—C—N—C—	70—90,000	(CHR), (CONH)	9,800

forces, its chains, the simple methylene zigzag hydrocarbon chains, fit easily into a crystal lattice, and polyethylene is, therefore, a plastic with fibrous tendencies and, under proper mechanical treatment, can be made even into filaments. Nylon, with cohesive intermolecular forces less strong than those of silk, shows greater mechanical strength, because its chains fit into a crystal lattice better than the chains of silk fibroin, or even those of cellulose. Polystyrene and polyvinyl acetate with forces approaching those of a fibre still are typical plastics because of the bulky benzene rings in the one and the acetate groups in the other which do not facilitate an easy fitting of the chains into a crystal lattice. But if the intermolecular forces are weakened by the elimination of hydrogen bonds and the ease of crystallization of the chains reduced by the replacement of the hydrogen atoms of —NH— by methyl or methoxy groups, the resulting nylon will acquire elastic properties characteristic to rubber, as was reported by Baker and Fuller[31], Briggs and others[32], and recently by Hill and Walker[33].

Influence of Side Groups

An interesting example of side group influence is that of polymethacrylate plastics[34], in which the side chain groups bring about considerable modification of physical properties. Polymethyl-methacrylate is the well-known tough, elastic, celluloid-like Lucite (or Plexiglass or Perspex) ; polyethyl-methacrylate is less tough, softer and elastic ; polybutyl-methacrylate is soft and sticky and finally polyoctyl-methacrylate is jelly-like, and the corresponding lauryl compound is a viscous liquid. With increasing length of side groups, the main long chain molecules are pushed apart more and more until the intermolecular forces become so weakened that the chains acquire almost the freedom they would in the liquid state, hence the viscous liquid properties of the laurylmethacrylate resin. It is of interest to examine here the solution of the problem of polymerizing isoprene to rubber. When isoprene is polymerized, the product is not the elastic natural rubber but a hard gutta-percha in which the methyl groups are mostly in the *trans* position, so that the chains fit well into a regular lattice and lead to the plastic product. To get round the difficulty, use has been made of the influence of bulky side groups on polymerizing butadiene with a certain amount of styrene, the resulting copolymer butadiene-styrene, Buna S, has rubbery properties and makes an excellent substitute for natural rubber[35]. In the light of the above considerations, it is easy to understand how the incorporation of a certain amount of bhilawan shell oil or cashew-nut shell oil[36], in which the phenolic molecule has a long aliphatic side chain, can reduce the brittleness of lac moulding compositions, here the incorporated long side chain compound acting as a plasticizer and giving flexibility and toughness to the rather brittle lac resin.

The foregoing general conclusions about the dependence of mechanical properties of high-polymers on the molecular texture and ultimately on the chemical nature of the monomers from which the polymeric material is produced, as revealed by the fundamental research on high-polymers carried out during the last two decades, are in general of a qualitative and in many cases of a quantitative nature. They are not only a help to synthesize new high-polymers with desired specific properties ; they indicate the need for further fundamental research in which we in India can make our own contribution.

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Cultivation of Rosha Grass *(Motia)* & Distillation of Oil therefrom

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ROSHA grass generally grows wild in the forest tracts of the Bombay Province in the Khandesh, Nasik and Panch Mahals districts. Possibilities of raising the grass as a cultivated crop were studied in the Punjab at Lyallpur[1], and the following observations were reported :

1. The grass can be grown successfully as a cultivated crop ;

2. it requires little attention except for burning the clumps when dry ;

3. the yield of oil was 15-20 lb. per acre, the oil content of the grass being about 0·5 per cent ; and

4. it was not necessary to sow the seeds every year.

It was thought desirable to undertake similar experiments in Bombay Province and study the suitability of the soil, yield and quality of the oil. The cultivation of rosha grass was, therefore, undertaken in the year 1942-43 in the experimental plots in the

Empress Gardens, Poona, in co-operation with, and under the supervision of, the Silviculturist of the Forest Department. The investigation was confined to *motia* variety of rosha grass as *motia* oil is superior in quality.

Cultivation — Initially a plot of land measuring about 1,295 sq. ft. was put under cultivation. Seeds were sown and germination was satisfactory. It was, however, found necessary to weed out the plots within about 10 days after sprouting, and once again later in the season. After the grass grew to a height of about 3', the growth of weeds was not a serious menace.

After the preliminary experimental cultivation, 5 plots were cultivated under different conditions (as detailed below) and the following observations were made during the period October 1944 and October 1947:

(i) Weight of grass from each plot;
(ii) percentage of blossoms and stalks in the grass and their respective oil contents (on wet basis); and
(iii) geraniol content of the oil.

Distillation Still — An improved type of still (50 lb. capacity), fitted with a false bottom and heated in such a way that the flames did not reach the part of the still containing the grass, was used.

Analysis of the Oil — The geraniol content of the oil was ascertained by acetylating the oil and determining the ester values of the oil and the acetylated product[2].

Plot "A"—This was the original plot in which seeds of *motia* variety were sown in 1942, the clumps being 6' apart. The blossoms obtained in 1942 and 1943 were allowed to dry and seeds collected for subsequent sowings. The average yield of grass for October seasons was about 4,000 lb. per acre, and the yield of oil was 11-17 lb. per acre. The oil content of grass slowly increased from 0·32 to 0·48 per cent during the first three years after which it decreased to 0·40 per cent.

It was observed that the grass grew vigorously in the second season and blossomed by the beginning of the following January, provided there were a few good showers after the first cutting in October. The yield of grass in January was almost half of that in October, while the oil content was 0·40-0·50 per cent.

Plot "B" (Area, 2,750 sq. ft.; seeds sown in 1943; clumps 3' apart) — Germination during the first year was not satisfactory, and data were collected only from October 1944. The average yield of grass per acre for the October seasons was 11,000 lb. and the yield of oil per acre was nearly 40 lb. The oil content of grass increased from 0·30 to 0·40 per cent during the three years and remained almost the same in the fourth year. During the summer of 1945, 10 out of the 32 rows from the plot were burnt, and it was observed during the following season that the yield of grass on the burnt part was 18,920 lb. per acre as compared to 11,280 in the unburnt part, the corresponding yield of oil per acre being 65·5 lb. as against 38·6 lb. in the unburnt plot. Repeated burning at the end of the second and the third seasons did not, however, yield similar results.

Plot "C" (Area, 3,700 sq. ft.; cultivation through transplanting rhizomes from plot "A"; clumps 3' apart) — The yield of grass was 12,780 lb. per acre in October 1944, after which it dropped down to 4,162 lb. per acre in October 1946. The stumps were burnt in the summer of 1947, which increased the yield of grass to 9,656 lb. per acre. The oil content of the grass varied between 0·22-0·37 per cent.

Plot "D": Irrigated plot (Area, 1,512 sq. ft.; crop raised from root stock) — During the first year (1944) the yield was 17,860 lb. per acre as against 8,600 lb./acre in plot "B" and 12,780 lb. in plot "C"; the corresponding yield of oil per acre in these three plots was: "B" — 26·6; "C" —28·5; and "D" — 38·1 lb. The effect was not marked in the subsequent years due to water-logging, and the crops were damaged.

Plot "E": Effect of fertilizers (Area, 1,512 sq. ft.; crop raised from root stock; dose of fertilizer, 40 lb./acre) — From the results of the 1944 season it appeared that although the yield of grass was 18,000 lb./acre, as in the case of plot "D", the oil content was higher, being 0·35 per cent as against 0·21 per cent in plot "D". The yield of oil per acre was 62·8 lb. Unfortunately, the cultivation in this plot was affected in the subsequent seasons by water-logging.

From the data collected it was observed that the blossoms formed 20 per cent of the grass, and the oil content of the blossoms was 0·76 per cent. The weight of stalks was about 4 times the weight of the blossoms, and the quantities of oil obtainable from the blossoms and stalks separately were about the same.

The geraniol content of the oil from the various plots was 95-97 per cent ; the ester values of the oil from blossoms varied between 42-54, while those from the stalks varied between 32-37.

Summary

1. It is possible to raise two crops of rosha grass during a year, viz. the first being harvested in October and the second in the following January, provided there are sufficient rains in the autumn after the first cutting.
2. The yield of grass in January is about half of that in October.
3. The oil content of grass harvested in January is higher than that in October.
4. Irrigation and manuring increase the yield and oil content of the grass.
5. 30 lb./acre is the normal yield of oil under the soil and climatic conditions prevailing at Poona.
6. It is possible to increase the yield by about 50 per cent by such cultural operations as burning of clumps, irrigation and manuring.
7. The oil content of blossoms is considerably higher than that of stalks.

Acknowledgement

Thanks are due to the *Board of Scientific & Industrial Research* for sanctioning a research grant for the scheme.

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A Note on the Tin Deposits of India

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TIN deposits of economic importance are few and sparsely distributed in India. Tinstone is rarely found in peninsular India, but in the north, mostly in Bihar and Bombay, the occurrence of cassiterite has been reported from a number of localities.

Deposits from the following localities have been investigated from time to time but none of them have been exploited to any great extent. So far no systematic prospecting has been undertaken to discover new deposits or to properly assess the extent of the known deposits in the country.

Bihar

(1) *Nurgo or Nurunga* (*Hazaribagh district*) — McClelland[1] reports the occurrence of tinstone in this area. Mining operations were started in 1867 but were later abandoned as the area proved unproductive.

Mallet[2] has given a brief account of this deposit. The ore occurs in 3 or 4 lenticular beds or nests in the gneiss, which are seldom more than a foot or two across. In one or two instances they were as much as 13 feet across and extended for 20 yards in a direction parallel to the bedding of the gneiss. The ore consists of gneiss with thickly disseminated crystals and grains of tinstone. At a depth of 20 yards the nests appear to be thinning out, the rock becoming harder. The mine was abandoned as extraction was rendered difficult on account of water in the mine. Brown[3] described this deposit as a thin layer of cassiterite-bearing granulite in a much thicker band of microcline granulite. Ball[4] observed that the ore occurred disseminated in gneiss and the weathered-out tinstone gravel occupied a zone 100 yards wide extending to an unknown distance with the strike of the strata. Oates[5] has described his preliminary prospecting experiments in this area : " A shaft was sunk to a depth of 614'. The ore body was cut out

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and no ore was encountered below 568'. The tin content in the ore was 1·87 per cent and estimated yield of the metal was 268 lb. per ton of the ore, but in reality it was only about half of this as the ore was contaminated with much gangue and iron."

(2) *Shimratari* (*West of Pihra, Hazaribagh district*) — Cassiterite was found by Mallet[2] in this area associated with lenticles of granite enclosed in mica schist. This occurrence suggests that tinstone is associated with granite in this area.

(3) *Pihra* (*Hazaribagh district*) — Cassiterite occurs in a dyke of lepidolite granite a little to the south-west of this locality[4].

(4) *Chappatand* (*Hazaribagh district*) — In this locality tinstone is found in a granulite[6].

All the above localities lie in the mica belt around Gawan.

(5) *Silli* (*Ranchi district*) — A few crystalline lumps of cassiterite have been found to occur in a pegmatite intrusive in granulite in this area[7].

(6) *Chhakkarbandah* (*Gaya district*) — Tinstone has been found to occur a few miles to the north of the village Chhakkarbandah[7]. Wolfram is associated with it. The rocks are mostly Archaean schists and gneisses intruded by pegmatite, aplite, etc. The vein containing tin has been traced for over a mile, the width varying from a few inches to a few feet.

Exploratory mining operations were commenced during the year 1940 and analytical work on the samples from this locality showed the cassiterite percentage in the rock to be 1·5.

(7) *Dhanras Pahar* (*Gaya district*) — Ray and Nag[8], while studying the geology and the mineral resources of the Deo-Raj Estate, found tinstone in this locality.

(8) *Kalikapur* (*Singhbhum district*) — The presence of cassiterite has been reported recently in this region.

Bombay

(9) *Hosainpura* (*Palanpur State*) — Cassiterite was found to occur with gadolinite in a tourmaline pegmatite[9].

(10) *Dambal Hills* (*Dharwar district*) — The gold-bearing sands in the area are reported to contain a mixture of tin oxide and metallic copper[10].

Of these deposits, those occurring in the Hazaribagh district have been worked to a certain extent. Little is known about the mining possibilities of other deposits.

The most promising deposit is that found in the Chhakkarbandah area.

The recent report of the occurrence of cassiterite in the neighbourhood of Kalikapur (Singhbhum district, Bihar) has encouraging features. It is interesting to note that the copper belt of Singhbhum passes close to this area and cassiterite may be associated with the copper deposits as in the case of the copper and tin deposits of Cornwall; abundant deposits of tin may be found deep down the copper veins.

The author desires to place on record his indebtedness to the U.P. Government for the award of a research scholarship to enable him carry out this survey.

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REVIEWS

Odors : Physiology & Control, by Carey P. McCord & William N. Witheridge (McGraw-Hill Book Company Inc., New York), 1949, pp. x+405. Price $6.50.

ODOURS MAY BE PLEASANT OR UNPLEASANT, attractive or disgusting. There is no common agreement on this point. The odour of garlic and onions may be more appealing to some people and very repulsive to others. Rotten cheese is liked and relished by some gourmands whereas others run away from it with a sense of nausea. The sense of smell depends upon the immediate and personal experience of "association" for the determination of pleasure or pain, attraction or repulsion by arousing past memories. "A misplaced aroma is an anathema and the lack of aroma is intolerable."

Man is said to be commonly endowed with five senses: sight, hearing, touch, taste and smell. Of these, sight is known to be caused by light waves which are vibrations in the ether, whilst hearing and touch are caused by pressure differences. Sound waves in the air impinge on the ear and bring about rapid changes in pressure on a diaphragm which vibrates and transmits the sensation of hearing to the mind and touch is caused by pressure applied to practically any part of the skin. There are definite mathematical laws as to harmony and melody in sound and colour which affect animals and ourselves to a large extent similarly. Taste and smell, however, are not induced by any known waves in the ether or in the air, but are caused by contact in the case of taste and nearness in the case of smell of certain specific substances. It is a very general experience that odours are more efficient in arousing memory than are mere colour effects or sounds. It is due to this close association with memory (conscious or unconscious) that an odour is agreeable or disagreeable. There are other factors that come into play. Taste and smell are classified as chemical senses by Moncrieff.

Continuous investigations have been made on the subject of odours in Western countries and a large volume of literature has come into existence. That the science of odour or smell is a very complicated phenomenon is proof of the fact that an extensive vocabulary has come into daily use when anybody wants to describe the smell or odour. The following are some of the words used in literature in relation to odour: "smells may be pleasant or unpleasant, feeble, faint, strong, bland, pungent, mawkish (Scotch mawk = maggot), fruity, dank, arid, stuffy, mephitic or sulphury, aromatic, ethereal, balsamic, acid, fragrant, ambrosial, burnt, repulsive, nauseating, foetid, penetrating, distracting, alluring, seductive, soft, heavy, sharp, alliaceous (smell of garlic), rancid, spicy, flowery, resinous, foul and so on" (Moncrieff). The various nuances of the perception of smell can thus be imagined depending on the personality of each man and the mental and emotional experience or associations he has had under different circumstances. Even metaphorically, words generally connoting "the odour" have crept into every literature of the world. The use of the word "odour" to emphasize past associations comes to a grand climax in the Sanskrit expression — **पूर्व जन्म वासना** (the haunting odour of a past existence or previous birth).

To produce the sensation of smell in animals and more specially in man, the quantity of the substance which is responsible for the smell is infinitesimally small. The most well-known example quoted in textbooks of science is that of musk. Statements have been made that a small speck of musk continues to emanate its smell for years continuously and still not lose any weight as can be measured by the most sensitive chemical balance in existence.

A great deal of work has been done recently on the subject of "threshold concentration", i.e. the minimum concentration for any particular substance which just arouses the sensation of smell in human beings. Two or three examples may be quoted. The concentration of odori-vector in air wt./wt. per cent in the case of chlorophenol will be 3×10^{-7} (corresponding to 0·004 mg. in a cubic metre of air); in the case of mercaptan it is 3×10^{-9} (0·00004 mg. in a cm. of air);

in the case of synthetic musk it is 4×10^{-10} (corresponding to 0·000005 mg. in a cm. of air) ; it is, in the case of vanillin, 2×10^{-11} (0·0000002 mg. in a cm. of air). These examples should suffice (Moncrieff). The importance of these estimations lies in the fact that when we have to consider the nuisance value of disagreeable odour in the life of the community, the actual quantity of a substance that goes to create the nuisance may be exceedingly small and may still be a nuisance. Purely from a physiological point of view, such small quantities of odorous substances permeating the air may not be harmful but they still create a horrible nuisance.

From the point of view of the life of a community, an odour — that which acts on the special nerves of smell distributed in the chambers of the nose — acquires its attractive or repulsive quality only as a result of mental association with what is beneficial (suitable food, mates, friends, safety, home, the nest) or what is injurious (unsuitable food, poison, enemies, danger, strange surroundings, solitude). These are conditioned as a result of tradition or through personal experience to be beneficial or injurious and hence determine man's liking for and choice or rejection of odours and flavours. For example, the odour of sewer gas, foul accumulations of refuse, or putrescence has become painful and almost unbearable to the more cleanly classes of mankind owing to the association with it, or as a result of education, of the fear of disease and poisoning. Those members of the despised profession, but none the less the real and true public servants, viz. those that are engaged in scavenging work or those that work in the so-called offensive trades and industries, get used to mal-odorous surroundings, and are known to eat their meals with gusto and relish even when on duty at mid-day intervals. It is but right and merciful that God grants some indescribable immunity to these noble public servants !

Several distinct and repulsive smells liable to occur on the human body are generally due to want of cleanliness. The fatty secretions of the skin are often decomposed by bacteria even before complete extrusion from the glands in which they are formed, as for example, perspiration. Through perspiration the skin gets rid of water, inorganic salts, traces of urea, certain odorous principles of the food eaten (like the smell of garlic) and others. They will undergo bacterial and chemical changes— and contribute to what is popularly termed as " body odour ". This body odour differs from person to person according to habits and according to different races and communities. But in the young and healthy animals in natural conditions (including man) there is some check on the putrefying activities of the omni-present bacteria, or decomposition due to chemical changes. Generally speaking, the skin of a healthy, youthful adolescent has a pleasant odour and the breath is naturally sweet smelling. These factors have an important bearing on the personal hygiene of human beings congregated in large communities and also the proper washing and treatment of the clothes they wear.

The foregoing general remarks on " odours " will give a general background of the various aspects of the subjects dealt within the book under review. In the introduction to the book, they state as follows :

" Granting endless opportunities for disagreement, for the objectives of this book an offensive odour is one that, from its own properties, chemical and physical, is disturbing to the majority of healthy persons exposed to its olfactory action. . . Without, on the one hand, condoning all the disturbances attributed to offensive odours or, on the other, rejecting all significance of offensive odours, this has been devised to make available, in objective fashion, personal and accumulated experience related to odours in general but chiefly to the offensive ones, their control, and their import in the human communality."

In other words, the aesthetic and beneficial contribution of odours (such as perfumes and cosmetics) as social embellishments to make one's self more pleasant or attractive in society do not form a serious part of this book. Nor is the significant part that odour plays in biological functions such as mating and the preservation of species, struggle for existence, etc., given any prominence in this book. In a community, offensive odours from solid, liquid and gaseous wastes are always present and the abatement, masking or elimination of such odours for the general well-being of the community from the public health point of view happens to be the main objective. From this point of view this book may truly be termed as a " community service book ". Every practising doctor,

every public health officer, anywhere in the world, will derive benefit by going through the pages of this book.

The book contains 23 chapters and an extensive bibliography. Starting with the anatomy and the physiology of the nose, all the subjects are historically dealt with in a most logical sequence with ample documentation. The next 3 chapters deal with the chemical constitution of odours, their classification, their detection and measurement. A good amount of work has already been done on the theory of odours. Starting from 1870 till 1947, there have been 23 theories on the subject and no agreement seems to have been finally arrived at. An odour may be due to the volatility of its constituent or constituents, solubility, chemical reactivity and to molecular vibrations. According to Dyson, an odorous substance must have appreciable vapour pressure so that the odorous molecules may make contact with the olfactory region. It must be soluble in the liquid matter of the olfactory region. It must have intra-molecular vibrations of such a period that it has Raman shifts between 1,400Å and 3,500Å. The tendency is to attribute the causation of an odour to intra-molecular vibrations while giving a minor but, none the less, a contributory place to other chemical and physical properties of the odour substance. The existing knowledge on the subject is ably reviewed by the authors in different chapters. After this, the place, functions and the influence of odours in relation to the well-being of the community and their control are dealt with according to a well thought-out plan, viz. the authors start with human beings, their personal hygiene in health and disease from the point of body odours; next in importance comes the home of a citizen and the subject of household odours are dealt with; next in order, the primary needs of human beings, viz. food and water, are dealt with from the odour point of view (including municipal drinking water supply and sanitary services). Human beings congregate in large offices for their daily work and also in industrial establishments that carry on processes which come under the category of offensive occupations — these are dealt with next. The question of proper ventilation and air-conditioning both in an ordinary household and also in large factories and offices are dealt with, with hints to architects and engineers in the designing of these buildings. Whether it be in one's own household or in a factory or the office, if the offensive odours should be controlled, abated, masked or eliminated, certain steps have to be taken to achieve the object in view and the authors have a number of suggestions which have proved effective in practice. Their own personal experience and achievements are recorded with a certain amount of modesty. For example, the treatment of sewage in a city in the most inoccuous manner and the treatment of the city drinking water supply by coagulants, chlorine or activated charcoal, etc., are dealt with comprehensively.

Finally, the legal aspect of the odour nuisance has been dealt with according to the American Law. The misgivings and misapprehensions which the ordinary man in the street has regarding the nature, character and influence of offensive odours have been carefully analysed. This is the first time that the legal aspects of a subject which has been the basis of scientific investigations in the theoretical and practical fields have been dealt with in a scientific text-book.

The authors deserve our thanks and our meed of congratulations. They have done the job systematically and thoroughly. It must have involved a very close and exhaustive study of the subject over a number of years and it is a boon to the community that such an excellent treatise should be made available to those who are interested in this subject. This would include doctors, public health officers and legislators and administrators. None the less, even an ordinary householder has a great deal to learn by reading some of the chapters of the book dealing with household and body odours.

One gets the impression on going through the book that special emphasis has been laid on human body odours, specially human sweat or perspiration. This may be looked upon as an indirect indication of the specially developed fastidiousness in matters of personal hygiene noticeable in American society. Personal cleanliness, subjectively, may bring about an agreeable sense of well-being and one may enjoy the luxury of the self-complacent thought that cleanliness is next to Godliness! But, objectively, from the detailed treatment of the subject in the book, the authors suggest that personal cleanliness is a social necessity. Who dares disagree with them?

Just a word about the bibliography. The text of the book covers 272 pages and the bibliography covers another 125 pages. As the authors claim, this may be the most complete bibliography in the world in English language. Even granting this, this chronicling and recording of anything and everything of the subject has, in my opinion, been overdone. There is no special point in trying to be thorough and too complete. In books of this nature, one need only mention important references leaving out other minor scientific communications, which may find a place in scientific journals when one special or distinct aspect forms the subject of a specialized investigation. There is also no special merit in making the bibliography too long and too exhaustive in a text-book of this nature. In this case the extra 125 pages must have added considerably to the cost of publication and the consequent increase in the price.

Finally, I would like to mention that this book will form a companion volume to another excellent earlier British publication entitled *Chemical Senses* by R. W. Moncrieff, published by *Leonard Hill Ltd.*, London, 1944.

I acknowledge with gratitude that I have made use of, and freely borrowed from, the literature on the subject available to me at Bangalore.

S. G. SASTRY

Theory of Groups and Its Application to Physical Problems, by S. Bhagavantam & T. Venkatarayudu (Andhra University, Waltair), 1948, pp. xi+234. Price Rs. 20.

THIS BOOK BY TWO AUTHORS WHO HAVE themselves made contributions towards the application of group theory to crystal physics is a valuable addition to the growing literature on the subject. The two main branches of theoretical physics wherein the theory of groups and group representations finds numerous applications are molecular, specially crystal physics, and the relativistic quantum theory of elementary particles. In the former the vital rôle is played by the rotation and crystallographic groups, and in the latter the Lorentz group, conditioned as the theory is by the requirements of Lorentz invariance. It is perhaps right to say that the book before us is mainly devoted to the former aspect of the physical applications. In this particular field in which the interest of the authors mainly lies, the exposition of the several topics is very lucid, and is bound to be of great use to those who want a rapid introduction to the subject, but have no time to study the more systematic treatises.

The bare outlines of the theory of groups are given in the opening chapters, and the fundamental theorems, although not fully proved, are effectively presented with an eye towards applications. We note a slight lapse in exposition in the definition of isomorphism of two groups on page 24, para 3. The correct definition can be found in Van der Waarden, *Moderne Algebra*, Vol. 1 (2nd edition), page 31. A brief and clear account of some irreducible representations of the rotation and Lorentz groups is given in chapter 12. The chapters on spectroscopy include derivations of the usual selection rules, intensities of spectral lines and discussions of electron spin and band spectra. A very good account is given of the applications to Raman effect, infra-red absorption, etc.

There is no doubt that the book will be widely used and appreciated by physicists who have occasion to work in these fields. The authors are to be congratulated for the production, and the *Andhra University* for the sponsoring of such a scholarly publication in the field of mathematical physics.

B. S. MADHAVA RAO

Fream's Elements of Agriculture, revised and edited by D. R. Robinson; prepared under the authority of the Royal Agricultural Society of England (John Murray, London), 1949, 13th ed., pp. xi+723; 110 figures and 58 halftone plates. Price 21*s*. net.

IN A RECENT SURVEY CARRIED OUT IN Cambridge, it was found that nearly 50 per cent of the scientific text-books recommended to the students were not available for purchase, and that nearly 33 per cent of the books so recommended had to be of American origin, as against 10 per cent before the war. This illustrates briefly, how serious is the shortage of suitable text-books in Britain, and how eagerly this new and completely revised edition of this well-known and classical text-book will be welcomed, particularly by students of British agriculture.

Fream's *Elements of Agriculture* was first published in 1892, and for the last half a century and more, it has served usefully, successive generations of students and agriculturists. The very fact that it had gone through a dozen editions by 1932 and had seen a number of reprints of each edition in between, indicates its high popularity. The last edition was edited by Sir Rowland Biffen and his colleagues of the *School of Agriculture*, Cambridge. That edition was reported to have been completely revised and entirely rewritten in the light of the great changes that had taken place in the agricultural science and in the outlook of agriculturists. The causes which justified the revision in 1932 are even more valid with the present edition, which appears after a lapse of nearly two decades during which revolutionary changes have taken place in British agriculture consequent upon the demands of World War II. Not only have high-powered machines replaced horse-drawn elements in various fields of farming, but systems of farming have been altered with a view to meet the greater demands for food crops. Bogs, fens and moors have been ploughed up and permanent pastures converted into arable lands. Ley farming, once confined to Scotland and the moist parts of England, has spread to other parts of the country. The advances in British agriculture have been so extensive and rapid, that a new edition incorporating advances in all branches of crop and animal husbandry had already become overdue.

The *Royal Agricultural Society of England* has to be congratulated for bringing out this new edition suited to the needs of post-war agriculture. The book is edited by Dr. Robinson with the assistance of a large team of well-known authorities.

The present edition follows the plan of the previous edition, but nearly all the chapters have been completely revised, rearranged and many parts rewritten in order to bring the matter up to date. No effort has been spared to bring out a readable and authoritative work suitable for both students of agriculture and farmers who wish to gain an all-round knowledge of agricultural science.

The subject-matter of the book is divided amongst 24 chapters and 5 appendices, covering in all 714 pages. The first 8 chapters deal with general agriculture. The next 8 chapters are devoted to crop husbandry and the last 8 chapters to animal husbandry. Following the text are 5 appendices summarizing a great deal of useful information. The first one gives a list of books for further reading. It is commendable that most of the books cited are the latest available in their respective fields. Appendix 2 summarizes sowing and yield data of crops and in a way replaces the deletion of a separate chapter devoted to this topic in the previous edition. Appendix 3 deals with *Seeds Act* of 1920 and appendix 4 with the control of weeds by chemicals. The last appendix summarizes the composition and nutritive value of feeding stuffs. A comprehensive index completes the volume.

The present edition possesses a number of useful features which are an improvement over the previous one. Amongst these, the most important are the inclusion of a new chapter on farm buildings and permanent equipment and the stress laid on the use of mechanized farming, particularly tractor farming. A rearrangement of the chapters has been made, particularly on crops, resulting in a more rational treatment of the subject. The chapter on insects which was at the end of the book in the previous edition has been shifted to a more logical position following the diseases of crops. The chapter itself has been considerably enlarged and copiously illustrated to include all the pests of crops and stock. Among other features may be mentioned the inclusion of such topics like the rôle of trace elements in plant and animal nutrition, use of composts, weed control by chemical methods and a greater emphasis on cytological details in plant breeding.

It is obviously difficult for a single reviewer to adjudge fairly a book which covers such a wide range of subjects. All the sections appear to have been brought up to date and much of the information that is new fully incorporated. While it is difficult in a book of this type to satisfy all the readers, it appears to the reviewer that the book could have been slightly enlarged, without increasing the bulk considerably and a short chapter included on farm management, in view of the changes brought about by extensive mechanization. A section on bee-keeping would have been useful in view of the importance attached to it as a subsidiary agricultural occupation. The chapter on animal production and dairy products included in the previous edition could have been usefully retained,

at least in an abridged form. The list of books intended for further reading could have been slightly enlarged and given under the appropriate chapters, as was done in the previous edition, rather than cited in an appendix. The index itself could have been made more exhaustive in order to include all the important topics and plant and animal names cited in the text, particularly in view of the absence of a detailed list of contents as in the previous edition.

In spite of these omissions, the book is comprehensive and provides an excellent introduction to students of agriculture. Although it is addressed to English students and farmers, the lucid exposition of the fundamental principles gives the book a much wider field of utility. The book is well printed and profusely illustrated. The revised edition maintains in all respects the high standard of its predecessors and is sure to enjoy a further span of fruitful life in agricultural education.

K. R. RAMANATHAN

Progress in the Theory of the Physical Properties of Glass, by J. M. Stevels (Elsevier Publishing Company Inc., Amsterdam), 1948, pp. xi+104. Price 10*s*.

THIS PUBLICATION IS ONE OF A SERIES OF monographs on the progress of research in Holland during the war, and is based on the results of investigations planned and carried out in the *Philips Research Laboratories*. The work reported upon relates to some important physical properties of glasses, particularly those which are understood to be correlated with the structure of glass at room temperature, such as density, dielectric losses, electrical conductivity and molecular refraction.

The first chapter of the book, viz. general introduction, gives an excellent résumé of the views so far propounded or currently held and our state of knowledge concerning structure in the vitreous state. It is largely based, therefore, on the ideas set forth by Zachariasen, and which found confirmation in the experimental work of Warren and his coworkers. As stated by Zachariasen, the atomic or molecular arrangement in the vitreous state is characterized by an extended network which lacks symmetry and periodicity. This is in strong contrast with the regular arrangement in the crystalline state and leads to the characteristic behaviour of glasses as super-cooled liquids in which, although the crystalline state is thermodynamically the more stable one, the mobility of the atoms has become so small as to disallow the possibility of regular packing taking place. Zachariasen concluded that the free energy of the solid glass cannot exceed that of the crystalline phase by a large amount and his conclusions have proved to be an excellent guide to subsequent workers in their investigations on this subject.

For calculating the densities of glasses from chemical compositions, a simple additive formula has been in vogue. On the basis of the work reported in the book, a new method, more closely connected with an insight into the structure of glass, has now been developed. In chapter II, dealing with density, the validity of the new method has been considered from the viewpoint of structure in the vitreous state, and its applicability to the cases of one-component and multi-component glass systems has been illustrated and discussed in considerable detail. On the basis of conclusions formed from considerations of density, a more precise understanding of the phenomenon of electrical conductivity in glasses as a function of temperature and composition is discussed in chapter III, and an explanation is advanced for the interesting results obtained by Gehloff and Thomas that although electrical conductivity in glasses is believed to be entirely due to the movement of Na^+ ions in silicate glasses with a constant total weight percentage of $Na_2O + K_2O$, such conductivity does not increase continuously on replacing K_2O by Na_2O, but decreases slowly to a minimum value and then increases rapidly.

Dielectric losses of glass form the subject-matter of chapter IV. This is a subject on which there is very scanty literature and hardly any systematic work has been carried out before except that by Strutt, who gave an empirical relationship between the power factor and temperature involving constants whose values were dependent upon the composition of glass and the frequency. A theory governing such dielectric losses has been developed by the *Philips'* workers on the basis of the structure of glass, and it has been surveyed in the light of experimental results. The last chapter gives a similar treatment of molecular refraction for which it had been found

by earlier investigators that experimental values often differ from the values calculated by adding the atomic refractions which are independent of the composition.

Altogether, this monograph is a very valuable contribution to the literature on glass in English language. Dealing as it largely does with a terse and speculative subject, viz. structure in the vitreous state, and an understanding of the physical properties in terms of structure and chemical composition, it may find but a limited circle of readers.

The numerous symbols and abreviations used and what they stand for are rather difficult to remember as one progresses through the book but perhaps this was inevitable in a research publication of this nature. It will find invariably a place in the library of every research organization dealing with glass technology.

The monograph has been well printed and neatly got up in a handy size.

Y. P. V.

Properties of Soft Solders and Soldered Joints (Research Monograph No. 5), by J. McKeown (British Non-Ferrous Metals Research Association, London), 1948, pp. 140 + 56 illustrations + 49 tables. Price 17*s.* 6*d.*

THE BRITISH NON-FERROUS METALS RESEARCH Association has, from its first days, taken an interest in the problem of solders and soldering. The results of its first investigation appeared in 1932 in the Association's Research Monograph No. 1, *Tin Solders* by S. J. Nightingale, a second edition of which, revised by O. F. Hudson, appeared in 1942. Meanwhile, the tin shortage following the beginning of the war in 1939 stimulated the *B.N.F.M.R.A.* (which was continuously consulted on methods of economizing in the use of this metal) to researches on solders of lower tin content.

Information was lacking on the mechanical properties of the tin-economy solders and joints made by them. To fill this gap, a wide variety of tests were carried out over a series of temperatures including tests on the creep properties of joints made with a range of solders. In addition, comparison was made (by soldering, area-of-spread and capillary penetration tests) of high-tin and tin-economy solders. The hot tearing of solders was examined in order to define suitable compositions for the avoidance of this trouble ; and investigation was made of the soldering of aircraft oil-coolers by lead-rich solders.

This experimental work and the conclusions drawn from it are described in the present volume by Dr. John McKeown who led the team concerned with this war-time research.

The monograph is divided into 6 chapters.

The first chapter deals with the properties required in solders and solder joints. Chapter II is devoted to composition of solders, under which head description of the former British standards, tin economy solders and solders investigated during the war years are given. Various soldering power tests are dealt with in the third chapter. This again is sub-divided into 3 sections : (i) bit-soldering tests ; (ii) area of spread tests ; and (iii) capillary penetration tests. Chapter IV deals in 5 sections mechanical properties of solders and joints, effect of addition of tin to lead-silver solders, life and creep tests on joints and fatigue tests on lap joints. The last two chapters deal with hot tearing in solders and the soldering of aircraft with lead-rich solders.

The investigation described in the present publication and the conclusions reached are of permanent value as a substantial addition to knowledge of the soldering process and the properties of behaviour of solder joints. The volume should prove valuable to all users of solders.

The get-up and printing of the book are of a high order.

A. K.

Fluorine Chemistry

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FLUORINE and its compounds have unique properties due to the fact that fluorine occupies the extreme upper right-hand corner of the Periodic Table and is much more electro-negative than its neighbours. The compounds of fluorine — both organic and inorganic — due to their extreme properties not only test and extend our theories of chemical combination, structure and reaction, but provide a large number of new substances of varied utility.

Though prepared first in 1886 by Moissan[1], it remained, for many years, a mere chemical curiosity. It is only after the first quarter of the present century that the chemistry of fluorine attracted serious study. It received a great impetus during the last war in view of its bearing on the development of atomic energy. Fluorine in the elemental form was first put up for sale in the American market[2] in 1946, and it is likely to become available in England this year.

Inorganic Compounds

A large variety of inorganic fluorine compounds is known. Some of them have established large-scale uses. A few examples will suffice : fluorite in metallurgy, particularly of iron ; cryolite in the metallurgy of aluminium ; sodium fluoride and barium fluo-silicate as insecticides. Liquid hydrogen fluoride provides a medium for the liquid phase oxidation of organic compounds with molecular oxygen as the oxidizing agent[3] at temperatures below 200°C. There are possibilities of numerous applications for other inorganic fluorine compounds based on the tendency of fluorides to form double and complex salts. Many crystalline compounds are formed with hydrogen fluoride, such, for example, as the hydrofluorates of sodium fluoride and potassium fluoride. Many complex ions in which fluorine is involved are known. The iron-fluorine complex is the basis for the use of potassium bifluoride in removing rust spots from clothing and similar materials. Compounds of fluorine with other electro-negative elements are of great interest. Sulphur hexafluoride is a surprisingly unreactive compound, and is, therefore, useful in high voltage work[4]. The fluorides of bromine and chlorine, on the other hand, are highly reactive. The latter (ClF_3) was made by the Germans in relatively small quantities for military purposes (incendiary) during the last war.

Organic Compounds

In the field of organic chemistry, many more fluorine-containing compounds are theoretically possible than are known. At present that number is not as imposing as that of organic chlorine compounds. One reason is that the usual methods of synthesis are not always applicable for the preparation of organic flourine compounds. A significant development in technique is the replacement of chlorine by fluorine by using silver and mercury fluorides. The Swarts reaction and the modified Sandmeyer (sometimes called Schiemann) reactions have proved satisfactory for the synthesis of many fluorine compounds. Organic fluorides vary in activity from extreme inertness to high reactivity. In general, the introduction of fluorine imparts inertness and stability.

Commercial Applications

The commercial applications of fluorine compounds are many. The freons, especially Freon-12 (CCl_2F_2), are important in refrigeration and air-conditioning. During the war, Freon-12 was employed in aerosol bombs[5] for exterminating malarial mosquitoes in ships and barracks. In India, where vast regions are malaria-ridden, Freon should prove a real boon. Hydrogen fluoride is extensively employed by the petroleum industry in the synthesis of high-octane gasoline.

Many inorganic fluorides, notably fluorspar, boron trifluoride, cryolite and sodium fluoride have been commercially important for years. Sulphur hexa-fluoride is being used as an effective insulator in high voltage electrical and X-ray fields. Sodium fluoroacetate is a valuable rodenticide, and fluorine-containing analogues of D.D.T. have found use as insecticides.

Fluorocarbons find a wide application in industry on account of their non-flammability and extreme stability to heat and chemical reagents[6]. The unique solvent properties of this class of substances should make them particularly valuable in the field of solvent extraction. The fluorocarbon plastic " Teflon " is a product of considerable interest. Its use in the generation and handling of fluorine is of special interest. On the basis of information now available, it may be stated without exaggeration that in the study of fluorocarbons we are confronted with a vast new field of " inorganic-organic " chemistry which is as immense as organic chemistry.

Future developments in fluorine compounds may be expected to include : dyes, plastics, pharmaceuticals, lubricants, tanning agents, metal fluxes, fumigants, insecticides, fungicides, germicides, rodenticides, fire-extinguishers, fire-proofing compounds, solvents and heat-transfer media. All present indications point to the conclusion that fluorine chemistry is destined to become important, both from the point of view of its theoretical importance and its commercial applications.

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Defence Research in Australia

THE work of the *Defence Research Laboratories* (*D.R.L.*), Department of Supply and Development, Australia, during the year 1947-48, continued its work along the lines described in the previous report. An important aspect of the research carried out by the *D.R.L.* (other than the confidential work carried out for the Armed Forces) is the prominence given to fundamental research. Other equally significant features are the amount of research carried out by the several defence research laboratories for private industry and the attention paid to long-term investigations.

The distribution of work as originating from the different groups of clients or initiated with the *D.R.L.* as long-term investigations was as follows :

	%
Department of Supply and Development and Defence Departments	40
Other Government departments and public Instrumentalities	23
Private industry	16
Long-term investigations	21

The *D.R.L.*, maintains close collaboration with the *Council of Scientific & Industrial Research* and with the New Zealand scientific establishments.

Fees for laboratory work are charged to private firms but not to governmental authorities. They are on a nominal scale and are not designed to make a recovery of overheads, the unrecovered portion of costs representing the government contribution to the development of industry.

Electrical work had hitherto been done by the Physics Section of the *D.R.L.* but the need for a new section for electricity had become urgent, as the facilities already obtaining at the *D.R.L.* for testing, consultative, investigational and research work in electricity and electronics are inadequate for the future needs. Sanction has been obtained for establishing a new Section for Electricity.

The major activities and developments of the various sections and inter-state branches are :

General Chemistry Section — Specification testing and advisory work for the Services have continued to be a substantial part of the Sections' activities, i.e. identification and checking of reserve and surplus stock materials such as lubricants, corrosion preventives and other general stores.

Chemical Defence Section — An increasing number of requests from Government departments and industry for advice and assistance in connection with the sampling and estimation of vapours and air-borne dusts have demonstrated that the Section meets a real want in this field.

Arising from a *F.I.A.T.* report describing a German process used for the preferential recovery of ethylene from coke-oven gas, the possibility of the utilization of charcoal for this purpose has been investigated. A laboratory plant based on the continuous principle was erected and a concentration of ethylene from 4 per cent to 20 per cent has been obtained.

Explosives & Ammunition Section — The work of the Section during the year under review has been concerned mainly with the design, manufacture, and functioning of ammunition, and the manufacture and storage of explosives required by the Defence Services.

Metallurgy "A" Section — A major proportion of the activity of the Section has been given to investigations relating to metal processing and the behaviour of metal in service.

Metallurgy "B" Section — Three-fourths of the routine and *ad hoc* investigations carried out by the Section has been for the Government departments and the rest for private industry. Outside activities which engage the attention of the Section include work for various Committees of the *Standards Association of Australia* and the *National Association of Testing Authorities.*

An important function of this section is the training of workers in industrial radiography for other establishments and industry.

Engineering Section — Both governmental bodies and private industry use the facilities available in this Section. Much of the work carried out is in connection with day-to-day problems, but long-term investigations have been an important part of the Section's activities. Fatigue characteristics of alloy steels, testing and calibration service and fabrication of testing instruments are some of the typical examples.

Metrology Section — The Section carried out a large amount of general examination and *ad hoc* investigational work on behalf of Government departments and private industry in connection with gauging and measuring methods, inspection of equipment, specifications, drawings, etc.

Physical Section — A study is being made of the modern techniques of interference microscopy and phase-contrast microscopy. Special-purpose monochromat objectives have been designed. A survey was made of possible formulae expressing the refractive index of optical glasses as a function of wavelength. Decade counting units have been built which are reliable in operation at frequencies up to 1 megacycle per sec. A magnetostriction oscillator, consisting of a nickel tube vibrating longitudinally at about 30,000 cycles per sec., has been built for the purpose of disintegrating bacteria.

Workshops — During the year there has been an increase in the proportion of work of a specialized nature carried out by the experimental glass-working, fine instruments, etc., as follows :

Glass-working — Construction and mounting of glass membranes, production of components for microscope lenses, experimental haemacytometer, etc.

Fine Instruments — Construction of platinum resistance thermometers, experimental " Vortex Tube " apparatus for the liquefaction of gases, components for a mercury diffusion pump, experimental sonic disintegrator for bacteria, etc.

Mechanical — Equipment for optical projection, X-ray diffraction equipment, mechanical components for microscopes, pantograph hob-measuring instrument, etc.

Technical Information Service — This Section works in close collaboration with the other laboratory sections. The number of enquiries received during the year has shown a marked increase.

NOTES & NEWS

Neomycin, a New Antibiotic

THIS NEW ENTRANT INTO THE field of antibiotics, active against streptomycin-resistant bacteria including streptomycin-resistant strains of *M. tuberculosis*, has been isolated from culture media on which *Actinomyces fradii* (now *Streptomyces fradial*) was grown (*Science*, 1949, **109**, 305). The bacterium, when grown on a medium containing peptone or meat extract, glucose and common salt, is found to produce the antibiotic under both stationary and submerged conditions of culture. Neomycin can be separated from the culture medium and concentrated, employing methods similar to those used in the case of streptomycin.

Neomycin is a basic compound, most active at an alkaline *p*H. It is soluble in water, insoluble in organic solvents, and is thermostable. It is active against numerous Gram-positive and Gram-negative bacteria, especially myco-bacteria, but not against fungi.

The outstanding properties of the new antibiotic are : (1) activity against both streptomycin-sensitive and streptomycin-resistant bacteria ; (2) high potency (in some cases greater than streptomycin) against various forms of *M. tuberculosis* and myco-bacteria ; (3) limited or no toxicity to animals ; (4) activity against various bacteria *in vivo*, including Gram-positive and Gram-negative organisms and (5) absence of resistance against neomycin among organisms sensitive to it, or only limited development of such resistance.

When a 20-hour old agar culture of *E. coli* was suspended in water and plated out in nutrient agar containing 5 μ or 25 μ of neomycin per c.c., no colonies of *E. coli* developed out of 22 billion cells after 9 days incubation at 28°C. Similar concentrations of streptomycin would usually allow the development of a dozen or more bacterial colonies per plate.

Broth or agar culture containing sufficient neomycin to inhibit the growth of bacteria were incubated for considerable periods of time. No further bacterial development occurred beyond a certain initial inhibiting concentration, thus pointing, on the one hand, to the stability of neomycin as contrasted with that of aureomycin and, on the other hand, to the lack of resistance developed among the sensitive bacteria, as contrasted with streptomycin.

Pyrethrin Substitutes

THE SYNTHESIS OF NEW PYRETHRIN-like compounds has been announced from the laboratories of the *Bureau of Entomology & Plant Quarantine*, U.S.A. (*Chem. Age*, 1949, **60**, 484). The chemical composition of the synthetic materials is stated to be identical with that of the active principle in pyrethrum. The material will not breakdown as quickly as the natural product. One of the compounds tested is reported to be 6 times more powerful in its knock-down action than the toxic principles from pyrethrum flowers.

Starting materials for the synthesis are pyruvic aldehyde and aceto-acetic ester. Basis of the first of these is propylene glycol, and the second is made from ordinary alcohol and acetic acid.

Soil Classification in U.S.A.

THE SYSTEM OF SOIL CLASSIFICATION developed through years of research and now used throughout the United States makes it possible to apply techniques of modern agricultural science to individual farms, according to a report of the U.S. Department of Agriculture.

Because soils differ widely within any area, the success of the application of new research findings on a given farm cannot be predicted accurately unless soils at the research station and at the farm are classified in terms that permit comparison.

On the basis of field and laboratory experiments conducted during 1912 to 1935, a new concept has been formulated. The process of soil formation in different environments are so unlike that soils developed from similar rocks in different places have widely different characteristics and behaviour.

In defining soil types, the characteristics taken into consideration are surface slope, texture, stoniness, fertility, depth, drainage, acidity, and presence of impervious layers.

More than 8,000 different soil types have been identified. In soil survey reports, the different types in a particular area, usually a single country, are classified, shown on maps, and described. A sandy loam is described as a poorly drained, acid, sandy soil, with no layers that cannot be penetrated by water and plant roots. It requires drainage to lower the water table, is deficient in plant nutrients, and needs heavy fertilization to produce high yields of most crops.

Such classification furnishes an accurate and orderly basis for assembling in usable terms the results of research and the experience of farmers. It permits prediction of crop adaptability, probable yields, and management requirements of specific areas of land. Experimental results or farmers' experience with one type of soil may have little or no prediction value for other soil types. Soil classification provides a means of showing the types of soil on any piece of property so that farmers may choose used practices that experience of research has shown to be suitable to these soil types. It has played a major role in the development of programmes for soil improvement and conservation and for the prompt and effective adjustment of agriculture to meet fluctuating economic conditions and emergencies (*USIS*).

Deficiency in Soils

A PRACTICAL METHOD OF DETERmining what elements essential for normal plant growth may be lacking in a soil, has been developed by the *Bureau of Plant Industry* of the U.S. Department of Agriculture. Research on the tobacco plant has demonstrated the possibility of detecting specific soil deficiencies through observations of plant abnormalities.

The lack of a specific element can be detected by certain typical symptoms, especially as they first appear on the plant. The symptoms produced by deficiencies fall into two groups : (1) those localized on the older or lower leaves, or more or less general on the plants, are due to lack of

nitrogen, phosphorus, magnesium, potassium and zinc — elements that are readily mobile; (2) those localized on the upper or bud leaves are due to lack of calcium, boron, copper, manganese, sulphur and iron — elements that are relatively immobile.

Local symptoms such as chlorosis of the older leaves, with or without necrotic (dead) spots, are due to potassium, zinc or magnesium deficiency. Potassium and zinc hunger are distinguished from magnesium deficiency by the development of necrotic spots at the tips and margins of chlorotic (pale) leaves. The breakdown from zinc deficiency differs from that of lack of potassium by progressing more rapidly and not being confined so sharply to leaf tips and margins. Nitrogen deficiency is manifested by general effects with the development of a light-green colour and drying of the lower leaves. Dark-green, immature plants are characteristic of phosphorus shortage.

The younger or bud leaves may become chlorotic or wilted with or without breakdown. Boron and calcium deficiencies both result in a die-back of the terminal growth but produce different symptoms in the early stages. Calcium shortage first becomes apparent in a light-green colour, followed by a typical hooking downward, with necrosis (dead tissue) developing at leaf tips and margins; if later growth takes place, these tips and margins are missing. Boron deficiency also first appears as a light-green colour, but this is followed by more or less breakdown at the base of the bud leaves; these may later make some distorted growth but the leaves break easily and the vascular tissue is black. Copper shortage is characterized by a permanent wilting of the upper leaves; if this occurs after the flowering stage, the seed stalk is unable to stand erect.

Manganese, iron and sulphur deficiencies produce chlorotic effects on the terminal growth or young leaves without complete breakdown. In managanese deficiency, chlorosis tends to follow out the minutest branches of the vascular system, giving the leaf a checkered effect, and this is accompanied by small necrotic spots scattered over the leaf. The chlorosis due to iron and sulphur deficiencies involves no necrosis. Iron chlorosis occurs first on tissue between the veins, but in extreme cases the entire leaf becomes white or yellow. Sulphur shortage is evidenced by loss of green on the upper leaves and by light-green veins. A deficiency of more than one element may cause a greater reduction in growth, but the most evident symptoms are commonly those typical of a shortage of the element most deficient.

These findings made it possible to prepare a key to facilitate diagnosis of deficiency effects on the tobacco plant, and have stimulated similar studies of other plants from which to establish a practical basis for compounding corrective fertilizers (*USIS*).

Detection of Sulphur

WHEN ORGANIC COMPOUNDS containing hydrogen are heated above the melting point with elementary sulphur, hydrogen sulphide is one of the decomposition products. Its evolution is marked when a polyhydric phenol, for example hydroquinone or pyrogallol, is the reducing agent. This reaction affords a means of detecting sulphur quickly and conveniently in complex or coloured materials, provided they are not too readily combustible (*Nature*, 1949, **163**, 537).

A small quantity of the substance to be tested is mixed in the dry powdered state with an equal weight of a polyhydric phenol, for example hydroquinone or pyrogallol, and the mixture heated in a bulb tube above the melting point. A freshly moistened lead acetate paper held in the issuing vapours is stained brown when sulphur is present. Under such simple conditions, it has been found that 0·0001 gm. of sulphur can be detected, but it is possible that an even higher degree of sensitivity might be attained.

Studies with a few typical sulphur compounds have shown the metallic sulphates, sulphides and sulphonates are unreactive, while sulphites are slowly reduced and yield hydrogen sulphide after a period of heating. Thio-urea yields hydrogen sulphide; presumably, any organic sulphur compound which decomposes on heating responds to the test.

The test promises to be of value in the examination of pigmented materials, dyestuffs and carbonaceous matter and, although it has obvious limitations, may prove useful in qualitative analysis as a confirmatory test for free sulphur or as an aid in the identification of organic sulphur compounds.

The conversion of sulphur to hydrogen sulphide with polyhydric phenols appears to be quantitative and the reaction can be made the basis of a method for estimating sulphur.

Amino Acids as Fat Stabilizers

THE COST OF STABILIZING LARD and other animal fats by means of phenolic anti-oxidants may be reduced by the use of methionine and other relatively inexpensive amino acids to synergize the activity of such costly anti-oxidants as α-tocopherol, hydroquinone and nordihydroguaiaretic acid. It has been found that 0·01 per cent of an anti-oxidant together with 0·01 per cent of amino acid is as effective as 0·1 per cent of the phenolic anti-oxidant alone.

With α-tocopherol as the primary phenolic anti-oxidant, the most effective synergists were found to be methionine and ascorbic acid. But with hydroquinone and nordihydroguaiaretic acid, methionine gives the maximum effect. Other amino acids, reported to be effective but not as effective as methionine, include threonine, leucine, norleucine, valine and cysteine and phenylalanine (*Chem. Eng.*, 1948, **55**, 19).

Aluminium Welding Alloy

A NEW LOW TEMPERATURE, aluminium welding alloy, Eutecrod 900X, that will not warp or distort aluminium surfaces, has recently been developed by the *Eutectic Welding Alloys Corp.*, New York (*Chem. Age*, 1949, **60**, 363). The alloy will permit the welding of thin aluminium parts at temperatures below the metal's melting point with greater fluidity than is attained by aluminium brazing. The low temperature operation is said to make it particularly suited for the manufacture of all light-gauge aluminium parts, tubing, sheets, bands and shapes without risk of distortion.

The new alloy is available in $\frac{3}{64}$" and $\frac{1}{32}$" in coil form. It bonds at 900°F. and re-melts at 950°F. It has a tensile strength of 30,000 p.s.i. Corrosion resistance is stated to be comparable with aluminium and colour match is excellent.

Amino Acid Antagonist

INTEREST OF MICROBIOLOGISTS and nutrition experts has been attracted to β,2-thionylalanine since the compounds has been found to possess specific activity against amino acids. It is used in medical and biological laboratories as a specific antagonist toward phenylalanine in the metabolism of a number of organisms. This white, soluble, odourless powder is now available for stock delivery from *Arapahoe Chemicals Inc.* of Boulder, Colo. (*Chem. Eng.*, 1949, **56**, 171).

Preparation of Ammonia Solutions

A SIMPLE PROCESS HAS BEEN developed for the preparation of aqua ammonia by direct line mixing of water and anhydrous ammonia as the ammonia is unloaded from tank cars. Equipment requirements are small; the process is simple and automatic; and it makes possible attractive savings for large-scale users of aqua ammonia in that it eliminates the cost of shipping 4 tons of water with every ton of ammonia (*Chem. Eng.*, 1949, **56**, 127).

Anhydrous ammonia, as it flows from tank cars under its own pressure, is mixed with an automatically controlled flow of treated water in a globe value line mixer. The proportioning of the flows of ammonia and water by means of flow instruments was considered impractical because of the difficulties in accurately measuring two-phase flow. Flow is, therefore, proportioned on the basis of the temperature rise resulting from the exothermic heat of solution. With this method of control, ammmonia flows freely and uncontrolled from tank car to storage and is line mixed with a controlled flow of water; water flow is automatically adjusted to hold a fixed temperature after mixing.

The theoretical temperature rise which occurs when anhydrous liquid ammonia at 68°F. and water at 68°F. are mixed, has been calculated for several aqua ammonia concentrations from the thermal data.

Typical installations using 3″ piping for liquid ammonia flow and 4″ piping for water and aqua ammonia flow permit the unloading of a 10,000 gal. ammonia tank car in 6 hr.

Effect of "Gammexane" on Paper

THE USE OF GAMMEXANE IN preserving valuable documents and books in libraries has been studied from the point of view of its possible effect on the durability of paper (*Nature*, 1949, **163**, 607).

No. 2 "Gammexane" smoke generators, weighing approximately 2 oz. per 1,000 cu. ft. as recommended by the manufacturers, *Imperial Chemical Industries Ltd.*, for insects infesting stored products, was employed. Samples of paper were exposed to the smoke for 72 hr. in order to allow it to settle down completely, and care was taken to prevent any scorching effect from the smoke generator. Samples exposed to "Gammexane" smoke were also submitted to accelerated ageing, which consisted in heating the samples for 72 hr. at 100°C. The tensile breaking strength and the folding endurance of the treated and control samples were measured according to the standard *TAPPI* methods.

The mere exposure of paper to "Gammexane" smoke brought about a substantial decrease in its tensile strength and folding endurance — as much as 53·7 and 71·5 per cent respectively in one instance. Papers exposed to "Gammexane" and then submitted to accelerated ageing turned slightly yellow, and there was a complete loss of folding endurance in nearly all cases. All-rag hand-made paper of an extremely durable quality used for the repair of old manuscripts had a normal folding endurance of 4,164; but on exposure to "Gammexane" smoke the retention of folding endurance was 28·5 per cent only, while on accelerated ageing, the retention of folding endurance further decreased to zero.

The data obtained conclusively prove that treatment with No. 2 "Gammexane" smoke generator is definitely injurious to paper records of all kinds and effects their durability as badly as acidic gases. As the water through which the smoke had been bubbled was found to be distinctly acidic, it is almost certain that at least a part of the embrittling effect produced on paper is due to the smoke-generating materials rather than to the "Gammexane" itself. However, the gases obtained from the smoke generator No. 2 has deleterious effect on paper, and it is advisable to prevent it coming into direct contact with paper records and manuscripts intended for permanent preservation.

Sunflower Oil

THE SUNFLOWER IS BEING INcreasingly grown in Britain as a source of vegetable oil. It needs no manuring and usually outgrows any weeds, resists drought and yet stands up to heavy rain. The yield of seed (oil content, 33 per cent; protein content, 30 to 40 per cent) is about 1 ton per acre. The oil is rich in Vitamin E.

Plochere Colour System

THE PLOCHERE COLOUR SYSTEM is a collection of 1,248 painted cards, each 3″ by 5″ in size, accompanied by an explanatory book, and intended mainly for the use of decorators. It is a pigment-mixture system, and the explanatory book on the subject gives directions for each of the 1,248 colours by the mixture of one or more of nine chromatic pigments with black and white. The nine basic pigments and the special black are obtainable from the publishers of the system. The colours are classified into 26 blocks of 48 each, each set being intended to represent 1 hue, beginning with yellow and proceeding through orange, red, purple, blue and green to a greenish yellow. It is stated that these hues represent the 24 hues of the Ostwald colour circle and 2 additional hues on either side of yellow, which were felt to give an improved gradation.

Each block of 48 colours is divided into 6 series of 8. Each of these series is intended to be at a certain chrome level, the first being the strongest in colour and the sixth the least saturated. In each series the first colour has the lowest value, the remaining 7 being produced by extending this first colour with increasing amount of white. (*Can. J. Res.*, 1949, **27**, 1).

Production of Titanium

AN IMPROVED METHOD OF MAKING pure ductile titanium with possible commercial significance is being worked out by the *Bureau of Mines* at Boulder City, U.S.A. A maximum of about 100 lb. is produced daily in a pilot plant by reducing titanium chloride

with metallic magnesium. Until recently, pure titanium was considered a laboratory curiosity.

Reduction is carried out in an air-tight iron container from which all oxide has been purged by hydrogen at 500°C. Magnesium ingots are introduced through an inlet tube, and the apparatus is heated to 150°C. under reduced pressure to remove absorbed gas. After the container has been blanketed with helium, the temperature is raised to about 750°C. Liquid titanium chloride is added slowly, then more rapidly as the reaction proceeds. The heat evolved is sufficient to maintain the temperature for about two-thirds of the run. A maximum temperature of 900°C. is held for a full half hour after all titanium chloride has been added.

When cool, the charge is removed, leached with cold hydrochloric acid, dried, finely ground, leached with 10 per cent hydrochloric acid and finally washed and dried at room temperature. The titanium is pressed and sintered for 16 hr. at 1,000°C. under vacuum (*Chem. Eng.*, 1948, **55**, 59).

Fish Albumen

A WHITISH POWDER, "EIWEISS", produced from stock fish and sharks has been used as a substitute for egg-white. The sensational value of eiweiss as a substitute for egg-white is shown by the fact that 1 lb. of eiweiss is the equivalent in whipped form of the whites of 250 eggs. The nutritional value of 1 lb. of fish albumen is the equivalent of the white of 125 eggs.

Fish albumen has a wide range of uses; it has a high nutritional value and can be used for all purposes for which egg albumen is used. In some respects it is stated to be superior to egg albumen, e.g. stronger whipping power, retention of this power with constant whipping, and resistance to coagulation by heat. It finds many uses in baking, confectionery, mayonnaise, custard power, ice cream, pharmaceutical products, leather industry, synthetic resins, lacquers, foam extinguishers, etc.

The yield of eiweiss is 14 per cent from fresh fish, 50 per cent from dried fish, and 75 per cent from shrimps.

Fillets of fish are treated to remove all water-soluble impurities. Fats are then removed, and the product is then processed to render it water soluble and spray-dried to produce a fine powder, slightly cream coloured, which, when whipped up in water, produces a smooth-textured, meringue-like mixture, free from any fish odour (*Fisheries Newsletter*, 1948, **7**, 23).

Manufacture of Fatty Alcohols

FATTY ALCOHOLS ARE NOW MANUfactured in the U.S.A. by reducing the esters in the presence of a reducing alcohol by metallic sodium. Research by *E. I. du Pont de Nemours & Co.* has shown that by suitable modifications, almost quantitative yields of fatty alcohols on the amount of sodium used could be obtained and the consumption of the reducing alcohol (alcohols other than ethanol) can be lowered markedly by adding this latter alcohol as fast as it is consumed (*C.T.J.*, 1949, **124**, 329).

The method is briefly as follows: the fat used is hydrogenate dcoconut oil, containing about 99 per cent triglycerides, 0·75 per cent unsaponifiables and 0·25 per cent free fatty acids. It is important that the free fatty acid content be kept as low as possible since it reacts with the sodium to form anhydrous soap and represents a loss of sodium. The coconut oil is passed through a two-stage vacuum dryer to reduce the moisture content to the lowest practical level (c. 0·03 per cent). The sodium used is almost pure, contaminated only by traces of calcium.

The reduction is a batch operation carried out in a mechanically agitated reactor fitted with a reflux condenser and blanketed with nitrogen. The molten sodium is dropped (2,000 lb. per batch) into the reactor which already contains 2,000 lb. toluol, the last mentioned acting as a solvent for the reaction mass and a dispersing medium for sodium. The reactor temperature is maintained at the boiling point of toluol.

The coconut oil solution (solvent: methyl amyl alcohol) is then fed to the reactor at a rate so controlled that only a slight excess of unreacted ester is present in the vessel at any time. The reaction is exothermic and the heat is removed by refluxing the toluol, the boiling toluol being reintroduced into the reactor without chilling the mixture.

The mixture in the reactor is then dropped into a mechanically agitated quench tank containing 17,000 lb. of water where hydrolysis occurs, the quench tank being fitted with a water-cooled reflux condenser. When the whole batch from the reactor vessel has been treated, the agitation in the quench tank is stopped and the content separated into 3 layers. The top layer comprises the product alcohol and the regenerated reducing alcohol. The middle and smallest layer is a dark, soap-stabilized emulsion of the solvent and aqueous layer. The aqueous bottom layer contains the glycerol and caustic formed in the hydrolysis.

Newsprint from Wheat Straw

THE POSSIBILITY OF MANUFACturing newsprint from wheat straw has been proved by large-scale trials conducted by the *Chemical Paper Mfg. Co.*, Holyoke, Mass. (*Ind. Pulp & Paper*, 1949, **3**, 354). In these trials the screening system was inadequate to remove shieves, and equipment was not available for multi-stage bleaching. The paper had excellent formation and was much stronger than regular newsprint.

The pulping process is simple. Bales of straw are dumped into a rotary cooker without any preparation. Cooking is effected at low temperature and pressure. The cost of chemicals is estimated at $14 per ton without recovery, but the use of a recovery system would materially reduce this figure. A 50 per cent yield of pulp on the weight of straw has been obtained.

Glycerine Refining

A RECENT INVENTION BY THE *Nopco Chemical Co.* relates to the refining of crude glycerine produced by saponification and alkyl esterification methods (*Chem. Age*, 1949, **60**, 478).

Briefly, the process consists in separating the acidic glycerine from the esterification mass, neutralizing with alkali, heating the neutralized glycerine with ammonium chloride and removing the insolubles. Neutralizing the alkali may be effected before separating the glycerine. The refined and substantially anhydrous glycerine may be further purified by distillation, co-distillation with mineral oil, or by solvent extraction, or a combination of these.

900 parts of groundnut oil were reacted with methanol in the

ratio of 15 molecules of methanol to 1 molecule of glyceride, with 1 per cent sodium hydroxide as catalyst. The mixture was refluxed for an hour, cooled, acidified with 20·2 parts of concentrated sulphuric acid and refluxed for another 4 hr. The reaction mixture separates into layers and the lower glycerine layer was drawn off; 36 parts of barium oxide were added to the glycerine layer and the mixture heated for an hour on the steam bath. It was then cooled, 29·5 parts of ammonium chloride added and further heated for an hour. Most of the methanol associated with the glycerine was then distilled off and the reaction mass filtered. The crude glycerine obtained was distilled under reduced pressure, yielding an odourless, water-white, anhydrous glycerine of *p*H 7 in 83·7 per cent yield.

In the second method, the crude anhydrous glycerine was first neutralized with calcium carbonate, either before or after the removal of glycerine from the mass, and the insoluble material removed by filtration. The glycerine may be heated for a short time at about 60°C. for 30 min. on the steam bath to aid filtration. Barium chloride is added along with more alcohol to increase fluidity. This eases handling and prevents loss of glycerine. After these additions, the mass is again heated at 60° to 120°C. for 30 to 60 min. at the reflux temperature of alcohol. Insolubles are again removed by filtration and any residual alcohol distilled off.

Improved Type of Plough

THE *Indian Agricultural Research Institute* has evolved a new plough which, with a single pair of bullocks, is capable of doing twice the work done by the existing standard plough.

The new plough is simple in construction and consists of two standard *desi* ploughs, suitably coupled by an iron frame-work and pulled by a single central beam. The ploughs are so spaced that identical furrows are cut, and they carry out in one operation the work which would be performed in two operations by the standard plough. The plough is comparatively light, its weight being only about 50 per cent heavier than the standard plough. Trials show that the draught did not exceed 260 lb. as against the normal draught of 155 lb. of a standard plough. The additional draught of the new plough is not likely to be heavy for bullocks as experience has shown that so far as ploughing is concerned bullocks are usually underloaded.

The quality of ploughing is also improved. Seasoned ploughmen who have used the new plough are enthusiastic about it and state that it is easier and less tiresome to operate due to its stability.

Besides its simplicity in construction, the new plough is comparatively economical, its cost being about 50 per cent more than the standard plough. It can be easily repaired and fabricated.

Manufacture of *Khandsari* Sugar

THE IMPROVED PROCESS OF MANUfacture of *khandsari* sugar evolved at the *Sugar Research & Testing Station*, Bilari, is working successfully on a commercial scale in some of the private firms that have adopted it. The improved process gives a higher recovery of sugar than that attained in the indigenous open-pan process. The improved process gives a recovery of 7·92 per cent of cane as against 6·22 per cent by the indigenous process and the quality of sugar obtained is comparable with that of the ordinary vacuum-pan factory product.

The *Pheona Sugar Works*, Bijnore district, which has adopted the improved process, reports that the quality of sugar manufactured by this process is quite comparable with ordinary grade factory sugar and is selling at Rs. 28/8 per maund. The firm is willing to accord all facilities to intending *khandsari* sugar manufacturers to study the process at its factory premises.

Indian Council of Agricultural Research, Annual Report, 1947-48

RICE, WHEAT, BARLEY, MAIZE, citrus fruits and commercial varieties of potatoes received special attention during the year 1947-48, according to the Annual Report of the *Council*, recently issued. On the veterinary side, bovine tuberculosis, rinderpest, foot and mouth diseases of cattle, nutritional deficiencies and Ranikhet disease of poultry were particularly investigated and useful results have been reported.

It has been shown that green manuring of paddy fields led to higher yields than those obtained by keeping land fallow for a certain period. Growing *jowar* prior to paddy is injurious to the paddy crop; this practice should be abandoned. Research on new varieties of paddy showed that Chinese varieties gave a very heavy out-turn, viz. 60 to 70 md. per acre.

13 hill varieties of wheat were selected for tests on resistance to yellow rust. Varieties "23" and "34" were found resistant to yellow and black rust; 2 newly discovered strains "D" and "26" are resistant to brown rust.

Of the 19 research schemes on fruits, 8 were on citrus. Rootstock trials for *Sathgudi* orange and the common acid lime have been completed at Madras; the optimum season for budding has been determined. Rootgrafting of mango was successfully developed for the first time.

Over 200 potato hybrids approaching the common commercial varieties, both in tuber size and yield, were evolved at the *Council's* Potato Research Station at Simla. Some of the hybrids (2, 9, 12 and 19) are frost-resistant. The sprouting method of growing potatoe has been of immense value both in experimental and multiplication work.

The use of desiccated goat-tissue powder vaccine (D.G.T.) for rinderpest was tried on a field scale in the United Provinces. It was found that even under adverse conditions, the vaccine remained viable from 10 to 17 days, and it provided immunity to animals for a period of 7 months. Animals were also immunized employing the "Pill" vaccine, which consists of spleen pulp, 1 gm. (or 0·25 gm. of D.G.T. vaccine); glucose, 0·75 gm. and peptone, 0·1 gm. rolled up with glucose syrup or normal saline solution. These pills are not hygroscopic and completely diffuse in 45 min. Tests have shown that the pills retain their potency for a month when kept in a frigidaire and on innonculation produce reaction on the third or fourth day and confer a satisfactory immunity lasting for 17 months.

The comparative feeding values of straws of wheat, barley, *jowar*, *bajra* and paddy on milk production has been investigated in the United Provinces. It was found that the feeding value of paddy straw is superior to other straws. This is followed, in order, by

wheat, barley, *bajra* and *jowar* straws. It was also found that alkali-treated straw augmented milk production in cows.

On the nutritional side, experiments at the *Indian Veterinary Research Institute*, Muktesar, showed that the use of *vanaspati* adversely influences the absorption of carotene, the absorption being 15 to 25 per cent less than that observed when ghee was used as the source of fat. *Vanaspati* was also found to lower the absorption rate of calcium and phosphorus.

Geodetic Work of the Survey of India, 1939-48

DURING THE LARGER PART OF the period, the geodetic activities of the *Survey of India* were concerned with the production of the war effort, according to a report prepared by the President, Survey Research Institute, Dehra Dun, and presented at the 8th General Meeting of the Geodetic Association held at Oslo in 1948.

From a review of the continuous chain of triangulation that exists from Syria to Malay, it has been possible to assess how much work remains to be done to continue the triangulation chain from India to Australia and Philippines, and to complete the block — Iran, Persia, India, Burma, Siam, French Indo-China and Malay.

Predictions of tides for an average of 39 ports between Suez and Singapore were carried out by the *Survey of India*. Proposals to increase the number of permanent observatories are being implemented, and a touring tidal detachment has started to take observations for a month in rotation, at older and secondary ports.

The Mineral Adviser to the Government of India in consultation with the *Geological Survey of India* had suggested some priority areas for gravity observations. Employing a Frost Gravimeter, a survey was carried out in the Raniganj coalfields, Bengal, and in an area north of Nagpur in Central Provinces during the field season 1947-48.

During the 2 field seasons, 1939-40 and 1940-41, 706 miles of high precision levelling in one direction was carried out and another 86 miles of high precision levelling and 252 miles of levelling in both directions have been added in 1946 and 1947, thus making a total addition of the equivalent of 648 miles of completed levelling in both directions. The second net of levelling of high precision in India commenced in 1913-14, and this net when complete is expected to comprise about 15,800 miles. An important achievement has been the connection of the Indo-Burma levelling to that of the Siamese levelling by No. 2 Indian Field Survey Company in December 1945.

The total number of stations, latitude, longitude or azimuth at which the deviation of the vertical has been observed is now 1,162, at about 970 of which Hyford anomaly has been calculated. A volume giving these results is under preparation.

Geophysical prospecting was carried out in the Central Provinces with a view to test the applicability of certain geophysical methods for the systematic location of hidden ore bodies. Gradiometer and Walts vertical force variometers were employed to verify the geophysical indications in areas which had been already opened up. It was clearly established that both magnetic and gravimetric methods are suited for such surveys and the reef containing manganese ore bodies can be fairly accurately delineated.

Indian Standards

THE *Indian Standards Institution* has brought out the following 8 Indian Standards which are now available to the public :

Rules for Rounding off Numerical Values — Indian Standard Rules for Rounding off Numerical Values, IS : 2-1949 (price as. 8), enunciates the problem that arises in rounding off of numbers which have to be expressed correct to several decimal places. The recommended rules for rounding off different classes of numbers, depending on the last integer to be rounded, and the explanation of the rules are covered by the Standard. The rules are so devised that subsequent operations performed on the rounded off numbers least affect the results.

Inch-millimeter Conversion for Industrial Use — For the use in industry, the *ISI* has published the Indian Standard on Inch-millimeter Conversion for Industrial Use, IS : 3-1949 (price as. 8). This Standard contains, in addition to the accepted ratio of conversion of inch to millimeters, conversion tables of inches to millimeters, millimeters to inches and binary fractions of an inch to millimeters. Explanatory notes are appended to facilitate the use of the tables.

Make-up of Periodicals — The Indian Standard Practice for Make-up of Periodicals, IS : 4-1949 (price as. 8) provides an agreed set of rules for the lay-out of periodicals. The purposes of the rules is to enable editors and publishers so to shape the form of their periodicals as to facilitate their use by readers and librarians. The standard covers the requirements of individual issues, annual compilations and cumulative indices, and guiding rules to deal with abnormalities in the make-up of periodicals. The rules set out in the Standard are in general conformity with the recommendations of the *International Federation of Documentation*.

Colours for Ready-mixed Paints — The Indian Standard Colours for Ready-mixed Paints, IS : 5-1949 (price Rs. 4), corresponds to the 1948 edition of the *B.S.* 381C (93 colours) issued in March 1948 by the *British Standards Institution* as a revision of the 1930 edition. The *Indian Standards Institution* considered that in view of the wide usage in the past in India of the British Standard on the subject, it would be desirable to accept this standard for the present. Eventually an Indian Standard may be produced to cater to the particular needs of paint manufacturers and users in India.

Fireclay Refractories — The following 3 Standard Specifications for fireclay refractories have been drawn up for use in Indian industry :

(i) Moderate Heat Duty Fireclay Refractories, Group 'A', IS : 6-1949 (Rs. 2) ;
(ii) Moderate Heat Duty Fireclay Refractories, Group 'B', IS : 7-1949 (Re. 1) ; and
(iii) High Heat Duty Fireclay Refractories, IS : 8-1949 (Rs. 2).

These specifications cover the methods for chemical analysis, the determination of pyrometric cone equivalents under load for full-size bricks as well as for sections of bricks, the determination of porosity and resistance to spalling.

Test for Shrinkage of Cloth on Washing — The Indian Standard Method of Test for Determining Shrinkage in Woven Cotton and Linen Cloth in Washing, IS : 9-1949 (price as. 8) describes the

test for estimating shrinkage in cloth resulting from washing. The Standard gives the description of the washing machine, the test sample and the procedure for the estimation of shrinkage after laundering.

Orders for these 8 Indian Standards may be placed with the Secretary (Publications), *Indian Standards Institution*, Block 11, Old Secretariat, Delhi 2.

Indian Standards for Nonferrous Metals

THE SECTIONAL COMMITTEE ON Non-Ferrous Metals of the Engineering Division Council of the *ISI* has prepared the following 16 draft Indian Standards to cover important non-ferrous metals used in Indian industry : Cast Aluminium Utensils ; Wrought Aluminium Utensils ; Zinc (Spelter) ; Pig Lead ; Silver Solder ; Soft Solder ; Tin Ingot ; Anti-friction Bearing Alloys ; Copper ; Phosphor Bronze Ingots and Castings ; Brazing Metals ; 98 per cent Aluminium Notched Bars and Ingots for remelting purposes ; 99 per cent Aluminium Notched Bars and Ingots for remelting for Aircraft purposes ; Aluminium Sheets and Coils for Aircraft purposes ; Aluminium-coated High Tensile Aluminium Alloy Sheets and Coils for Aircraft purposes ; and Aluminium-manganese Alloy Sheets and Coils.

Comments on these drafts (available with the Secretary, Publications) will be received by the Director, *Indian Standards Institution*, Block 11, Old Secretariat, Delhi 2, up to July 18, 1949.

Indian Forest Statistics

A COMPREHENSIVE BROCHURE containing a large mass of statistical information regarding forest areas in India and their out-turn, imports and exports of various forest products, employment of labour in forestry and forestry industry, etc., during the period 1936-37 to 1947-48 has just been published by the Directorate of Economics and Statistics of the Ministry of Agriculture.

The data presented in the pamphlet mainly relate to Indian provinces, though some data in respect of a few States have been included, where available. The classification adopted in the brochure is different from that prescribed by the *F.A.O.* in connection with the inventory of forest resources.

Among the items on which information is available in the brochure are : (1) forest area according to various classifications, e.g. ownership, reserved, protected, merchantable, unprofitable, timber producing, etc. ; (2) areas showing progress in regeneration and afforestation ; (3) areas under fire protection ; (4) areas open and closed to grazing animals ; (5) out-turn of timber and fuel according to different categories, namely timber, round wood, fire wood and charcoal ; and (6) foreign trade in respect of wood and timber, wood products and minor forest produce. Sources of imports and destinations of exports have been given for the last three years.

Narcotics Board for India

THE GOVERNMENT OF INDIA HAVE decided to set up an All-India Narcotics Board to improve and co-ordinate the various aspects of narcotics administration throughout the country and to to implement India's obligations under international agreements.

The Board will consist of 6 members, comprising 2 representatives of the Central Government, 2 of the provincial governments and 2 of the states. The Board will employ a Narcotics Adviser, and the expenditure incurred by the Board will be met by income derived initially by the levy of a surcharge on the opium supplied to provinces and states.

The functions of the Board will be mainly to see that the various governmental understandings, agreements and obligations regarding narcotics administration are being observed and, in case of non-observance, suggest remedies to the authorities concerned.

To assist the U.N.O. in formulating a new Narcotics Limitation Convention, the Board will recommend to the International Control Board, through the Government of India, India's annual production and consumption quota. The Board will allocate among the various producing and consuming units within the country their production and consumption quotas as fixed by the International Control Board.

Journal of the Zoological Society of India

THE FIRST NUMBER OF THIS *Journal* (half-yearly) contains 4 sections. The first section is devoted to original research paper and review articles, and the subsequent 3 to notes, reviews, recent advances and announcements. Among the articles included in this number are : (1) The fish fauna of the Rihand river and its zoogeographical significance ; (2) On zoological standards and progress ; (3) Life history and bionomics of the Potato Tuber Moth ; (4) Notes on the free living and plant-parasitic Nematodes of Ceylon.

The *Journal* is well printed and neatly got-up.

Announcements

National Institute of Sciences of India — At a meeting of the Institute held at Bangalore on 6th May 1949, the following awards were announced :

National Institute of Sciences Senior Research Fellowship — (1) Mr. U. R. Burman ; (2) Dr. A. B. Kar ; (3) Dr. S. M. Mukherje ; (4) Dr. K. V. Srinath.

National Institute of Sciences Junior Research Fellowship — (1) Miss Ira Bose ; (2) Mr. S. Datta Majumdar ; (3) Dr. S. G. Joshi ; (4) Mr. T. M. Mahadevan ; (5) Mr. D. K. Mukherji ; (6) Mr. K. Subramanyam ; and (7) Mr. B. V. Sukhatme.

Imperial Chemical Industries (India) Research Fellowship — (1) Mr. A. K. Chakravarti ; (2) Dr. A. P. Mahadevan ; (3) Mr. C. Ramasastry ; and (4) Dr. K. K. Reddi.

UNESCO — Belgium Fellowship for India — The Belgium Government has placed at the disposal of the UNESCO four fellowships to be offered, one each to China, India, Italy and Norway.

The fellowships are offered for advanced study in the following fields : *Education* (study of Decroly methods) ; *Museum* (problems and techniques of restoration of works of art), and *Fine Arts* (study of Flemish Art and the history of art in general).

These fellowships are intended for candidates already established in their professions for a period of six months, and carry a monthly stipend of 4,000 Belgian francs.

Reports from States & Provinces

HYDERABAD

New Sugar Factory

COMPLETION OF A NEW PLANT AT the Bodhan Factory will make the combined unit the biggest factory in India. The present output of the factory is 120 tons of unrefined sugar and 3,500 gallons of power alcohol per day. When the new plant goes into operation, the daily output is expected to reach 300 tons of sugar and 9,000 gallons of alcohol.

The factory, which is 51 per cent State owned, is considered one of the most modern in India.

Extensive cane-breading experiments are in progress at the research stations attached to the factory.

MYSORE

New Fertilizer Factory

THE GOVERNMENT HAVE CONCLUDED an agreement with the *Chemical Construction Co.*, New York, for the erection of a 50,000 ton fertilizer factory at Bhadravti at a cost of Rs. 2·5 crores. The factory is rated to produce 25,000 tons of ammonium sulphate and 25,000 tons of super phosphate per annum. The plant is expected to go into production in about 2 years.

TRAVANCORE

Jute Cultivation

THE TRIALS CONDUCTED IN TRAvancore with a view to put under jute cultivation 50,000 acres of low lying land have shown promising results. Within 2 months of plantation, the jute plants have grown to a height of 5′ without any inter-cultivation or special manuring as is generally done in Bengal. In areas of low soil moisture content, seeds did not germinate, emphasizing the need for showers prior to the sowing of crop.

WEST BENGAL

Forest Development

THE FOREST DEVELOPMENT schemes in West Bengal envisage the conservation and improvement of existing private forests and the extension of forest areas by afforesting waste lands. At present, only about 15 per cent of the 28,000 sq. miles of the province is covered by forests.

The *West Bengal Private Forests Act*, 1948, provides for the conservation of private forests and afforestation of waste land. As long as private owners manage their forests according to the working plans approved by the regional Forest Officer, there is no interference by Government, but failure to do so enables Government to take over the management of forests as vested forests. At the controlled stage, Government demands no profit and technical service is provided *free* for the first 10 years. In the vested stage, Government's share of profit is 50 per cent. Afforestation by State is undertaken by agreement with private owners or by acquisition.

So far, 700 sq. miles of privately owned forests have been brought under the control of the State, and provision has been made to extend the *Act* over the entire province during the current year.

The Provincial Forest Advisory Board aims to utilize all available areas not suitable for production of food crops for afforestation, and the provincial Government has earmarked nearly the entire forest revenue for the conservation, development and expansion of provincial forests. State nurseries are being opened all over the province to offer facilities for tree-planting by villagers and afforestation of roadsides and waste lands.

An expansion of the existing coastal belt of tidal forests along the entire sea-coast of the province has been taken up and afforestation on an extensive scale has been planned for the current year. For this purpose, 19 ranges and 70 beats have been opened.

BOMBAY

Forestry College for Dharwar

A FORESTRY COLLEGE HAS BEEN opened in Dharwar — the first of its kind in the province and the third in India. The need for such a college arose because the existing facilities in the country for training of personnel in forestry are quite inadequate.

MADRAS

Lignite Deposits

DEPOSITS OF LIGNITE HAVE BEEN found extending over an area of 100 sq. miles between Vriddhachalam and Cuddalore areas, south of Madras city, during a survey carried out by Mr. H. K. Ghose, Lignite Officer, South Arcot. Preliminary surveys have disclosed that at several places in this area the lignite bed is about 80′ thick. The seams dip seawards and thicken out in that direction. The lignite now found is of very good quality, the colour ranging from snuff to jet black. It can be used as fuel for industries, locomotive boilers, domestic purposes and for power generation.

ERRATA

This Journal :

1949, Vol. **8**, No. 5 : Page 164, line 30, article entitled " Stabilization of Plant Names ", *for* " *Emolista* " *read* " *Emelista* ".

1949, Vol. **8**, No: 6 : Page 232, article entitled " A Study of the Colouring Matter of *Tambul* Seeds ", the botanical name " *Zanthoxylum acanthopodium* " for " *Tambul* " was inadvertently omitted from the text.

INDIAN PATENTS

The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II, Section 1, for May 1949.

Plastics & Plasticizers

38153. LEWIS BERGER & SONS LTD. : Manufacture of interpolymers of aromatic vinyl hydrocarbons and oils : *Heating with sulphur present in an amount* 0·5 *per cent to* 5 *per cent by weight of the drying oil which is present in an amount* 10 *per cent to* 70 *per cent by weight of reaction mixture.*

Organic Chemicals

38677. I.C.I. LTD. : New azo dyestuffs : *Coupling diazotized* 4*-nitro-*2*-aminophenol-de-*6*-sulphonic acid with* 1*-amino-*8*-naphthol-*3 : 6 *di* (*sulphon-alkylamip*).

Miscellaneous Chemicals

40066. FOUNDRY SERVICES LTD. : Heat producing mixtures : *Aluminium and an oxidizing agent characterized by the addition of metal fluoride.*

Instruments (Professional, Scientific & Controlling)

39389. N. V. PHILIPS' GLOEILAMPENFABRIEKEN : Method of manufacturing magnetic anisotropic permanent magnets : *Alloy containing* 30 *to* 42 *per cent Co,* 7 *to* 20 *per cent Ni,* 5 *to* 11 *per cent Al,* 2 *to* 10 *per cent Ti,* 0 *to* 10 *per cent Cu,* 0 *to* 2 *per cent additional elements and the rest Fe and impurities, magnetized whilst cooling from a temperature exceeding the Curie point of the alloy down to a temperature* 100°C. *below it and annealed and finally magnetized, both magnetization being in the preferential direction.*

Medical Research & Practice, including Clinical Application of Drugs & Pharmaceuticals

38573. DISTILLATION PRODUCTS INC. : Preparation of material having vitamin E activity : *Reacting beta or delta tocopherol to introduce methyl groups in the nucleus.*

Metals & Metal Products

36182. MALHOTRA, PRAKASH & AGARWAL : Copper-silicon bronzes : *Preparing "hardner" alloy containing copper, silicon, manganese and iron, and adding the alloy to molten copper.*

41077. MOND NICKEL CO. LTD. : Cast iron : *Containing* 2·0 *to* 4·5 *per cent carbon,* 0·1 *to* 3 *per cent silicon,* 0·1 *to* 2·0 *per cent manganese,* 0·15 *to* 0·5 *per cent magnesium,* 0 *to* 6·0 *per cent nickel,* 0 *to* 2·5 *per cent chromium and* 0 *to* 2·0 *per cent molybdenum, the rest iron.*

Rubber & Rubber Products

38489. DAYTON RUBBER : Method of making sponge rubber : *Mixing salt crystals with rubber-like materials, vulcanizing the mixtures and removing the salts from the materials.*

38264. WINGFOOT CORPN. : Rubber hydrochloride film for wrapping packages : *Preparing film from rubber hydrochloride composition containing a hydrophilic surface active agent or treating rubber hydrochloride film with this agent.*

40721. WINGFOOT CORP. : Blended rubber latex frothed sponge : *Containing* 70 *per cent of rubber latex and* 30 *per cent of resin latex.*

Textile & Textile Products

38426. DUNGLER : Autoclave for the continuous treatment of cloth at open width : *A close chamber, means for fluid-tight inlet and outlet of the cloth at open width, means for pre-impregnating the cloth with treating liquid.*

40755. NABAR & DARUWALA : A new method for the simultaneous dyeing of mineral khaki and vat dyes on textile materials : *The mineral salts, vat dyes and caustic soda being mixed together to form the dye liquor and the cloth subsequently subjected to the action of steam and hydrosulphite.*

Food & Kindred Products

37377. GRIFFITHS HUGHES LTD. : Treatment of coffee beans : *Surrounding the coffee beans with waxes, heating the beans and finally removing the waxes from the body of the beans.*

Packing & Packaging

40551. N. V. DE BATAAFSCHE PETROLEUM MAATSCHAPPIJ : Process for the treatment of materials, particularly packing material, so as to cause said material to emit corrosion-inhibiting vapours : *Applying inorganic nitrite and salt of organic base on packing material and crystallizing nitrite of organic base on said material.*

38637. PRASAD & PRASAD : Packing and preservation of fruits, vegetables and the like : *Packing material comprising chemical preservative, saw dust and/or wood shavings and/or magnesium carbonate.*

Miscellaneous

39486. SOCIETE INTERNATIONALE SOIE-COSMETIQUE : Method for pulverizing fibres of animal and vegetable tissues : *Subjected to oxidation and then ground.*

39661. CHAUDARY : An improved filter-press : *Upper compartment of cylinder has perforated cylinder with conical opening and lower compartment has a cone for removal of cake formed in perforated cylinder.*

Journal of
Scientific & Industrial Research

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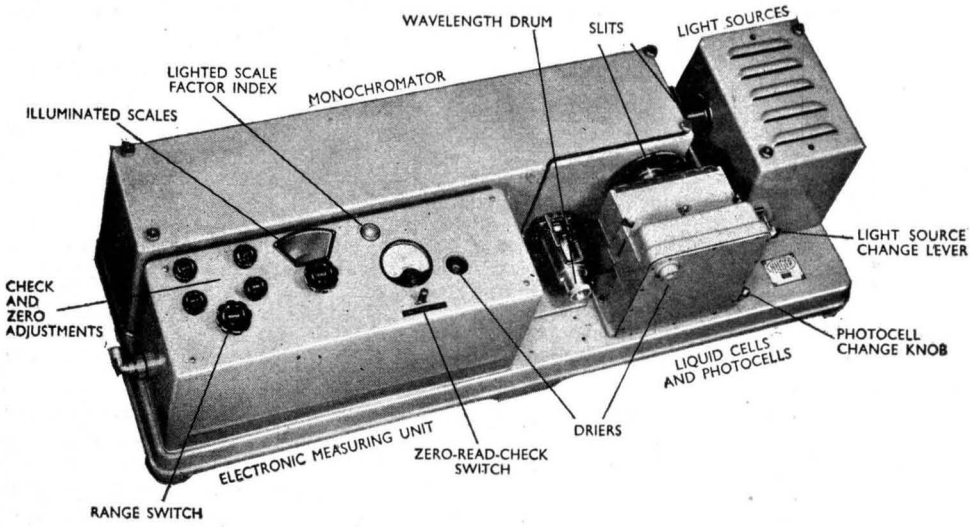

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Chemical Examination of *Tinospora cordifolia*, Miers

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TINOSPORA cordifolia Miers (Hindi — *Giloe, Gulanch*) is a well-known indigenous drug commonly used as a febrifuge, an antiperiodic and as a general tonic. The fresh plant material is extremely bitter in taste.

Fluckiger[1] reported that the therapeutic properties of the drug as well as its bitterness are due to the presence of a glucoside and traces of berberine. Kirtikar[2] also ascribes the medicinal properties to the presence of berberine. Pendse and Dutt[3] reported the presence of a waxy substance and an alkaloidal constituent different from berberine. They further stated that the bitter constituent was a semi-solid product which could not be crystallized. Subba Jois[4] isolated from the material three crystalline substances melting at 75°-77°C., 83°-84°C. and 181°C. respectively. Out of these, the substance melting at 181°C. was assigned the molecular formula $C_{16}H_{18}O_5$, while the product melting at 83°-84°C. was noted to be a monohydroxy alcohol of the fatty series. Bhide, Phalnikar and Paranjpe[5] isolated two bitter substances : (A) $C_{22}H_{34}O_{10}.5H_2O$, m.p., 226°-228°C.; and (B) m.p., 186°-188°C., and a neutral fatty alcohol, $C_{28}H_{58}O$, m.p. 82°-83°C.

In view of the great importance attached to *Giloe* in the indigenous systems of medicine and the varied claims put forward by different authors in regard to its active constituents, a systematic chemical examination of the plant was undertaken. As a result of these investigations, the following crystalline substances have been isolated and characterized :

1. Giloin, $C_{23}H_{32}O_{10}.5\frac{1}{2}H_2O$; glucoside ; m.p., 226°-228°C. ; $[\alpha]_D^{38} = +69{\cdot}5°$ (after drying to constant weight *in vacuo* over P_2O_5) in 1 per cent alcoholic solution ; yield 0·2 per cent on the weight of fresh bark-free stem ; bitter in a dilution of 1 in 10,000.

2. Giloinin, $C_{17}H_{18}O_5$; non-glucosidic ; bitter ; m.p., 210°-212°C. ; $[\alpha]_D^{33} = +40°$ in 1 per cent acetone solution ; yield, 0·001 per cent on the weight of fresh bark-free stem ; bitter in a dilution of 1 in 1,000.

3. Gilo-sterol, $C_{28}H_{48}O$; m.p., 192°-193°C. ; $[\alpha]_D^{32} = +92°$ in alcoholic solution.

The method worked out for the isolation of the bitter crystalline constituents was based on the extraction of the bark-free, crushed stems with water in the hot or alcohol at the ordinary temperature, concentration of the combined extracts under reduced pressure, and separation of the different fractions from the aqueous concentrate with the help of miscible and non-miscible solvents and solvent mixtures, without the use of any chemical reagents. The gilo-sterol was isolated from the unsaponifiable fraction of fatty matter through crystallization from organic solvents. The mixture of giloin and giloinin which initially formed the crude crystallizate obtained on dissolving the ether-insoluble fraction in dilute alcohol and concentration of the solution on the water bath, yielded the individual crystalline substances after a long process of repeated fractional crystallization. There was considerable wastage involved in this process of separation but

it yielded pure products which showed no increase in their melting points on subsequent crystallization.

Giloin is sparingly soluble in ether, petrol ether and benzene, soluble in water and ethyl acetate in the hot and fairly soluble in alcohol, methanol and acetone. It does not contain any methoxy group. It could not be catalytically reduced with platinum black and does not readily absorb bromine in the cold, which would indicate the absence of ethylenic linkages. Giloin is fairly stable to acid hydrolysis but is readily hydrolysed on warming with dilute alkali for a few minutes. Due to its susceptibility to alkaline hydrolysis, it could not be benzoylated by Schotten-Baumann's method, nor methylated with dimethyl-sulphate and alkali. The sugar component of the glucoside was identified as glucose through its osazone. The aglucone could not be isolated, but from the products of acidic hydrolysis, crystalline barium and silver salts of an organic acid have been obtained which are under investigation. Giloin appears to be an α-glucoside as it is not hydrolysed by emulsion. It does not give tests for aldehydes and ketones but reduces Fehling solution due apparently to its initial hydrolysis in alkaline medium. The melting point of giloin would indicate that it is identical with the crystalline product (A) isolated by Bhide and coworkers. In so far, however, as Bhide *et al's* product shows dextro rotation of 48° and analyses for $C_{22}H_{34}O_{10}$ with C, 57·6; H, 7·4 per cent as against giloin, $C_{23}H_{32}O_{10}$, $[\alpha]_D^{35} = +69{\cdot}5°$ with C, 59·0; H, 6·8 per cent, the latter appears to be definitely different from the former. This conclusion gets further support from the fact that in contrast to substance (A), giloin has been established as a glucoside. Bhide *et al's* substance (A) failed to reduce Fehling solution after attempted hydrolysis and it was considered by them to be non-glucosidic in character.

Giloinin does not contain any methoxy group and fails to give an acetyl derivative or a phenyl hydrazone. It is recovered unchanged on heating with dilute acids on the water bath, but on treatment with dilute alkali, it is degraded to water-soluble products from which no crystalline substance could be isolated. It does not give any colouration with ferric chloride and does not reduce Fehling solution.

Giloinin is quite distinct from substance (B), reported by Bhide, Phalnikar and Paranjpe, which melts 24° lower. As no molecular formula has been assigned to their product, no suggestion about its possible relationship to giloinin can be made at this stage.

Comparing the molecular formula of giloin, $C_{23}H_{32}O_{10}$, with that of giloinin, $C_{17}H_{18}O_5$, it was expected that giloinin might prove to be the aglucone of the glucoside. As already stated, however, it has not so far been possible to isolate giloinin or any other aglucone from the hydrolysate of giloin. Further work on the elucidation of this point is in progress.

From the fatty portion, a number of lower melting crystalline substances corresponding to the waxy products reported by the previous authors were obtained, but these were not pursued further. Gilo-sterol, which has not so far been reported by any of the previous authors, was isolated from the unsaponifiable fraction of the fatty matter. It conforms to the formula $C_{28}H_{48}O$ and showed $[\alpha]_D^{32} = +92°$ in alcoholic solution. It gave all the colour reactions of sterols and formed a crystalline acetyl derivative and the digitonide.

Experimental

25 lb. of the fresh stem of *Tinospora cordifolia*, stripped of the green bark and then crushed, was extracted 4 times with water in the hot at 80°-100°C., till the residue was no longer bitter to taste. The aqueous extracts were concentrated under reduced pressure to a thick syrupy liquid (5 kg.) which was treated with 5 gallons of rectified spirit. The alcoholic solution was filtered off from the insoluble matter and concentrated to a small volume *in vacuo*. After a repetition of this process with the concentrate for eliminating most of the starchy matter, the semi-solid residue was successively extracted with ether and benzene. The ether-benzene insoluble portion yielded, through its dilute alcoholic solution, a mixture of crude giloin and giloinin (23 gm.) which were separated through a process of purification and repeated fractional crystallization from alcohol as described later. The combined ether-benzene extracts gave a further small quantity of crystallizate consisting mainly of giloinin, which was separated off. The filtrate was freed of the solvent and the residue consisting of the total fatty constituents was saponified with alcoholic potash. The unsaponifiable matter was separated from the acids in the usual manner, when,

on repeated crystallization through acetone, it finally yielded gilo-sterol, m.p., 192°C.

In a separate working, 25 lb. of the fresh, crushed material were repeatedly percolated with alcohol at the ordinary temperature. The extracts were concentrated under reduced pressure and the concentrate digested with benzene. The benzene layer on removal of the solvent gave nearly 50 gm. of the fatty constituents. The benzene-insoluble residue was dissolved in alcohol and the solution was filtered, charcoaled, concentrated *in vacuo* and kept in the cold, when colourless needles melting at 215°-220°C. separated out. The mother liquors, on further concentration, gave a further crop of crystals, *ca.* 1 gm., consisting mainly of giloinin making up a total yield of 22·5 gm. of the crude crystallizate consisting of giloin and giloinin. The final mother liquors which were not appreciably bitter were rejected.

Giloin — The crude crystallizates consisting of a mixture of giloin and giloinin were dissolved in alcohol, and the solution treated with ether and a small quantity of petrol ether which removed coloured impurities. The clarified solution was concentrated and the alcoholic concentrate diluted with water to turbidity, when, on keeping in the cold, straw-coloured needles of giloin melting at 220°-222°C. separated out, which were filtered, washed with dilute alcohol and dried on a porous plate. After repeated crystallizations from dilute alcohol, dilute acetone and moist ethyl acetate, giloin was finally obtained in the form of colourless, silky needles melting at 226°-228°C. There was no rise in the melting point on further crystallization from any of the solvents. On drying to constant weight at 100°C. *in vacuo* over phosphorus pentoxide, giloin crystallized from dilute alcohol, dilute acetone and moist ethyl acetate showed a loss of 17·9, 17·2 and 17·7 per cent respectively; $C_{23}H_{32}O_{10}\cdot 5\frac{1}{2}H_2O$ requires H_2O, 17·4 per cent. Found after drying: C, 59·0, 59·3, 59·1, 59·4 per cent, mean, 59·2 per cent; H, 7·0, 7·0, 6·9, 6·9 per cent, mean 6·9 per cent; M.W. (cryoscopic in phenol), 496; O-CH_3 (after Zeisel), nil; $C_{23}H_{32}O_{10}$ requires C, 59·0; H, 6·8 per cent; M.W., 468. An air-dried sample in 1 per cent alcoholic solution showed $[\alpha]_D^{28} = +59°$, while the dried product showed $[\alpha]_D^{28} = +69·5°$.

Giloin is nearly insoluble in petrol ether, sparingly soluble in ether or benzene, fairly soluble in alcohol, acetone, methanol, moist ethyl acetate and water in the hot. Giloin does not show any colouration with ferric chloride. It reduces Fehling solution but fails to react with phenyl hydrazine or semicarbazide. It could be recovered unchanged on evaporation of its solution in glacial acetic acid or liquor ammonia on the water bath. It dissolves in cold, concentrated sulphuric acid to a dark-red solution which, on dilution with cold water, gives a cream-coloured precipitate from which some unchanged giloin could be recovered. It dissolves in dilute alkali or saturated baryta on slight warming, but does not separate out on cooling or acidification of the solution due apparently to hydrolysis. It is also hydrolysed when heated with 10 per cent hydrochloric acid on the water bath or on heating with liquor ammonia in a sealed tube at 100°C. The products of hydrolysis in all these cases were water soluble and no crystalline product could be isolated from the reaction mixture.

Hydrolysis of Giloin with Dilute Sulphuric Acid — Giloin (2 gm.) was heated with 200 c.c. of 7·5 per cent sulphuric acid on a water bath for 3 hours. The resultant yellow-coloured solution which showed a greenish fluorescence was shaken out with ethyl acetate. The ethyl acetate extract was washed with water, dried over anhydrous sodium sulphate, filtered and freed of the solvent, when a reddish treacly residue which was insoluble in petrol ether and ether but soluble in other organic solvents was obtained. It was dissolved in ethyl acetate and purified through the addition of ether and a little petroleum ether. The resulting yellowish solution yielded a small quantity of a crystalline deposit (0·07 gm.) melting indefinitely between 245°C. and 252°C. which is under investigation.

The acidic layer was treated with barium carbonate till the solution was neutral, and the filtrate separated from barium sulphate was evaporated to dryness on a water bath. The residue was repeatedly washed with methanol, when a crystalline, colourless product was left behind which gave 53·7 per cent barium. An aqueous solution of the barium salt on treatment with silver nitrate yielded the corresponding silver salt in the form of colourless shining needles, which after drying to constant weight *in vacuo* over phosphorus pentoxide at 100°C. gave C, 14·3, 14·6 per cent; H, 1·9, 1·7 per cent; Ag, 62·0, 64·6 per cent (as AgI).

The methanol solution was freed of the solvent and the residue was taken up in alcohol and purified through ether and a small quantity of petrol ether. The clear solution was concentrated and then refluxed with phenyl hydrazine and 50 per cent acetic acid on the water bath for one and a half hours. The osazone of the sugar component of the glucoside separated out in yellow needles which were filtered, washed with water and dried on the plate. After crystallization from alcohol, it melted at 202°C. and did not show any depression in melting point on admixture with pure glucosazone.

Isolation & Characterization of Giloinin — The combined ether-benzene extracts of the alcoholic extractive of the drug gave, on keeping, a small fraction of crude giloinin melting at 190°-200°C. After repeated crystallizations from a mixture of alcohol and acetone, giloinin was obtained in the form of colourless, silky needles melting at 210°-211°C. Another alcohol-insoluble crystalline substance was also obtained during the process of purification of giloinin which melted at 286°C., but its quantity was too small for a detailed investigation. A further small quantity of giloinin could also be obtained in the course of the fractional crystallization of the crude crystallizate obtained from the ether-benzene insoluble portion of the alcoholic extractive which mainly consisted of giloin ; total yield, 0·001 per cent on the weight of fresh, bark-free stem.

Giloinin is sparingly soluble in petrol ether, ether and benzene, fairly soluble in alcohol, and methanol in the hot, more readily in acetone and chloroform. From alcohol, it crystallizes in colourless, short, prismatic rods. In 1 per cent acetone solution, it showed $[\alpha]_D^{33} = +40°$. It does not contain any methoxyl group, and does not reduce Fehling solution. The air-dried substance does not suffer any appreciable loss in weight on drying *in vacuo* at 100°C. over phosphorus pentoxide. Found after drying : C, 66·8, 67·0 per cent ; H, 6·3, 6·15 per cent ; M.W. (cryoscopic in phenol), 331 ; $C_{17}H_{18}O_5$ requires : C, 67·5 per cent ; H, 6·0 per cent and M.W., 302.

Giloinin dissolves in dilute alkali on slight warming and is not precipitated out on acidification. On treatment with acetic anhydride and fused sodium acetate, also after heating with 5 per cent sulphuric acid, the substance is recovered unchanged. It does not give any colouration with ferric chloride in alcoholic solution.

Isolation & Characterization of Gilo-sterol — After the separation of giloinin from the ether-benzene soluble product, the fatty residue was saponified with 10 per cent alcoholic potash on a water bath. The dark-red hydrolysate was diluted with water and extracted with ether. The ethereal extract was washed with water, dried over anhydrous sodium sulphate and freed of the solvent by warming on a water bath. The residue (15·8 gm.) was kept in the cold in acetone solution, when clusters of colourless needles melting within a range of 151°-158°C. separated out ; yield 5·5 gm. On repeated alternate crystallizations from petrol ether and acetone, the crystallizate finally yielded pure gilo-sterol melting at 190°-192°C. A number of lower melting fractions melting between 157°C. and 182°C. were also obtained in the course of the fractional crystallization, but their quantities were too small for detailed study.

Gilo-sterol gives the Liebermann-Burchard reaction and forms a digitonide. It is fairly soluble in petrol ether, alcohol methanol and acetone in the hot, readily soluble in ether and chloroform. In alcoholic solution, it gave $[\alpha]_D^{32} = +92·8°$. Found after drying to constant weight at 100°C. *in vacuo* over phosphorus pentoxide : C, 83·7 per cent ; H, 11·9 per cent ; M.W. (after Rast), 399. $C_{28}H_{48}O$ requires : C, 84·0 per cent, H, 12·0 per cent and M.W., 400. The acetyl derivative prepared in the usual manner melted at 234°C. with previous shrinking at 220°C.

Acknowledgement

The authors take this opportunity to thank Drs. Weiler and Strauss and Mr. R. C. Tewari for some of the analytical data embodied in the paper. One of the authors (A. K.) is also deeply indebted to *Messrs Cipla Ltd.*, Bombay, for the facilities provided to him in the early stages of these investigations.

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A Method for the Production of Carotene Concentrate from Water Hyacinth (*Eichhronia crassipes*, Solms)

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SEVERAL workers have pointed out the possibility of production of carotene from water hyacinth (*Eichhronia crassipes*, Solms) which is regarded as a pest in Bengal. It grows luxuriantly in ponds and, according to official reports, it has been spreading over an area of 4,269 sq. miles in the lower districts of Bengal. It has been calculated that about 107 million tons of green water hyacinth can be easily had in Bengal. No process or method for the production of carotene from water hyacinth appears to have been recorded so far. A method developed for the production of carotene concentrate on a laboratory scale has been worked out, and described here.

The method consists of the following stages: (1) dehydration of the leaves; (2) extraction of the total pigment by an organic solvent; (3) purification of the extract by chromatographic separation; (4) concentration and recovery of the solvent; and (5) storage.

Experimental

Water hyacinth leaves were collected at Singur, 25 miles away from Calcutta, and were immediately treated as follows:

Dehydration — Lots of 1,200 gm. of fresh leaves were dehydrated by several procedures. In one set of experiments the untreated leaves were placed inside an electric air oven at 60°C. In another set, leaves were chopped and blanched (immersion in boiling water in an aluminium vessel for 3 min.) and dried in an air oven at 60°±5°C. Fig. 1 represents graphically the course of dehydration in the samples treated. The carotene contents of samples treated by the 2 methods are recorded in Table I. The untreated leaves on dehydration show considerable discolouration, while the blanched samples retain much of the greenness.

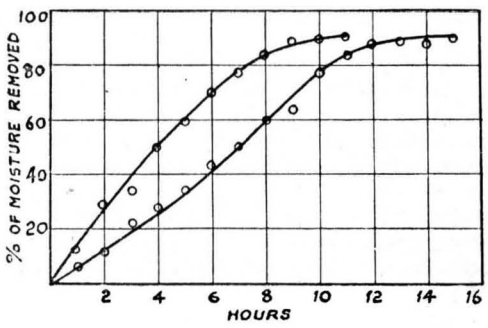

FIG. 1

TABLE I — CAROTENE CONTENT (ON DRY BASIS)

(*mg. per* 100 *gm.*)

UNTREATED	BLANCHED	DIFFERENCE
16·86	28·1	40·1
19·40	35·3	45·0
20·93	34·2	41·7
18·18	31·8	42·8
21·21	36·2	41·4

Blanching hastens dehydration and raises the yield of carotene by about 42 per cent.

Extraction — Extraction was conducted in (1) a glass Soxhlet (2 litres); (2) copper Soxhlet (3 litres); and (3) long-necked, round-bottomed flask (2 litres), fitted with a reflux condenser for direct boiling on water bath. Petroleum ether (b.p., 40°-60°C.) was used for Soxhlet extraction and high-boiling petroleum ether (b.p., 80°-100°C.) was used for direct heating. The yields of carotene are shown in Table II.

It is seen that a maximum yield of 85·3 per cent is attainable when extractions are made by direct heating over a water bath employing high-boiling petroleum ether.

Purification of the Extracts — As phasic separation is unsatisfactory and expensive for adoption on a commercial scale, chromatographic separation was adopted for the purification of the extract. A mixed adsorbent consisting of soda ash and light

TABLE II — 100 GM. OF DRIED LEAVES EXTRACTED FOR 6 HR.

Moisture %	Carotene mg.	Petroleum ether 40°–60°C.				Petroleum ether 80°–100°C.	
		1		2		3	
		Yield	Recovery %	Yield	Recovery %	Yield	Recovery %
84·7	35·1	21·4	61·0	18·6	53·0	29·7	84·6
86·1	28·7	17·04	59·9	15·9	55·0	24·6	85·7
88·3	32·7	18·30	56·1	17·1	52·2	28·4	86·9
85·7	39·7	23·02	59·0	18·7	47·0	34·4	86·6
87·6	37·1	22·33	60·2	18·97	51·1	30·7	82·7
Average							
86·4	34·7	22·24	59·2	17·6	51·6	29·6	85·3

magnesia (*Darlington Brand*) was found to be satisfactory for chromatographic separation. Soda ash is cheap and selective in adsorption. Of the adsorbed materials, the carotenoid pigments, being the least adsorbed constituents of the mixture, passed through while the contaminants, chlorophylls and allied chromogens remained bound to the adsorbent. There was little decomposition of the pigments during the chromatographic analysis. A battery of 3 or more large adsorption tubes, 2″×10″, was employed. Each tube was uniformly packed with an intimate mixture of soda ash and magnesia (6 : 1). The tubes were fitted into rubber stoppers fitted to suction flasks. Petroleum ether (40°-60°C.) was forced through the tubes until the columns were covered with the solvent. The extract was then poured into the tubes and washed with fresh petroleum ether. The process was continued until the carotenoid column (least adsorbed) was washed into the filtering flasks, the washing being deemed complete when the washings began to show the brownish colour of chlorophylls. The principal bands obtained during the chromatographic separation are shown diagrammatically in Fig. 2.

The orange (2) and light-yellow (3) bands were taken together as total carotenes.

The carotene concentrate prepared as above contained a mixture of isomeric forms of carotenes.

Analytical Methods — For the analysis of fresh leaves, the method of Moore[4] was adopted with suitable modification. 4-5 gm. of leaves were minced and refluxed with 50 c.c. of 95 per cent alcohol for 30 min. The extract was filtered into a separator, and the residue further refluxed with 25 c.c. alcohol, filtered, and the filtrate added to the former extract. A mixture containing 90 per cent methanol and petroleum ether

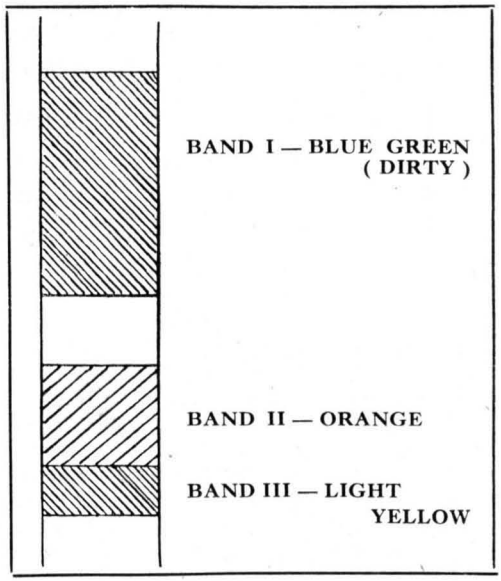

FIG. 2 — CHROMATOGRAPHIC ADSORPTION OF EXTRACT.

(b.p., 40°-60°C.) was used for washing the residue. The residue was macerated in a mortar and re-extracted with further 25 c.c. portions of petroleum ether containing a little methanol. The extraction was continued till the residue was almost colourless. 50 c.c. of water and 2-3 gm. of sodium chloride were then added to the separator containing the combined extracts, shaken, and the two phases were allowed to separate. The alcohol water layer was transferred to a second separator and re-extracted with 25-30 c.c. portions of petroleum ether. The partitioning was repeated 2 or 3 times. The petroleum ether solution was washed with water and dehydrated with anhydrous sodium sulphate. The solution was then chromatographed on a column of 2″×10″, made of the mixed adsorbent described above. The carotene in the solution was estimated using the Evelyn photoelectric colorimeter with filter No. 420, with the aid of a reference curve showing the relationship between colorimeter readings and the concentration of carotene in a standard solution of β-carotene in petroleum ether.

The dried leaves were treated according to the method (E) described by Nelson[5] for dried grass, with the modification that the adsorbent used was a mixture of soda ash and magnesia (6 : 1). 2-2·5 gm. of weighed samples were extracted in a Kjeldahl flask with 50-60 c.c. of *B.D.H.* (Analar)

petroleum ether (b.p., 80°-100°C.) for 2-2·5 hr. and the solution decanted. The residue was further extracted for half an hour with 25 c.c. of petroleum ether and filtered. The combined extracts were purified by chromatographic separation and the carotene concentration estimated as above.

Yield of Carotene — 3 kg. of fresh, chopped leaves were blanched in boiling water for 3 min. and dried in an electric air oven at 60°C. The dried leaves were pulverized and extracted in a series of 3 long-necked flasks with 1 litre of petroleum ether (b.p., 80°-100°C.) for 5 hr. The extract was decanted, and the residue treated with further 100 c.c. of the solvent for half an hour. The combined extract was concentrated to a fourth of its volume and subjected to chromatographic separator in a battery of 3 adsorption tubes (2″×10″) using the mixed adsorbent. The carotenoid pigments were washed with petroleum ether (b.p., 60°-70°C.), collected in a suction flask, and the solvent recovered by distillation under reduced pressure. The residual petroleum ether was removed by a draught of carbon dioxide. The final product was kept in sealed bulbs wrapped in black paper. The results obtained are given in Table III.

TABLE III
(*3 kg. fresh leaves extracted*)

Moisture %	Carotene content (fresh basis) mg	Yield (fresh basis) mg.	Recovery %
87·1	168·3	143·1	84·0
84·9	163·8	138·7	84·6
85·4	156·3	134·6	86·1
86·0	172·7	146·7	87·9

Biological Assay — A group of 6 normal young rats (1 male and 5 females) were maintained on a vitamin A-free diet for about 6 weeks to reduce the body store of the vitamin. The animals were fed on a daily dose of 50 γ of the test product dissolved in 0·1 c.c. of olive oil for a period of 4 weeks. They were weighed at weekly intervals. The average weights of the test animals at the end of the successive weeks are shown in Fig. 3, along with those of rats fed on a normal diet during the same period. There is a graded gain in the weights of test animals after the intake of the product at the end of the depletion period.

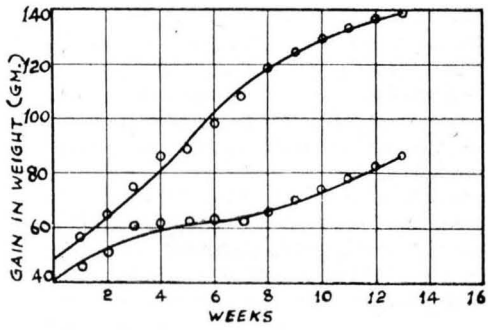

FIG. 3

Acknowledgement

The authors' thanks are due to Shree G. Karmarkar for valuable assistance in the spectro-photometric estimation of carotene.

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Activation of Gangetic Silt

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INVESTIGATIONS on the bleaching properties of Fuller's earth reveal that this is due either to adsorption or absorption phenomenon or to both. Other clays also possess bleaching properties though not to the same extent as Fuller's earth. The bleaching property of such clays can be improved by activation, i.e. by submitting these to certain pre-treatments. Even Fuller's earth has been found to

acquire better adsorptive properties on pre-treatment.

Activated earth and clays find use in the refining of animal, vegetable and mineral oils.

Deposits of Fuller's earth are found in Jodhpur, Jaisalmeer, Jubbulpore and other places in India. Kaolin deposits of Pathraghat and Mangalhat in Bhagalpur, of Singhbhum, Jubbulpore and Gwalior might have been activated and used, but their utilization for pottery and porcelain goods rules out their use for other purposes.

The bleaching property of clays is due mainly to two factors: colloidal nature, and porosity (capillary action). According to Menard and Mallory[1] the mechanical and electrical properties of the earth are responsible for its bleaching action. Benedict[2] holds that the colloidal matter in the earth first undergoes atmospheric oxidation when its adsorptive properties develop. As to the mechanism of adsorption, there is hardly any unanimity of views. Sloan[3] holds that removal of colouring matter is mechanical while Kobayashi and Yamamoto[4] find that adsorption proceeds quantitatively according to Freundlich's adsorption isotherm formula. Haseman[5] discredits any explanation based on adsorption. According to Jatkar[6], the clarification by bleaching earth is solely due to the neutralization of electric charge on the colloidal matter. The removal of large quantities of colouring matter cannot be explained by adsorption alone. Puri and coworkers[7] observe that the colour and other suspended impurities are absorbed in the interstices of clay particles and as such creation of increased pore space of optimum size increases bleaching property of clays. The presence of humus fills up the pore spaces between clay particles and reduces adsorbing property. Hence according to Puri and his coworkers[7] one of the criteria for bleaching clay is the presence of the least amount of humus in it. If humus is present, its removal is essential for activation. The dissolution of aluminium and ferric oxides by acid treatment results in the release of more capillary spaces and increased bleaching power. Parekh and Vaidya[8] also support the view that colouring matter is removed by adsorption.

Clays and earths for adsorptive purposes possess certain characteristics. Each and every clay cannot be activated. The suitability of a clay for activation does not depend on any single characteristic but on a combination of factors, some of which are: (a) high percentage of silica; (b) a rectilinear dehydration curve; (c) an optimum amount of acidity in the clay; (d) base exchange capacity equal to 30 m.e.; (e) negligible quantity of humus; (f) large proportion of conventional clay fraction and very low ultra-clay fraction; (g) specific amount of sesquioxides removable by acid treatment under certain conditions; and (h) montmorillonite type crystal structure under X-rays.

It is, however, unanimously agreed that a soil cannot be activated unless its humus content is negligible and it possesses an optimum quantity of clay fraction and a specific base exchange capacity.

The present work was undertaken to study the suitability of Gangetic silt for activation. As will be evident from the analysis given below the proportion of silica and conventional clay fraction in Gangetic silt is high, and such clays have been known to be amenable to activation.

The process of activation of clays as recommended by previous workers consists of the following stages: (a) acid treatment for part removal of aluminium oxide to obtain a porous structure; (b) washing the acid-treated clay to a definite degree of acidity; and (c) heating to an optimum temperature.

In the present paper the following procedure has been adopted to activate the clay:

(i) Alkali treatment (for removal of humus); (ii) acid treatment (with mineral acid); (iii) washing the acid-treated clay; and (iv) heating the treated clay to an optimum temperature to partially remove water of hydration to give a stable and porous structure to the clay material. (Heating to a very high temperature is not desirable since it may break down the chemical structure.)

Experimental

Gangetic silt collected at Calcutta after the rainy season has the following composition and characteristics:

		per cent
Free silica	..	27·7
Clay substance	..	56·7
$CaCO_3$	..	8·0
Limonite	..	8·8
Al_2O_3	..	22·4
Fe_2O_3	..	9·8

Fe_2O_3 and Al_2O_3 passing into solution on acid treatment (0·5 N HCl for 3 hr.), 16 per cent.

"Humus" passing into solution on treatment with alkali (0.5N NaOH for 3 hr.), after acid treatment, 16·5 per cent.

1 gm. of silt required 65 mg. of NaOH for removal of the humus.

Dehydration Curve — The dehydration curve is determined by noting the loss of weight over a range of temperature between 100°-600°C. when a weighed quantity of the clay was heated in an electric furnace (FIG. 1).

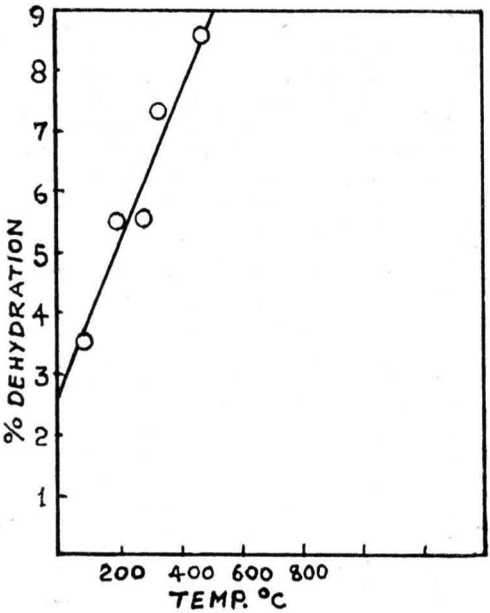

FIG. 1

Gangetic silt contains high silica, low humus and a high clay fraction. It also gives a rectilinear dehydration curve. These are favourable characteristics as will be evident from the following comparison with the analysis of clays activated by previous workers[7].

TABLE I

CLAY TYPE	Fe_2O_3 + Al_2O_3 %	HUMUS %	CLAY SUBSTANCE %	Fe_2O_3 + Al_2O_3 DISSOLVED BY ACID TREATMENT %
Indian bentonite	3·56	0	77·2	3·56
Rawalpindi clay	8·62	0	40·1	...
Puri[7] (P.C. 261)	15·34	0·28	44·3	...
Puri[7] (P.C. 123)	14·78	0	85·5	14·78
Puri[7] (P.C. 72)	15·57	0·44	45·9	15·75
Gangetic silt	32·2	3·5	56·7	16·0

Eight samples of treated Gangetic silt were prepared as follows:

(1) Treated with 3N·NaOH for 4 hr. under reflux, filtered and washed free of alkali.

(2) Treated with 2N·$KMnO_4$ (alkaline) and washed free of alkali after filtration.

(3) A portion of (1) was treated with HCl, filtered and washed free of acid.

(4) A portion of (2) was treated with HCl, filtered and washed free of acid.

(5) Treated with 4N·HCl under reflux for 4 hr., filtered and washed free of acid.

(6) Treated with 4N·HNO_3 as in (5), filtered and washed free of acid.

(7) Treated with 4N·H_2SO_4 as in (5), filtered and washed free of acid.

(8) Untreated sample of silt.

The samples prepared as above were divided into two sets. One set of samples was heated at 200°C. for 2 hr. in a tube furnace and the other set of samples was heated at 400°C. for 2 hr. and these were allowed to cool in a desiccator. The samples were stored in well-stoppered bottles for subsequent tests.

The following tests were carried out with the activated samples: (a) determination of specific pore volume; (b) acetic acid adsorption; (c) caramel adsorption; (d) methylene blue adsorption; and (e) oil refining characteristics.

(a) *Specific Pore Volume* — Test pieces were made with each of the samples prepared above and also of the untreated clay. These were slowly heated at 200°C. and 400°C., cooled in a desiccator and weighed in air (W_1). The pieces were then left overnight soaked in dry kerosene and again weighed after removing the kerosene film on the surface with a filter paper (W_2). Then the pieces were again weighed in kerosene (W_3). From these weights the specific pore volume is given by

$$\text{Sp. pore vol.} = \frac{W_2 - W_1}{W_2 - W_3}$$

where

W_1 = dry weight,
W_2 = weight when soaked in kerosene,
W_3 = weight in kerosene of the soaked sample.

The specific pore volumes are given in Table II.

It will be observed that except in the case of permanganate treatment, there is a marked increase in specific pore volume. But this is not the decisive factor, as the size of the pores is also a determninig factor

TABLE II

Sample No.	Heated at 200°C., Sp. pore vol.	Heated at 400°C., Sp. pore vol.
1	0·49	0·49
2	0·41	0·40
3	0·57	0·55
4	0·53	0·53
5	0·52	0·51
6	0·51	0·54
7	0·51	0·51
8	0·39	0·42

in adsorption and the capillary size is not known here. It is also seen that heating at 400°C. does not appreciably increase the pore space.

(b) *Adsorption of Acetic Acid* — For adsorption of acetic acid, an N/10 solution of acetic acid was employed. About 0·5 gm. of each sample and 25 c.c. of N/10 acetic acid were taken in stoppered bottles and shaken for half an hour in a mechanical shaker and allowed to settle. 10 c.c. of the supernatant were withdrawn and titrated with standard N/10·NaOH solution. The results are given in Table III.

TABLE III

Sample No.	Heated at 200°C., wt. adsorbed per gm. of sample (gm.)	Heated at 400°C., wt. adsorbed per gm. of sample (gm.)
1	0·057	0·036
2	0·031	0·016
3	0·018	0·0016
4	0·020	0·0016
5	0·016	0·0014
6	0·019	0·0015
7	0·016	0·0013
8	0·011	0·0041

An examination of the data shows a gradual decrease in the amount of acid adsorbed from sample 1 to 8. It may be concluded that not only the porous structure formed by the removal of humus plays a part in adsorption, but the oxides of iron and aluminium are also partly responsible for adsorption. In case of acid digestion, these oxides get dissolved and hence the decrease in the adsorption capacity of such samples (No. 3 and 7).

Varying the condition of NaOH treatment, the following results were obtained :

TABLE IV

Sample No.	Treated with 2N. NaOH for, hr.	Temp. of activation, °C.	Wt. of acetic acid adsorbed (gm.)
A	2	200	0·0305
B	2	300	0·0360
C	4	200	0·0385
D	3	200	0·0305
E	3	300	0·0360

It is thus observed that treatment with alkali for greater length of time increases adsorptive capacity.

From Table III it will be seen that if the temperature of heat treatment is increased to 400°C., the amount of adsorption decreases. It is further observed that raising the temperature to 300°C. increases the absorptive quality. There is evidently a structural breakdown beyond 300°C. This is substantiated by the dehydration curve.

(c) *Adsorption of Caramel* — 6 gm. of cane sugar were taken in a conical flask and heated in a sulphuric acid bath to 210°C. The caramelized sugar was dissolved in water and made up to 1 litre and rendered slightly acid with dilute hydrochloric acid ; 50 c.c. portions of this solution were taken in separate stoppered bottles, each containing differently prepared samples of activated silt. The bottles were put in a shaker for half an hour. A Dubosq colorimeter was used to study the amount of decolourization.

TABLE V

1 gm. of sample + 50 c.c. of caramel solution

Sample No.	Heated at 200°C., % decolourization	Heated at 400°C., % decolourization
1	nil	nil
2	28·5	nil
3	25·0	26·0
4	10·4	7·7
5	17·8	11·8
6	32·6	5·3
7	30·2	19·0
8	4·1	nil

Table V shows that acid-treated samples are better decolourizing agents.

(d) *Adsorption of Methylene Blue* — 1·0875 gm. of methylene blue were dissolved in water and made up to 1 litre. 75 c.c. of this solution were taken, made alkaline with 5 c.c. of N/10·NaOH (methylene blue is better adsorbed in alkaline medium) and made up to 100 c.c. ; 50 c.c. portions of this solution were taken in bottles containing different samples. The contents were shaken for half an hour in a mechanical shaker and allowed to settle. The colour of the supernatant was matched with that of the remaining 50 c.c. of methylene blue solution. The results obtained are shown in Table VI.

It will be seen that the acid-treated silt samples are better adsorbents of colour.

TABLE VI

Sample No.	200°C. without alkali		200°C. with alkali	
	wt. of sample (gm.)	% decolourization	wt. of sample (gm.)	% decolourization
1	0·53	13·0	0·52	16·6
2	0·54	37·5	...	...
3	0·54	23·0	0·52	66·0
4	0·52	20·0	...	...
5	0·52	23·0	0·52	60·0
6	0·54	23·0	...	...
7	0·53	16·6	...	...
8	0·51	13·0	...	...

The removal by acid of iron and aluminium gives a better porous structure and higher specific pore volume irrespective of the size of pores, and is more responsible for decolourization. It is also observed that electro-positive dyes are more effectively adsorbed than electro-negative dyes.

(e) *Decolourization of Groundnut Oil* — The decolourization of groundnut oil with mixtures of activated clay No. 3 and " clarit " was studied. 50 c.c. of oil were shaken with each sample for 25 min. at 90°C., cooled and the colour matched with the original oil sample (TABLE VII).

TABLE VII

Wt. of sample (gm.)	% adsorption of colour
0·5 clay	25·1
0·4 clay + 0·1 clarit	26·4
0·3 clay + 0·2 clarit	27·5
0·2 clay + 0·3 clarit	28·5
0·1 clay + 0·4 clarit	28·0
0·5 clarit	26·8

It will be seen that there is a slight increase in the percentage adsorption in the initial stages which reaches a maximum, and then there is a slight downward trend.

Discussion

The above results show that the adsorption property displayed by activated clay varies with the nature of the substance to be adsorbed. It is also seen that while acid-treated silt, which has been previously treated with alkali, is a good adsorbent of colour, the simple alkali-treated clay is a good adsorbent of acetic acid. Here the aluminium oxide and ferric oxide are effectively removed. These perhaps play an important rôle. It is, therefore, difficult to hold that in the case of acetic acid adsorption the removal of alumina and iron oxide is necessary. Humus may choke up pore spaces and so hinder adsorption, but alumina and iron oxide, which form a lyophobic suspension and are easily precipitated by an electrolyte, may not do so. But, for colour adsorption from caramel solution, which takes place better in an acid medium, there may be dissolution of some iron present in the clay and thus impart colour to the solution. Hence, the presence of iron oxide is undesirable. It is not clearly known what part alumina plays in such cases.

From these considerations it may be held that the process of activation must vary with the purpose for which the clay is to be used. Further, though by the removal of humus and sesquioxides the pore space is increased, the size of these pores are not known. For viscous substances a fine capillary is inactive, while for a non-viscid substance the same pore space may be active. Determination of the pore space does not lead to any definite conclusion.

Acknowledgement

The authors wish to express their sincere thanks to Dr. H. N. Das Gupta for his keen interest in this work.

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A Note on Infra-red Radiation Treatment of Paddy

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ABOUT 60 per cent of the rice consumed in India is par-boiled. The par-boiling process as practised in the country is not standardized. The drying of treated paddy, for instance, has not received sufficient attention, and sun-drying, which is widely followed, is time consuming, and does not lend itself to control. There is also the risk of infection by putrefying organisms and the development of objectionable odour in the finished rice. The moisture content of cured paddy also is an important criterion in husking without damage, and has to be controlled.

By shortening the period, and improving the technique of drying cured paddy, the objectionable odour in par-boiled rice can be eliminated and the husking process improved.

The present investigation relates to a comparative study of the water soluble vitamins (B Group), odour, colour and swelling number of samples of par-boiled rice obtained from cured paddy dried by exposure to (1) sun, and (2) infra-red radiation.

Experimental

A variety of *aman* rice (*Bhasamanik*) was used for this investigation. The equipment used for infra-red exposure consisted of an oven, enclosed on the sides, with top opening for ventilation, and provided with 2 units in series (dull emitters), one above and one below a wire rack on which the material to be dried is spread. The standard rating of each unit is 700 W and the wavelength emitted is 40,000Å. The heating chamber is totally reflective. The oven can be worked either with both lamps on or with one.

3,000 gm. of paddy were steeped in 6 litres of water and then boiled in the steep. The details of treatment are given in Table I.

Portions of the treated paddy were dried by sun-drying and by infra-red radiation.

TABLE I

No.	Temp. of steep, °C.	Duration of steep, hr.	Temp. during par-boiling, °C.	Duration of boiling, hr.
1	35	24	80	1·25
2	35	72	80	1·0

TABLE II — RICE FROM PADDY DRIED IMMEDIATELY AFTER PAR-BOILING

	Steeped for 24 hr. followed by 1·25 hr. boiling		Steeped for 72 hr. followed by 1 hr. boiling	
	Sun-drying	Infra-red drying	Sun-drying	Infra-red drying
Thiamin content, µgm./gm.	1·88	1·85	1·78	1·76
Nicotinic acid content, µgm./gm.	31·89	31·80	31·15	30·9
Swelling number	270	267	268	269
Drying time, hr.	12	2·25	12·5	2·35
Final moisture content, per cent	11	10	10	10
Colour	reddish	reddish	cream	cream
Odour	slight	faint	prominent	faint
Average temperature of grains during drying, °C.	45	70	44	77

TABLE III — RICE FROM PADDY LEFT FOR TWO DAYS AFTER PAR-BOILING BEFORE DRYING

	Steeped for 24 hr. followed by 1·25 hr. boiling		Steeped for 72 hr. followed by 1 hr. boiling	
	Sun-dried	Infra-red	Sun-dried	Infra-red
Thiamin content, µmg./gm.	1·8	1·78	1·76	1·73
Niacin content, µmg./gm.	30·4	30·05	29·8	29·4
Swelling number	263	260	261	262
Drying time, hr.	11	2	11·50	2·08
Final moisture content, per cent	11	10	11·25	10·5
Colour	reddish	reddish	reddish	reddish
Odour	prominent	slight	objectionable	prominent

TABLE IV

Thiamin, µgm./gm.	0·78
Niacin, µgm./gm.	21·7
Swelling number	370
Colour	cream
Odour	nil

The drying time required to bring down the moisture content to the air-dried level (10 per cent) was noted in each case.

The dried samples were husked in a laboratory mill, and thiamin[1], nicotinic acid[2], and swelling number[3] determined. The results are shown in Tables II and III.

The characteristics of raw milled rice obtained from the same paddy are given in Table IV.

It will be observed that infra-red radiation reduces the period of drying to a considerable extent without lowering the vitamin value. The space required for drying is also much smaller than in sun drying.

The adoption of radiant drying in parboiling process may help to eliminate the boiling or wet-heating stage, if the steeping is carried out with water at a higher temperature.

The authors are grateful to Mr. P. B. Sen for his kind encouragement and helpful guidance during the progress of the work.

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A Simple Volumenometer

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DETERMINATION of the volume of powders like rice flour, powdered coffee, cement, etc., by displacement methods are often vitiated by the solution effects of the displacing liquids. Difficulties of this type have been overcome by the use of volumenometers : Blyth and Blyth[1], Francis and Oxnard[2], Binnington *et al.*[3], Reilly and Rae[4] among others.

With regard to rice, Kondo[5] and Kondo and Okamura[6] determined the volume of raw and cooked rice by water displacement. Srinivasan and Mudaliar[7] improvised an improved dilatometer for the same purpose. Verghese[8], during the course of an investigation on quality in rice, felt the necessity for measuring the volume of rice, raw and cooked, and of rice flour out of contact with water or other displacing liquids and the apparatus detailed in this paper was consequently devised.

The Volumenometer — (A) The volumenometer bottle is a jam jar, 200-300 c.c. capacity, (B) a rubber washer and (C) the inner lid. A short length (6-9 inches) of a narrow metal tube is soldered air-tight over a suitable aperture cut in the centre of (C). The tube then passes through an opening cut on the collar-like outside lid of the jar so that when the jar is closed and the collar tightly screwed on, the bottle is connected to outside air only through the metal tube (D).

The metal tube (D) is connected by a bent capillary tube (F) to a 100 c.c. pipette bent as shown and fixed to a wooden board by clips. Prior to being fitted upon the board, two marks (G_1) and (G_2) are made on the straight end portions of the pipette and the volume of the tube in between these two marks established by determining the weight of water contained therein at room temperature. The lower end of the pipette is connected by rubber tubing to a **y** piece (H). The other two ends of the **y** piece are connected to a manometer. This is formed by a glass tube (I) fixed on the board and a rubber tube (J) attached to a reservoir of mercury (K). Readings of the manometer are made on the scale (L) screwed on to the board. Two meter scales are placed end to end so that their zero points coincide. On one side of the scale are the straight end portions of the pipette tube and on the other the glass tube arm of the manometer.

(M) is a small bottle containing a known volume of distilled water, a provision for creating aqueous tension of saturated water vapour when the apparatus is in use.

Volume of the Volumenometer Bottle — This is determined as follows :

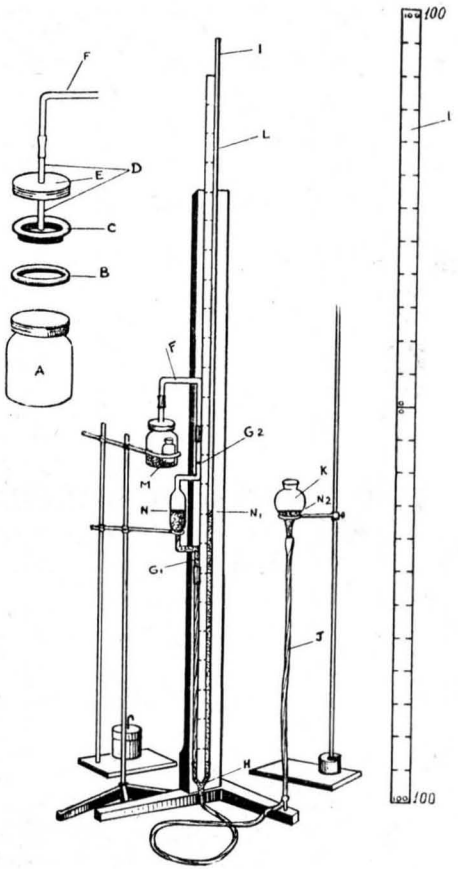

FIG. 1 — A SIMPLE VOLUMENOMETER.

Step I — To start with, the mercury reservoir is raised or lowered until the pipette tube is about half filled with mercury — approximately at position N-N_1-N_2. The reservoir is clamped in this position for a while. When the mercury level at N_1 is constant, the volumenometer bottle is attached and closed air-tight. A certain mass of air is thus enclosed at room temperature and atmospheric pressure.

Step II — The reservoir is then lowered until the mercury level stands at the mark G_1 of the pipette. The enclosed air thus expands in volume and consequently there is a fall in pressure. The difference in pressure is noted. The reservoir is again raised to its initial position and once more brought down and a second reading of pressure made. The average of the two readings is taken for calculation. Let the difference in pressure be P_1. Then, the room temperature remaining constant, according to Boyle's Law,

$$(V+V_1)\ (B-P_1-W)=K \qquad (1)$$

Where

V = volume of the volumenometer bottle, i.e. volume of air contained in the bottle plus the connecting tube up to the mark G_2 of the pipette

V_1 = volume of the pipette tube = volume from mark G_2 to G_1

B = barometric pressure at room temperature

P = difference in pressure due to the rarefication

W = tension of saturated water vapour at room temperature

Step III — The reservoir is then raised to the upper mark G_2. The enclosed air is compressed and hence the mercury level in the manometer tube rises. The increase in pressure is noted. The reservoir is again brought down, then raised to the mark G_2 and another reading for increase in pressure taken. The average of the two readings is noted. Let this be P_2. Then

$$V\ (B+P_2-W)=K \qquad (2)$$

From equations (1) and (2), we get

$$(V+V_1)\ (B-P_1-W)=V(B+P_2-W) \qquad (3)$$

or

$$V=\frac{V_1\ (B-P_1-W)}{P_1+P_2}$$

V_1, P_1, P_2 are already known. B is read on a standard barometer fitted up in the same room and W is read from tables. V can then be calculated. A number of separate determinations are made and the average value taken as the volume of the bottle. The results of two sets of determinations are given in Tables I and II.

TABLE I — VOLUME OF VOLUMENOMETER BOTTLE NO. 1

V_1	B	W	P_1	P_2	$V=\frac{V_1(B-P_1-W)}{P_1+P_2}$ c.c.
100	72·510	3·9565	9·40	8·5	330·5
100	72·475	3·9565	7·10	11·5	330·2
100	72·400	4·0007	11·40	11·4	331·4
100	72·410	3·9560	7·50	10·9	331·3
100	72·500	3·9340	4·90	14·4	329·9
100	72·450	3·8045	3·35	16·35	331·4
100	72·500	3·3045	7·45	11·05	331·1
				AVERAGE	330·8

TABLE II — VOLUME OF VOLUMENOMETER BOTTLE NO. 2

V_1	B	W	P_1	P_2	$V=\frac{V_1(B-P_1-W)}{P_1+P_2}$ c.c.
100	72·595	3·5760	12·45	15·10	205·3
100	72·730	3·7410	12·46	15·04	205·5
100	72·550	3·6165	12·25	15·35	205·3
100	72·085	2·9441	12·98	14·30	205·9
100	72·335	3·4761	13·28	15·55	205·7
100	72·630	3·0479	12·75	15·02	204·9
100	72·350	3·0480	12·85	14·58	205·8
100	72·360	3·1190	12·90	14·50	205·6
100	72·460	3·0131	13·00	14·45	205·6
100	72·480	2·9782	13·30	13·98	206·0
100	73·085	3·0479	11·48	17·00	205·6
100	72·890	2·7290	11·25	17·47	205·2
				AVERAGE	205·5

TABLE III

No.	Weight gm.	Volume	
		Raw, c.c.	Cooked*, c.c.
1	20	13·5	31·1
2	20	15·0	31·1
3	20	14·9	32·8
4	20	15·4	31·6
5	20	14·5	40·4
6	20	14·9	30·5
7	20	14·3	30·8
8	20	14·0	30·2
9	20	14·7	31·1
10	20	14·9	31·1
11	20	14·6	33·2
12	20	14·8	35·6
13	20	15·0	34·3
14	20	14·0	33·6
15	20	14·1	33·8
16	20	14·6	35·7
17	20	14·6	36·8
18	20	14·8	37·3
19	20	14·0	37·1
20	20	14·8	38·2
21	20	13·9	37·9
22	20	13·7	38·0
23	20	14·3	39·3
24	20	14·1	39·1
25	20	14·1	40·2
26	20	14·3	44·4
27	20	14·3	41·2
28	20	14·3	54·5
29	20	14·2	53·6
30	20	14·0	54·6
31	20	14·7	54·8
32	20	14·5	57·7
33	20	14·6	67·7
34	20	14·6	63·1
35	20	14·9	60·9
36	20	14·0	59·1
37	20	14·4	53·2
38	20	13·8	67·4
39	20	13·5	66·1
40	20	14·1	69·7
41	20	14·7	66·0
42	20	13·9	64·6

* After reading the volume in the volumenometer, the rice is cooked for different intervals of time and the volume of cooked rice determined. The results are given in column 4.

Volume of Sample — The sample of rice or any other material, the volume of which is to be determined, is carefully introduced into the volumenometer bottle at step I before it is clamped and closed air-tight. Steps II and III are repeated just as before. In other words the volume of the volumenometer bottle is once more determined. The difference in the two determinations will give the volume of the sample.

The accuracy of the apparatus was tested by estimating the volume of known weights of glass beads, lead shots, etc. Results obtained were concordant.

During the last six years, several hundreds of samples of rice were examined for the gain in volume on cooking by the method detailed above. Results of the volume measurements of forty-two 20 gm. aliquot portions of a uniformly grained sample of hand-pounded rice GEB 24 are given in column (3) of Table III. A statistical analysis of the data gave a low standard deviation, 0·41, and a low coefficient of variation 2·84, testifying to the reliability and accuracy of the method.

Acknowledgement

The author is deeply indebted to Mr. P. D. Karunakar, Government Agricultural Chemist, Madras, for affording facilities for conducting the work and for helpful suggestions and criticism.

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Letters to the Editor

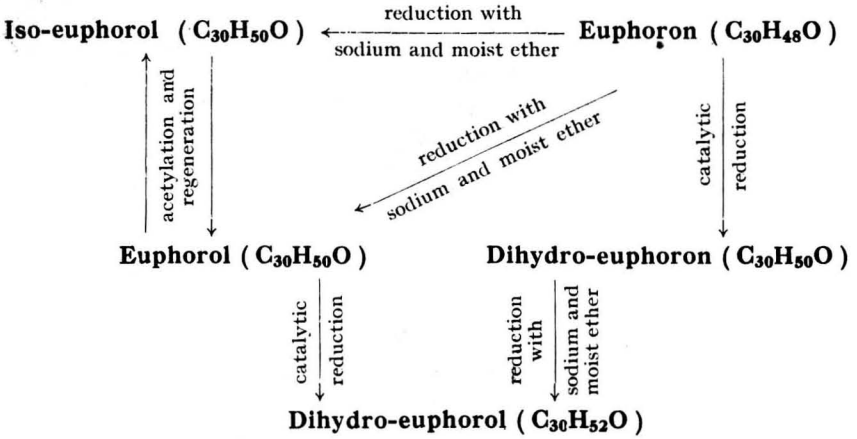
CHEMICAL EXAMINATION OF THE LATEX FROM *EUPHORBIA TIRUCALLI*

Karimullah and Dutta[1] reported the isolation of a crystalline ketone from the dried latex of *Euphorbia tirucalli*. Karimullah and Gopalachari[2] subsequently named this ketone euphoron, $C_{30}H_{48}O$, and showed that it forms the main crystalline constituent of the dried latex.

Working on a sample of the fresh latex of *Euphorbia tirucalli* recently received from South India in a sealed tin, a new

crystalline substance has been isolated in a yield of 5 per cent (on the weight of dry matter) in place of the ketone isolated earlier (loc. cit.). This substance is an alcohol, m.p., 118°-119°C., $[\alpha]_D^{32°} = +36{\cdot}5$ which analyses for the formula $C_{30}H_{50}O$ (found: C, 84·0; H, 11·94; calculated for $C_{30}H_{50}O$; C, 84·41; H, 11·74) and has been provisionally named *iso*-euphorol. It is isomeric with euphorol, $C_{30}H_{50}O$, m.p., 108°-109°C., $[\alpha]_D^{28°} = +24$, obtained from euphoron by reduction with sodium and moist ether[3]. Its acetyl derivative as well as the product of its catalytic reduction are identical with euphorol acetate, $C_{32}H_{52}O_2$, m.p., 107°-108°C., and dihydro euphorol, $C_{30}H_{52}O$, m.p., 122°-123°C. respectively. Euphorol acetate, on hydrolysis with N/10 alcoholic potash, yields a crystalline product from which both euphorol and *iso*-euphorol have been obtained by fractional crystallization. Further, it has been noted that when euphoron dissolved in the minimum quantity of moist ether is reduced with a large excess of sodium, the resultant product gives, after a series of fractional crystallizations, euphorol as the major fraction of the total crystallizate, and a small quantity (2 per cent) of a substance which melts at 118°-119°C., shows no depression in m.p. when mixed with *iso*-euphorol and gives euphorol acetate on treatment with acetic anhydride. It would thus appear that *iso*-euphorol is also produced along with euphorol in the reduction of euphoron with sodium and moist ether and that these two alcohols are stereo-isomerides derived from the same ketone euphoron. The formation of these isomeric alcohols in the reduction of euphoron is somewhat similar to the formation of the two borneols from camphor by reduction with sodium and alcohol.

Results of further studies in the constitution of euphoron and the various products derived from it are being communicated in a separate paper[3]. The relationship between these products and euphoron may be represented as follows:



Acknowledgement

The authors thank the District Forest Officer, Madura for supplying the latex used in these investigations.

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S. SIDDIQUI

Chemical Laboratories, Council of Scientific & Industrial Research, Delhi
May 9, 1949

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OCCURRENCE & UTILIZATION OF VANADIUM-BEARING IRON ORE IN BIHAR

OVER A STRETCH OF 30 MILES FROM BARIARPUR railway station (Sahibganj Loop, E.I.R.) running more or less along the Monghyr-Jamooee Road, up to the Jamooee railway station (E.I.R. Main Line) and close to the eastern slopes of the hills lie partially smelted vanadium-bearing iron ore deposits. They are concentrated at Mainma Tal near the Abhaipur railway station. Large dumps are seen at Khotadih and Bhaduridih and Kharagpur Lake in the low-lying fields. At Ghorakhpur, Pankul, Lakhon Sukhmaria, Kusmaha, Jogti, Kadarkol and Kauba, they

occur in hilly regions. The first is easily accessible from Shampur, and the others from Bharhat, 5 miles east of the Jamooee railway station. The ore bodies appear to be associated with schists at the out-crop near the village Nauagarhi, 5 miles west of Monghyr, and lie in dumps near the mines worked long ago. These can be worked side by side with the dumps. However, the dumps are large enough to give all the mineral required for several years to come.

Partially smelted ore bodies have been also observed about 70 miles from this zone at Ranijharna close to the village Lohsingha in the Banka sub-division of Bhagalpur district. The present investigations are confined to Benaili Zamindari only, but similar ores may occur in the areas of other zamindaris, particularly, the Lachmipore Zamindari.

Analysis of a representative sample of the ore from Benaili Zamindari gave the following results :

SiO_2	26·60	per cent
Al_2O_3	12·67	,,
Fe_2O_3	56·67	,,
TiO_2	0·71	,,
MnO_2	1·95	,,
V_2O_3	0·1-0·5	,,
Undetermined	1·45-0·95	,,

On the basis of this analysis, the following conclusions appear justified : (1) the vanadium content of the ore is not high enough to hold out prospects for the extraction of vanadium oxide ; (2) direct manufacture of suitable alloys from the ore by suitable treatment is a feasible alternative. The titanium content of the ore is low and is unlikely to interfere with the smooth working of the blast furnace ; it can be removed easily along with the slag. The vanadium content is high enough to produce the desired alloys (vanadium steels contain V_2O_3 varying from 0·11 to 0·18) ; (3) the silica (26·6 per cent) can be removed completely during the smelting operation. The elimination of silica raises the vanadium content by 26·6 per cent.

A careful survey of the whole area has to be made and further samples have to be analysed in order to establish the suitability of the ore for the direct manufacture of vanadium steels. Jamalpur is a convenient site for erecting the smelting furnaces. The nearest dump is 6 miles away from it and cheap power is available for running electric furnaces.

Bhagalpur A. N. CHOWLA
April 30, 1949

IONOSPHERIC ABNORMALITIES DURING SOLAR DISTURBANCES

IN COURSE OF OUR ROUTINE OBSERVATIONS on ionosphere carried out at Calcutta, certain abnormal characteristics of the E and the F regions have been observed since the middle of January 1949. These appear to be related to the pronounced increase in sun-spot activity noticed since the same time. The purpose of the present note is to record the salient features of these ionospheric abnormalities.

The days in which the abnormal disturbances occurred were more frequent in February than in January. The disturbed days in January were : 17, 18, 20, 21, 26 and 27. In February almost all the days throughout the month excepting those in the first week were found to be disturbed. On January 26 and on February 16, the disturbances were very pronounced and were accompanied by radio fade-outs. The other days were only moderately disturbed.

During the days of moderate disturbance, the ionospheric characteristics showed abnormal variations, but reflections could be obtained throughout the hours of observations. The general nature of variations during such days was as follows : the ionization of region E increased abnormally, specially in the afternoon and in the early part of the night. The ionization of region F_2 during daytime did not deviate appreciably from the normal trend, but the values of y_m (vertical semi-thickness of the layer assuming parabolic distribution of ionization) and h_{max} (height of maximum ionization) were found to be higher than normal. At night, however, the ionization of this region attained abnormally high values while the values of y_m and h_{max} came down nearly to normal.

During days of pronounced disturbance, January 26 and February 16, the abnormalities were very great, so much so that during certain periods reflections from all ionospheric layers ceased altogether. In other words, fade-outs occurred. The nature of variations on these days for the different ionospheric regions is discussed below.

On January 26, the ionization of region E suddenly began to increase from 10.45 hr. and very high frequencies were reflected from this region. Reflections from region F_2 could not be observed from 11.00 hr. On the low frequency side, reflections could not be obtained on frequencies on which

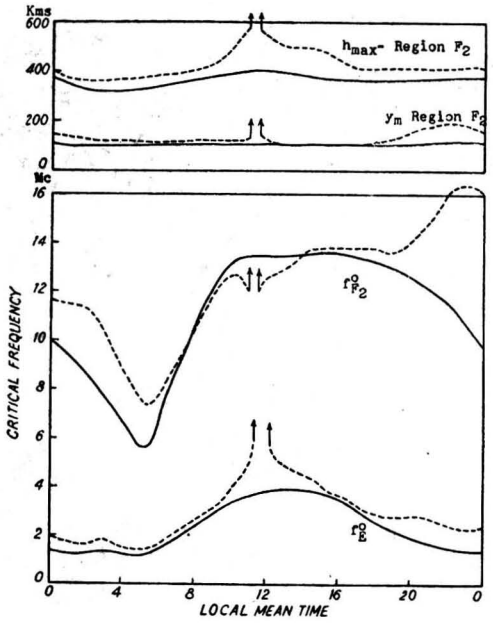

FIG. 1 — VARIATION OF THE CRITICAL PENETRATION FREQUENCY OF REGIONS E AND F_2 (BOTTOM CURVE) AND OF THE THICKNESS AND HEIGHT OF MAXIMUM IONIZATION OF REGION F_2 (TOP CURVE) ON NORMAL DAYS IN JANUARY 1949 (CONTINUOUS LINE CURVE) AND ON THE DAY OF FADE-OUT (BROKEN LINE CURVE). ON THE DAY OF FADE-OUT (26TH JANUARY), REFLECTIONS FROM REGION F_2 STOPPED AT 11.00 HR. AND REAPPEARED AT 11.30 HR. REFLECTIONS FROM REGION E STOPPED AT 11.12 HR. AND REAPPEARED AT 12.12 HR.

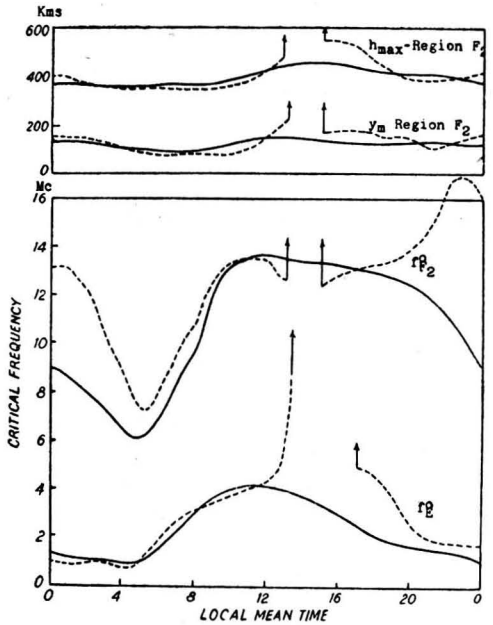

FIG. 2 — THE CURVES DEPICT SIMILAR VARIATION AS FOR FIG. 1. CONTINUOUS CURVE FOR NORMAL DAYS, FEBRUARY 1949. BROKEN LINE CURVES FOR FEBRUARY 16, 1949, ON WHICH FADE-OUT OCCURRED.

E region reflections are normally obtained. Evidently this was due to the formation of a strongly absorbing lower (D) region. About 12 minutes later all reflections ceased. This complete fade-out lasted for about 24 minutes, and reflections began to reappear first from region F_2 at 11.30 hr. and then from region E at 12.12 hr. (FIG. 1).

On February 16, the ionization of region E suddenly began to increase abnormally from about mid-day, and at 13·06 hr. reflections from region F_2 could not be obtained. At 13.30 hr. reflections from both the regions ceased altogether. This fade-out lasted for one hour and a half. Echoes were again obtained first from region F_2 at 15.00 hr. and then from region E at 17.00 hr. (FIG. 2).

On both the days, just before the fade-out of F_2 region reflections, the ionization of this region began to decrease while y_m and h_{max} both increased enormously till reflections from this region ceased altogether (FIGS. 1 and 2). The frequencies which were normally returned from this region were then found to be reflected from E region heights.

About 7 to 8 hr. after the fade-out, the ionization of region F_2 began to increase steadily and on both the days attained a maximum value round about midnight. This value was found to be almost 200 per cent of the normal value. About 2 to 3 hr. after the fade-out, the intensity of the reflections began to increase steadily suggesting the gradual disappearance of the strongly absorbing D region. During the nights following the disturbed days, region E ionization was found to be abnormal (FIGS. 1 and 2).

Investigations described above form part of the programme of the Radio Research Committee of the *Council of Scientific & Industrial Research*, Government of India, and have been carried out in the Ionosphere Laboratory of Prof. S. K. Mitra.

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May 13, 1949