Journal of Scientific & Industrial Research

A — General

N THIS ISSUE

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Journal of Scientific & Industrial Research

Vol. 15A, No. 7, JULY 1956

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COVER PICTURE

The picture on the cover shows the feldspar jig washer installed recently at Lodna in the Jharia coalfield area. The plant, which has a rated capacity of 70 tons/hr., has been tested at the Fuel Research Institute for its efficiency under various operating conditions.

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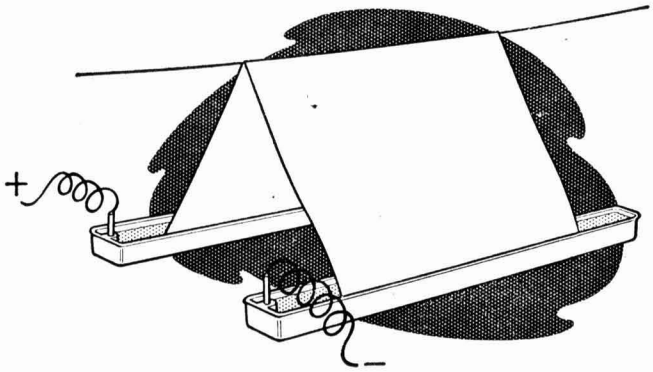
PROGRESS IN

CHROMATOGRAPHY 2



SEPARATION OF LARGE MOLECULES BY ELECTROPHORESIS

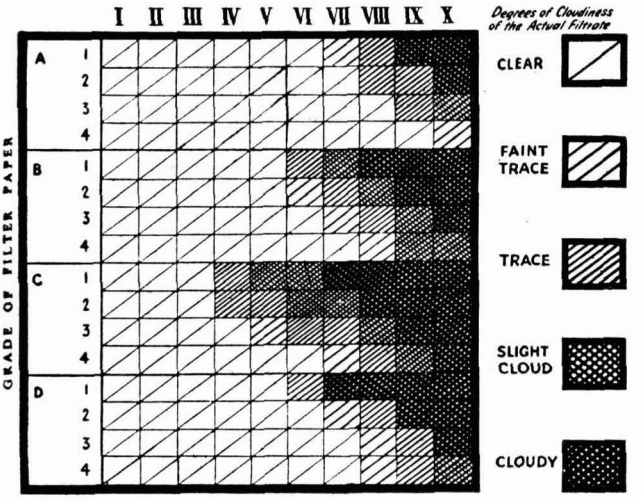
Since most large molecules and colloidal particles carry a charge, electrophoresis is obviously a convenient method of separation. However, the disadvantage is that, when the potential gradient is merely applied across a buffered solution of the material to be separated, re-mixing may occur owing to convection currents, and complete resolution of the fractions is not possible.

Such difficulties have been overcome by using filter paper to provide a capillary mesh to hold the solution. Each end of a filter paper sheet soaked in buffer dips into a trough containing an electrode and a quantity of the buffer solution. When a solution of the test material is applied to the centre of a strip, its components will migrate towards one or other of the electrodes. Their direction and rate of travel (hence their position on the strip) will furnish a clue to their identity. Re-mixing cannot occur, and the fractions are available for both qualitative and quantitative examination.

ELECTROPHORETIC ANALYSIS OF SERUM PROTEINS IN CHRONIC RHEUMATIC DISEASES

The analysis of serum protein for purposes of diagnosis has been greatly advanced by paper electrophoresis. Kunkel and Tiselius (*J. Gen. Physiol.*, **35**: 89. 1951-2) have described a procedure which is 'extremely simple and surprisingly accurate', but lay great stress upon the importance of using the right filter paper. The reason for this is that, though human albumin migrates towards the anode, there is an electro-osmotic flow of buffer solutions towards the cathode. It has been found that Whatman 3MM. paper is satisfactory in reducing this flow to the desired minimum. The physician's diagnosis is confirmed by an increase of gamma globulin and some decrease in albumin, both of which are revealed by simple inspection. The paper strip method brings electrophoretic analysis well within the scope of normal clinical laboratory routine, and compares very favourably with previous techniques on cost, time and accuracy.

A test for filter papers



A FAVOURITE and well-tried test for a filter paper is to examine its performance in filtering a suspension of barium sulphate. T. B. FORD LTD., LONDON, have been examining the possibilities of developing this method, and the process described here may be of considerable general interest.

The method which they adopt is based on the general theory of small-particle formation propounded by von Weimarn, who stated that

Initial rate of condensation (V) =

$$K \frac{\text{condensation pressure}}{\text{condensation resistance}}$$

He suggested that the normal solubility of the precipitate substance is a measure of the condensation resistance, and that the condensation pressure is the difference between the total concentratoin (Q) momentarily produced as a result of a chemical reaction and the normal solubility S, so that

$$V = K \frac{(Q-S)}{S}$$

If V is large, the rate of condensation is high and the particles will be small. This condition is brought about by having a high value for Q or a low value for S.

Taking 7N solutions mixed in equal quantities they get a momentary concentration of barium sulphate of $3\frac{1}{2}$N, whereas the normal solubility of barium sulphate — the S above — is 2×10^{-5}N, thus

$$V = 175000$$

However, with the relatively high concentration of electrolyte, coagulation would take place and it is, therefore, preferable to keep Q small and reduce the value of S.

By such considerations they are able to produce an accurately graded series of small particles down to colloidal dimensions (labelled I, II, III, etc., in the diagram on left, the smallest, measuring 0.06 microns, shown as X).

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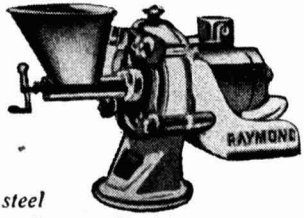

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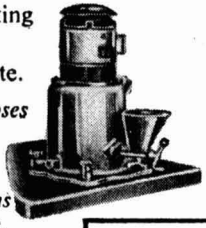

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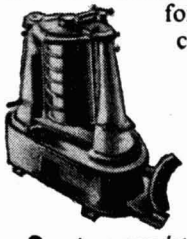

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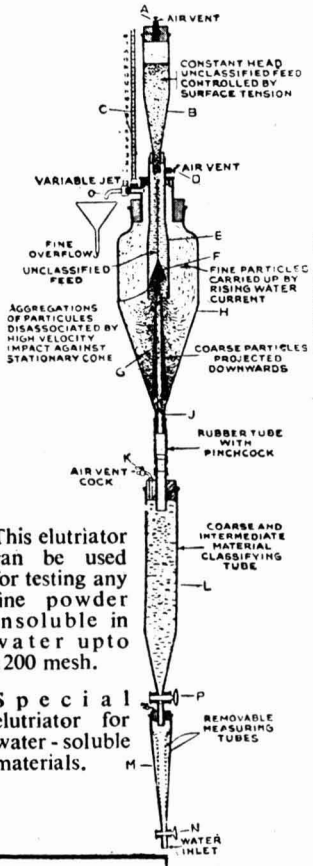

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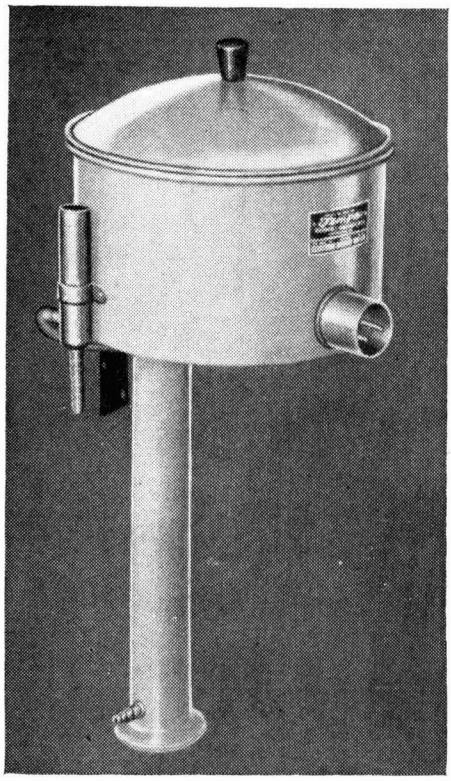

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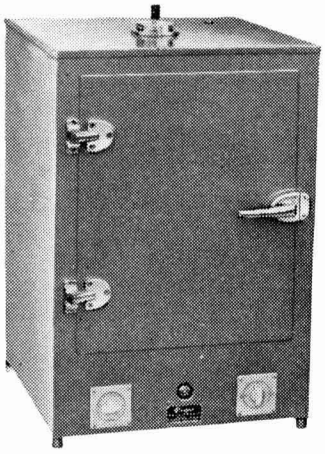

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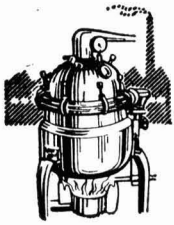

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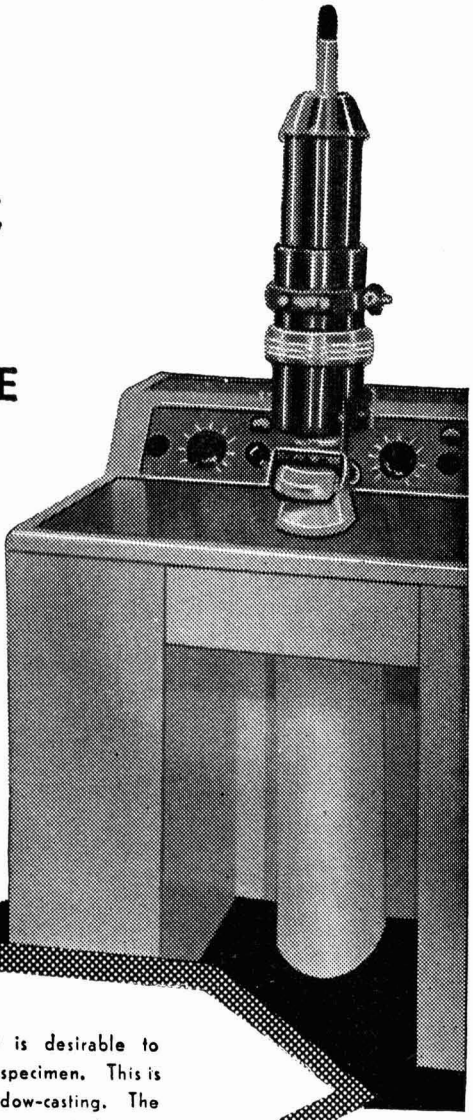

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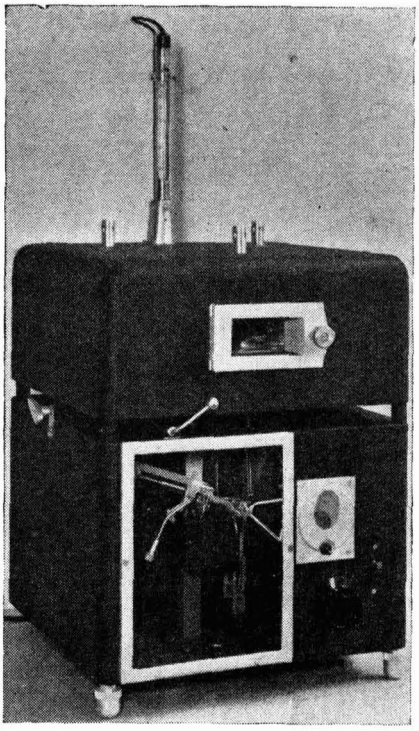

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Engineering Personnel & the Five-Year Plan

THE Engineering Personnel Committee, set up by the Planning Commission in September last year to undertake an overall assessment of demand and supply in regard to engineering personnel and to make such recommendations as may be essential for ensuring an adequate supply of personnel for the next 15 years, with particular reference to the immediate requirements of the Second Five-Year Plan, has just published its report.

The main recommendations of the Committee are: (1) Creation of deployment machinery to co-ordinate the release of personnel from one project and their absorption in another; (2) advance mapping of fields in which specialized training is needed and earmarking personnel for positions on the completion of the training; (3) grant of scholarships for training in urgently needed techniques; and (4) creation of facilities for advanced work in specialized fields.

Supply and demand

The report reveals that in 1960-61 the shortage in the supply of engineering personnel will be 1,800 graduates and 8,000 diploma holders in different branches. It may be possible to secure a 20 per cent increase in the out-turn of graduates and 25 per cent increase of diploma holders, and meet the deficit of graduates and 60 per cent of diploma holders by organization, additional training facilities and expansion of the existing engineering institutions. The Committee has recommended the opening of 18 new colleges and 62 new diploma institutions. The total cost of creating the additional training facilities, expansion of existing institutions and establishment of new institutions is estimated at Rs. 16 crores.

The Committee has also suggested certain interim measures to meet the shortages in engineering personnel. These are: (1) Promotion from lower ranks; (2) more balanced utilization of available talent; a systematic survey should be conducted by employers, particularly in the public sector, with a view to assuring that all employees with engineering experience are fully engaged in activities which make for maximum utilization of their talent; (3) retention of superannuated persons in service; and (4) organization of functional training at the supervisory level.

The Committee has taken into consideration the need for skilled workers for the implementation of development programmes. The Committee has, therefore, suggested that there should be as much planning in the organization of supply of skilled workers as in that of personnel belonging to supervisory and higher grades.

These recommendations are based on the assumption that (1) no major technical change as would seriously affect the requirements of the engineering personnel will take place in the next five years; (2) the present pattern of distribution of work between departments and contractors will continue; (3) an increasing proportion of qualified engineers will be employed in the private sector; and (4) a substantial number of qualified engineers will be required to staff the additional capacity to be created for institutional training.

Emphasis on quality

The Committee observes that the strength and the effectiveness of fututre development will depend, to a large extent, on the quality of engineering personnel available for absorption. No efforts should, therefore, be

spared in achieving a high level of competence in engineers to be trained during the coming years.

The Committee has laid great emphasis on qualitative rather than quantitative improvement and points out that there has been a certain lowering of educational standards in regard to engineering education. According to the report, dearth of teachers of right calibre, inadequate facilities for practical training, insufficiency of equipment and ineffective examinations are some of the main reasons which have contributed to the lowering of general educational standards. The improvement of service conditions for the teaching staff so as to bring them on a par with those obtaining in executive positions under Government and the releasing of competent and experienced men from Government cadres for teaching in colleges are considered important for improving educational standards in engineering institutions. Other suggestions in this regard are: promotion of research in universities, encouraging consultation work by university staff and allowing engineers in service, who display a special aptitude and potentiality for research, to enter the teaching profession on adequate remuneration.

Training of personnel

The report points out that unemployment among engineers is due mainly to the lack of adequate postgraduate practical experience. The employers prefer experienced men and the only possible solution to the problem would be for employers to provide opportunities for experience to persons who have adequate educational qualifications. The Committee suggests that, as far as possible, new institutions should be built around factories and projects so that training could be imparted in a proper environment and employment for trained people could be facilitated. The Committee has further recommended that employers should take full advantage of the basic training given in such institutions before they tap other resources. Considerable advantage is likely to be gained if the institutional training at present available, and to be created, is geared to the requirements of employing authorities by consultations between training institutions and the employers.

Another important recommendation of the Committee is a phased programme of purchase of machinery from foreign countries. Such a programme, according to the Committee, would help stepping up internal production and widen the scope of apprenticeship in the engineering trade. The Committee has further emphasized the need for utilizing all training opportunities offered by foreign consultants and suppliers of machinery. Arrangements for training Indian personnel at the moment are not uniform and the Committee has, therefore, suggested that when foreign consultants are engaged by the Government of India they should lay down a condition that these consultants should train Indian technicians to meet not only the needs of the single plant, but also of similar plants.

Manpower policy

The Committee has emphasized the need for a suitable manpower policy in respect of engineering personnel. The successful implementation of such a policy implies (1) an effective and continuous collection of necessary information; (2) framing of policy on the basis of information thus collected; and (3) execution of such policy. The Committee has recommended the maintenance of a Register of Technical Manpower in the form of a card index, the creation of a Technical Manpower Committee at the Cabinet level and a Committee of Secretaries for carrying out the three functions mentioned above. For this purpose, the Committee has suggested the creation of a Technical Manpower Division in the Planning Commission.

Another important suggestion of the Committee is in regard to the introduction of technical and scientific personnel at suitable levels in the general administrative machinery. The Committee observes that there is a great need for diversification in administration in the present context of building up of a welfare state and recommends that technical and scientific personnel should be introduced at suitable levels in the general administrative machinery, especially to hold posts where their experience is of value.

The implementation of the Committee's recommendations would go a long way in meeting the demand for engineering personnel of the type required in the coming years. Government agencies like the All India Council for Technical Education and the

C.S.I.R., and professional bodies like the Institution of Engineers and the National Institute of Sciences have an important role to play in achieving the objectives set forth in the report. The implementation of the recommendations calls for active co-operation and collaboration between these institutions, Government and industry.

Field Strength Measurements of Radio Waves during the Partial Solar Eclipse of 14 December 1955 at Ahmedabad

R. G. RASTOGI & R. SETHURAMAN
Physical Research Laboratory, Ahmedabad

THE study of ionospheric reflections during a solar eclipse has been of great help in ascertaining the causes of formation and maintenance of ionization in the ionized layers of the atmosphere. Field strength measurements during a solar eclipse also give an indication of the changes in the absorption of radio waves. When the waves are incident obliquely, the intensity of the reflected waves is sensitive to smaller changes in ionization than when they are incident vertically. Measurements of field strengths of obliquely reflected radio waves were taken during the last two solar eclipses at Ahmedabad. During the total solar eclipse on 30 June 1954, Rastogi and Sheriff[1] observed at Ahmedabad an increase in the signal strength of the B.B.C. signal on 15·07 Mc/s. The propagation in that case was presumably by two-hop reflection from the F_2 layer and the increase in the signal strength was due to a decrease in the absorption in the F_1 layer. A more convincing result was obtained from the field strength measurements of the Colombo transmission on 4·87 Mc/s. received by Rastogi[2] at Trivandrum during the total solar eclipse on 20 June 1955. The propagation in this case was single-hop reflection from the E layer and the increase in field strength observed during the eclipse could be attributed to a decrease of absorption in the D layer.

The study of the results obtained by a number of other workers indicated that the observed changes in field strength during a solar eclipse could be better understood by comparing the equivalent vertical incidence frequency of the signal with the critical frequencies of the reflecting layer and the layer through which the waves passed. There would be a decrease or an increase in the intensity of the reflected waves as the critical frequency of the reflecting layer approached or receded from the equivalent vertical incidence frequency. In order to verify the above conclusion, the field strength measurements of two different frequencies on the same path, one of which would be reflected from the layer and the other penetrated it, were taken during the partial solar eclipse of 14 December 1955. The transmissions from the Bombay station of All India Radio on 7·24 and 9·55 Mc/s. were chosen since it was found that 7·24 Mc/s. would be reflected from the E layer and 9·55 Mc/s. was expected to penetrate it on normal days.

The details of the eclipse at Ahmedabad and Bombay are given in Table 1.

The distance between Bombay and Ahmedabad is about 470 km.

In Table 2 are given the equivalent vertical incidence frequencies for 7·24 and 9·55 Mc/s.

TABLE 1 — DETAILS OF ECLIPSE

	Ahmedabad	Bombay
Commencement of the eclipse	10.44 I.S.T.	10.36 I.S.T.
Maximum phase of the eclipse	12.40 I.S.T.	12.39 I.S.T.
End of the eclipse	14.30 I.S.T.	14.38 I.S.T.
Magnitude of the eclipse	47%	55%

TABLE 2 — EQUIVALENT VERTICAL INCIDENCE FREQUENCIES OF TRANSMISSION FROM BOMBAY AT AHMEDABAD

Signal frequency *Mc/s.*	Equivalent vertical incidence frequency for reflection from	
	E layer *Mc/s.*	F_1 layer *Mc/s.*
7·24	3·1	5·1
9·55	4·2	6·7

from Bombay to Ahmedabad for a single-hop transmission through the E and F_1 layers.

The sky waves were received on two modified BC-342 communication receivers from which the A.V.C. had been removed and the voltages across the second detector were measured by a bridge type d.c. amplifier V.T.V.M. These were calibrated with a standard G.R. signal generator. In order to eliminate the errors due to fluctuations in the mains voltage, a constant voltage transformer was used. The readings were taken daily from 12 to 16 December 1955. On the eclipse day, a recording milliammeter was also connected to the receivers to study the fading patterns during the eclipse. Half-minute readings were taken daily from 10.00 to 14.30 I.S.T. except on the eclipse day when, due to some unavoidable causes, the transmissions started only from about 11.00 I.S.T. The readings were later averaged over successive ten-minute intervals and the averaged readings were plotted against time on each day. It was found that the field strength curves on the control days were all similar and a single mean curve was plotted to represent the variations on the control days. Figs. 1 and 2 show the signal strength variations on the control days and on the eclipse day on the 7·24 and 9·55 Mc/s. transmissions respectively from Bombay.

These curves show that on normal days the field strengths on both the transmissions were minimum at about noon, indicating that the non-deviative D layer absorption was effective in both the transmissions. The minimum in the field strength was attained earlier on the 9·55 Mc/s. transmission than on the 7·24 Mc/s.

Shortly after the commencement of the eclipse, the field strength of the 7·24 Mc/s. transmission decreased below the normal control-day values, while the 9·55 Mc/s. transmission showed an increase. Neither the maximum of the 9·55 Mc/s. transmission nor the minimum of the 7·24 Mc/s. transmission coincided with the maximum phase of the eclipse. The minimum occurred after the maximum phase in 7·24 Mc/s. transmission while the maximum of the 9·55 Mc/s. transmission occurred before it. The critical frequencies of the E and F_1 layers at Ahmedabad on the control and eclipse days are given in Table 3.

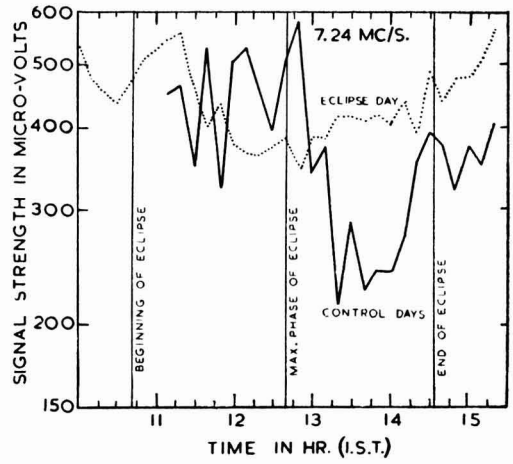

FIG. 1 — AVERAGE SIGNAL STRENGTH OF THE TRANSMISSION FROM BOMBAY (7·24 Mc/s.) AT AHMEDABAD ON CONTROL DAYS AND ON THE ECLIPSE DAY

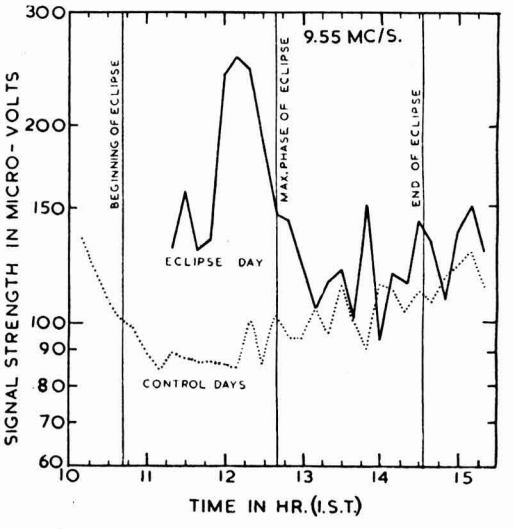

FIG. 2 — AVERAGE SIGNAL STRENGTH OF THE TRANSMISSION FROM BOMBAY (9·55 Mc/s.) AT AHMEDABAD ON CONTROL DAYS AND ON THE ECLIPSE DAY

TABLE 3 — CRITICAL FREQUENCIES OF E AND F_1 LAYERS AT AHMEDABAD

Time I.S.T.	Control days		Eclipse day	
	f_0E (*Mc/s.*)	f_0F_1 (*Mc/s.*)	f_0E (*Mc/s.*)	f_0F_1 (*Mc/s.*)
10.00	3·4	5·0	3·25	5·00
11.00	3·5	5·2	3·15	4·80
12.00	3·5	5·2	3·25	5·20
13.00	3·4	5·1	3·30	5·15

Comparing these with the figures given in Table 2, it will be seen that on normal days, the 7·24 Mc/s. transmission could be reflected from the E layer, while the 9·55 Mc/s. transmission would have penetrated the E and F_1 layers and got reflected from F_2. On the eclipse day, the critical frequencies of the E layer were lower than those on normal days and were very near the vertical incidence frequency for 7·24 Mc/s. transmission. This increased the deviative absorption for 7·24 Mc/s. and, therefore, the field strength decreased on the eclipse day. There was, apparently, not much change in the F_2 layer during the eclipse as seen from the ionospheric records at Ahmedabad. However, as 9·55 Mc/s. transmission penetrated both the E and F_1 layers there was decreased absorption of this transmission in the lower layers during the eclipse resulting in increased field strength.

Conclusions

The above observations show that although there is a general decrease in the non-deviative absorption in the D layer during the solar eclipse, the field strength changes observed at any particular place depend not only upon this factor but also upon the deviative absorption in the layers penetrated by the wave.

Summary

The results of field strength measurements made at Ahmedabad during the partial solar eclipse of the 14 December 1955 on radio transmissions from Bombay on 7·24 and 9·55 Mc/s. are described. The 7·24 Mc/s. waves are reflected from the E layer, while the 9·55 Mc/s. waves penetrate E and are reflected from the F_2 layer on normal days. During the eclipse, the field strength of the 7·24 Mc/s. transmission decreased below the value for normal days, while the 9·55 Mc/s. waves showed increased field strength. The changes are explained in terms of the vertical incidence frequencies of the waves and the critical frequencies of the ionospheric layers at Ahmedabad.

Acknowledgement

The work was done under the kind guidance of Prof. K. R. Ramanathan to whom the authors are indebted. Thanks are also due to Shri K. M. Kotadia for assistance in taking the observations, and to the authorities of the All India Radio for arranging special transmissions from their Bombay station. The authors are in receipt of financial assistance from the Council of Scientific & Industrial Research, India.

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Some New Aspects of Acoustical Animal Behaviour

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THE study of animal phonoreactions is a relatively new branch of acoustics which has developed during the past fifteen years as a result of newly perfected registration techniques on magnetic records and the introduction of mobile equipment facilitating biologists to carry out outdoor work. The newly acquired knowledge in ultrasonics has also opened up new possibilities. Research is being carried out in a number of countries, principally France, Germany, U.S.A., U.K. and U.S.S.R. The pioneers in this field are Griffin and Galambos of the Harvard University who have carried out interesting work on bats, and Everest who has studied the ultrasonic waves emitted by marine *Crustaceae*. The experimental animals which have been employed in various laboratories for study include mosquitoes, butterflies, grasshoppers, porpoises, fish, frogs, snakes, birds, bats and monkeys. The general trend of research in animal acoustics is summarized in the following paragraphs.

Physics and biology of acoustical signals of animals

To start with, the mechanism responsible for the emission of signals and the morphology of the organs connected with it are studied. Then comes the registration of the emitted signals which have a bearing on a particular behaviour of the animal, i.e. courtship, distress, rivalry, alarm, joy, assembly, etc. The recordings are then analysed and physical data such as frequency spectrum, oscillographic picture, intensity and rhythm are determined. The variations in these data may then be studied with respect to factors such as temperature, humidity, vegetation, state of the animal, etc. From these static but necessary data, the semantic character of the acoustic information is deduced. For example, it would be very interesting to study the acoustical variations in signals in different geographical races of the same animal species.

Animal reactions to their natural signals

This field has been scarcely explored and only few studies have been carried out with mosquitoes, birds and grasshoppers. Somewhat different acoustical techniques have to be used in these studies since natural sounds and ultrasonics must be recorded and retransmitted using loudspeakers and an adequate chain of amplifiers. Indeed in some cases the distortions introduced by the circuits can bring about negative results, while in other cases the distortions, if they are known and voluntarily made, may enable an accurate definition of the limits of acoustical sensitivity of animals. For our researches on grasshoppers, we have used as loudspeaker the ' ionophone ' of S. Klein, which gives correct retransmission from the sonic to the ultrasonic range.

The reactions of animals to their own reemitted signals can be extremely interesting and can lead to practical applications. For instance, Kahn has succeeded in attracting male mosquitoes by diffusing the recording of the noise given out by females while flying. Frings was able to obtain a definitive repulsion of starlings from their dormitory by diffusing a cry of fright. He also succeeded in attracting or repulsing herring gulls from a great distance. We have succeeded in attracting numerous species of grasshoppers, and attracting or repulsing crows and making them abandon their nests and their dormitories.

An important application of great practical significance of this branch of study is in agriculture, particularly pest control.

For basic researches these methods allow a better comprehension of animal behaviour. Acoustic signals can be classified according to the sign-stimulus category defined by Tinbergen. From the reaction of animals to

their own signals, psycho-physiological problems can be attacked; for instance, in measuring the integration time, which is the time between the beginning of the emission and the beginning of the animal's reaction. Detailed researches have been initiated in this field on higher mammals (monkeys, etc.). It is possible that these methods will lead to a more rational study of languages than what has already been achieved without the use of the physical characteristics of sounds.

The use of signals which the tape-recorder sends backward (for instance a human word like ' acoustic ' would become ' citsuoca ') is one of the best ways of studying the effect on animals of the semantic value of different signals representing an information. This method allows very interesting psychic discrimination.

Animal reactions to artificial signals

This aspect of the problem is certainly the most interesting and it touches a great number of problems. In the first place, it is necessary to be in touch with and use the knowledge acquired by human beings living in different regions of the world or by groups of people like hunters or fishermen having a perfect knowledge of the animals which are a means of subsistence for them. These people use acoustical means to localize, attract or repel living animals. The signals they use are often near-copies of natural signals made either with the mouth or with pipes. They can also use the cry of one animal to attract another one. But sometimes these people are seen using generators producing very simple sounds, having no common characteristics with those emitted by animals, which nevertheless produce displacement reactions. A fisherman's gadget called ' cotio-cotio ' used in Senegal and Nigerland (West Africa) is made of a rough surface scratched with an iron pick at the surface of the water; the waves it generates attract carnivorous fishes.

The ' tam tam ' is also used by Senegalian farmers to repel huge bands of Quelea birds

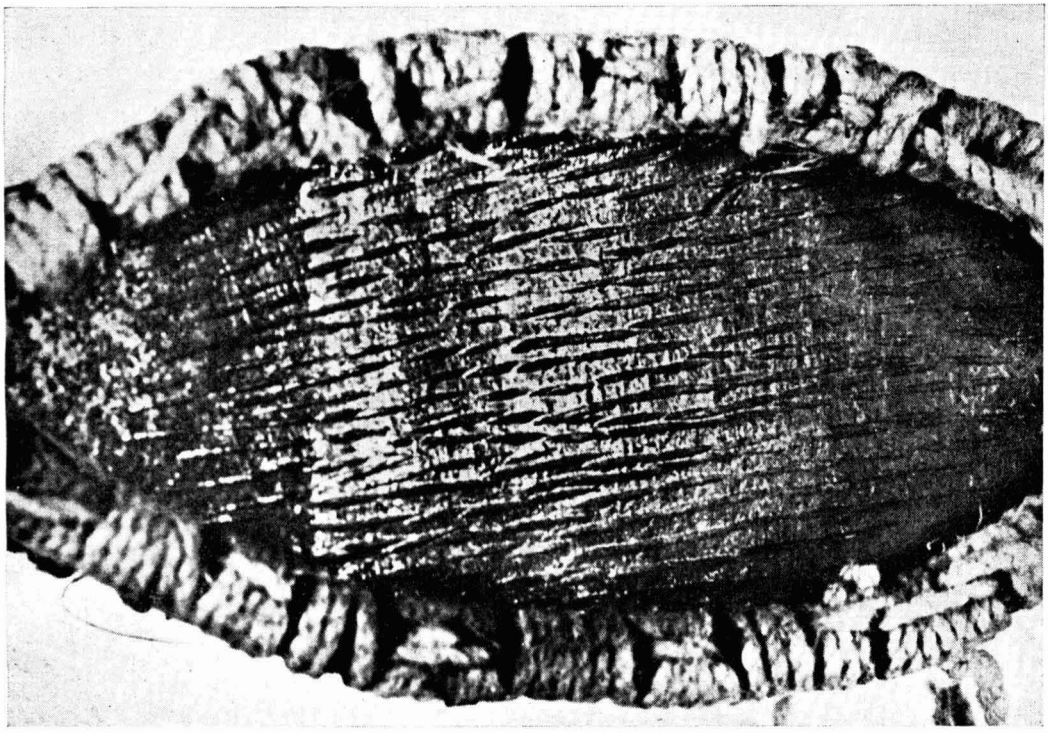

FIG. 1 — INSIDE SURFACE OF A COTIO-COTIO, SENEGALIAN FISHER'S DECOY [This skiff, which is held at the surface of water, is made of iron and streaked when hot with a graving tool. A nail on a long handle scrapes this surface and the noise thus made attracts fish]

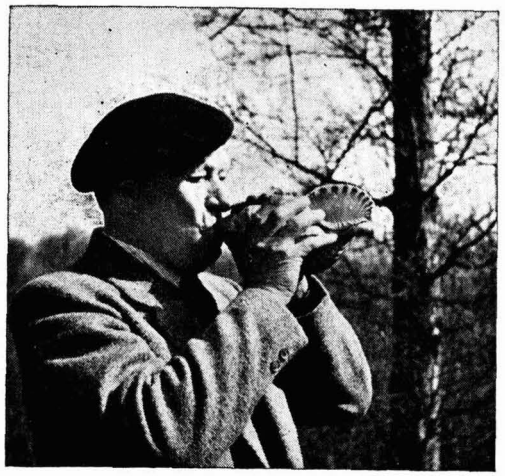

FIG. 2 — SHELL OF A BIG SEA MOLLUSK (PIERCED AT THE TOP) [When blown violently the noise produced attracts stags during the mating time. In woods it can be heard 2 km. away]

which eat in a few minutes their whole rice and millet harvest; the Eskimos use bear nails to scratch the ice and attract seals. In fact, many are the specialized cries used to call or repel wild animals. The knowledge of these traditions and usages is of a primordial interest for the acoustical biologist, but unfortunately, exact data on these subjects are difficult to obtain, and must be observed, confirmed and recorded in the region from which they originate. In this connection it is of interest to observe that India is particularly a rich field for the study of animal acoustics.

It is also very important to find out, in a natural signal provoking an animal reaction, which is the physical part of the information which brings about the reaction. All the non-reactive songs are first eliminated, the reactive ones are recorded on magnetic tapes, and are then treated as a chemist treats a compound which he wants to analyse, discovering its essential elements, from which he can eventually make a synthesis.

We have been trying in our laboratory to find, in a great many species, a physical characteristic having a reaction on lower vertebrates as well as invertebrates. This character was found after investigation to be the presence of a sudden change in the intensity of the signal, called a transient; it was observed that the frequency is not an important factor in a wide band (for instance from 50 to 100,000 kc/s. for Tettigonides and from 50 to 25,000 kc/s. for Acridians). Having found this general characteristic, many interesting studies on acoustical physiology can be undertaken, for instance, measurement of the speed of an animal attracted by sound. In some cases this speed is according to the Weber-Fechner law, which allows us to say that these phonodisplacements, which we have called ' phonotaxy ', may be classified as tropism. Another example is the study of the threshold of reaction, which again is primarily more a function of the form of the signal and of its intensity than of its frequency. A third example still is the phonoresponse of an insect or of a frog to acoustic stimulation.

These new branches of biology or acoustical physiology, which are completely independent of Pavlovian reflexes, bring us to study a great number of physio-psychological problems from a new angle; for instance, the

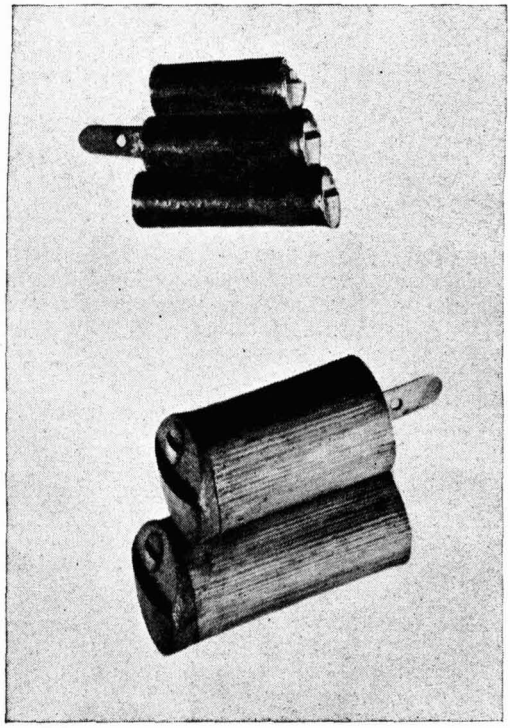

FIG. 3 — EOLIAN CHINESE WHISTLE [The whistle is made of bamboo and fixed on the wings of pigeons. It serves to frighten falcons]

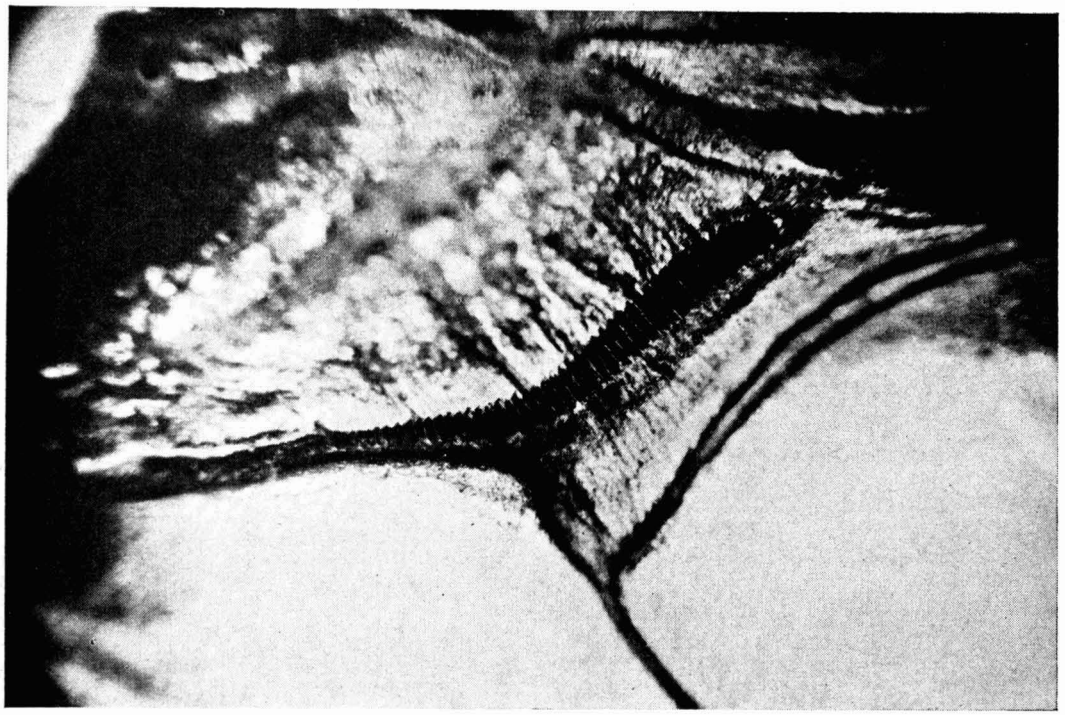

FIG. 4 — STRIDULATING MECHANISM OF A GRASSHOPPER [The grater with its hard chitinous teeth is rubbed against the side of the elytra (length 1·5 mm.); the edges of the grater are connected to resonating membranes. The sound emitted is a complete spectrum rich in ultrasonic vibrations as high as 80 kc/s.]

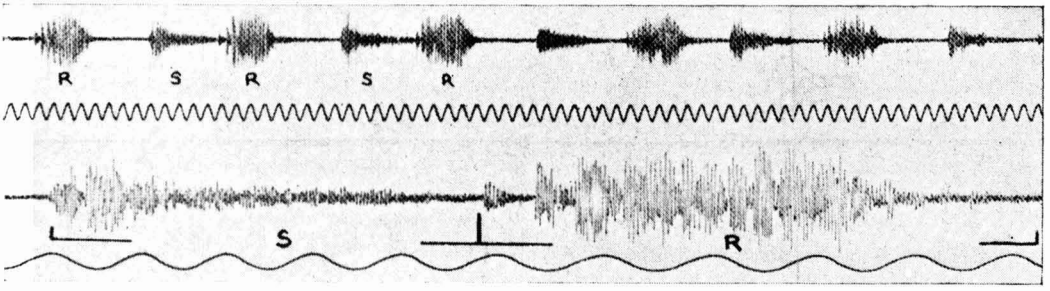

FIG. 5 — OSCILLOGRAPHIC ANALYSIS [The inferior sinusoidal picture shows the 50 c/s. phonoresponse of a frog (*Hyla arborea*) to an artificial noise, i.e. the beating of a metronome. S = signal, R = response of the animal]

temporal aspect of the quantitative intensity evaluations and the study of physiological mechanism of appreciation. In fact, till now, physiologists have not been fully aware of the physical factors, even in the case of man, of signals emitted to produce a reaction. Many problems should be re-studied keeping in view the fact that studies so far carried out have been done without due regard to signal form. Frequency and intensity of signals

are the factors usually studied but very little attention has been paid to signal form.

There is no doubt now that during the past few years much new knowledge has accrued due to this new application of acoustical problems to biology. Practical problems connected with fisheries are being investigated in many laboratories and much basic knowledge has been gathered on animal behaviour and sensorial physiology. But much remains to be done in this new branch of biophysics.

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The Chemistry & Biogenesis of Vitamin B_{12}

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THE complete deciphering of the chemical structure of so complicated a molecule as vitamin B_{12}, which was announced in August 1955 by workers in Cambridge led by Sir Alexander Todd, is truly a triumph of scientific ingenuity. In the elucidation of the structure of the vitamin B_{12} almost all the important techniques available in chemistry and other disciplines of science were mobilized in a conjoint effort by the scientists in different parts of the world. Of these, however, the X-ray crystallographic method has proved of immense value. The credit for this goes to Dr. Dorothy Hodgkin and her colleagues for their successful application of the new tool in determining one of the most complex chemical structures. The structural similarity of the vitamin to haem and chlorophyll and other natural porphin derivatives holds interesting possibilities for determining with greater certainty the main biological function of the vitamin, as also the pathway of its biogenesis.

Tracing back to the history of the isolation of the anti-pernicious anaemia principle, one recalls the pioneering work of Minot and Murphy[1] in 1926 in which liver or concentrates from it was therapeutically used as a cure for pernicious anaemia. Since then work has been carried out to isolate the active principle, using a variety of fractionation techniques, and in April 1948 came the announcement of the simultaneous isolation of a red crystalline anti-pernicious anaemia principle from liver by the laboratories of Glaxo in England and Merck & Co. in U.S.A. The new principle was christened vitamin B_{12}, one of its unique features being its effectiveness in very minute amounts, i.e. 0·5-5·0 micrograms. Another feature of the vitamin is its sole microbiological origin[2] and in this respect it differs from other members of the B-group.

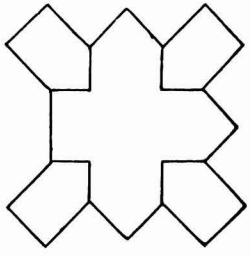
Vitamin B_{12} has the formula $C_{63}H_{90}O_{14}N_{14}PCo$, with a molecular weight of about 1,350 for the anhydrous material. Another unique feature is the presence in it of a cobalt atom which has not been found as yet in any other known organic compound in nature. A number of closely related substances has been found to exist, all possessing comparable biological activity; vitamin B_{12} has a cyano group attached to the cobalt atom and by substitution of the cyanide by hydroxyl or nitrite gives rise to B_{12a} (B_{12b}, B_{12d}) and vitamin B_{12c} respectively. The nomenclature has been simplified by designating vitamin B_{12} as cyanocobalamin, B_{12a} as hydroxocobalamin and B_{12c} as nitritocobalamin; various other analogues have lately been reported. They are distinguished by their chromatographic behaviour and partition coefficient in solvent mixtures.

The first idea about the chemical structure of the vitamin came from studies of its acid hydrolysis. The vitamin, when heated with concentrated hydrochloric acid at 150°C. for several hours, produced a red cobalt containing resinous matter and two other products detected by paper chromatography in addition to the liberation of ammonia (5-6 molecules per molecule of the vitamin) and phosphoric acid. The two compounds detected on paper chromatograms were found to be D_g-l-amino 2-propanol and 5: 6-dimethylbenzimidazole. Hydrolysis studies later revealed the presence of a nucleotide, 5: 6-dimethyl-l-(α-D-ribofuranosyl) benzimidazole-3′-phosphate. Another group of B_{12}-like factors recently isolated differs from vitamin B_{12} by the presence of adenine, 2-methyl adenine or 2-methyl hypoxanthine in place of 5: 6-dimethylbenzimidazole and recently various other bases have been substituted into the molecule by microbiological synthesis. Apart from the nucleotide the remainder of the vitamin B_{12} molecule, the so-called Factor B is common to all these compounds.

Vitamin B_{12} molecule subjected to strong oxidation has yielded to a series of simple and methyl-substituted aliphatic acids and also some uncharacterized acidic fractions but none containing nitrogen. These small molecules by themselves do not give any clear idea of the final structure of the vitamin but are important in being component parts of it. Controlled hydrolysis studies with cold dilute acid or alkali, however, gave a series of red carboxylic acids containing 1-4 acidic groups. That these acidic groups arise from carboxylic amides is demonstrated by the resynthesis of vitamin B_{12} from the acids.

By increasing the time of hydrolysis, concentration of acid or temperature, the nucleotide could be removed along with ammonia, and another series of acids lacking the nucleotide was derived from the parent substance Factor B. The presence of acid group in the B_{12} molecule is detectable through hydrolysis with nitrous acid. Under suitable conditions 6 red acids, having 1-6 carboxyl groups, can be separated from the reaction mixture, which suggests a total of 6 $CONH_2$ groups in the vitamin. The nitrous acid hydrolysis has also yielded 7 orange-coloured acids which shows that the nucleotide is attached via a seventh carboxyl group.

None of the above methods helped towards an understanding and formulation of the complete structure of the vitamin, though they were in themselves useful in giving an idea of the component parts of it. The most successful approach for that purpose was that of X-ray crystallography, enabling one to probe into the intact molecule directly. This approach helped to reveal the position of the surrounding groups of atoms round the centrally located heavy cobalt atom. In this investigation a pure hexacarboxylic acid obtained from the hydrolysis of the vitamin with 30 per cent aqueous alkali, in the form of monochloride-monocyanide, was used in the crystalline form. This acid had the molecular formula $C_{46}H_{60}O_{13}N_6CoCl.2H_2O$ and possessed a visible spectrum very similar to that of the parent vitamin showing that the chromophore had not undergone any change. The general pattern of the nucleus (I) surrounding the cobalt atom was derived on the basis of X-ray crystallographic examination and it was shown that the structure



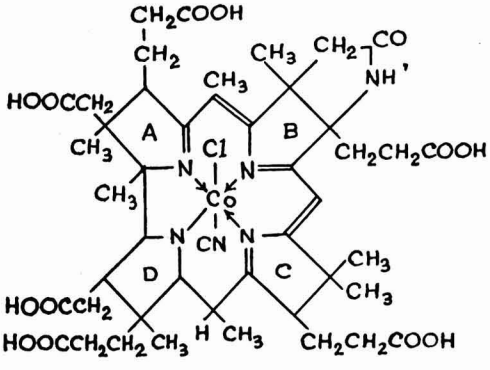
I

was quite like that of natural porphins but two of the four rings present were joined together directly rather than by way of an intermediate carbon atom.

The relative positions of all the atoms were then determined (II) by Dr. Hodgkin and her colleagues[3] through X-ray analysis, taking into account the already determined chemical properties of the vitamin described before. It was shown that of the six acidic groups, four were present as propionic acid residues and the other two as acetic acid residues. The eight single atom side chains were all formulated as methyl groups. The double bond arrangements as given were, however, considered tentative subject to slight revision in future.

On the basis of hexacarboxylic acid the complete structure of the vitamin has been more or less established (III). The vitamin does not contain a five-membered lactam ring fused to ring B; instead this ring has a methyl and an acetamide residue in one β-position and in the other a propionamide residue. The cyanide in the vitamin is attached at the side of the cobalt atom opposite to that of the cyanide in the hexacarboxylic acid. The aminopropanol is attached to the propionic acid side chain of ring D and the phosphate is substituted only by the nucleoside.

An examination of the complete structure of the vitamin shows a striking resemblance of the arrangement of propionic acid and acetic residues corresponding to that of uroporphyrin III, an important precursor of haem and chlorophyll. Use of possible precursor or intermediates in the synthesis of vitamin B_{12} has been extremely limited



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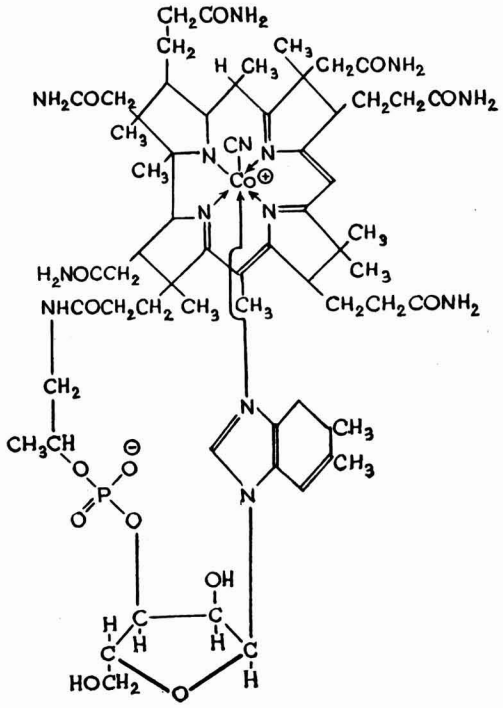

III

till now. The most significant precursor-like effect has been observed in the case of cobalt, when incorporated in the fermentation medium[4]. The compound 1: 2-dimethyl-4: 5-diaminobenzene, a component of dimethylbenzimidazole riboside found in the hydrolysate of vitamin B_{12} was first reported by Wooley[5] to fulfil the B_{12} requirement of lactic acid bacteria and algae. He further indicated that the compound might serve as a precursor of vitamin B_{12}. Davis[6], while studying the specific effect of *p*-aminobenzoic acid upon the synthesis of vitamin B_{12} by mutants of *Escherichia coli*, suggested that it might act as a precursor of vitamin B_{12} on the basis of its sparing action. However, it was shown later that certain other forms of vitamin B_{12}—pseudovitamin B_{12} and B_{12b}—exert the same sparing action and the structural precursor theory was rendered unlikely.

Dulaney and Williams[7] working recently with *Streptomyces griseus* reported the stimulating effect of some compounds, specially *o*-phenylenediamine, *o*-nitroaniline, *o*-xylidine and 3: 4-diaminotoluene, on the yield of vitamin B_{12}. On the basis of the toxicity

of these compounds at higher concentrations they suggested that the stimulation of B_{12} synthesis might be due to their acting as competitive inhibitors. Fantes and O'Callaghan[8], however, while reinvestigating the findings of Dulaney and Williams reported the isolation of a new analogue of the vitamin having benziminazole in its hydrolytic fragment. Ford *et al.*[9] in their work with a mutant of *E. coli* have reported the isolation of several new analogues of vitamin B_{12} when a variety of compounds structurally related to adenine or 5: 6-dimethylbenzimidazole were incorporated into a synthetic medium containing, in addition, Factor B. Recent studies with *Streptomyces olivaceus* by Ganguly and Roy[10] have revealed that the organism is able to synthesize the complex cobalt containing moiety Factor B in both synthetic and non-synthetic media and given suitable nucleotide bases, it completes the synthesis of the vitamin. *o*-Phenylenediamine, a compound having a closely similar structure to 1: 2-dimethyl-4: 5-diaminobenzene which appears to be the ultimate fragment of vitamin B_{12}, has been found to exert a competitive influence in diverting the synthesis of vitamin B_{12} to another analogue of it. In this respect the metabolic behaviour of *S. griseus* and *S. olivaceus* appears to be similar so far as the synthesis of the vitamin is concerned.

With the advances already made in the chemistry of vitamin B_{12} it seems not a very distant possibility when the complete biosynthetic pathway will be determined. The micro-organisms, specially those belonging to the species *Streptomyces*, will continue to be important tools in these investigations and a more precise idea will be obtained about the role and function of vitamin B_{12} in their metabolic activities.

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Lady Tata Scholarships

The trustees of the Lady Tata Memorial Trust have announced the award of the following scholarships for the year 1956-57.

International scholarships, totalling £6962, for research in diseases of the blood with special reference to leucaemias have been made to Dr. J. F. Kieler (Denmark), Dr. J. Ringsted (Denmark), Dr. J. Rygaard (Denmark), Dr. J. Nordmann (France), Dr. M. Seligmann (France), Professor H. Teir (Finland), Dr. C. G. C. Wasastjerna (Finland), Dr. G. Marinone (Italy), Dr. M. Simensen (Copenhagen), Dr. B. G. Thorell (Sweden), Dr. A. J. Therkelsen (Denmark), Dr. Alice Stewart (England) and Dr. A. Sreenivasan (Bombay).

Indian scholarships of Rs. 250 per month each for one year for investigations having a bearing on the alleviation of human suffering from disease have been awarded to Dr. Prem Nath Satsangi (Lucknow), Dr. Mahendra Kumar Trambaklal Mehta (Patna), Dr. Gangadhar Vyankatesh Bhide (Bombay), Mr. Umakant Waman Kenkare (Bombay), Dr. Hargobind Jashanmal Mulchandani (New Delhi), Dr. Ram Krishna Arya (Lucknow) and Miss P. Parvathi (Calcutta).

Moulding Characteristics of Jubbulpore Sands

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National Metallurgical Laboratory, Jamshedpur

INVESTIGATIONS on the moulding characteristics of Jubbulpore sands were taken up at the instance of the Director of Geology and Mining, Madhya Pradesh, with a view to determine their suitability for use in steel foundry practice. Three different varieties of sand, viz. Jubbulpore Green Sand, Jubbulpore Yellow Sand, and Jubbulpore White Sand, were received from the owners of the sand quarries. These sands are obtained from the deposits occurring on the east Ghamapur hills, situated about a mile from Jubbulpore. The deposits are stated to be fairly extensive and belong to the Lameta bed occurring below the Deccan trap. The overburden, overlying the sand beds, consists primarily of a super structure of red morram and sandy strata intermingled with impure kaolin. The thickness of the overburden varies from 3 to 4 ft. on the eastern side of the hills to as much as 10 ft. on the northern side. This is followed by the Jubbulpore white sand with an average bed height of 5-7 ft., below which occur the Jubbulpore yellow and green sands, with the bed heights varying from 7 to 10 ft. The greenish tinge imparted to the Jubbulpore green sand may be due to the presence of glauconite, a secondary mineral probably formed under marine conditions.

Sands of similar origin and type as the green sand from Jubbulpore are extensively worked at King's Lynn, Leighton Buzzard and Aylesbury in U.K. These sands are very well graded and their grain size is uniform throughout the depth. Besides, they have a characteristically rounded shape in the medium and coarse grades, the average coefficients of angularity ranging from 1·04 to 1·08. Cumulative grading curves for the above U.K. sands are furnished in Fig. 1, to enable comparison with the Jubbulpore green sand.

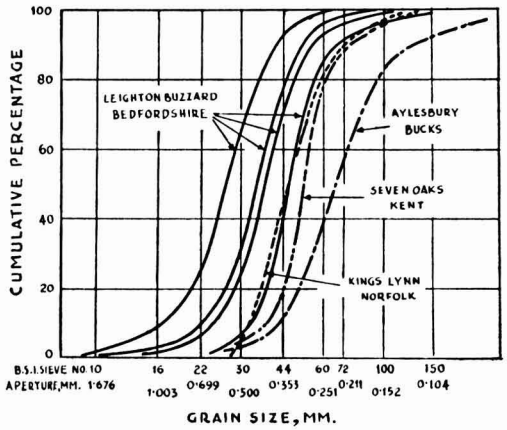


FIG. 1 — CUMULATIVE GRADING CURVES FOR U.K. GREEN SAND

Materials and methods

Standard methods as specified by the American Foundrymen's Association for sand testing were followed throughout these investigations, using Dietert sand testing equipment. All the results of physical tests reported are averages of three tests.

Chemical analyses of the sands were done in duplicate on representative samples after drying at 110°C. Average values have been reported.

Refractoriness of the sands was assessed by the standard pyrometric cone equivalent test, the temperature being checked by 'Pyro' optical pyrometer.

High temperature tests were conducted by firing A.F.A. standard 2 × 2 in. test pieces, rammed by 3 blows, at 900°, 1000°, 1150°, 1250°, 1450° and 1550°C. The volume of the test piece before firing was 6·284 cu. in. The fired test pieces were cooled to room temperature and examined for volume changes, surface characteristics, etc., and ultimately tested for crushing strength. Approximate sintering range has been assessed in the light of the above findings.

Microscopic study of the washed sand grains was made with a low power Bausch and Lomb stereoscopic microscope under

reflected light, using magnifications of 10, 20 and 45.

Investigations on the moulding characteristics were carried out by milling the raw sand in batches of *c.* 2,500 g. employing the 18 in. Simpson laboratory sand mixer. A milling time of 3 min. was allowed, after tempering the sands to the desired moisture content. In the case of Jubbulpore green sand, the moulding characteristics of the sand after washing through a hydroclassifier and blending with Bihar bentonite and dextrine were also studied. The washed green sand was milled with the dry additions for 2 min., tempered to the desired moisture content and then milled for another 5 min., with scraping done at the end of the second and fourth minutes.

The milled sands were then aerated and allowed to stand in airtight jars for 3 hr., prior to testing. Moisture contents of the sand mixtures were determined by the loss in weight method and expressed as percentages of wet sand.

All the tests on moulding characteristics of the sands, i.e. A.F.A. green permeability, green compressive strength, mould hardness, flowability, bulk density before and after compression, shatter index, dry compressive strength and dry shear were carried out with A.F.A. standard 2 × 2 in. test pieces rammed with 3 blows except in the shatter test where specimens rammed with 10 blows were used. For determining dry compressive strength values, specimens dried in a Dietert core baking oven for 2 hr. were used.

In addition to the above, the casting characteristics were studied by casting 3 × 3 × 3 in. steel test blocks in the sands. The cast blocks were examined for surface characteristics and any defects attributable to the sands.

Results

Jubbulpore green sand — As received, the sample was in the form of boulders, 4 × 6 in. in size, pale green in colour, friable and with a fairly open texture (Fig. 2). The boulders were stage-crushed to approximately pea size in a laboratory jaw crusher. A study of the effect of milling time on the mechanical grading of the raw sand showed that 5 min. milling was sufficient to yield a well-graded sand as shown in Table 1 and Fig. 3.

Standard A.F.A. fineness test on the raw sand showed the presence of nearly 5 per cent of A.F.A. clay grade matter. The sand grains were mostly medium coarse (A.F.A. grain fineness No. 32). Seventy-five per cent of the sand grains were retained on three adjacent sieves, namely 30, 40 and 50. Results of the standard A.F.A. fineness test

TABLE 1 — EFFECT OF MILLING TIME ON THE GRAIN DISTRIBUTION OF GREEN SAND

U.S. SIEVE SERIES EQUIVALENT No.	% RETAINED AFTER MILLING FOR			
	2 min.	5 min.	8 min.	10 min.
6	4·60	0·58	nil	nil
12	3·62	1·09	0·24	0·21
20	16·48	16·67	9·88	5·99
30	33·56	34·85	29·31	24·36
40	31·10	33·48	37·43	39·31
50	6·70	7·49	12·00	14·59
70	1·40	1·70	3·60	5·49
100	0·68	1·00	2·26	3·56
140	0·38	0·56	1·20	1·90
200	0·20	0·36	0·65	1·05
270	0·16	0·20	0·36	0·53
Pan	1·12	2·02	3·07	3·01

FIG. 2 — GREEN SILICA SAND BOULDER SHOWING THE COARSE OPEN TEXTURE OF THE ROCK

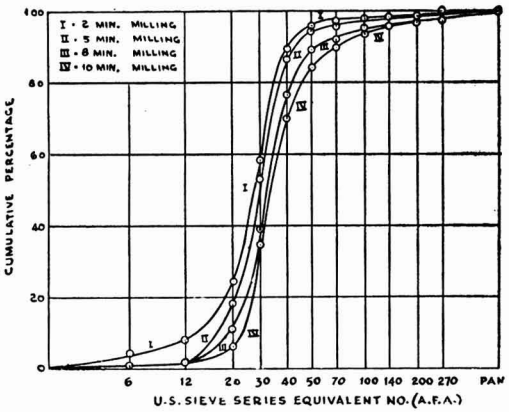


FIG. 3 — EFFECT OF MILLING TIME ON THE CUMULATIVE GRADING OF GREEN SAND

are given in Table 2 (Fig. 4). A comparison of cumulative grading curve of this sand with that of U.K. lower green sands in Fig. 1 showed that the former compared well with the U.K. sands.

Petrological examination of the sand revealed mostly quartz, coated uniformly with glauconite — a complex silicate containing iron and potassium with varying amounts of aluminium, calcium or magnesium. Like feldspar, glauconite is a readily fusible mineral.

Heavy minerals like ilmenite, tourmaline, staurolite, zircon and sillimanite were also present in minor amounts, while muscovite and limonite were found in traces only.

Microscopic examination of the washed sand sample showed its grains to be mostly sub-angular to round, the rounded grains

TABLE 2 — A.F.A. FINENESS TEST ON GREEN SAND

U.S. SIEVE SERIES EQUIVALENT No.	% RETAINED
6	nil
12	0·46
20	0·02
30	23·58
40	37·20
50	14·08
70	4·62
100	2·68
140	1·38
200	0·78
270	0·32
Pan	1·10
A.F.A. clay grade, %	4·88
A.F.A. clay class	C
A.F.A. grain fineness No.	31·57
A.F.A. grain class No.	7
Maximum distribution on three adjacent sieves, viz. 30, 40 and 50, %	74·86
Fines, %	2·20

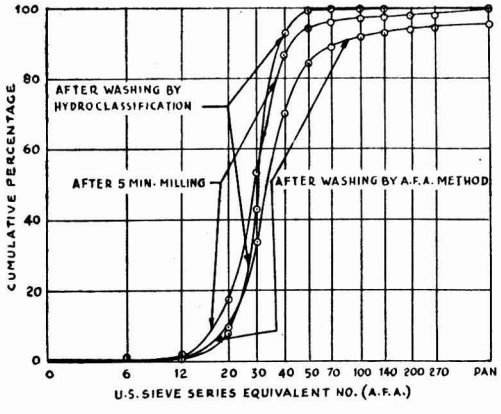


FIG. 4 — EFFECT OF WASHING ON THE CUMULATIVE GRADING OF GREEN SAND

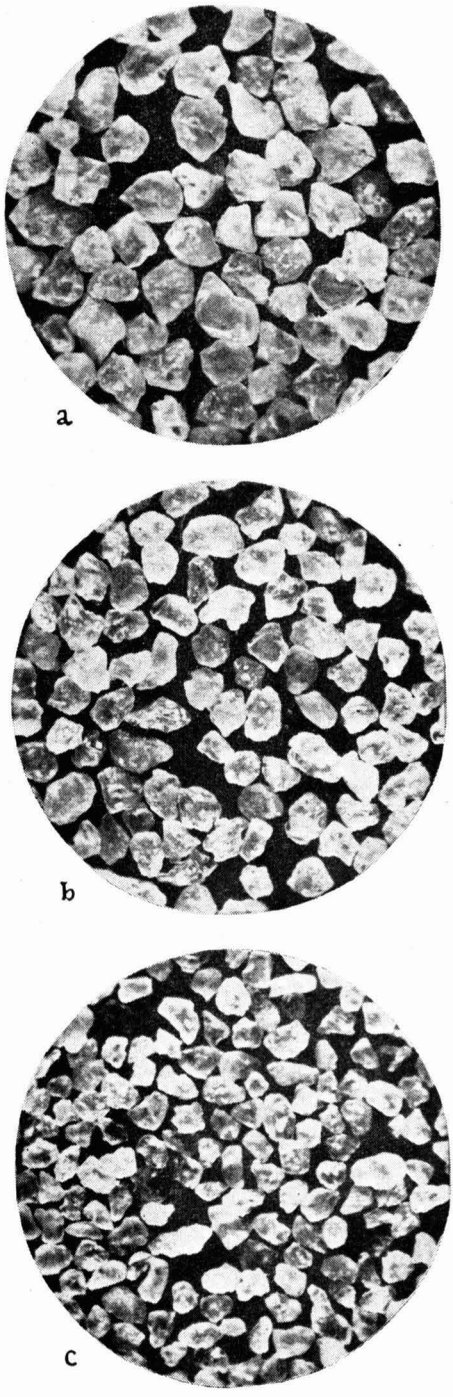


FIG. 5 — WASHED SAND GRAINS OF GREEN SAND RETAINED ON (a) 30, (b) 40 AND (c) 50 MESH [×25]

predominating on the 30 and 40 mesh fractions (Fig. 5). All grains were stained pale green due to glauconite.

Chemical analysis of a sample of the washed clay-free sand assayed 96 per cent silica with small amounts of iron oxide, lime and alkalies (Table 3). The analysis of the raw sand, as furnished by Director of Geology and Mining, Madhya Pradesh, is also included in the table.

A standard P.C.E. test conducted on the raw sand sample showed its refractoriness to be fairly high, the fusion point being above 1700°C., corresponding to Orton cones 32-33.

A.F.A. standard 2 × 2 in. test pieces fired at 1550°C. for 2 hr. showed no signs of cracking, distortion or squatting, but sintered hard and compact with a pale brown colour. A study of the effect of temperature on test pieces fired at 900°, 1000°, 1150°, 1250° and 1450°C. for 1½ hr. showed that the test pieces fired between 900° and 1000°C. crumbled to powder on cooling to room temperature, but those fired at the higher temperatures showed increasing strength and rigidity. Sintering took place between 1300° and 1400°C. Results of these tests are given in Table 4 and Fig. 6.

Moulding characteristics — A study of moulding characteristics of the raw sand with 3 and 4 per cent moisture content showed green compressive strengths of 7·4-9·1 lb./sq. in. and a remarkably high green permeability of 320-93. Beyond 4 per cent moisture, the green strength decreased markedly although the permeability

TABLE 3 — CHEMICAL ANALYSIS OF GREEN SAND

Chemical constituents	Raw sand* %	Washed sand† %
Silica	91·05	96·60
Alumina	4·52	1·60
Iron oxide	1·52	0·62
Titania	0·73	Trace
Lime	—	0·20
Magnesia	Trace	Trace
Alkalies	—	0·10
Loss on ignition	1·40	0·64

*Data furnished by Director of Geology & Mining, Madhya Pradesh.
†After washing free of A.F.A. clay grade.

TABLE 4 — HIGH TEMPERATURE TESTS ON GREEN SAND

Firing temp. °C.	Time of soaking *hr.*	Volume of test piece after firing *cu. in.*	Surface characteristics of the test pieces after firing	Ultimate crushing strength *lb./sq. in.*	Remarks
900	1½	—	Crumbled to powder	—	
1000	1½	—	do	—	
1150	1½	6·595	Dark brown in colour, open texture; dull note when struck	—	
1250	1½	6·615	Grains showed signs of fritting; slightly glassy in character; brown in colour; dull note when struck; surfaces more compact although having an open texture	252·5	
1450	1½	6·898	More compact; positive signs of fritting; non-friable; pale brown in colour; a low metallic sound when struck	558·6	Sintering temp. range 1300°-1400°C.
1550	2	7·418	Slight bulging; other characteristics the same as in sample fired at 1450°C. excepting that the colour was pale brownish; at places where it came into direct contact with the flame, glauconite was completely removed exposing the free sintered surface; low metallic sound when struck	975·9	

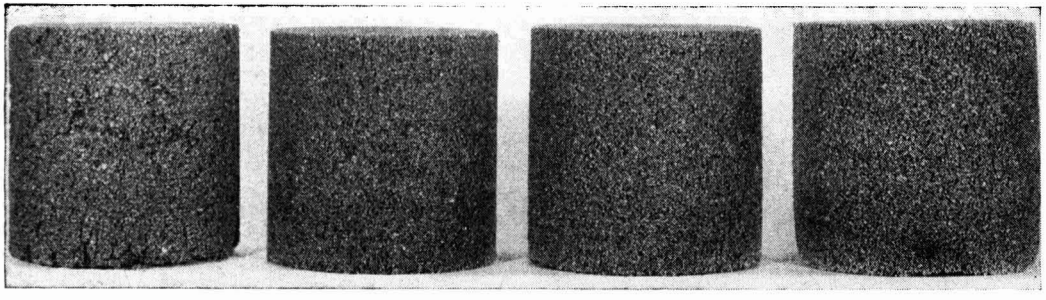


FIG. 6 — SURFACE CHARACTERISTICS OF TEST PIECES MADE OF GREEN SAND AND FIRED AT (*left to right*) 1150°, 1250°, 1450° AND 1550°C.

was still high. The sand showed fairly good flowability throughout the moisture range studied. Its dry strength values ranged from 55 to 75 lb./sq. in. between 5 and 7 per cent moisture contents. However, test pieces containing less than 3 per cent moisture showed signs of surface friability (Figs. 7, 8) while those containing above 5 per cent moisture appeared sticky. Between 3 and 4 per cent moisture contents the test pieces stripped well from the specimen tube. Results of the above tests are furnished in Table 5 and graphically represented in Fig. 9.

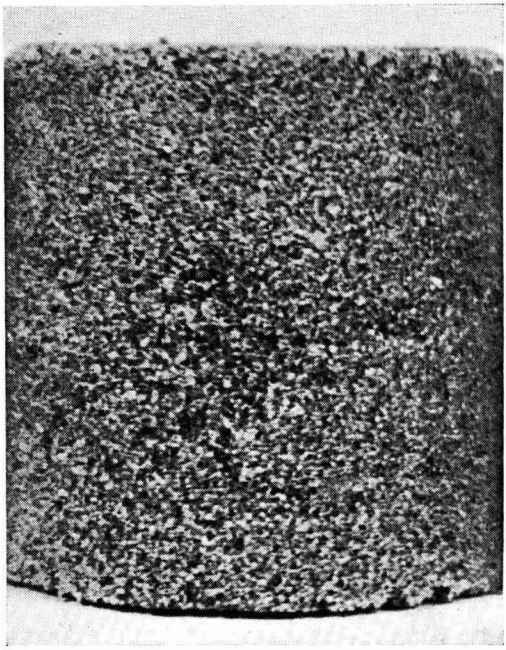


FIG. 7 — DRIED RAW GREEN SAND TEST PIECE SHOWING COARSE-GRAIN SURFACE TEXTURE AND CRUMBLY EDGES [Moisture content, 3 per cent]

Standard $3 \times 3 \times 3$ in. test steel blocks cast in the raw sand properly rammed had a poor surface as the sand was burnt on to the casting, especially near the gates, probably

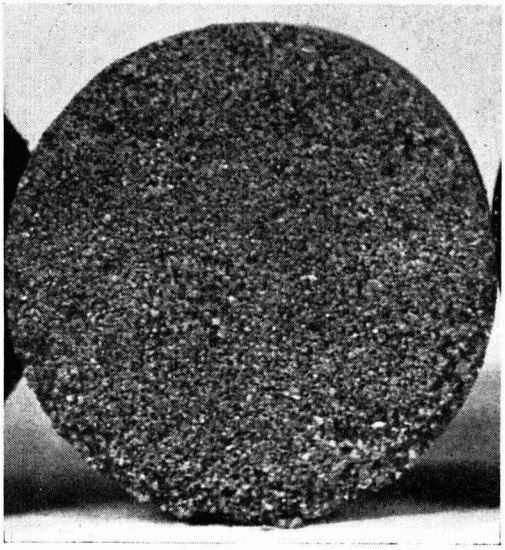


FIG. 8 — TOP PORTION OF DRIED RAW GREEN SAND TEST PIECE SHOWING CRUMBLY EDGES [Moisture content, 3 per cent]

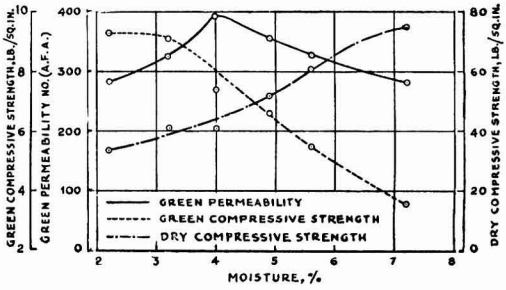


FIG. 9 — GREEN AND DRY BOND CHARACTERISTICS OF GREEN SAND

TABLE 5 — MOULDING CHARACTERISTICS OF GREEN SAND

	Moisture content, %					
	2·200	3·200	4·000	4·900	5·600	7·200
A.F.A. green permeability No.	284	327	393	355	327	282
Green compressive strength, lb./sq. in.	9·300	9·100	7·400	6·600	5·500	3·600
Green shear, lb./sq. in.	1·700	2·000	1·700	1·500	1·200	0·850
Mould hardness	85	85	84	82	80	72
Flowability	81·500	83	78·500	78	78	84
Bulk density before compression	1·162	1·136	0·893	0·833	0·833	0·893
Bulk density after compression	1·621	1·621	1·621	1·621	1·650	1·690
Shatter index	21·140	35·990	52·000	49·720	36·520	34·060
Dry compressive strength, lb./sq. in.	33·500	41	41	52	61	75
Dry shear, lb./sq. in.	4·000	5·400	6·700	8·200	10·500	12·350

as a result of reaction between glauconite and molten steel.

In view of the poor casting characteristics and limited moulding range (3-4 per cent moisture), it was decided to wash the sand free of clay, glauconite and silt to assess its suitability as a high silica sand base for steel foundry practice. Treatment in a hydro-classifier yielded a sand grade with grains ranging from 0·84 to 0·29 mm. in size corresponding to A.F.A. standard sieves 20 and 50 (Table 6).

The washed sand was bonded with 5 per cent Bihar bentonite and the results of the moulding characteristics of the synthetic mixtures studied are reported in Table 7 and graphically represented in Fig. 10.

From Table 7 it can be seen that the sand mixture possessed high permeability values over a wide range of moisture content. This was presumably due to the remarkably uniform size of the grains of the washed sand coupled with complete absence of the finer sand and clay grades after washing. A maximum green compressive strength of 9·5 lb./sq. in. was attained at 2 per cent moisture while at 5·2 per cent moisture, the washed sand still had a compressive strength of 4 lb./sq. in. The sand showed very good flowability but exhibited poor dry strength and shatter values.

Addition of 2 per cent dextrine was, therefore, made to the above sand mixture with a view to improve its dry strength and shatter index values. The results are given in Table 8.

From Table 8 it can be seen that addition of dextrine to the sand improved the dry strength and shatter index values as compared to bentonite addition alone.

A study of the effect of exposure of the rammed test pieces to laboratory atmosphere revealed the air setting qualities of the sand mixture. Test pieces after exposure for 1 hr. gained as much as 60 per cent in green strength as shown below:

	Green strength *lb./sq. in.*
At 3·2% moisture content	7
After 1 hr. exposure	11·50
After 2 hr. exposure	12·71

TABLE 6 — MECHANICAL GRADING OF WASHED GREEN SAND

U.S. sieve series equivalent No.	% retained
6	nil
12	nil
20	8·29
30	33·03
40	49·01
50	9·00
70	0·63
100	0·02
140	nil
200	nil
270	nil
Pan	nil
A.F.A. grain fineness No.	26
A.F.A. grain class No.	8
Maximum distribution on 3 adjacent sieves, viz. 30, 40 and 50, %	91·04

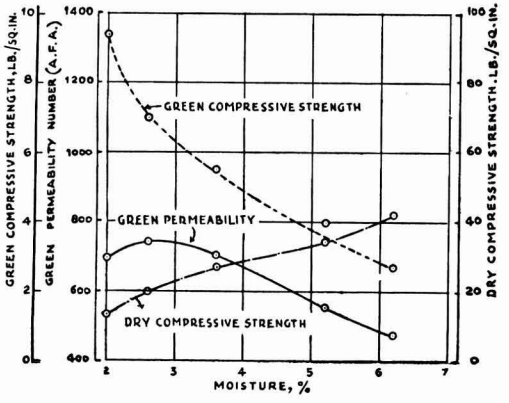


FIG. 10 — GREEN AND DRY BOND CHARACTERISTICS OF WASHED GREEN SAND BONDED WITH 5 PER CENT BIHAR BENTONITE

TABLE 7 — MOULDING CHARACTERISTICS OF WASHED GREEN SAND BONDED WITH 5% BIHAR BENTONITE

	Moisture content, %				
	2·000	2·600	3·600	5·200	6·200
A.F.A. green permeability No.	696	741	705	556	478
Green compressive strength, lb./sq. in.	9·400	7·000	5·500	4·000	2·700
Green shear, lb./sq. in.	2·000	1·700	1·200	0·900	0·800
Mould hardness	88	84	82	77	—
Flowability	83	80	81	82	84
Shatter index	21·610	32·100	35·370	41·180	25·860
Dry compressive strength, lb./sq. in.	13·200	19·500	27	34·500	42
Dry shear, lb./sq. in.	2·500	4·400	4·900	7·100	8·200
Bulk density after compression	1·505	1·505	1·534	1·573	1·603

TABLE 8 — MOULDING CHARACTERISTICS OF WASHED GREEN SAND BONDED WITH 5% BENTONITE AND 2% DEXTRINE

	Moisture, %	
	3·600	5·000
A.F.A. green permeability No.	751	539
Green compressive strength, lb./sq. in.	6·000	3·700
Green shear, lb./sq. in.	1·800	1·400
Mould hardness	82	75
Flowability	70	76·500
Shatter index	77·840	48·840
Dry compressive strength, lb./sq. in.	45	66
Dry shear, lb./sq. in.	11	26
Bulk density after compression	1·524	1·573

During the course of the above investigations, it was observed that test pieces whether rammed with the raw sand or with the synthetic sand mixtures underwent considerable bulging prior to rupture, when tested under compression. This suggests that sand moulds made with this mixture should strip well from the pattern.

The casting characteristics of the synthetic sand mixture employing washed green sand as base with additions of 5 per cent Bihar bentonite and 2 per cent dextrine were also studied. Test steel blocks (3 × 3 × 3 in.) showed superior surface characteristics compared to unwashed sand. No signs of 'burning on' were observed, and the surface sand peeled off readily during knocking off the casting from the mould.

Jubbulpore yellow sand — As received, the sample was pale yellow in colour, consisting of coarse sand grades with an abundance of pea-size lumps mixed with finer grades, and a moisture content of 1·2 per cent.

The sand sample, after 10 min. light milling in the Simpson mixer, gave a size grading shown in Table 9 (Fig. 11). These results were confirmed by standard A.F.A. fineness tests on sand samples subjected to 10 min. light milling. These showed the presence of 6·4 per cent of A.F.A. clay grade matter. The size grading of the sand grade was more or less similar to that of well-known natural moulding sands, inasmuch as bulk of the sand grains were spread over a fairly wide range of meshes. The results of the fineness tests are given in Table 10 (Fig. 11).

Petrological examination of the raw sand showed mainly quartz with calcareous matter and kaolin. Some glauconite-bonded sand grains were also observed. Muscovite mica and its products were present in fair amounts. Heavy minerals present in meagre proportions were tourmaline, ilmenite, limonite, sillimanite, staurolite and zircon.

TABLE 9 — SIZE GRADING OF YELLOW SAND AFTER 10 MIN. LIGHT MILLING

U.S. sieve series equivalent No.	% retained
6	
12	3·95
20	24·51
30	16·71
40	18·35
50	13·81
70	8·27
100	5·87
140	2·68
200	1·56
270	0·70
Pan	3·55
Maximum retention on the three adjacent sieves, viz. 20, 30 and 40, %	59·57
Fines, %	5·81

TABLE 10 — A.F.A. FINENESS TEST ON YELLOW SAND

U.S. sieve series equivalent No.	% retained
6	nil
12	3·88
20	21·62
30	16·48
40	17·54
50	13·54
70	7·92
100	5·58
140	2·56
200	1·38
270	0·70
Pan	1·94
A.F.A. clay, %	6·40
A.F.A. clay class	D
A.F.A. grain fineness No.	38·56
A.F.A. grain class No.	7
Maximum retention on three adjacent sieves, viz. 20, 30 and 40, %	55·64
Fines, %	4·02

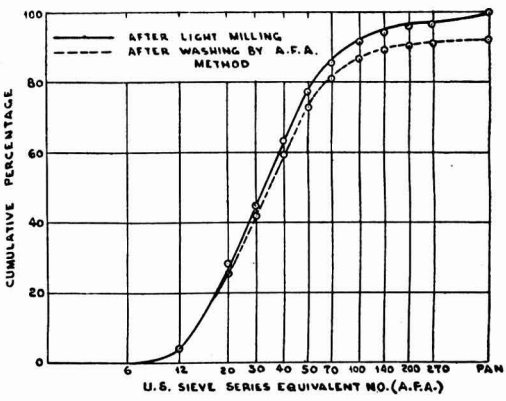


FIG. 11 — CUMULATIVE GRADING CURVES OF YELLOW SAND

Microscopic examination of the washed sand grains showed these to be mostly sub-angular to rounded in shape, the sub-angular grains being more conspicuous on the finer meshes (Fig. 12). Quite a number of the grains were stained with limonite.

Complete chemical analyses of the sand in the raw state and after washing free of A.F.A. clay grade matter are reported in Table 11.

Standard P.C.E. test conducted on the raw sand showed its refractoriness to be fairly satisfactory, the fusion point being 1690°C., corresponding to Orton cone 31-32.

A.F.A. standard test pieces after firing at 1550°C. for 2 hr. showed fairly open texture with a mottled appearance and no signs of

TABLE 11—CHEMICAL ANALYSES OF YELLOW SAND

Chemical constituent	Raw sand %	Washed sand (A.F.A. method) %
SiO_2	85·14	94·06
Al_2O_3	5·66	3·26
Fe_2O_3	2·16	0·67
TiO_2	0·80	0·23
CaO	2·19	1·21
MgO	Trace	Trace
Na_2O, K_2O	0·89	0·26
L.O.I.	3·56	1·29

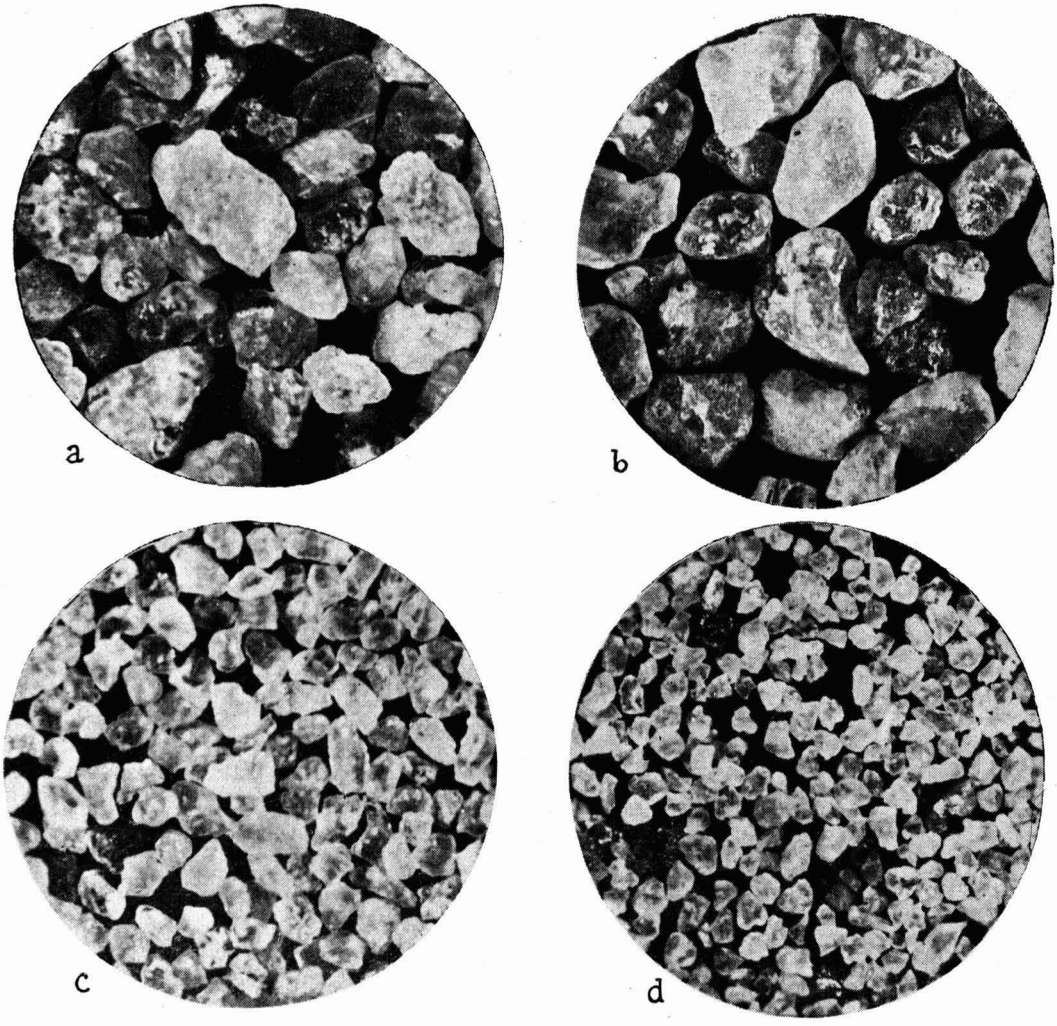


FIG. 12 — WASHED SAND GRAINS OF YELLOW SAND RETAINED ON (a) 20, (b) 30, (c) 40 AND (d) 50 MESH [×25]

cracking, distortion or squatting. When tested in compression, the fired test pieces showed a crushing strength of 1169 lb./sq. in. A study of the effect of different firing temperatures for 1½ hr. showed that samples fired at higher temperatures showed increasing strength and rigidity. The above test pieces revealed indirectly that sintering took place between 1250° and 1350°C. Samples fired between 900° and 1000°C. crumbled to powder on cooling to room temperature. The results of the above tests are furnished in Table 12 (Fig. 13).

A study of the moulding characteristics of the sand in the raw state showed a maximum permeability of 204 at 4·4 per cent moisture which came down to 159 at 7·4 per cent. The green compressive strength varied from a maximum of 13·6 lb./sq. in. at 2·3 per cent moisture to 6·7 lb./sq. in. at 7·4 per cent moisture. The optimum moisture range for working this mixture was assessed to be between 4·5 and 6 per cent. The sand exhibited fairly good flowability and had a shatter index of 57-58 in the optimum moisture range. The sand mix-

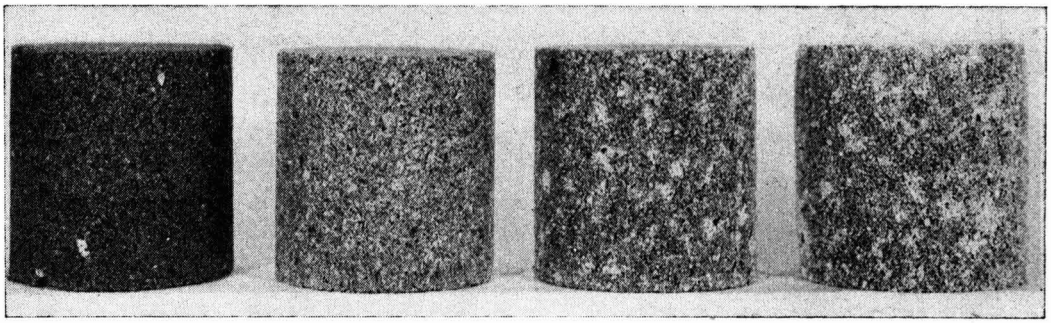


FIG. 13 — SURFACE CHARACTERISTICS OF TEST PIECES MADE OF YELLOW SAND AND FIRED AT (*left to right*) 1150°, 1250°, 1450° AND 1550°C.

TABLE 12 — HIGH TEMPERATURE TESTS ON YELLOW SAND

FIRING TEMP. °C.	TIME OF SOAKING *hr.*	VOLUME OF TEST PIECE AFTER FIRING *cu. in.*	SURFACE CHARACTERISTICS OF THE TEST PIECES, ETC., AFTER FIRING	ULTIMATE CRUSHING STRENGTH *lb./sq. in.*	REMARKS
900	1½	—	Crumbled to powder	—	
1000	1½	—	do	—	
1150	1½	6·546	Dark brown in colour; open texture; surfaces friable; dull sound when struck	—	
1250	1½	6·685	Pale brown; mottled texture; grains showed signs of fritting; more compact and less friable; dull sound when struck	271·5	Sintering temp. range 1250°-1350°C.
1450	1½	7·108	Grains showed greater fritting; mottled appearance; pale brown in colour	688·4	
1550	2	7·174	Open texture; no friability on the surface; dull sound when struck	1169·0	

TABLE 13 — MOULDING CHARACTERISTICS OF YELLOW SAND

	MOISTURE CONTENT, %					
	2·300	3·000	4·400	5·000	6·000	7·400
A.F.A. green permeability No.	122	190	204	195	168	159
Green compressive strength, lb./sq. in.	13·600	11·800	10·000	9·100	7·900	6·700
Green shear, lb./sq. in.	2·700	2·500	2·200	2·000	1·800	1·650
Mould hardness	89	87	87	86	83	78
Flowability	82	77	74·500	73	73	79
Bulk density before compression	1·128	1·104	0·962	0·893	0·909	0·962
Bulk density after compression	1·719	1·670	1·699	1·719	1·767	1·797
Shatter index	28·340	50·810	58·290	59·890	57·290	44·110
Dry compressive strength, lb./sq. in.	62	70	88	97	105	108
Dry shear, lb./sq. in.	6·500	8·400	17·400	21·000	23·000	23·500

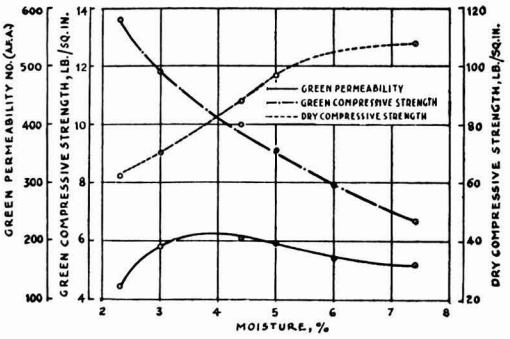


FIG. 14 — MOULDING CHARACTERISTICS OF YELLOW SAND

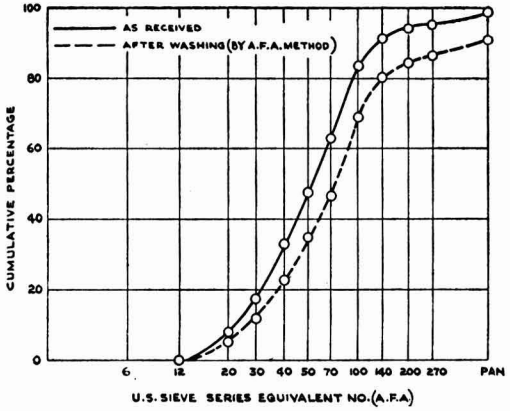


FIG. 15 — CUMULATIVE GRADING CURVES OF WHITE SAND

ture rammed fairly hard in the specimen tube, the hardness values ranging from 73 to 74. Besides, the sand mixture possessed a good dry strength when moulded in the optimun moisture range, the dry strength at 6 per cent moisture being 105 lb./sq. in. Green sand test pieces showed perceptible bulging, prior to rupture, when tested under compression. The surfaces of the dried sand test pieces were, however, found to be friable in the optimum moisture range, the edges being prone to chipping. The moulding characteristics are furnished in Table 13 and graphically represented in Fig. 14.

Casting characteristics of the sand were also studied by casting 3 × 3 × 3 in. steel blocks. While making the moulds, the patterns could be lifted easily from the moulds. The castings showed a clean surface with no stuck on sand; the sandy layer peeled off easily during knocking from the box.

Jubbulpore white sand — The sample as received had a moisture content of 2 per cent and was pale in colour. The sample was of fairly fine grade with a mixed grain size.

A standard A.F.A. fineness test conducted on the sample showed the presence of nearly 8·5 per cent of A.F.A. clay grade matter. The sand grade was mostly medium fine (A.F.A. fineness No. 73) and was distributed over a wide range of meshes, only 50·4 per cent being retained on 3 adjacent sieves, as shown in Table 14 and Fig. 15.

Petrological examination of the raw sand sample showed mainly quartz with appreciable amounts of calcite. Heavy minerals such as tourmaline, zircon, staurolite, sillimanite and ilmenite were observed in small amounts while muscovite and limonite were present in comparatively larger amounts.

Microscopic examination of the washed sand grains showed them to be mostly subangular to rounded in shape, similar to green and yellow sands. The grains were mostly pale in colour, a few of them stained with

TABLE 14 — A.F.A. FINENESS TEST AND SIZE GRADING OF WHITE SAND

U.S. SIEVE SERIES EQUIVALENT No.	% RETAINED	
	As received	After washing by A.F.A. method
6	nil	nil
12	0·12	0·08
20	8·18	5·28
30	9·16	6·60
40	15·65	10·98
50	14·98	11·96
70	14·80	12·16
100	20·67	22·40
140	7·90	11·06
200	2·93	4·14
270	1·02	1·64
Pan	3·87	5·02
A.F.A. clay, %	—	8·52
A.F.A. clay class	—	D
A.F.A. grain fineness No.	—	72·19
A.F.A. grain class No.	—	4
Max. retention on 3 adjacent sieves, viz. 50, 70 and 100, %	50·45	46·52
Fines, %	7·82	10·80

TABLE 15 — CHEMICAL ANALYSES OF WHITE SAND

CHEMICAL CONSTITUENT	RAW SAND %	WASHED SAND (A.F.A. METHOD) %
SiO_2	80·48	89·04
Al_2O_3	6·27	4·34
Fe_2O_3	1·20	0·61
TiO_2	1·05	0·41
CaO	4·44	2·27
MgO	Trace	Trace
Na_2O, K_2O	0·80	0·48
L.O.I.	5·57	3·11

limonite. The degree of staining increased with the fineness of the grains (Fig. 16).

The complete chemical analyses of the sand in the raw state and after washing free of A.F.A. clay grade matter are furnished in Table 15.

Standard P.C.E. test conducted on the raw sand showed its refractoriness to be low, the fusion point being only 1530°C., corresponding to Orton cone 23.

A.F.A. standard test pieces after firing at 1550°C. for 2 hr. were distorted and deformed in shape and showed considerable squatting, with almost complete vitrification of the sand grains. At 1250°C., the test pieces sintered into hard and compact bodies, and possessed a fine texture unlike the yellow and green sands from Jubbulpore. Samples fired between 900° and 1000°C. crumbled to powder on cooling to room temperature whilst others fired at the higher temperatures showed increasing strength and rigidity. The results of the above tests are given in Table 16 and Fig. 17.

A study of the moulding characteristics of the sand in the raw state showed a high green strength over a wide range of moisture content. A maximum green strength of 21 was attained at 4·4 per cent moisture (by interpolation). The sand possessed a low permeability throughout the moisture range studied, the maximum being only 22·5 at 6 per cent moisture (interpolated). Its flowability was fairly satisfactory. A

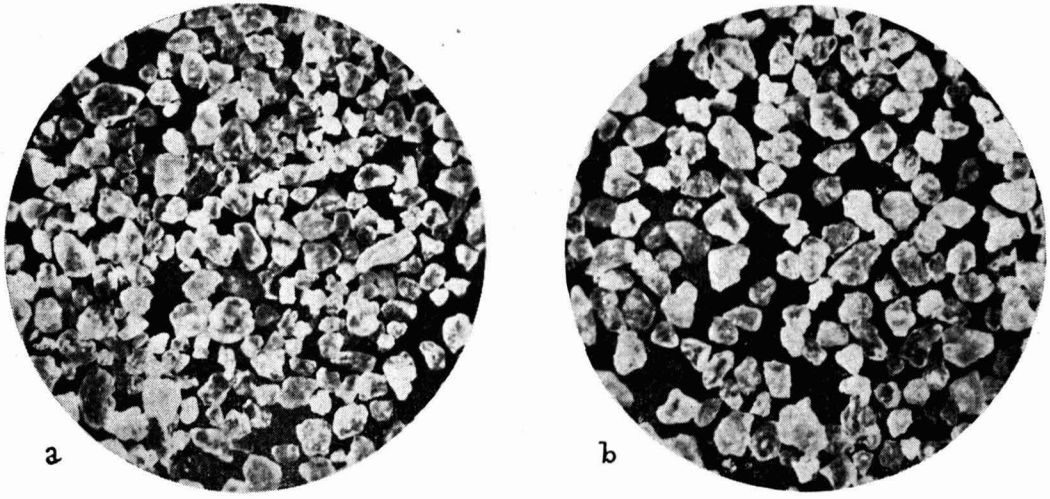


FIG. 16 — WASHED SAND GRAINS OF WHITE SAND RETAINED ON (a) 30 AND 40, AND (b) 40 AND 50 MESH [×25]

TABLE 16 — HIGH TEMPERATURE TESTS ON WHITE SAND

FIRING TEMP. °C.	TIME OF SOAKING *hr.*	VOLUME OF TEST PIECE AFTER FIRING *cu. in.*	SURFACE CHARACTERISTICS OF THE TEST PIECES AFTER FIRING	ULTIMATE CRUSHING STRENGTH *lb./sq. in.*	REMARKS
900	1½	—	Crumbled to powder	—	
1000	1½	—	do	—	
1150	1½	6·530	Yellowish in colour; very compact; friable when rubbed between fingers	—	
1250	1½	6·401	Complete fritting of the grains; slightly mottled texture; brown spots in a white matrix; surfaces compact; texture fine	839·2	Sintering temp. 1250°C.
1450	1½	—	Slight deformation; cracked slightly at the bottom; mottled texture less prominent; dull brick sound when struck	—	
1550	2	—	Distorted and deformed; considerable squatting; grains showed complete vitrification, slightly glassy and compact; dull brick sound when struck	—	

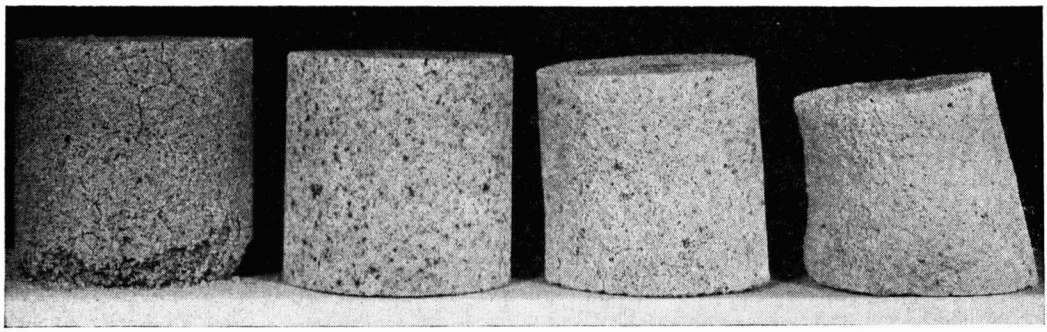


FIG. 17 — SURFACE CHARACTERISTICS OF TEST PIECES MADE OF WHITE SAND AND FIRED AT (*left to right*) 1150°, 1250°, 1450° AND 1550°C.

TABLE 17 — MOULDING CHARACTERISTICS OF WHITE SAND

	Moisture content, %				
	3·100	4·000	5·000	5·700	7·000
A.F.A. green permeability No.	10	15	19	22	20
Green compressive strength, lb./sq. in.	13	20	20	19	16·400
Green shear, lb./sq. in.	1·900	3·300	4·000	4·200	4·100
Mould hardness	90	91	90	89	87
Flowability	80	70	71	64	51
Bulk density before compression	1·250	1·136	1·064	1·000	0·909
Bulk density after compression	1·699	1·699	1·699	1·719	1·767
Shatter index value	25·940	52·970	79·450	87·880	94·910
Dry compressive strength, lb./sq. in.	21	45	86	92	122
Dry shear, lb./sq. in.	2·500	5·700	9·200	12·200	30·000

characteristic feature of this sand was the high values of shatter index obtained for it between 5 and 7 per cent moisture, the maximum value obtained being 94 at 7 per cent moisture. Its dry strength properties were also good. The surfaces of both green and dried sand test pieces showed no signs of friability unlike the Jubbulpore green and yellow sands. The results of the above tests are given in Table 17 and graphically represented in Fig. 18.

In view of the low fusion point and high green compressive strength of the sand coupled with low permeability, it was considered necessary to incorporate with it an equal weight of sharp silica sand in making sand mixtures, in order to improve the quality of the sand for steel moulding. Three sand mixtures were, therefore, prepared employing additions of Jubbulpore yellow sand in two of the mixtures and washed quartzite sand in the third.

Mixture No. 1 contained the Jubbulpore white and yellow sands in the ratio 1: 1. The moulding characteristics of the above mixture at three different moisture contents are given in Table 18.

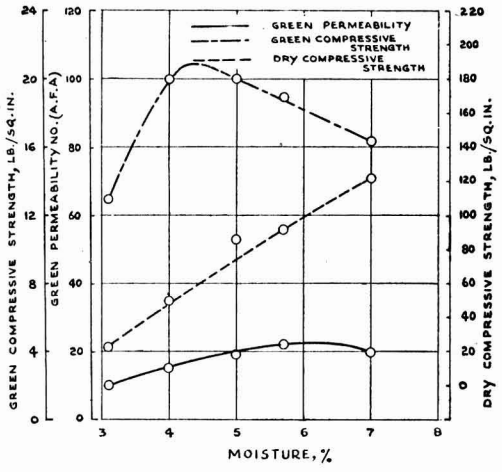


FIG. 18 — MOULDING CHARACTERISTICS OF WHITE SAND

The moulding characteristics of mixture No. 2 containing the Jubbulpore white and yellow sands in the ratio 1: 2 are given in Table 19.

It is observed from Tables 18 and 19 that the addition of Jubbulpore yellow sand,

TABLE 18 — MOULDING CHARACTERISTICS OF MIXTURE No. 1

	Moisture, %		
	3·400	4·200	5·200
A.F.A. green permeability No.	22	35	45
Green compressive strength, lb./sq. in.	18·300	17·250	15·300
Green shear, lb./sq. in.	3·200	4·000	3·300
Mould hardness	88	86	85
Flowability	69	68·500	62·500
Shatter index	77·250	76·560	79·690
Dry compressive strength, lb./sq. in.	82·000	95·500	114·700
Dry shear, lb./sq. in.	10·200	19·000	34·500
Relative density	1·748	1·767	1·767

TABLE 19 — MOULDING CHARACTERISTICS OF MIXTURE No. 2

	Moisture, %		
	2·200	2·800	4·000
A.F.A. green permeability No.	39	75	65
Green compressive strength, lb./sq. in.	14·200	14·900	16·100
Green shear, lb./sq. in.	2·600	2·800	3·900
Mould hardness	87	87	87
Flowability	81	74	66
Shatter index	21·580	48·420	81·550
Dry compressive strength, lb./sq. in.	34·500	61·000	97·000
Dry shear, lb./sq. in.	6·000	8·000	10·000
Relative density	1·748	1·748	1·748

especially in mixture No. 2, increases the permeability and decreases the green strength of the sand to some extent and also lowers the high shatter index value of the white sand.

It is also seen that addition of yellow sand imparts better dry strength properties to the mixture as compared to the white sand although the permeability value of the former needs improvement.

In mixture No. 3, Jubbulpore white sand was blended with washed quartzite sand (A.F.A. fineness No. 55 and silica content 96 per cent) in the ratio of 1 : 1 to improve its permeability and refractoriness. The moulding characteristics of this mixture are given in Table 20 (Fig. 19).

It is observed from Table 20 that addition of sharp sand like quartzite improved the permeability of the sand (mixture No. 3) as compared to mixtures No. 1 and 2, although other properties were adversely affected to some extent, particularly the shatter index value. The mixture could be worked only between 5 and 6 per cent moisture content. It may prove suitable only for light and medium castings. Firing test pieces rammed with sand mixtures No. 2 and 3 showed

TABLE 20 — MOULDING CHARACTERISTICS OF MIXTURE No. 3

	Moisture, %			
	2·600	3·100	5·200	6·600
A.F.A. green permeability No.	88	100	100	87
Green compressive strength, lb./sq. in.	8·400	7·900	5·900	4·700
Green shear, lb./sq. in.	1·500	1·700	1·100	1·000
Mould hardness	84	84	79	75
Flowability	77·500	82	82	79
Shatter index	24·710	33·140	30·290	26·810
Dry compressive strength, lb./sq. in.	38·500	41	70	79
Dry shear, lb./sq. in.	10	12	15	17
Relative density	1·573	1·592	1·621	1·641

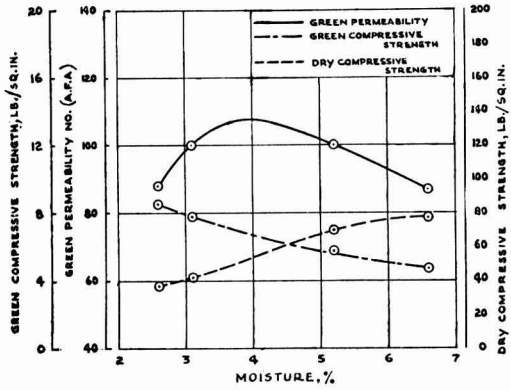


FIG. 19 — MOULDING CHARACTERISTICS OF MIXTURE No. 3

improved results. No signs of squatting, distortion or cracking were observed even in the case of test pieces fired at 1450° and 1550°C.

A study of the casting characteristics of the mixtures revealed that the Jubbulpore white sand when used alone does not give a satisfactory steel casting response. Mixtures No. 2 and 3 gave satisfactory steel castings. The former gave superior castings. The castings in both these cases showed clean surfaces and the adhering sand layer was easily knocked out.

Conclusions

Jubbulpore green sand — The parent rock is friable and possesses an open texture. Simple crushing and light milling of the sand for 5 min. yielded an exceedingly well-graded sand. The sand was medium coarse with an A.F.A. fineness No. of 32 and with nearly 80 per cent of the grains between 0·5 and

0·3 mm. It was mainly composed of quartz of sub-angular to rounded shape uniformly coated with the mineral glauconite. In these respects it compares well with the lower green sands of U.K. Its refractoriness was sufficiently high. Moulding characteristics of the raw sand showed limited range of workability between 3 and 4 per cent moisture. Its casting characteristics revealed poor surface finish, presumably due to a reaction between glauconite and molten steel.

Treatment in a hydroclassifier yielded a well-graded sand, and as much as 91 per cent of the sand grains were retained on 30, 40 and 50 mesh sieves. The washed sand after bonding with 5 per cent Bihar bentonite and 2 per cent dextrine showed very high permeability values. Its green compressive strength, flowability, shatter index, etc., were fairly satisfactory. However, it was felt that the additions of *c.* 1·5 per cent cereal binders like ' Mogul ' corn flour, 2 per cent of plastic fireclay and 10-15 per cent silica flour to the above sand mix may enhance its dry strength to the extent required for heavy steel castings. Test castings produced with the washed sand and bonded with Bihar bentonite and dextrine showed much superior surface characteristics with no visible signs of burning on.

Jubbulpore green sand washed free of clay and glauconite and suitably blended may, therefore, prove suitable for steel foundry purposes. However, in view of its coarse grain, the sand may not be suitable for light and medium castings for which a finer grade is more desirable.

Jubbulpore yellow sand — This sand is of medium coarse grade with an A.F.A. fineness No. of 38·56. As received, the sand contained 85 per cent silica and 5·66 per cent alumina. Its fusion point was 1690°C. The sand does not require auxiliary binders as it possesses requisite strength and other physical properties for steel castings, in the raw state. However, surface friability of the test pieces was observed in the green and dried states. The surfaces of the test blocks produced with this sand revealed clean surfaces, free from defects.

This sand may be recommended for dry sand moulding for medium and heavy steel castings. The surface friability associated with this sand can be eliminated to a large extent by suitable surface dressing.

Jubbulpore white sand — Jubbulpore white sand is a fine-graded sand with an A.F.A. fineness No. of 78. The raw sand contained 80·48 per cent silica and 6·27 per cent alumina. Its fusion point was fairly low (1530°C.), which may be due to a rather high percentage of lime (4·4 per cent). High temperature tests showed that even at 1250°C., the test pieces sintered into hard and compact bodies.

In the raw state, the sand showed a high green strength over a wide range of moisture contents, the maximum being 21 lb./sq. in. at 4·4 per cent moisture. Other characteristic features of this sand are its high shatter index and low permeability value throughout the moisture range tested.

The Jubbulpore white sand when blended with the Jubbulpore yellow sand in ratios of 1: 1 and 1: 2 resulted in the improvement of the properties of the resulting sand mixtures as regards permeability, refractoriness, green strength and shatter index.

This sand in its raw condition is, therefore, not suitable for use in steel foundry due to its poor refractoriness, low permeability and high green strength and shatter index. Addition of sharp high silica sand is necessary to reduce its green strength to requisite limits and to improve its permeability. Such blended mixtures may prove suitable for moulding light and medium steel castings.

Acknowledgement

The authors wish to thank Mr. S. K. Borooah, Director of Geology and Mining, Madhya Pradesh, for referring these sands to National Metallurgical Laboratory and to the owners of the sand quarries for supplying the sands. Their thanks are also due to Mr. B. V. Somayajulu, Senior Laboratory Assistant, General Metallurgy Division, for technical assistance and to Messrs V. Jagannathan, R. K. Das and A. R. Dass of the Chemical Division for conducting the chemical analyses of the sand samples.

Molecular Engineering

ENGINEERING practice, despite its impressive achievement, has remained largely empirical. In the last 50 years, physics and chemistry have arrived at precise, quantitative statements about the structure of atoms and molecules and their interaction in gases, liquids and solids. But it cannot be said, excepting in a few rare instances, that engineers are alive to this newly acquired mass of knowledge to respond adequately to the technical challenges that engineering is being called upon to tackle in regard to the increasing demands and stringent requirements for new materials as a result of the growth of nuclear and other modern sciences. The answers to the demand for new materials, with the traditional macroscopic approach, are often slow in realization and are arrived at after a number of uncertain approaches with mounting costs.

In a thought-provoking contribution to *Science* [**123** (1956), 315] a new mode of thinking about engineering materials and problems, termed 'molecular engineering', to secure a more fundamental foundation on which a more powerful technology can be erected, has been suggested by A. von Hippel, Director, Laboratory for Insulation Research, Massachusetts Institute of Technology (MIT). Molecular engineering involves a change-over from the phenomenological approach towards matter to a full appreciation of the fundamental properties and characteristics at the molecular level and uses them to suit the requirements in view. In Hippel's words, the molecular engineer, "instead of taking prefabricated materials and trying to devise engineering applications consistent with their macroscopic properties, builds materials from their atoms and molecules for the purpose at hand. This new approach gives the engineer a true spiritual connection with modern science, a rich and fruitful partnership and a new freedom of action. He can play chess with elementary particles according to prescribed rules until new engineering solutions are apparent. He can be selective by insight, foreseeing inherent limitations of materials, and making use of their actual capabilities."

In many problems in modern engineering — mechanical, electrical, aviation, etc.— what appears from a macroscopic point of view to be an elementary phenomenon, described by a few simple parameters, may be the outcome of unrecognized complicated molecular events which, depending on the circumstances, may take a variety of courses, thus involving uncontrolled molecular parameters. The prehistory of a material in regard to dislocations, disorders or imperfections of a molecular nature, or impurities and their mode of distribution, enter as variables to reckon with in critical performance tests. The decisive nature of the procedures of the classical engineer cannot be relied upon in the present context of the new and critical requirements. For example, a material cannot be characterized by chemical composition alone; its prehistory and detailed arrangement of constituents matter vitally. Phenomena such as metal fatigue, explosion hazard, electric failure or loss of ferromagnetism, which are important from design considerations of the future aeroplane, are all structure sensitive and can be tackled and controlled only from a step by step appreciation of the molecular and atomic processes taking place. Though incomplete and not made to order to fit in any and every situation, much of the needed information has been and is being acquired by the scientists. The incompleteness of the data should not allow the engineer to let slip the leadership from his hands and wait in complacence a further generation till the information he needs is supplied to him by physicists and chemists. Engineers should get familiar with sensitive non-destructive tools like X-ray analysis, spectroscopy, electric and magnetic measurements and the new probing methods of nuclear and magnetic resonance. Only by enlisting the engineer as an active partner of scientists in such molecular thinking can the squandering of resources in precarious approaches be avoided.

This reorientation in the practice and teaching of engineering cannot be brought about by merely adding some more courses to existing engineering and science departments of schools. The real answer to this problem requires a pioneering effort by the universities in retraining engineers in a basically new teaching and research programme

envisaging interdepartmental laboratories having no boundaries between different departments or between schools of science and those of engineering. An appraisal of the present capabilities of the new methods in competition to the old ones is also necessary to foster molecular engineering consciousness.

Such an organization must think in terms of a three-tier structure. The first floor consists of pure scientists laying the strong foundation in fundamental research with the object of exploring the unknown for accumulation of fresh basic knowledge. The second floor accommodates those who are engaged in its long-range application. The third is the implementation stage to develop prototypes. Such a composite laboratory structure offers a challenge to all kinds of talent found in schools of engineering, from the mathematical and theoretical physicist to the designer of gadgets. There will be a feedback among all activities cross-fertilizing each other's mind and stimulating thinking and critical appraisal in a chain reaction and allows a more searching approach of any problem from many angles. If such broad-based laboratories are established and their aims supported by teaching on an interdepartmental level, the problem of learning and applying with dispatch the concepts of molecular engineering can be solved.

The Laboratories for Insulation Research, MIT, built up since 1937, have been serving as the proving ground for this novel experiment. Its staff consists of physicists, chemists, electrical engineers and ceramicists; mechanical, chemical and metallurgical engineers as well as biologists will be added in due course as experience and confidence grow. Their endeavour is to contribute to the fundamental understanding of the electric and magnetic properties of matter and to their application in engineering devices.

Abstracting Board of ICSU

THE International Conference on Scientific Abstracting organized by the Department of Natural Sciences of the Unesco, held at Paris in June 1949, recommended that (1) good co-operation between existing scientific abstracting services should be established and co-ordinating committees should be created, (2) all original articles appearing in scientific journals should begin or end with an author's abstract prepared according to a set of rules published by the Royal Society, and (3) a single international general abstracting journal for physics and cognate sciences should be published. To implement the above recommendations, a joint commission was constituted by the International Council of Scientific Unions (ICSU) in 1949. Experience in the working of this joint commission and the discussion that followed as to the best way of organizing such a service revealed that the international co-operation obtaining at present in physics abstracting was a more promising starting point than in other subjects in the vast field of scientific documentation. Thus it was recommended in 1950 that two independent journals be helped in their work by a responsible, permanent, international organization to publish a single international general abstracting journal for physics in two important languages, as a first step towards the ultimate goal of a single journal for all cognate sciences. Accordingly, the joint commission was dissolved and the Board for International Abstracting Service was formed in 1952. The Board, maintained by funds from Unesco and ICSU, and controlled by the ICSU, began functioning from June 1952. It was given legal recognition by an Arrete Royal dated 3 November 1953.

An account of the different aspects of the work that the Board has done, since its inception, in the field of physics is given below:

Authors' summaries — As a result of the efforts made by the Board, most periodicals being published in Australia, Belgium, France, Germany, Italy, Netherlands, Scandi-

navia, Canada, Japan, U.K. and U.S.A., which contain original articles on physics, have agreed to publish, either in French or English (or both), authors' summaries prepared according to the rules approved by the Royal Society and Unesco. The editors of the respective journals see to it that the synopses sum up and bring about correctly the substances of the papers so that the Board's member-journals can save delays resulting from further abstract revision and print them *verbatim*. These summaries which the Board receives, generally by air mail, from 55 journals printed in different countries are in the form of either complete page proofs or clippings of authors' summaries. They are microfilmed or photocopied to serve all member-journals.

Russian literature — Keen interest is being shown in making available the Russian research literature in physics. The editors of member-journals are being provided, since February 1955, with microfilm copies of proofs of a dozen important Russian journals of physics. On receipt of the results of an enquiry instituted by the Board, at the request of the American Institute of Physics (AIP), in 12 European countries to assess the feasibility of a scheme, the AIP has started a full-scale literal English translation of the Russian *Journal of Theoretical and Experimental Physics*. The Board also helped, in association with the publications committee of International Union of Pure and Applied Physics, in the publication of reviews describing the activities and progress of principal schools of research in physics of U.S.S.R. and other Slavonic countries.

Classification — The Board is represented by the editor of one of the member-journals on the special committee of the Federation International de Documentation, from which originated the revision of the UDC classification in physics. Full co-operation is given to this new classification by uniform adoption of it by all the member-journals.

Non-periodic publications — Organizers of congresses and colloquia are requested to ensure proper means of publication of the proceedings in recognized journals and to send incidental special reports to the Board for thorough abstracting. Also the editor of each member-journals deals with abstracting such publications of a group of countries and draws the attention of his fellow-editors to the worthwhile physics publications.

Chemistry — The Board's activities were extended to include chemistry also in October 1954 and *Chemical Abstracts* (for English) and *Bulletin Analytique* (for French) have been unanimously elected as member-journals. Work has begun in this field and the editors of the chief chemical journals are being contacted with a view to exchange page proofs between the members for chemistry.

The growth of the ICSU Abstracting Board, though continually supported by the Unesco, has been necessarily slow because of the necessary prudence that governed its actions and of the limited means coupled with the vast scope of the undertaking. Even so, the feasibility and utility of the enterprise was completely demonstrated by the members of the Board, which can be judged from the interest evinced in the work of the Board by the International Union of Mechanics and the International Union of Biology with a view to instituting similar services in those sciences. The problem of dealing successfully with the large increase of work by its extension to other subjects and other means of supporting the service still remain to be tackled [*Science*, **123** (1956), 423].

REVIEWS

CENTRIFUGAL AND OTHER ROTODYNAMIC PUMPS by Herbert Addison (Chapman & Hall Ltd., London), Second Edition, 1955. Pp. x + 530. Price 50*s*.

This book deals with principles, design and construction, performance and installation and operation of pumps to which the author has given the apt generic name rotodynamic pumps, in which " the interchange of energy between the fluid and the rotating blades depends upon the development of tangential acceleration in the fluid elements ". The author has taken great pains to illustrate " the kinship between radial-flow, mixed-flow and axial-flow pumps ". Positive pumps fall outside the scope of this volume.

The book is divided into five parts and contains a fairly comprehensive bibliography, two charts useful for design purposes, a table of symbols, and tables of conversion factors and computation data. The method and order of presentation remain substantially the same as in the first edition as also the subject matter. The style of presentation is direct and at times graphic. The large number of illustrations form a special feature of the book. The illustrations are generally excellent. The reviewer, however, had occasional difficulties in distinguishing the different letterings on the illustrations.

The introductory chapter is lucid. The writer draws attention to the facts that in rotodynamic pumps " discharges up to 10 tons per second per pump are not unusual ", " pressures up to 3,000 lb./sq. in. may be generated " and " powers up to 60,000 h.p. per unit may be absorbed ".

Part A of the book dealing with the fundamental principles is divided into 5 chapters (Chapters 1-5). In Chapter 1, the author deals with centrifugal pump impeller under ideal conditions. The author introduces the datum blade, i.e. " the particular shape of blade which under ideal conditions will have no effect on the flow whatever ", and from it evolves the working blade. The usual equations are then derived and the relation between the blade form and impeller performance deduced. In Chapter 2, the flow conditions in the impeller are described. An excellent diagram giving idealized representation of distribution of pressure heads in the impeller corresponding to a radial velocity is given, which should help greatly to picture the flow conditions within the impeller. An estimate of the dynamic thrusts on a blade has been made and the author introduces the term ' relative blade loading ' as the ratio between average differential pressure head and the total head generated by the pump. In Chapter 3, the mixed-flow and axial-flow rotors are dealt with. The author indicates a method of establishing blade form for mixed-flow centrifugal pump rotors and discusses briefly the aerofoil type of axial-flow blade. In Chapter 4, the principles of recuperation are discussed as also casing, diffusers, etc. Chapter 5 will be of great interest to professional engineers and designers. In this chapter the author has emphasized the need for non-dimensional standards for comparing pumps. After introducing non-dimensional quantities such as the ' width ratio ', ' speed ratio ' and ' flow ratio ', the author poses the question how two pumps should behave if both of them work under the same head or if both of them work under the same speed. He establishes the necessary conditions under which comparisons can be made; the idea of geometrically similar rotors is introduced and methods given for reducing the performance of any pump to standard conditions based under two systems, viz. (i) performance under ' unit conditions ' and (ii) performance under ' specific conditions '. Under unit conditions, " the ideal performance of a pump geometrically similar to the actual pump, having a rotor of unit diameter revolving at unit speed " is computed and the author deduces non-dimensional numbers such as the ' characteristic head number ' and ' characteristic discharge number ' independent of the system of unit and the size of the pump. So long as one is concerned with a given shape of rotor, working under its specified conditions of speed ratio, etc., the characteristic numbers are wholly unaffected by changes of head, speed and diameter. The second approach, i.e. performance under

specific conditions, is based on the concept that a pump is of standard size if, when generating unit head, it delivers energy to the liquid at unit rate. Such an imaginary wheel is termed 'specific wheel' and its speed the 'specific speed'. The author introduces an alternative non-dimensional number, viz. the characteristic shape number, to take the place of specific speed normally used by hydraulic engineers.

Part B (Chapters 6-10) of the book deals with design and construction of the pumps. In Chapter 6 the general problems of pump designs have been presented. In Chapter 7 a fairly comprehensive treatment of the constructional details of centrifugal pumps has been given. Especially interesting are the paragraphs dealing with axial hydraulic thrust on the impeller and methods of relieving it. There is also an interesting paragraph dealing with the theory of the sealing ring and one on the types of sealing rings. In the second part of this chapter routine computational procedure to be followed in the design of centrifugal pumps has been lucidly presented. In Chapter 8 constructional details of mixed-flow and axial-flow pumps have been given as also an elementary but lucid presentation of the aerofoil theory of propeller pump design. In Chapter 9, the author answers the question why pumps with multiple rotors should be used. The chapter is largely descriptive but has been carefully written and illustrated with a number of excellent diagrams. In Chapter 10 the special features of pumps for special duties have been briefly indicated. The range covered is wide and includes well pumps, mine pumps, borehole pumps, shaft-driven pumps, submersible pumps, etc. Many construction details have been given as also design data for borehole pumps with which many engineers are concerned. The constructional peculiarities of pumps for hot and volatile liquid, corrosive, abrasive and of sub-standard pumps have been briefly described.

Part C (Chapters 11-17) deals with performance of pumps and Chapter 11 largely with definitions and terminology. One using the book for the first time would be well advised to recapitulate Chapter 5 before reading Chapter 11. In Chapter 12, testing of pumps is described: types and conditions of tests, measurement of speed, pressure, power, etc., are described. Under sections dealing with plants for testing at works, the author describes closed circuit test rigs for low head pump and high delivery head and high suction head pumps. Many practical tips have been given, as also typical layout for routine testing. There are a few paragraphs on tests at site which a young engineer would be well advised to read with care. Finally, there is a section on special tests dealing with testing with air, on scale model tests and on test for observation of internal flow conditions. In Chapter 13, performance under design conditions has been studied and the various losses such as power loss, friction loss of different kinds have been indicated and an interpretation of the energy diagram given. In it will be found an interesting section dealing with the connection between the shape number and the energy loss. The author has also indicated the general trends in design. In Chapter 14, the author has described the performance of pumps under reduced flow and increased flow conditions, i.e. when deviations are made from design conditions. In the opinion of the reviewer this chapter and the Chapters 5 and 6 should be studied along with Chapter 15 which deals with universal flow conditions. These form the backbone of design theory and performance calculations. In Chapter 16, pumps are studied in their installed conditions. This is an interesting chapter in which the author has described the effects of excessive suction head. A paragraph on minimum pressure follows a paragraph on critical suction head and the reader is introduced to the concept of cavitation and the effects of cavitation. The author gives practical rules for estimating suction lift and introduces the formulae for Thomas's cavitation factor and suggests that instead of using graphs a cavitation factor may be computed from the formula constant multiplicity specific speed raised to the power $\frac{4}{3}$ for single-inlet impellers. Service effects on pumps have also been briefly indicated. Chapter 17 dealing with transitory conditions is also an interesting chapter. In it the phenomena during starting and stopping of pumps are discussed and practical hints on starting and stopping of pumps are provided.

Part D (Chapters 18-21) deals with installation and operation of pumps. In Chapter 18, allied machinery and auxiliary appliances are dealt with including pump rooms. Chapter 19 contains a final survey

of the complete pumping plant. Topics covered are overall cost of pumping, choice of prime-mover, choice of pump, etc. In Chapter 20, the author gives his views on certain typical installation problems such as grouping of pumps, principles of boosting, surge chambers, reduction of positive and negative surge, etc. Chapter 21 is a brief chapter on erection, operation and maintenance of pumps. The scope of the chapter may be seen from the section headings: erection on site, preparation for running, starting the pump, routine attention during running, stopping the pump, some possible faults including suction trouble, repairs and renewals.

Part E contains illustrative examples. There are 47 worked out examples which are a great help in understanding clearly the principles formulated in the body of the book and to understand the application of the formulae to design and performance calculations.

This is indeed one of the most comprehensive books on centrifugal and rotodynamic pumps which has come to the notice of the reviewer. If at all there is a complaint against the book, it is that the author has tried to give the readers perhaps too much information in some 530 pages. The beginner would perhaps like a more detailed presentation particularly of material contained in Part A and in the earlier chapters of Parts B and C. Comparison of this volume with other publications of this type is not possible; nevertheless one cannot help naming another contemporary book, Stepanof's book on *Centrifugal and Axial Flow Pump* (Wiley & Sons, 1948). Both are admirable books, each having a special approach, and the reviewer commends them to young engineers who want to make a specialized study of the subject.

That a specialized book of this kind has run into a second edition in seven years is an adequate testimony to its usefulness. The author has to be congratulated on his presentation. The book is aimed to answer such questions as: how pumps work ? how to build pumps ? how pumps behave ? and how pumps should be installed ? These questions have been answered competently and satisfactorily.

S. R. SEN GUPTA

CHEMICAL PILOT PLANT PRACTICE, Vol. I by D.G. Jordan (Interscience Publishers Inc., New York), 1955. Pp. viii + 152. Price $ 3.50

What is a pilot plant, how, when and why it should be built, what data should be derived from it, and how pilot plant data should be used for the design of a bigger plant — these are some of the questions which the author has attempted to discuss in a simple, clear and objective manner. The book is divided into six chapters, viz. general considerations, scale up problems, handling of solids, liquids and gases, chemical reactors, separation process, and cost estimation and report writing. At the end there is also a list of references.

The author has made many practical and valuable suggestions on several aspects of pilot plant practice including the human aspect.

The author is on the staff of the American Cyanamid Company, Stanford, Conn. In the preface he says that his experience has been mainly in the synthetic organic industry, and naturally the book has a bias in this direction. This is not an exhaustive treatise, nor a complete reference work on pilot plant practice. It does not give information on many points on which the pilot plant engineer would want guidance. But the book serves as a good introduction to the subject and is eminently readable.

The value of the book would have been considerably enhanced if the author had illustrated the many points he has discussed by an actual example of the development of a process from the laboratory through pilot plant to a large-scale plant.

This book should be read by every one who has anything to do with development of products and processes, and particularly by every worker in the field of industrial research.

N. R. KULOOR

Recent Publications

*EUROPEAN BREWERY CONVENTION — PROCEEDINGS OF THE CONGRESS OF BADEN, 1955 (Elsevier Publishing Co., Amsterdam — Houston — London — New York), 1955. Pp. xi + 358. Price 55*s*.

*GERMANIUM DIODES by S. D. Boon (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland) [*Distributors in India*: Philips Electrical Co. (India) Private Ltd., Calcutta], 1956. Pp. viii + 85.

*WOOL RESEARCH, VOL. 2 — PHYSICAL PROPERTIES. Edited by H. Lemon (Wool Industries Research Association, Leeds), 1956. Pp. vi + 234

*PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY HELD IN GENEVA, 8 AUGUST-20 AUGUST 1955, VOL. 3— POWER REACTORS (United Nations, New York), 1955. Pp. 389. Price $ 7.50

THE CHEMISTRY OF THE MORPHINE ALKALOIDS (MONOGRAPHS ON THE CHEMISTRY OF NATURAL PRODUCTS) by K. W. Bentley (Oxford University Press, Bombay). Price 55*s*.

THE COLLOID CHEMISTRY OF SILICA AND SILICATES (CORNELL) by Ralph K. Iler (Oxford University Press, Bombay). Price $ 5.50

SPHEROIDAL WAVE FUNCTIONS by Stratton *et al.* (John Wiley & Sons Inc., New York). Price $ 12.50

GENERAL PHYSICS — A TEXT-BOOK FOR COLLEGES, 2nd Ed., by Blackwood Kelly (John Wiley & Sons Inc., New York). Price $ 6.75

SYMPOSIUM ON FINE STRUCTURE OF CELLS (SYMPOSIUM HELD AT LEIDEN, 1954) (Noordhoff). Price Rs. 52/8

REDUCTION WITH COMPLEX METAL HYDRIDES by Gaylord (Interscience Publishers Inc., New York). Price $ 15.00

POLYMER PROCESSES — HIGH POLYMERS, VOL. 10 by Schildknecht. Price $ 19.50

ARITHMETIC — ITS STRUCTURE & CONCEPTS by Mueller (Prentice-Hall, London). Price $ 7.35

FACTS IN PERSPECTIVE by Krieghbaum (Prentice-Hall, London). Price $ 8.00

PROCESS CALCULATIONS by Osborn-Kammermeyer (Prentice-Hall, London). Price $ 6.60

THE MANUFACTURE OF GLYCEROL (Technical Press, London). Price 84*s*.

AN ENCYCLOPAEDIA OF THE IRON & STEEL INDUSTRY by Osborne (Technical Press, London). Price 90*s*.

AN INTRODUCTION TO THE THEORY OF FUNCTIONS OF A COMPLEX VARIABLE by E. T. Copson (Oxford University Press, Bombay). Price 35*s*.

MODERN SCHOOL MATHEMATICS by E. J. James (Oxford University Press, Bombay). Price: Book I, 6*s*.; Books II & III, 6*s*. 6*d*. each

DRIVER'S TEXTBOOK OF PHARMACEUTICAL CHEMISTRY by J. E. Driver (Oxford University Press, Bombay). Price 55*s*.

THE THEORY OF RELATIVITY by C. Moller (Oxford University Press, Bombay). Price 40*s*.

THE THIRD DIMENSION IN CHEMISTRY by A. F. Wells (Oxford University Press, Bombay). Price 21*s*.

*Received for review in the *Journal of Scientific & Industrial Research*.

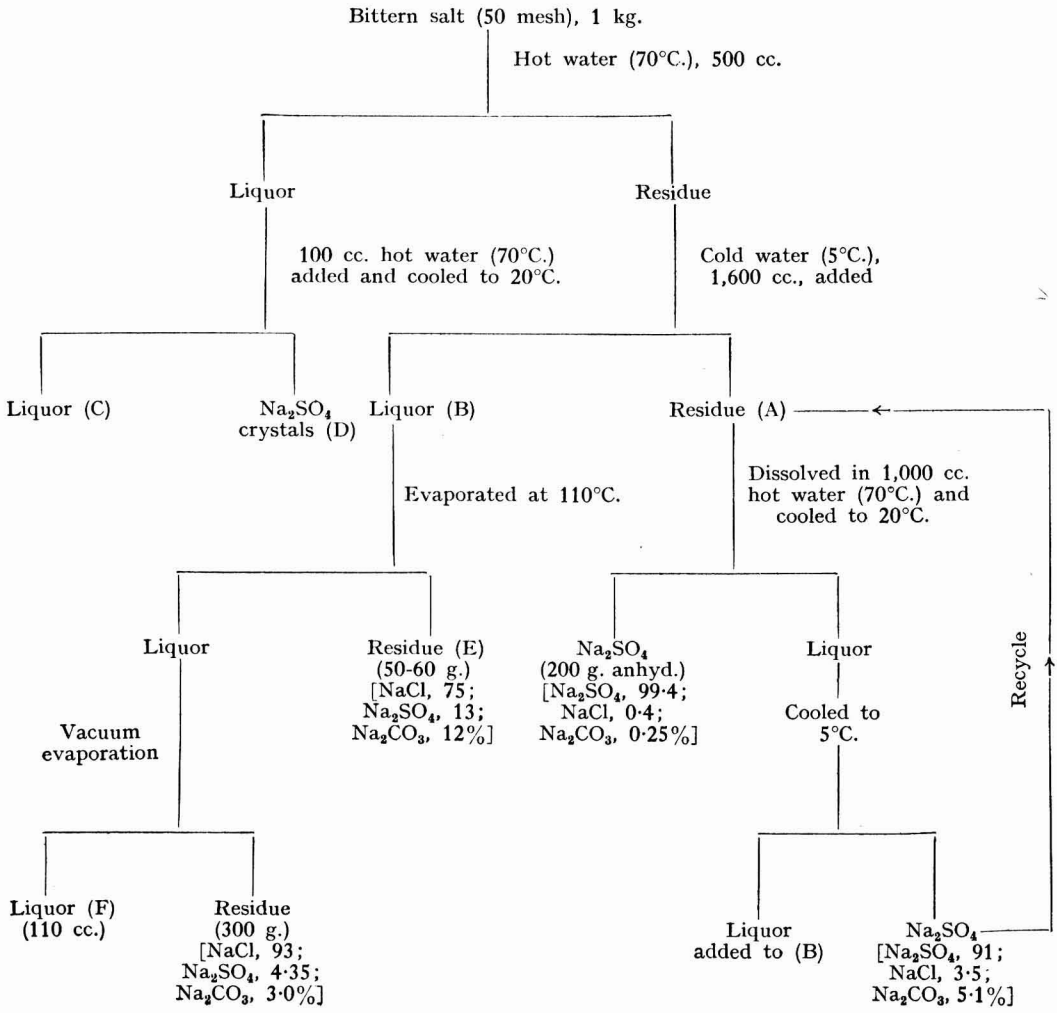
NOTES & NEWS

Sambhar Lake bittern salt

SHRI S. L. CHAWLA OF THE Department of Applied Chemistry, Indian Institute of Technology, Kharagpur (present address: Applied Science Department, Delhi Polytechnic, Delhi), has communicated the results of preliminary phase rule and fractional crystallization studies carried out with Sambhar Lake bittern salt. No profitable use has been found at present for Sambhar Lake salt bittern though it is a good source of sodium sulphate, carbonate and bicarbonate.

Salt deposited as a result of evaporation of the bittern contains: sodium chloride, 50; sodium sulphate, 30; and sodium carbonate and bicarbonate, 20 per cent. The separation of these constituents is not only of theoretical interest from the point of phase rule and fractional crystallization studies, but also from the point of recovery of sodium sulphate and sodium carbonate.

As a result of investigations carried out at the Institute, a procedure for the separation of the constituents of bittern salt has been worked out. The results of typical experiments are presented in the flowsheet which forms the basis for large-scale trials. The recoveries shown are the result of a batch process and are expected to improve in continuous operation. The residue at E can be added to the bittern salt and the liquor at C and F can be used for the recovery of sodium carbonate. The crystals of sodium sulphate obtained at D can be mixed with the residue A.



R. serpentina grafts

SHRI K. N. KAUL (NATIONAL Botanic Garden, Lucknow) reports the successful grafting of the aerial parts of *Rauvolfia canescens* on the subterranean parts of *Rauvolfia serpentina*. The graft, which can be grown in the open, combines the characteristics of *R. serpentina*, namely the presence of reserpine in its roots, with the hardiness of *R. canescens*. At the time of harvesting, the subterranean portion can be removed leaving a small portion of the root for transplanting purposes. If the basal portion of this aerial part is treated with growth-promoting hormones (β-indolyl acetic acid, β-indolyl propionic acid, etc.), before planting, 100 per cent rooting takes place.

Enzymatic synthesis of cholyl coA and taurocholic acid

THE PRESENCE OF A NEW ENZYME is reported in the microsomes of liver which activates cholic acid according to the following reaction:

$$\text{Cholic acid} + \text{coA} \xrightarrow{\text{ATP, Mg}++} \text{cholyl coA} \quad \ldots . (1)$$

The isolation of cholyl coenzyme A is the first instance of the occurrence of an activated steroid in a biological system.

A second enzyme has been found in the supernatant fraction of liver that will carry out the reaction:

$$\text{Cholyl coA} + \text{taurine} \longrightarrow \text{taurocholic acid} + \text{coA} \quad \ldots (2)$$

Both microsomal and supernatant fractions were isolated from a phosphate buffer homogenate by the differential centrifugation method. The microsomes were washed once each with isotonic potassium chloride and distilled water. The supernatant was dialysed for 24 hr. against distilled water and then lyophilized. Mitochondria were isolated from a 0·88M sucrose homogenate.

Incubation of 50 mg. of washed, lyophilized guinea-pig liver microsomes with 4 μ moles of coA, 10 μ moles of cholic acid, 44 μ moles of adenosine triphosphate (ATP) and 30 moles of magnesium chloride in 1·0 ml. of 0·1M potassium hydrogen phosphate buffer at *p*H 7·6 for 60 min. resulted in the formation of 2·2 μ moles of a cholic acid derivative. The compound was identified as cholyl coA by chromatography and by means of colour reactions. Hydrolysis of the compound resulted in the appearance of two bands on paper chromatograms, one having the R_f value and colour reaction of cholic acid, the other having R_f value and colour reaction of coA.

If chromatographically pure cholyl coA is incubated together with taurine in the presence of dialysed guinea-pig liver supernatant, taurocholic acid is produced; this demonstrates that cholyl coA is an intermediate in the synthesis of the conjugated bile salt.

Taurocholic acid can also be readily synthesized by combining the reactions given in equations (1) and (2). Microsomes, dialysed supernatant, cholic acid, coA, ATP and taurine are all required for taurocholic acid production in this overall reaction. Either microsomal or supernatant fraction alone is inactive [*Science*, **123** (1956), 377].

Synthesis of rubber by micro-organisms

RUBBER (*cis*-POLYISOPRENE) HAS been isolated from the sporophores of certain species of fungi belonging to the genera *Lactarius* and *Peziza*. The first evidence of rubber synthesis by micro-organisms has been demonstrated in the case of two species of fungi belonging to the genera *Lactarius* and *Peziza*.

Sporophores of *Lactarius* species and ascocarps of *Peziza* species were collected and preserved in ethanol. The carpophores were separated, ground in a meat grinder, and extracted for 24 hr. with acetone. The acetone-extracted mycelia were then extracted for 24 hr. with redistilled benzene containing 0·1 per cent N, N-diphenyl-*p*-phenylene-diamine as antioxidant. The benzene extracts, blanketed with nitrogen, were reduced to known volume and characterized.

The sporophores of the mixed *Lactarius* species contained, on a dry weight basis, 1·7 per cent of a rubbery polymer which was soluble in benzene. The infrared absorption curve of the material showed it to be *cis*-polyisoprene. Its curve is identical with that of Hevea rubber. From the limiting intrinsic viscosity values of the polymer in benzene at 25°C., its average molecular weight was found to be 13,900. The rubber extracted from ascocarps of *Peziza* was also *cis*-polyisoprene, but was much tougher than that from *Lactarius* [*Science*, **122** (1955), 1271].

Structure of stevioside

STUDIES HAVE BEEN CARRIED OUT to elucidate the structure of stevioside, the sweetest natural product yet discovered. By the use of ion-exchange resins, about 7 per cent of the stevioside can be extracted from dried leaves of *Stevia rebaudiana* Bertoni, a small wild shrub found in certain parts of Paraguay.

Stevioside is a glucoside, containing three glucopyranose units and no nitrogen. One of the glucopyranose units is esterified at C_1 by a highly hindered carboxyl group in the aglucon. The remaining two glucose units are joined together with a C_2 linkage and then to the aglucon. C_2-glucose units are relatively rare, having been found in only three other instances. Carbohydrate esters of sterically hindered acids have not so far been found in nature.

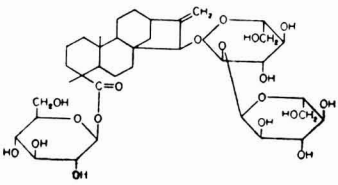


FIG. 1 — STEVIOSIDE

The tentative structure assigned to stevioside (Fig. 1) shows that the aglycon possesses a perhydrophenanthrene skeleton to which a five-membered ring is attached, but not at the 1, 2-positions as in the steroids. The ring is analogous to the structures of the diterpenoid hydrocarbons phyllocladene and isophyllocladene, as well as the diterpenoid alkaloids like the Garrya alkaloids veatchine, garryine, cuauchichicine and laurifoline. It is likely that aglucon is a diterpenoid acid and as such is remarkable in that it exists in nature as a glucoside [*Chem. Engng. News*, **34** (1956), 124].

Ion-exclusion process

THE ION-EXCLUSION PROCESS IS A unit operation which utilizes ion-exchange resins to separate solutes without the use of chemical regenerants. The separation is dependent upon the physical and chemical properties of the resin, and no net ion exchange takes place. Thus, when an aqueous solution of

two or more solutes is percolated through an ion-exclusion column (which consists of ion-exchange resins), a separation of the solutes occurs and they appear in separate fractions in the effluent. While ion exclusion is most applicable at higher ionic concentrations, it is generally not feasible to effect complete removal of all the ionic material by ion exclusion. Therefore, when complete deionization is desired, the bulk of the ionic material can be removed by ion exclusion and the remaining ionic material can be removed by conventional ion exchange.

Although separations by the ion-exclusion process are functions of several variables, one of the most important variables from a theoretical standpoint is the distribution constant K_d ($K_d = C_i/C_o$, where C_i is the concentration of the solute in the resin phase and C_o, the concentration of solute in the outside solution). A differential in K_d means that a separation of solutes is possible and can, therefore, be used to determine the separability of solutes. The values of K_d for sodium chloride and glycerine are 0·19 and 0·59 for the ion-exchange resin Dowex 50-X8 (sodium form; a strongly acidic cation-exchange resin of the sulphonated polystyrene divinylbenzene copolymer type; 50-100 mesh). Thus, theoretically, glycerine can be separated from sodium chloride by ion exclusion on the basis of the difference in K_d. This has been established by laboratory trials, and the process has been worked out on a pilot plant scale.

By employing the ion-exclusion process, it is possible to separate up to 90 per cent of the total dissolved ionic salts from soap type crude glycerine. The glycerine losses were approximately 0·6-per cent by weight. The following operating conditions proved to be most satisfactory for the separation of glycerine from its dissolved solids: crude feed rate, 4·25 lb. 82 per cent crude per hr. per cu. ft. resin; feed concentration, 30 per cent glycerine by weight; feed volume, 26 per cent; flow rate, 0·42 g. per sq. ft.; temperature, 180°F.

Although C.P. glycerine cannot be made by ion-exclusion process alone, further processing of the glycerine effluent from an ion-exclusion column by ion exchange to remove the remaining traces of ionic material and concentration by evaporation, will produce C.P. glycerine conforming to U.S.P. specifications. A cost analysis indicates that C.P. glycerine could be produced by this process at a cost of one cent per lb. [*J. Amer. Oil Chem. Soc.*, **33** (1956), 103].

Syntactic foams

SYNTACTIC FOAMS, PRODUCED BY Bakelite Ltd., London, are low density structural materials which can be used in heat or sound insulation, or where reasonable strength is required without adding much weight. They can also be used for producing stable and durable flotation units. In their uncured state they are putty-like in consistency and can be moulded into shape, trowelled on to suitable surfaces and forced into cavities, as well as pressed in sandwich core constructions.

Syntactic foams are produced by bonding together very tiny hollow spheres, known as Microballons, with phenolic, polyester or epoxy resins. Where the foam is employed as a spacing layer between skins, the resin used in the skin construction may also be used as the binder. In other cases the choice of binding medium will be determined by the particular method of production and the conditions under which the foam will operate, but the result in every case is a uniform foam material of homogeneous density.

Microballons consist of extremely small spheres of phenolic resin, each of which contains nitrogen gas. This construction gives each particle considerable mechanical strength which is transferred to the final material when Microballons are used as fillers in syntactic foams. In general, the individual particles have the same properties as thin films of heat-cured phenolic resin.

The use of polyester resins as binding media with Microballons gives a certain latitude of curing rate and provides a means of producing variable mechanical properties.

Phenolic resins have good adhesion to Microballons and can be used to produce primary structures for heat or sound insulation. The foams can be produced *in situ* to provide an enduring, heat-resistant medium which is highly resistant to water and chemical attack and adverse weather. The proportion of Microballons to resin can be varied as required to provide light foams of maximum insulation value or heavier foams with the maximum mechanical strength.

Where the maximum chemical resistance to alkali and the maximum adhesion is demanded of a light-weight structural member Bakelite, epoxy resin R 18774 can be used as the binding medium for Microballons [*Chem. Tr. J.*, **138** (1956), 716].

Transparent conductive coatings

SIERRACOTE, A TRANSPARENT, electrically conductive coating developed by Sierracin Corp. (U.S.A.), is being evaluated in aircrafts (Douglas RB-66 and Convair F-102A) for replacing conventional anti-fogging gear which are heavy and restrict the pilot's vision. Sierracote is the first transparent conductive coating applicable to plastic (polyester only) as well as glass and to areas of compound curvature. The coating is metallic and is applied by a high vacuum method to a thickness of about 20 millionths of an inch. For best durability, the coating should be between layers in laminated panels.

The coated panels are heated by a power input of 0·5-2·0 watts per sq. in. Equipment needed to supply necessary power in the Douglas RB-66 weighs about 2·5 lb., which eliminates 60 lb. of anti-fogging equipment used in the present method.

Coated polyester panels transmit 60-70 per cent of visible light, as compared to 90 per cent for uncoated polyester panels. But elimination of inner panels used with current anti-fogging equipment reduces distortion and increases the area of vision, resulting in a substantial net gain in visibility. And since moisture evaporates as soon as it forms, no vision-blurring water marks remain. Coated panels also are efficient infrared reflectors and thus prevent much of the sun's heat from entering the aircraft through transparent surfaces [*Chem. Engng. News*, **33** (1955), 4646].

Wax-plastic film

EXCELLENT PROTECTION AGAINST corrosion has been obtained by coating underground pipes with a microcrystalline wax and then covering the wax with polyvinylidene chloride film. The wax used is a mixture of *n*-paraffins, iso-

paraffins and naphthenes having an average molecular weight ranging from 580 to 700. In liquid state, the waxes have a very low surface tension and a viscosity near that of water. These properties permit the wax to get into the pipe's surface pores and thoroughly wet the metal surface, thus increasing the bond and excluding all moisture. The outer cover of a plastic film is needed to prevent the waxes from being displaced by soil pressure. Polyvinylidene chloride film seems most suited for external pipe protection because of its inertness to soil chemicals and to hydrocarbons.

The waxes are applied after preheating to 275°-325°F. and at this temperature range they can be flooded on to the metal surfaces. The plastic film is spirally wrapped around the pipe and the heat of the wax undercoat shrinks the plastic film into tight conformity with the pipe surface. For most commercial applications, a $\frac{1}{32}$-in. thick wax layer and 2-mil plastic film are considered adequate [*Chem. Engng. News*, **34** (1956), 1132].

High density polythene

ALKATHENE HD, A NEW HIGH density polythene developed by ICI, has many advantages over normal low density polythene. The new product can be processed in the same way as normal low density or flexible polythene. Articles injection-moulded or extruded from Alkathene HD can be treated without distortion for 15 min. at 110°C., as the Vicat softening point of the product is 116°C. compared with 83°C. for normal polythene. The rigidity of Alkathene HD moulded objects is one and a half times as great as of those made with the normal product. Alkathene HD is less permeable than normal polythene to most vapours and gases and more resistant to oils and fats [*Chem. Age*, **74** (1956), 585].

Quality of musical instruments

A NEW METHOD FOR IMPROVING the musical quality of musical instruments in which an arrangement similar to the one obtaining in the Indian *Tambura* — making the note rich in harmonics by artificial addition — has been worked out at the Physics Department, Nowrosjee Wadia College, Poona. It has been developed as an alternate method (by rectification, in this case) for the injection of generated harmonics in the 'Automatic Musical Instrument', designed earlier, which uses bridges with gradual slope, the vibrating string striking the bridge continuously near its end and generating a series of harmonics.

Fourier analysis shows that full-wave rectification of a sine wave provides a method of generating mainly the second harmonic, others being of smaller amplitude.

Half-wave rectification can be considered to be the result of the addition of two waves of equal amplitude: one, the original wave, and the other a fully rectified wave. If the amplitude of the latter is increased, a fully rectified wave with alternate suppression results. The proportion of harmonics, mostly second, can thus be changed by using different stages of rectification.

In the experimental set-up used to test the workability of this method, the current from a microphone is amplified and the amplified current is rectified using a doublediode. The rectified current rich in second harmonic excites a reed motor and communicates the vibrations mechanically through a coupling mass to the tuned string. A small portion of the string is placed in a magnetic field and the minute e.m.f. developed at the ends of the string is applied to a cathode-ray tube after amplification for studying the wave form. The input is 175 c/s. sine wave from an audio oscillator and the vibrating length of the string tuned to fundamental is 60 cm.

The oscillograms indicated that when a rectified current excites a string tuned to the fundamental, it is capable of reproducing the harmonic also, provided the amplitude of the harmonic is in large proportion and the vibrating length of string large. The string can vibrate in more than one mode corresponding to different phase relations among the fundamental and harmonic. Slight detuning changes the form of vibration from one mode to another. A strong fourth harmonic can be produced (using a finer wire) by two successive full-wave rectifications. The d.c. part after first rectification is eliminated by transformer coupling. The method was found to work satisfactorily and to give the desired effect [*J. Univ. Bombay*, **24**(NS)(3), 23].

High resolution microradiography

A METHOD HAS BEEN DEVELOPED for coupling the high penetrating power of X-rays with the high resolving power of the electron microscope. The new technique enables for the first time to have X-ray micrographs at useful magnifications of 10,000-23,000 diameters, showing details that hitherto could be seen only with the help of the electron microscope.

The basic technique consists of three steps: (1) making a relief image of the specimen in a grainless medium by means of the high penetrating power of X-rays; (2) obtaining a thin replica of this which is then shadow-cast and made suitable for examination with an electron microscope; and (3) examining this replica under the high resolving power of the electron microscope.

The first step is the essential one and involves new techniques that make the subsequent steps practicable. From a search among known photo and X-ray-sensitive substances for one that would show no structure in the electron microscope range, ammonium dichromate was found to be most suitable. While growing large crystals of dichromate for this use, it was found that the slight amount of solution adhering to the crystal as moisture deposits tiny crystals on the otherwise plane surface and that the plane surfaces crack on drying.

A successful technique finally developed consisted in removing the crystal from the mother liquor and immediately agitating it in a viscous collodion solution. The collodion solution aids in washing off the residual mother liquor, and because it dries to a film on the crystal face, it provides a membrane through which moisture can diffuse slowly. When the collodion film has become completely dry, it can be stripped from the crystal, leaving a completely plane surface without either grain or roughness. It was found that other materials, particularly certain type of plastic sheetings, which are structureless in the working range and are also adequately sensitive to X-rays, were also suitable. One such material is the commercial polyvinyl chloride-acetate film that undergoes change of solubility under X-ray bombardment.

The technique for using either dichromate crystal faces or poly-

vinyl films is quite similar. The specimen is mounted tight against the sensitive surface so that there is no space between them and so that no motion of one with respect to the other is possible. The combination is then mounted in the path of a carefully limited beam of soft X-rays for a sufficient period to form the image.

The effect of the X-ray exposure is to change the solubility of the plane surface; the image is developed in relief by dissolving away the more soluble portion of the exposed surface. A mixture of anhydrous alcohols has been found satisfactory for developing the X-ray image on the dichromate crystal face. With polyvinyl films, 30 per cent acetone in water can be used.

A cast, thin enough to permit the passage of the electron beam, is then made of the relief surface, using silicon monoxide or other suitable material. The replica is mounted on the customary screen. Finally, the relief of the replica is emphasized by volatilizing a thin metal coating, e.g. chromium, on it from an angle. The shadow-cast replica is then ready for examination in the electron microscope.

By this means excellent electron micrographs of carbon black particles showing variation in dispersion have been obtained. The new technique will enable examination of biological specimens without exposure to the high vacuum of the electron microscope [*Science*, **123** (1956), 370].

Phase measurement in a four-terminal network

A SIMPLE BUT ACCURATE METHOD of measuring the change in phase produced by a four-terminal network, often encountered in problems on electronic circuits, has been described in a paper in a current issue of the *Journal of the Institution of Telecommunication Engineers* [**2**(2) (1956), 93]. The method outlined is a detailed development of the elementary treatment given in a recently published paper by A. Van Weel, suggesting a simple method of phase measurement in a four-terminal network.

The principle employed is that, if a four-terminal network is inserted in the closed loop of an oscillator circuit, then the phase change $\Delta\phi$ produced by such introduction alters the frequency of the oscillator by $\Delta\omega$

$$\text{where } \Delta\phi = \left(\frac{\partial\phi}{\partial\omega}\right) . \Delta\omega$$

Thus if the rate of change of frequency for the entire circuit is known, then by measuring $\Delta\omega$, which can be done very accurately, $\Delta\phi$ can be obtained to a high order of accuracy, even to a few tenths of a degree under favourable circumstances. It is advisable to see that the value of $\left(\frac{\partial\phi}{\partial\omega}\right)$ for the whole circuit remains constant, irrespective of the particular network introduced.

A tuned load amplifier with a feedback of the phase inverted output serves as the oscillator which would normally oscillate at the parallel resonant frequency of the tuned impedance. This frequency is designed to be the same as the one at which the network is to be studied. Intervening cathode follower stages reduce interaction between the network and the oscillator. When the network is inserted within the closed loop, the oscillation frequency will be changed to such a value that the resultant change in phase of the tuned load impedance compensates the phase change introduced by the network.

In a parallel resonant circuit containing inductance (L), capacitance (C) and resistance (R) at and near the resonant frequency, it can be shown that

$$\frac{\partial\phi}{\partial\omega} = 2\,CR\,cos^2\,\phi$$

$$\text{or } |\,\Delta\phi\,| = 2\,CR\,cos^2\,\phi.\,\Delta\omega$$

Thus using a suitable load, according to the frequency desired, the phase change produced by the network can be found out accurately by noting the change in the frequency with an accurate frequency meter loosely coupled to the circuit. It is important to maintain the sinusoidal wave form throughout the operating period to avoid inaccurate results. This is generally facilitated by the application of negative feedback in the amplifier system. Oscillator stability is to be ensured also. If desired, a discriminator circuit may be used to measure the frequency, and knowing the value of $\left(\frac{\partial\phi}{\partial\omega}\right)$, the discriminator output may be directly calibrated in terms of phase.

Uranium recovery by ion exchange

ION-EXCHANGE TECHNIQUE HAS now been adapted for extracting uranium from low grade ores as a result of the discovery that when the leach solution is passed through an anion-exchange column, uranium is adsorbed on to the resin while practically all other metallic impurities pass straight through the column. This was an unexpected result, since metals in general are adsorbed only by cation exchange.

For uranium recovery, the ' De-Acidite FF ' anion-exchange resin is used, on to which uranium from the leach liquor is adsorbed in anionic form. This adsorption continues till the resin is fully loaded with uranium, which is subsequently precipitated from the eluate. The final product consists of dry cake containing up to 90 per cent uranium oxide.

Owing to the valuable nature of the leach liquor, and the necessity of producing pure eluate with the highest possible uranium value, the liquor is passed through two or three columns working in series. Also, to reduce the consumption of eluant, elution is also carried out on a recycling basis [*Chem. Tr. J.*, **138** (1956), 708].

Treatment of slurries by ion-exchange technique

A CONTINUOUS COUNTERCURRENT ion-exchange process has been developed which extends the use of the conventional ion-exchange procedure to the direct adsorption of soluble constituents from suspensions of finely divided solids, without the necessity for prior filtration. The essential feature of the process is that the free passage of a suspension through a virtually compact bed of resin is achieved by pulsating the flow. The resin bed becomes alternatively slightly expanded and then recompacted. Each pulsation opens the bed sufficiently to allow the suspension to progress a short distance during the forward stroke, but the duration of the expansion is too short for turbulence to develop in the bed. Pockets and channels are eliminated, and for some applications an important feature is that segregation of resin beds of differing densities takes place very efficiently. The pulsating flow also prevents the blockage of the screen which retains the resin.

This process has been found to be as efficient as the conventional procedures using the same resin. Since the coarser resin must be used with the 'resin-in-pulp' process, considerable reductions in resin loadings are inevitable as compared with the standard process, and shorter cycle times must be used. A greater volume of resin, and standard cycle times, could be used as an alternative. Since little free space is required above the top of the bed as the backwashing operation of the conventional plant is eliminated, the extra volume of resin could be contained in a column of the same dimensions as the standard plant.

It would be possible to modify an existing ion-exchange column by fitting an external pulsator unit and the requisite screens or filter beds [*Austr. J. appl. Sci.*, **7** (1956), 98].

Propylene polymerization

LIQUID PHOSPHORIC ACID HAS been successfully used as catalyst in the polymerization of C_3 olefins to produce motor gasoline components of high quality and certain molecular weight olefins. Preliminary batch reactor investigations demonstrate that 85-109 per cent liquid phosphoric acid could be used as a catalyst for producing predominantly C_9 to C_{12} of olefin polymers from propylene containing gases at 350°F. and at 40 atm. pressure.

Pilot plant investigations were carried out in a countercurrent downflow packed reactor. Preheated, vaporized olefinic feed and recirculated liquid phosphoric acid were introduced into the top of the packed reactor (packed with $\frac{3}{16}$ in. copper pellets) and brought in contact as they flowed down over the packing. Acid and hydrocarbon from the bottom of the reactor passed through a cooler and into a separator from which the acid was pumped back to the reactor inlet. The hydrocarbon phase leaving the separator flowed to a stabilizer, where continuous separation of tail gas and polymer was effected.

The feed stock employed in these studies was produced by fractionation of the C_3 plus the product from the catalytic cracking of process gas oil and contained 58, 41, 0·5 and 0·5 mole per cent respectively of propylene, propane, butylenes and butanes. Phosphoric acid catalysts containing less than 100 per cent phosphoric acid were prepared from commercial 75 per cent phosphoric acid by heating to remove excess water. Catalysts containing more than 100 per cent equivalent phosphoric acid were prepared by combining the commercial 75 per cent acid with Baker's C.P. phosphorus pentoxide.

When operations were carried out with 98 per cent acid at 360°F. and at an average acid circulation rate equivalent to 0·6 vol. per volume of reactor per hour, olefin conversion varied over the range 22-94 per cent when feed rate was varied from 0·5 to 2·2 liquid volumes per hour and the pressure from 300 to 700 lb. per sq. in. Reaction rate constants of about 3, 10, 19 and 30 volumes of olefin per volume of reactor per hour for the reactor system employed were obtained with the 92, 98, 103 and 109 per cent phosphoric acid catalyst respectively. The reaction is relatively insensitive to temperature in the range 275°-400°F., and has a relatively low temperature coefficient, the average activational energy being about 5,000 cal./g. mole for 98 and 109 per cent catalysts. Polymer molecular weight increased and the octane number of the gasoline fraction decreased with increasing catalyst strength. From the pilot runs it appears that a replacement rate between 1 and 4 lb. of phosphoric acid per 100 gal. of polymer will be necessary in a commercial installation.

One of the major disadvantages of the liquid phosphoric acid-catalysed polymerization process is the corrosiveness of the catalyst at polymerization temperatures. Data obtained in the preliminary work showed that the corrosion rate of either type 304 (Cr: Ni, 18: 8) and type 316 (Cr: Ni: Mo, 18: 8: 3) stainless steel at 360°F. was controlled satisfactorily by the addition of 0·5 per cent arsenic trioxide to the phosphoric acid catalyst. Copper resists strong phosphoric acid up to 400°F. if oxygen is absent and the surface is protected from velocity effects [*Industr. Engng. Chem.*, **48**(3) (1956), 370].

Fused phosphate fertilizer

FUSED PHOSPHATE INDUSTRY HAS made great strides in Japan. At present there are 14 plants in operation, of which 11 are electric furnace plants, the total capacity of which is about 300,000-340,000 tons yearly.

Japan imports almost all the phosphate rock she needs, those for the fused phosphate industry being drawn mainly from Florida, Makatea and Kossier. Ease of furnace operation is dependent on the type of phosphate rock used. Serpentine and low grade dunite are also used.

The electric furnaces consist of a cylindrical steel shell lined with a layer of firebricks and a layer of carbon blocks. The shell is cooled with water sprays so as to form a layer of solid phosphate slag on the internal surface of the carbon refractory. The internal diameters of the furnaces range from 12 to 20 ft., and their depth from 2 to 4 ft. Furnaces vary in capacity from 1,500 to 5,500 kVA. All are three-phase, with the electrodes in delta connection, and voltages between electrodes vary from 200 to 220 V. The power factor obtained is high, usually about 0·98-0·99 [*Chem. Tr. J.*, **138** (1956), 978].

Guaiacol manufacture

A NEW METHOD OF MANUFACTURing guaiacol from *o*-anisidine via the corresponding diazo compound has been developed. Refrigeration is not necessary in the new method and hence the cost of production is lower than in the conventional diazotization method.

To a boiling solution of copper sulphate in dilute sulphuric acid, and containing in solution *o*-anisidine, is added a solution of sodium nitrite. Superheated steam is passed into the reaction mixture and distillation is arranged to be as rapid as possible and at about the same rate as the addition of nitrite solution. Pure guaiacol is distilled off and the yield is about 80 per cent of that theoretically possible, based on the *o*-anisidine used. The first runs in guaiacol are separated first and the aqueous portion, mixed with the later steam distillate, is extracted with ether or benzene. In this manner, the yield can be augmented and 90 per cent of the weight of *o*-anisidine is obtained [*Chem. Tr. J.*, **74** (1956), 631].

Fluorocarbon-based inks

A SERIES OF FLUOROCARBON COMpounds which can be used as the bases for printing inks that will adhere tenaciously to nylon, fluorocarbon and polyethylene sur-

faces have been developed. The compounds can also be used for marking a wide variety of rubbers and other plastics, including rigid and plasticized vinyl materials.

The inks can be made up as either air-drying or heat-setting compounds. To obtain the best adhesion of the inks to the surface to which they are applied the 'Kel-F' air-drying inks, as they are called, must be dried in a forced current of hot air, or by radiant heat. The heat-setting inks, on the other hand, which are designed for applications where the inked impression must withstand the attack of solvents or other chemicals, can be cured in a hot-air oven, with infrared radiation, or by direct application of a hot iron. Test applications have shown that settling times of the order of one-half minute can be used, while hot iron applications were found to produce effective results in only 5 sec. A silver formulation of these fluorocarbon ink compounds has proved especially suitable for printing electronic circuits on fluorocarbon and polyethylene plastic film and moulded sheet under experimental test conditions [*Chem. Tr. J.*, **138** (1936), 696].

Descaling with ammonium bicarbonate

RECENT STUDIES HAVE SHOWN that calcium sulphate scale in heat exchanger tubes or other equipment can be successfully removed by the use of ammonium bicarbonate solution if the scales are relatively thin. Removal of a thicker layer can be accomplished by treating alternately with ammonium bicarbonate solution and dilute hydrochloric acid. Calcium sulphate is converted to calcium carbonate (which precipitates out), and soluble ammonium sulphate.

During trials it was found that calcium carbonate is precipitated on the scale itself, retarding further action of ammonium bicarbonate on calcium sulphate. This calcium carbonate scale could be removed easily with a dilute hydrochloric acid wash.

Temperature and rate of flow did not have any significant effect on the descaling process. Temperature increase speeds up reaction rates, but any advantage is offset by thermal decomposition of ammonium bicarbonate in solution. Increasing the concentration of ammonium bicarbonate solution increases its rate of attack on the scale. The only noticeable effect of pressure was to keep in solution the carbon dioxide formed in the reaction and by thermal decomposition of ammonium bicarbonate. The rate of solution of calcium sulphate per unit of exposed surface was found to be substantially independent of particle size or shape, and of operating conditions, up to *c.* 45°C. [*Industr. Engng. Chem.*, **48**(3) (1956), 102A].

Brightening of aluminium

REFLECTAL, AN ALLOY OF HIGH purity aluminium with 0·5 per cent of magnesium, is finding increasing use in German automobile industry as a finish in place of chromium-plated metal. The aluminium alloy is brightened by Erftwerk process which has been patented by Vereinigte Aluminium-Werke. The brightening solution consists of 13 per cent nitric acid, 16 per cent ammonium bifluoride and 0·2 per cent lead nitrate, at a temperature of 50°-80°C. The bath is gently agitated and parts are dipped for 5-30 sec. There is a vigorous reaction when aluminium enters the solution, resulting in removal of a 0·001-0·002 in. thickness from the part being dipped.

After brightening, the part is rinsed in tap water, and then rinsed in a 50 per cent nitric acid solution. The part can then be anodized by conventional methods, dyed if required, and sealed in boiling water. It is essential that total impurities in the metal do not exceed 0·01 or 0·02 per cent if the subsequently applied anodic film is not to impair the brilliance of the surface [*Chem. Tr. J.*, **138** (1956), 523].

NBS electron tube information service

TO MEET THE INCREASING NUMBER of requests for information not readily available on little-known tubes or tubes of foreign manufacture, the 7 years old NBS information service for disseminating technical data on radio tubes, originally meant as a service to its own personnel, has been extended to all scientists and engineers in government and industry, and its coverage expanded to include junction diodes and transistors. This unique service enables to obtain information about (1) any particular tube, (2) all tube types whose electrical characteristics, bulb sizes, base configurations and ambient operating conditions fall within particular ranges, (3) construction details where possible, and (4) domestic tubes that can be substituted for unavailable foreign tubes. The information is collected mainly from the manufacturer's brochure or handbook in the case of major established companies, and by direct queries from new and small companies on receipt of preliminary information of their products. Special attention is paid to keep the file on crystal diodes and transistors up to date. The files include products of about 80 domestic and 15 foreign manufacturers. To process requests more rapidly and to include the latest data on all the steadily increasing domestic and foreign tubes, the service has at present a 10,000 card source filed by the tube type number, and appropriately referenced to the manufacturers' data, for automatic selection. General information on the basis of operating voltages, transconductance, etc., will be coded. Punched-card coding has been completed for the miniature and sub-miniature tubes for mechanical sorting. For queries on tube types with specified electrical, mechanical or geometrical characteristics, machine selection of several tubes meeting the specification of the inquiry is made first, and the more specific information like cathode operating temperature or contact potential, which are liable to vary with the manufacturer, is supplied after reference research [*NBS Tech. News Bull.*, **40**(2) (1956), 17].

Unesco technical mission in India

UNESCO HAS SENT AN INTERnational mission of scientists and engineers to India to help the Government to draw up final plans and determine equipment requirements for the Western Higher Institute of Technology at Bombay. This is the second of four technological institutes which the Indian government is organizing along the lines of Massachusetts Institute of Technology, U.S.A.

The mission is led by Prof. N. B. Cacciapuoti of Italy, Deputy Director of Unesco's Department of Natural Science. Its members include six engineers from the Soviet Union and a British Aero-

nautical engineer. The Unesco will also help the Institute by supplying both professors and equipment.

Catalogue of Nuclear Reactors

THE NUMBER AND VARIETY OF nuclear reactors now in use have become so great that a need has been felt for a document which would present, under one cover, a description of all those known to exist.

Such a " Catalogue of Nuclear Reactors " has been compiled by the Atomic Energy of Canada Ltd. Technical Information Office at Chalk River, Ontario, with the co-operation of the Information Office at the Atomic Energy Research Establishment, Harwell. It contains a data sheet for each of the fifty-odd reactors known to have been operated before the middle of 1955. Data for each reactor are summarized under such headings as " Fuel Elements ", " Fuel Core ", " Coolant ", " Neutron Flux ", etc.

The " Catalogue of Nuclear Reactors " has now been published by Her Majesty's Stationery Office, London, and priced at Rs. 3/6.

Announcement

■ *National Research Fellowships*, 1956 — The Government of India have instituted National Research Fellowships to encourage promising young Indian scholars to carry out research in science or technology at any recognized university or research institute in India. Each fellow will receive a monthly stipend of Rs. 400 and a grant of Rs. 1,000 per year for any special apparatus required for the work. The duration of the Fellowship is three years extendable up to five years in special cases. The following sixteen candidates have been selected for the award this year:

Botany — Dr. (Shrimati) Archana Sharma (née Mookerjea), Calcutta University; Dr. A. R. Zafar, Osmania University, Hyderabad; Shri R. C. Sachar, Delhi University; Dr. (Miss) Nalini Nirodi, Indian Agricultural Research Institute, New Delhi.

Chemistry — Dr. B. N. Mattoo, Poona University; Dr. (Miss) Kazi Hemlata Jayadevlal, M.T.B. College, Surat; Shri G. S. Krishna Rao, Indian Institute of Science, Bangalore; Dr. A. K. Barua, Bose Research Institute, Calcutta; Dr. P. N. Rao, Indian Institute of Science, Bangalore; Dr. N. Arumugam, Madras University.

Engineering—Shri N. Ananthanarayana, Indian Institute of Science, Bangalore.

Mathematics — Dr. S. N. Barua, Gauhati University.

Physics — Dr. V. G. Krishnamurthy, Indian Institute of Science, Bangalore; Dr. G. S. Sastry, Osmania University, Hyderabad.

Physiology — Shri J. Mukherjee, Calcutta University.

Zoology — Dr. Joseph Jacob, Annamalai University.

INSTRUMENTS AND APPLIANCES

ELECTROSTATIC LOUDSPEAKER

The electrostatic loudspeaker, which will be first demonstrated to public at the London Audio Fair, in the spring of 1956, is likely to be the first major development in loudspeaker design after the advent of the Rice-Kellogg moving-coil system in 1925. New materials, techniques and ideas, in recent months, mainly developed in Britain, which had been the foremost in advancement in this field, have made this hitherto laboratory curiosity a commercial reality. From the technical point of view it may even effectively replace present high-fidelity reproducers. The latest models besides being highly efficient are claimed to be capable of reproducing the full musical spectrum (till recently this type of speaker could handle only top notes) with high fidelity.

The new device is different in principle from the moving-coil speaker, where a conical diaphragm made of a heavy paper is mechanically driven by the coil and the driving force is applied to only a small area of the diaphragm, resulting in energy loss and distortion. In the electrostatic loudspeaker the driving force is applied almost evenly over the whole surface of the vibrating element which is usually an extremely light plastic sheet with a metallic coating on one side to sustain an electrostatic charge. Very close to it and effectively insulated from it is a rigid backplate, also coated with metal. A highly polarizing voltage is applied to both the elements. Signal voltages are superimposed on the system and the moving element vibrates at the signal frequencies, reproducing the appropriate sounds [*The Times Review of Industry*, **10**(11) (N.S.) (1956), 87].

TRANSVERSE PROFILE ATOMAT

Mechanical difficulties and the uncertainties in obtaining a true picture of the transverse profile of materials like paper, board or plastics in continuous production inherent in the use of previous type of atomats have been overcome in a latest development of nucleonic thickness gauge designed to provide a simple and accurate means of measuring weight variations at right angles to the direction of production. The latter is made completely self-contained by providing its own amplifier and no longer dependent on the Atomat Beta Ray Thickness Gauge. Not only is the information more accurate and comprehensive, but the saving in time is impressive.

The operator has to cut a sample about 1 foot wide across the end of the reel and wind it on to the spool on top of the atomat. By operating a switch, the sample is automatically fed through the unit and the minute weight variations are plotted on a recorder chart within 2 or 3 min. The operator can then take immediate steps to make necessary adjustments. One transverse profile atomat generally serves a whole mill and if it is placed in the production control office samples can periodically be brought to it from all machines [*Indian Pulp Paper*, **10**(9) (1956), 445].

HIGH STABILITY RADIOFREQUENCY VOLTMETERS

Highly stable r.f. voltmeters, known as attenuator-thermoelement or AT voltmeters, have been designed at the Boulder Laboratories of the National Bureau of Standards. The instruments can maintain for a year or longer, calibration stability of about 1 per cent (available present-day voltmeters using thermionic or crystal diodes have, under most favourable treatment, a 10-20 per cent calibration uncertainty, the constancy being over far shorter intervals) over a voltage range of 0·1 to several hundred volts up to 1,000 Mc/s.

One of the r.f. AT voltmeters possessing superior long-time calibration stability and designed for high voltages and higher frequencies consists of a continuously

adjustable waveguide-below-cut-off piston attenuator, a thermo-element and a d.c. millivoltmeter. The travelling piston of the attenuator houses the thermo-element and a built-in r.f. probe which is used for calibrating the AT voltmeter in terms of a primary standard bolometer bridge whose output is approximately 1 volt. The probe provided the means to calibrate the voltmeter with 1 volt or lower voltage levels at all frequencies. If the voltmeter is calibrated at one voltage level at a given frequency, then all other voltages at that frequency in the range of the instrument are accurately known.

Another design having closer electrode spacing behaved over a part of its range (1-100 V.) like a continuously adjustable capacitive attenuator, but requires extensive calibration. Single meters incorporating both the above types of design can push the upper voltage limit to 1,000 V. at all frequencies. A third kind which is relatively economical and of simple construction is the fixed capacitive attenuator designed for a single frequency (except those employing resistive pads); however, they can be used over a range of frequency with calibration. Their input impedance approximates to that of commercial vacuum tube voltmeters.

Nomographs designed for AT voltmeters enable their quick application either as reliable transfer standards or as working instruments.

AT voltmeters are particularly suitable as secondary reference standards for all laboratories requiring accurate voltage measurement, better than 10 per cent [*NBS Tech. News Bull.*, **40**(2) (1956), 29].

Semi-micro Gelometer

A compact gelometer, working on the principles similar to the Tarr-Baker tester and the Bloom gelometer, with which both the strength and rigidity of a gel can be measured, has been developed at the Maritime Regional Laboratory, National Research Council, Montreal, Canada. In this instrument, breaking strength is estimated as the force required to rupture the gel surface with a cylindrical plunger. Rigidity is calculated from the depression of the gel under a known load. Rapid measurements are possible with a sample of even 4 ml. volume.

A plunger, driven at one time by one of the four interchangeable Bodine motors of different speeds but each with a constant speed (to obtain different plunger speeds in conjunction with a fine screw), depresses the gel resting on the pan of a dietary balance. A shoulder on the screw shaft of the motor eliminates any vertical play of the plunger which is 15 mm. long and 4-8 mm. in diameter, with a slightly conical shape to give a clean break after the puncture of the gel. The gels are made in cylindrical 5 mm. beakers. The plunger penetrates the gel and the pointer momentarily moves backwards leaving an indicator needle at the maximum point; then the motor is stopped. The scale reading shown by the needle gives the breaking strength, G, of the gel. For rigidity (R) determination the pointer movement is timed by means of a stop watch between a reading of 10 g. and X, approximately one half of the estimated gel strength. Distance of descent, d, of the plunger is computable from the plunger speed. A calibration factor relates the movements of the pan and pointer and so the movement of the pan, p, between the readings 10 and X can be obtained. The depression, g, of the gel is given by $g = d - p$.

Experience with the instrument on gelatin, carrageenin and agar gels shows that it is simple to use and that operation is sufficiently rapid as to permit measurements on 100 gels in a day. Mean deviation is observed to be small. A cleaner break was obtained at 10°C. than at 20°C. in the case of gelatin. Reproducibility of G and R values has been found to be within ± 6 per cent. G for agar and gelatin increased by a factor of 1·3 for the full range of plunger speeds, probably due to a combination of elastic and plastic behaviour of the gel. Dependence of G and R on the plunger diameter can be empirically correlated though not in terms of absolute units of elasticity (which is difficult due to a larger plunger size/gel-volume ratio and the probability of plastic response of the gel). However, the reproducibility is such that figures obtained under a set of standard conditions may be used as reliable empirical measurements of G and R [*Canad. J. Tech.*, **34** (1956), 53].

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Progress Reports

INDIAN STANDARDS INSTITUTION

THE EIGHTH ANNUAL REPORT OF THE INDIAN STANDARDS Institution for the year 1954-55 records an all-round increase in its various activities, viz. formulation of standards, participation in international standardization and research and testing. The number of subscribing members of the Institution rose from 897 during the previous year to 1,032, and the financial contribution from the members increased from Rs. 242,290 to Rs. 268,638.

The total number of Councils and Committees at the end of the year was 486 against 423 of last year and the number of meetings held by the Committees increased from 214 during the previous year to 290 during the year under review. One hundred and twenty-three Indian Standards (including 4 revisions) were published during the year, bringing the total number to 589; 65 per cent of these have been adopted by the Central Government. The number of new proposals received from industry during the year for formulating standards was 97, of which 74 were accepted.

The first Engineering and Building Standards Convention arranged by the Institution was held at Calcutta during 11-15 December 1954. Another notable event of the year was the laying of the foundation-stone of the ISI secretariat by the Prime Minister on 21 August 1954. The building fund collections amounted to Rs. 4 lakhs by the end of the year under review.

The *ISI Bulletin*, a quarterly periodical, is now being published every two months from January 1955.

Considerable progress was made on the ISI Certification Marks scheme. A special feature of the draft rules and regulations finalized by the Certification Marks Committee and published during the year is the provision for setting up special Inspectorates by the Institution for the inspection of the products of a group or groups of small-scale manufacturers who are not individually able to arrange for routine inspection and marking of their products.

The main activities of the different Divisions during the year are summarized below:

Engineering division — Among the 34 standards published during the year were those on cotton and hair beltings, stationary accumulators (lead acid type), Leclanche type dry batteries for radio receivers, radio receivers, split cotton pins, safes, bicycle tube valves, black plate for tinning and tinplate, combined drills and countersinks (centre drills), aluminium and aluminium alloy ingots and castings and tool handles. A standard of far-reaching importance in the development of electrical generation and distribution, including the designing of transformers, transmission lines, switchgear, etc., published during the year was the Indian Standard Recommended Voltages and Frequency for A.C. Transmission and Distribution Systems.

Thirty-three new subjects accepted for formulation of standards included sewing machines, power-driven pumps, optical and mathematical instruments and system of marking import and export cargo with suitable symbols.

A new sectional committee was set up to deal with standardization of lead pencils. Work was started on standardization of pulleys, one of the most commonly required items in power transmission. Surprisingly enough, no other country seems to have attempted work on standardization of pulleys so far.

Building division — At the Engineering and Building Standards Convention held at Calcutta, the Building Division Council accepted in principle the suggestion that standards for new materials and new methods should be prepared on the basis of experience of other countries and on this principle work was started in the field of gypsum and gypsum products for use in building.

Three new standards, viz. for portland blast furnace slag cement, code of practice for the preservation of timber and for test sieves were published during the year. New projects taken up include roofing hardware, wire nails, fanlight pivots, precast concrete blocks, air entraining agents in concrete, electrical casings and cappings and steel pipes with concrete lining.

On the basis of studies conducted by the research panel of the division, important changes are being carried out in the specifications for portland cement. These relate to the introduction of the autoclave test for determination of soundness of cement and the substitution of compression strength test as a compulsory test in place of tensile test and the relegation of tensile strength as an optional test.

Textile division — Twenty-eight new standards were published of which 3 relate to physical tests for single jute fibres, viz. methods of determining twist, breaking load and grist of jute yarn. Another three standards were concerned with chemical testing of fibres, viz. methods of determining the desizing efficiency and relative efficiency of amylolytic enzymes; method for determination of relaxation shrinkage of woven fabrics containing wool; and simple methods for identification of common commercial textile fibres.

Chemical division — To ensure the quality of products from new refineries coming into operation, a sectional committee on Petroleum Products was set up to undertake work on the standardization of motor spirit, kerosene, light diesel oil, high speed diesel oil, furnace oil, vaporizing oil and aviation turbine fuel. A new sectional committee was also set up for Edible Starches and Cereal Products.

A notable achievement of the Division was the successful completion of experiments on aluminium grain storage bins as a result of which the type of bins experimented upon were found to be suitable for the storage of wheat, barley, jowar, bajra, maize and gram. A standard code of practice was also finalized regarding the measures to be adopted for bringing such acquired structures as are not originally built for such purposes but are utilized for storage of foodgrains to the desired level.

The sections of Agricultural and Food Products and Steel Economy issued 9 and 7 draft standards respectively during the year.

More than 100 research projects sponsored by the Institution were being investigated at various research institutes and National Laboratories. These problems covered a wide range in the fields of engineering, textiles, chemicals and agricultural and food products.

TEA RESEARCH

THE ANNUAL REPORT OF THE TOCKLAI EXPERIMental Station of the Indian Tea Association for the year 1954 records interesting results obtained in connection with investigations on fermentation and maturing of teas, and of investigations on natural and artificial withering of tea, manurial trials and tea parasites.

The annual conference held at Tocklai during December 1955 was different from the previous ones. It took the form of a symposium and a number of topics such as (1) withering of tea, (2) shade in tea plantations, and (3) drainage and soil conservation were discussed.

The following is a summary of the work carried out during the year:

Agriculture --- Manurial trials with tea seedlings have shown that 1:2:3 N.P.K. mixture at 2 lb. per acre at fortnightly intervals, for a period of six months, is beneficial. The application of as little as ½ oz. of superphosphate per plant at the time of transplanting appears to have a beneficial effect on the subsequent growth of plants. Application of 20 lb. of phosphate per acre has been found to increase the yield of tea by 1·28 md. per acre. Trebling the amount of phosphate or adding up to 60 lb. of potash along with phosphate do not significantly increase the yield of tea, the maximum yield being 1·95 md. per acre. Manuring of a bi-clonal seed hair has shown that seeds from trees receiving heavy doses of superphosphate have low viability. The germination of seeds is reduced by one-third when the dose of phosphate is increased. Increasing doses of phosphate have not shown any effect on the set of the seeds.

The yield of tea has been found to increase significantly under reduced light intensity; under 70 per cent of full light the increase in yield was 29 per cent and under 50 per cent light the increase was found to be 19 per cent. Under the shade of bamboo screens, the weight of the shoots and the number of pluckable shoots have been found to increase. The effect of varying light intensity on the growth and assimilation of different phenotypes of tea is being studied.

Soils — The effect of continuous leaching with sulphate of ammonia on the soil exchange complex has been examined and it has been shown that this treatment brings about rapid diminution in the exchangeable cations, especially the exchangeable calcium.

The contribution made by the organic matter fraction to the total exchange capacity of soils has been measured by determining the total exchange capacity of a number of soil samples by leaching with ammonium acetate before and after destruction of organic matter with hydrogen peroxide. The exchange capacity contributed by the organic matter varies with the type of soil and ranges from about 30 per cent to 90 per cent of the total exchange capacity.

Plant pathology — Fumigation of nursery sites with shell D-D-fumigant has been found to reduce eelworm population and the plants thus treated were larger and heavier. Methyl bromide has also been found to reduce the infestation, but appears to retard the growth of the plants to some extent.

Aranite has given promising results in the control of red spider; the compound does not taint tea.

Manufacture — Comparisons of teas made from leaf withered naturally at the usual thickness of spread and those made from leaf stored overnight and then withered in 3 hr. at a spread of 3½ lb. per sq. yd. showed no significant difference in leaf appearance and liquors. Leaf artificially withered at a spread of 1 lb. per sq. yd. showed no improvement over leaf artificially withered at a spread of 3½ lb. per sq. yd. A comparison of natural wither and an artificial wither at 100°F. showed no significant difference. A prototype withering tunnel based upon the results of trials conducted in the experimental withering chamber has been completed and is being tested. Though no improvement is claimed for the quality of tea, the advantage of the tunnel system of withering is that it gives the desired degree of wither all through the season.

Biochemical research — Caffeine has been shown to stimulate the oxidation of catechins in tea, and therefore directly concerned in the fermentation of tea leaf. An increase in extractable caffeine during withering has been confirmed. The increase also occurs when the leaf is kept in a saturated atmosphere. An increase in caffeine content of the leaf results in an increase in colour and strength of the made tea. It is explained that in the presence of caffeine, polyphenols combine with caffeine rather than with protein. The caffeine-polyphenol complex is water-soluble and can be extracted by a 5-min. infusion of tea whereas the protein complex is insoluble. It has been shown that fired tea still possesses appreciable enzyme activity and that, provided sufficient moisture is present, fermentation can continue after firing. The enzyme in fermented leaf is much less sensitive to heat than the enzyme in fresh leaf. This post-firing fermentation is considered to be partly if not largely responsible for the maturing of teas and also for their ultimate deterioration on prolonged storage.

A method has been developed for determining the total volatile matter in tea. It consists in steam distilling a tea under standard conditions and recording the amount of permangnate required to oxidize the volatile matter in the distillate. By comparing teas made from the same leaf, but manufactured under different conditions, it will be possible to obtain information on the conservation of flavour during manufacture.

INDIAN PATENTS

[A few of the Patent Applications notified as accepted in the *Gazette of India*, Part III, Section 2, 28 April to 12 May 1956, are listed below.]

Chemicals, plastics, rubber, paints and allied products

52942 and 52943. Preparation of aminophenoxy alkanes: *Reacting disubstituted aliphatic compound with a disubstituted benzene.*

Condensing hydroxalkyl halide or alkylene oxide with primary or tertiary amine — WELLCOME FOUNDATION LTD.

52945. New guanidine compounds, their preparation and use as reagents for picric acid: *Treating p-aminophenol ether with cyanamide or with a salt of S-alkylisothiourea* — FARMACEUTICI ITALIA S.A.

53187. Process for the manufacture of vat dyestuffs of the indanthrone series: *Subjecting a 1-aminoanthraquinone to fusion with small proportion of an alkali metal phenolate in the presence of an oxidizing agent wherein high concentration of distillable constituent is maintained in the melt* — CIBA LTD.

53960. New quinoline derivatives: *Reacting di-(4-amino-1:2-dimethyl-6-quinolyl)-amine with quaternary salt-forming agent* — I.C.I. LTD.

54477. New spasmolytically active compounds and process for preparing them: *A dialkylamine of the formula H-NR$_1$-R$_2$ and an alkali metal cyanide are reacted with methoxy-4-benzaldehyde and the resulting nitrile is saponified* — N. V. NEDERLANDSCHE COMBINATIE VOOR CHEMISCHE INDUSTRIE

54800. Detergent composition: *Comprising water-soluble non-ionic detergent of polyalkylene ether type and a higher aliphatic alcohol* — COLGATE-PALMOLIVE CO.

54866. Preparation of phthalic anhydride: *Subjecting a mixture of naphthalene vapour and an oxygen-containing gas to the action of high frequency energy impulses* — JAGER

55025. Recovery of cycloserine: *Cycloserine is precipitated from solution as an insoluble metal salt, and after separation, is slurried with water, the metal ion is precipitated as a water-insoluble salt and the resulting cycloserine is recovered* — COMMERCIAL SOLVENTS CORP.

55232. Metallizable azo dyestuffs: *Diazotizing o-aminophenol phosphoric acid ester and coupling with coupling component containing at least one coupling position adjacent to metallizable group* — I.C.I. LTD.

55284. New pigment compositions and the colouring of cellulose acetate plastic media therewith: *Having from 50 to 500 parts by weight of basic aluminium sulphate for 100 parts of lead chromate pigment* — I.C.I. LTD.

55549. Methods of producing crude hexachlorocyclohexane: *Chlorinating benzene under actinic radiation in presence of an ammonium salt* — N. V. PHILIPS' GLOEILAMPENFABRIEKEN

53079. Manufacture of diethyl dithiol esters: *Reacting isophthalyl chloride with ethyl mercaptan* — I.C.I. LTD.

54234. Amino ketone compounds and methods for producing the same: *Dl-α-methyl aminopropiophenone is reacted with an optically active organic acid and the d- and l-salts are separated by fractional crystallization* — PARKE, DAVIS & CO.

54334. Process for the production of tetra-azaporphin dyestuffs: *Subjecting to heat treatment 2-amino-5-imino pyrrolenine together with an organic solvent and a heavy metal or metal compound* — FARBENFABRIKEN BAYER AKTIENGESELLSCHAFT

55544. Manufacture of sulphate of ammonia: *Treating ammonia-containing gases with acid liquor which is subsequently treated in an evaporator* — SIMON-CARVES LTD.

56620. Amino ketone compounds and methods for producing the same: *The secondary hydroxyl group present in l-ephedrine is oxidized to a keto group* — PARKE, DAVIS & CO.

53007. Manufacture and use of certain polymerization products: *Polymerizing an ester or amide of at least copolymerizable acid containing in the ester or the amide portion at least one quaternary ammonium group which is not bound to a hetero atom through methylene bridge and at least another polymerizable compound* — CIBA LTD.

54296. Carbinols and preparation thereof: *By condensing under anhydrous conditions an aliphatic β-haloalkyl ketone with a metal acetylide* — CHAS PFIZER & CO. INC.

55643. Production of foam rubber: *Vulcanizable rubber latex is foamed, the foam is shaped and gelled and then the gelled foam is treated with a coagulating gas and vulcanized* — DUNLOP RUBBER CO. LTD.

Chemical processes, engineering and equipment

54768. Process for the hydrogenation of carbon monoxide: *Maintaining a temperature difference of 30° to 150°C. between the uppermost layer of catalyst suspension and the gas inlet zone* — RHEINPREUSSEN AKTIENGESELLSCHAFT FUER BERGBAU UND CHEMIE

55647. Method of bringing liquids into contact with granular materials: *The bed of the material is moved as a whole and some of the material is expelled from the container* — PERMUTIT CO. LTD.

54840. Dehydrogenation of secondary aliphatic alcohols with a branched or unbranched carbon chain: *Characterized in transmitting heat to reaction tube through fluidized bed of solid particles in furnace* — N. V. DE BATAAFSCHE PETROLEUM MAATSCHAPPIJ

53167. Improvements in or relating to centrifugal and like pumps: *Pump casing carrying suction end flange, delivery end flange, feet, a drive end cover supporting and carrying complete rotating element with water sealing devices and cover fixed to casing by studs or bolts so that the end cover can be separated and bodily removed together with rotating element and sealing devices from pump casing without interfering with suction flange or pipe of delivery pipe or flange* — CHANDER

53168. Self-priming centrifugal pumps: *Reservoir communicating through ports directly with the chamber housing the impeller whereby direct communication between priming reservoir and the suction side is avoided* — CHANDER

Physics — General

54267. Electromagnetic coils: *Comprising an electrical conductor wound into a coil and a coating of ferro-magnetic powder in insulating powder over said coil* — SYLVANIA ELECTRIC PRODUCTS INC.

53080. Regenerative modulators: *Comprises a frequency mixer, harmonic generator and filters* — AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

54793. Glass insulators: *Insulator produced by pressing operation to form a zone of radial portion which prevents propagation of a fracture initiated in the part of the skirt below* — PILKINGTON BROTHERS LTD.

Food and kindred products

53999. Methods of making edible oil-cakes from peanuts: *Cleaned kernels are pressed to extract the major portion of the oil content while avoiding an excess heating* — CALIL & GUERNIER

55810. Improvements in or relating to sterilizing milk: *Milk in bottles is fed in sterilizing tunnels and sterilizing is effected by steam* — CROSS

Drugs and pharmaceuticals

53457 and 53458. Stable suspensions for therapeutic use: *Consists of a salt of penicillin and coconut oil substantially free of tristearin.*

Consists of a special coconut oil which has been chemically changed or modified by ester interchange or esterification — BRISTOL LABORATORIES INC.

53890. New acaricidal compositions: *Condensing substituted benzyl halide with thiol* — BOOTS PURE DRUG CO. LTD.

54290. Acaricidal preparations: *Comprises p-chlorophenyl-p-nitrobenzyl sulphide in a suitable diluent or carrier* — BOOTS PURE DRUG CO. LTD.

54492. Therapeutically useful compositions and method of making same: *Comprising extract of an organism of the sub-order isopoda* — VLASSOPOULOS & LOGOTHETIS

54519. Process for the preparation of hydrocortisone esters and salts thereof: *Hydrocortisone is contacted with a polycarboxylic acid acylating agent to produce acid ester* — CHAS PFIZER & CO. LTD.

54407. Process of recovering basic antibiotics: *Contacting whole broth with particulate cation exchanger, separating the same and eluting antibiotic adsorbed therein* — OLIN MATHIESON CHEMICAL CORP.

54880. Method of manufacturing products adapted for preparing the large intestine for roentgenographic purposes: *Combining laxative agent with agent having tanning effect and/or of reducing mucus secretion* — FERROSAN

Fuels and lubricants

55745. Latch operating means for coke oven doors: *Comprising a pressure applying means adapted to be releasably connected to the door and to compress the spring means for the purpose of releasing the latch characterized by a coupling device constructed and arranged for connecting the pressure applying means to the door body* — HEINRICH KOPPERS GESELLSCHAFT MIT BESCHRANKTER HAFTUNG

55543. Improvements relating to the treatment of coke oven gas: *Gas is passed through two spray absorbers in succession, the first absorber supplied with less concentrated acid liquor than the second*— SIMON-CARVES LTD.

52558. Quenching of coke: *Comprising a battery of inclined cooling chambers subdivided into individual compartments having an inner shell, and a wall permeable to cooling gas* — HEINRICH KOPPER G.M.B.H.

53539. Coke ovens: *Comprises in combination a carbonization chamber, a distribution and heating chamber for washing gas which communicates with the carbonization zone through checker work, a combustion chamber fired with a mixture of fuel gas and air, a heat exchanger through which the waste gases from the combustion chamber flow, a further distribution chamber communicating with the after carbonization zone* — DR. C. OTTO & CO. G.M.B.H.

Metals and metal products

52506. Process for the electro-deposition of iron-chromium alloy: *Electrolytic bath has divalent iron, trivalent chromium, urea and sulphate radical* — YOSHIDA

54909. Welding of low alloy steel: *Welding wire containing by per cent weight carbon* 0·04-0·08, *manganese* 1·20-1·50, *silicon* 0·30-0·60, *nickel* 1·10-1·30, *vanadium* 0·10-0·20, *molybdenum* 0·30-0·55 *and remainder iron* — AIR REDUCTION CO. INC.

55592. Dilute mineral acid metal-coating bath and method of coating stainless steel: *Metal-coating bath comprising a mineral acid, manganese oxalate, a sulphur-bearing compound which contains oxygen and which yields sulphur dioxide and sulphur upon decomposition* — AMERICAN CHEMICAL PAINT CO.

56129. Producing from ferromanganese ore a manganese ore concentrate suitable for conversion into ferromanganese: *Ore subjected to reducing roasting followed by controlled cooling so that iron compounds are converted into ferromagnetic ferric ferrite, finally manganese ore concentrate magnetically separated* — AKTIENGESELLSCHAFT FUR UNTERNEHMUNGEN DER EISEN-UND STAHLINDUSTRIE

Glass and ceramics

53299. Method and apparatus for bending glass sheets or plates: *Comprising hingedly connected mould sections, defining a shaping surface on the upper surface thereof and means on the end sections forming a part of the shaping surface*

and movable in alignment therewith — LIBBY OWENS FORD GLASS CO.

Leather and leather products

53196. Manufacture of upholstery leathers: *Subjecting bark tanned hides and splits to retanning with normal or basic aluminium salts* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

53197. Process for the manufacture of tanned skins: *Tanning acid or calgon pickled snake skins with aluminium salts* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

Building materials and methods

53019. Improvements in or relating to reinforced concrete arches: *Having intrados and extrados of identical curvatures* — SOCIETE DU VACUUM CONCRETE

52861. Pre-stressed concretes and their method of construction: *Wherein the pre-stressed concrete layer is disposed on the ground with means for uniforming the frictional forces and is divided to receive means for forcing apart its edges and also wedging members* — FREYSSINET

52969. Building constructions: *At least two longitudinally extending beams formed from coplanar concrete blocks placed in end to end relationship, are connected in intersecting planes by a knuckle block around which pass two tensioning cables one loop of which passes through the loop of the other* — THE CEMENTATION CO. LTD.

Miscellaneous

53043. Improved anodes for primary galvanic cells: *Consisting of finely divided metal and a binder, the binder being a thermoplastic resin and constituting a substantially continuous matrix throughout the anode* — UNION CARBIDE & CARBON CORPORATION

52696. Process for preparing pulp from sugarcane bagasse for the manufacture of paper: *Subjecting bagasse in a hydropulper, removing the pithy substance, and then subjecting the purified bagasse to steam treatment under pressure at 100° to 140°C. for at least one hour and then subjecting to usual cooking* — ASCHAFFENBURGER ZELLSTOFFWERKE AKTIENGESELLSCHAFT

52930. Improvements in sewage treatment: *Subjecting the sewage to clarification treatment in a clarifier, withdrawing the sewage sludge and subjecting it to concentration and anaerobic digestion* — DORR OLIVER INC.

53034. Improvements in process and apparatus for the continuous production of synthetic thread: *Simultaneously spinning a plurality of multi-filament threads, moving said threads through liquid treating zones, delivering treated threads to a drying zone* — NORTH AMERICAN RAYON CORP.

52430. Improvements in and relating to colour photographic processes and materials: *Producing negative separation images from at least three colour-sensitive emulsions comprising developing exposed negative, applying a take-off material with metallic sulphide to produce an image in silver sulphide and the take-off material of the uppermost image in the negative, then applying further take-off material to produce an image similarly on it of an image in a layer of negative material below the uppermost layer* — FRAUNHOFER & COOTE

55035. A composition for stimulating plant growth and more particularly latex production of rubber trees: *Comprising α-naphthoxy acetic acid or esters thereof and sulphur mixed with vegetable oil* — CHEMARA PLANTATIONS LTD.

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