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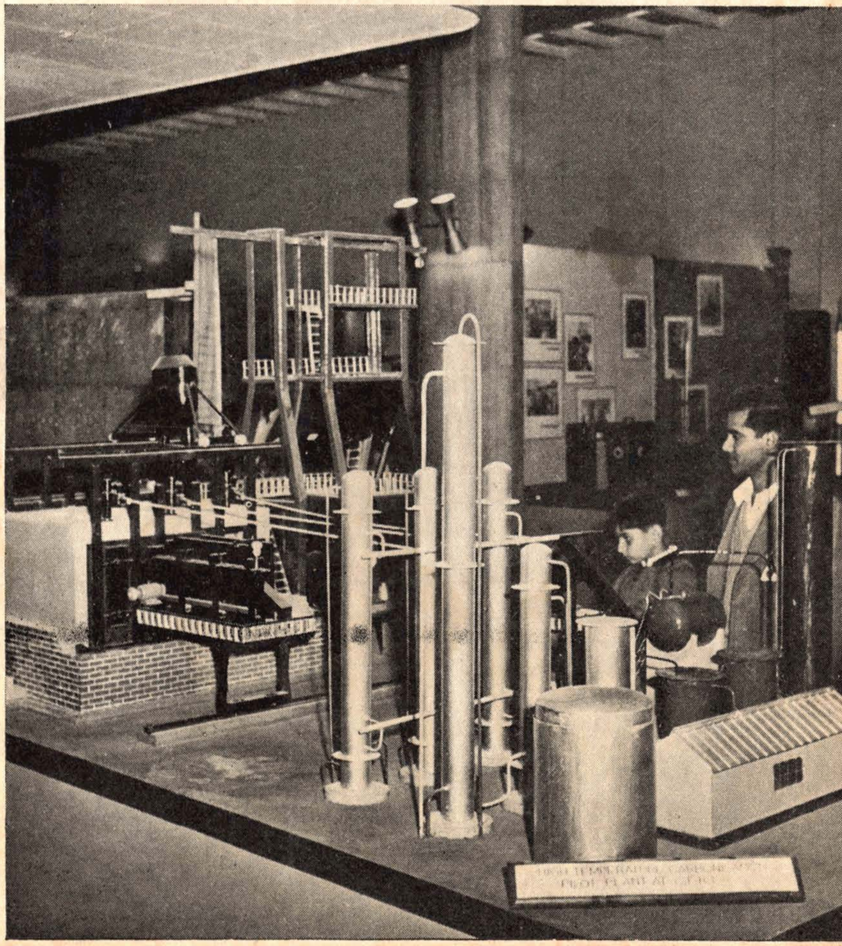

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Journal of Scientific & Industrial Research

Vol. 15A, No. 12, DECEMBER 1956

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COVER PICTURE

The picture on the cover shows a model of the high temperature coal carbonization pilot plant, with byproduct recovery, set up at the Fuel Research Institute, Jealgora. The model was one of the exhibits in the ' Science in the Service of Industry ' Exhibition recently held in New Delhi (*see* page 542).

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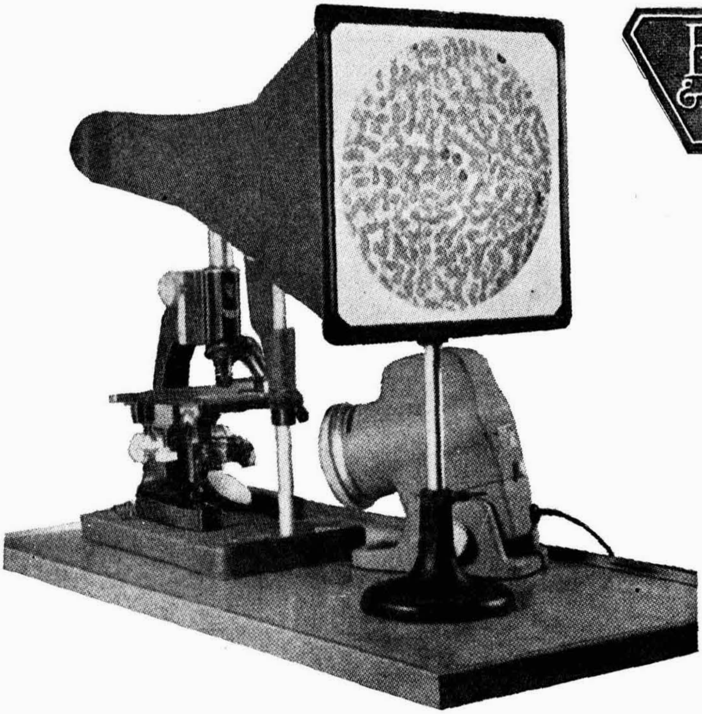

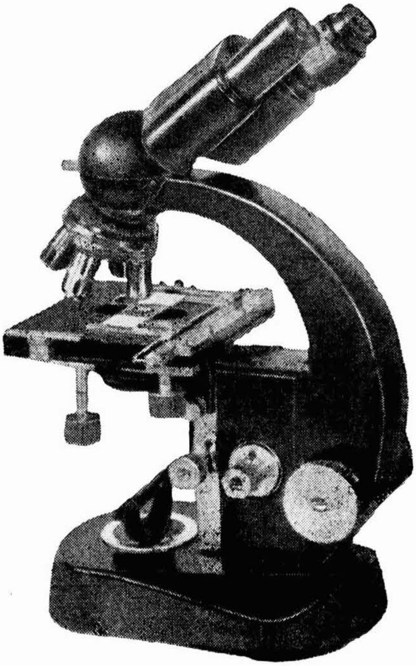

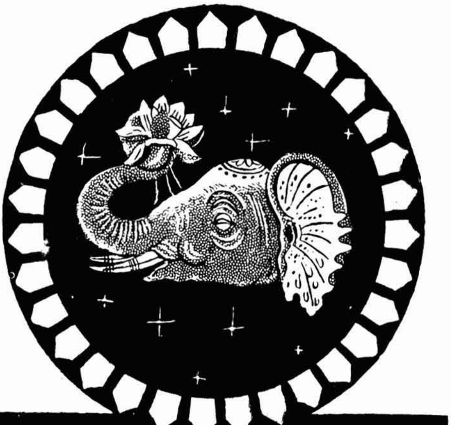

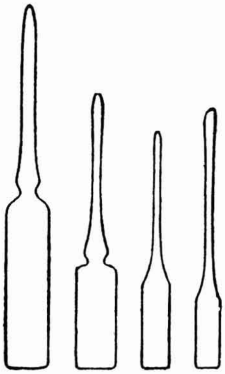

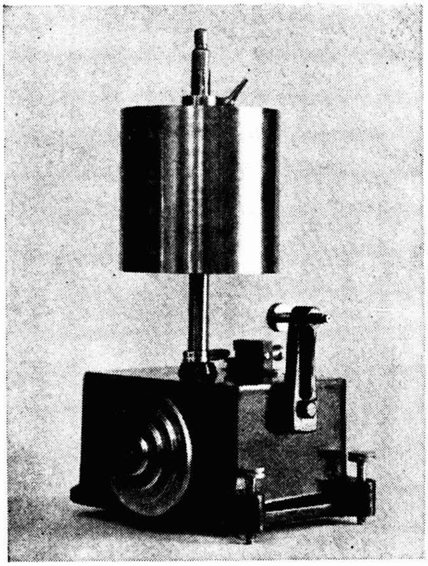

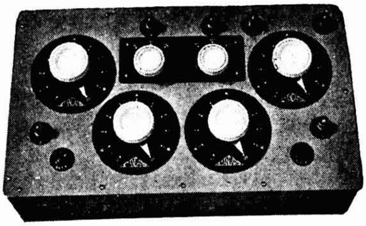

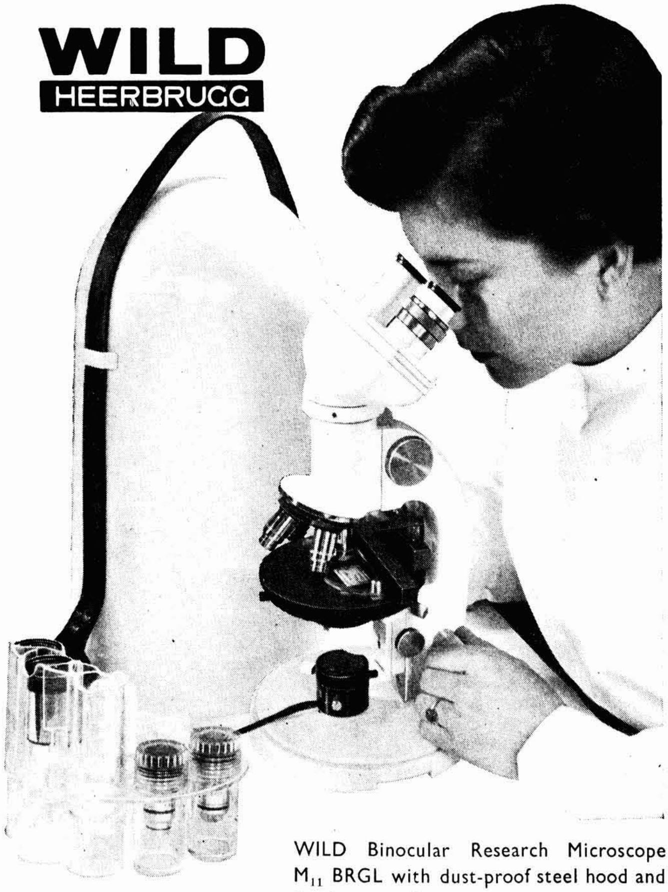

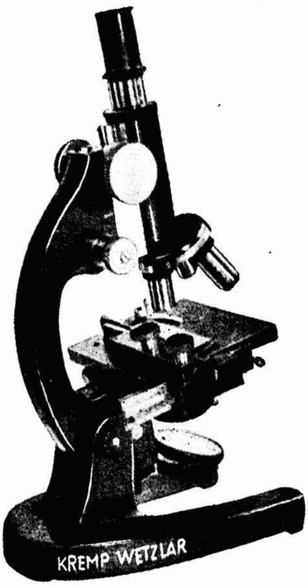
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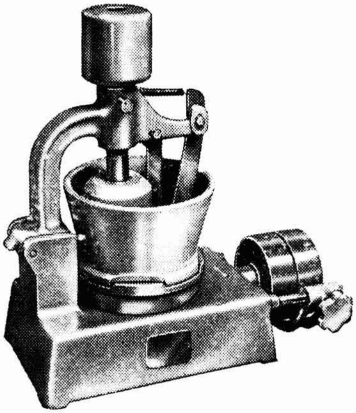

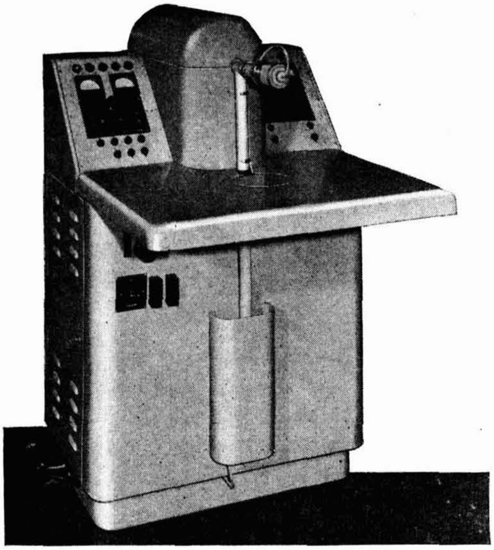

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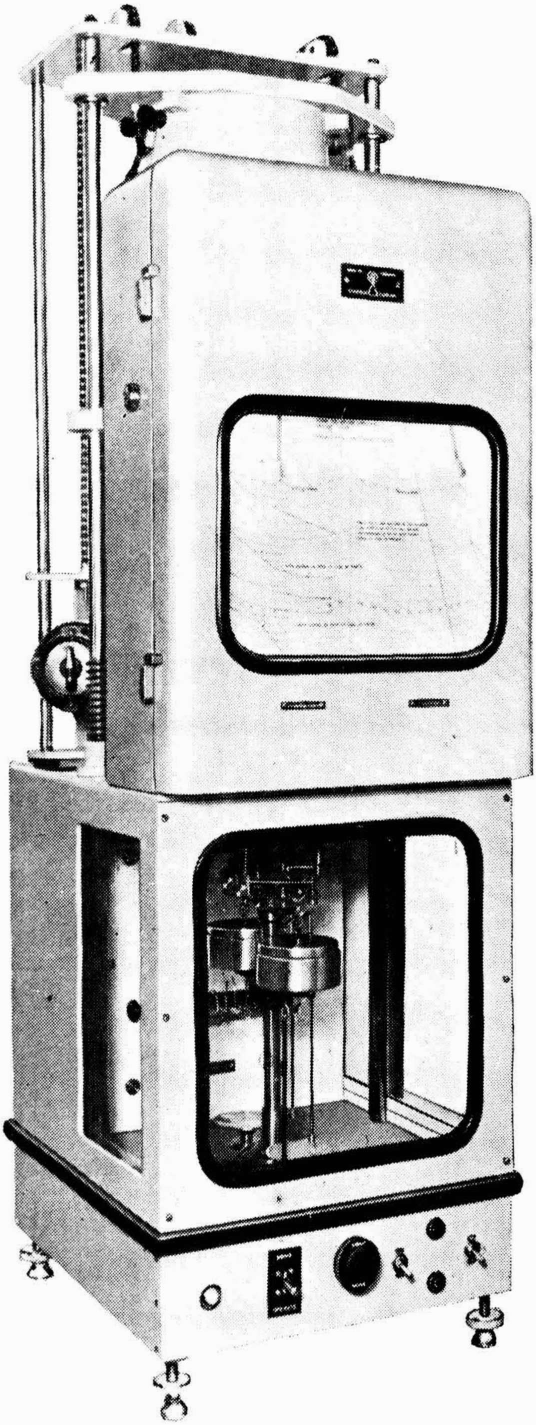

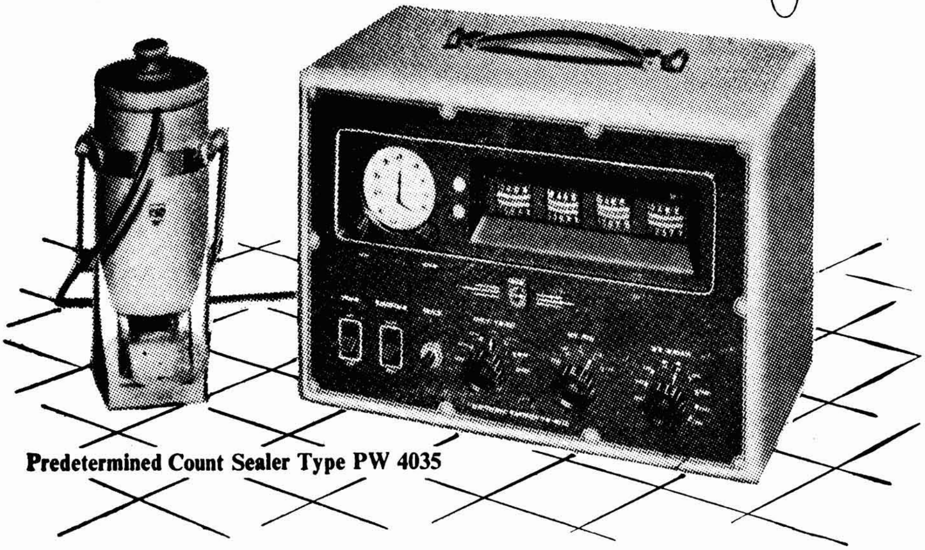

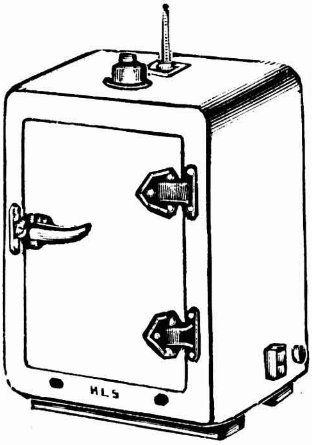
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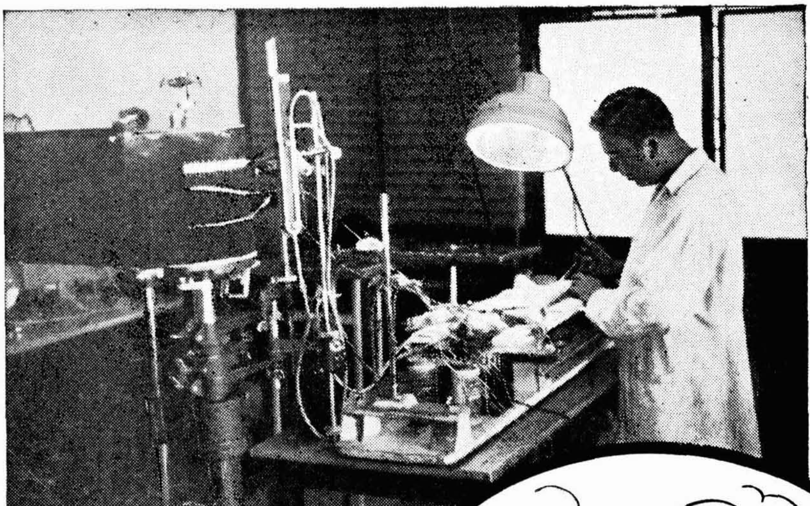
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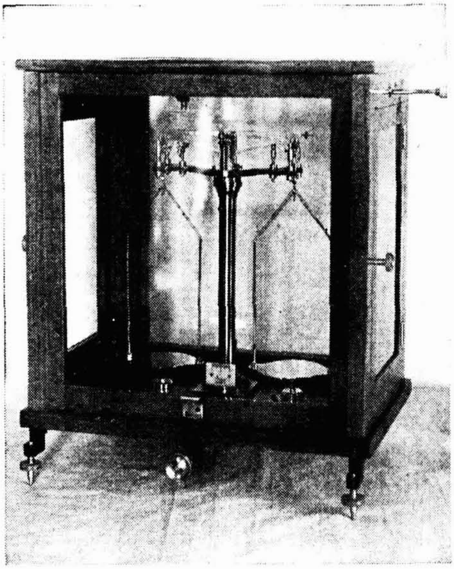

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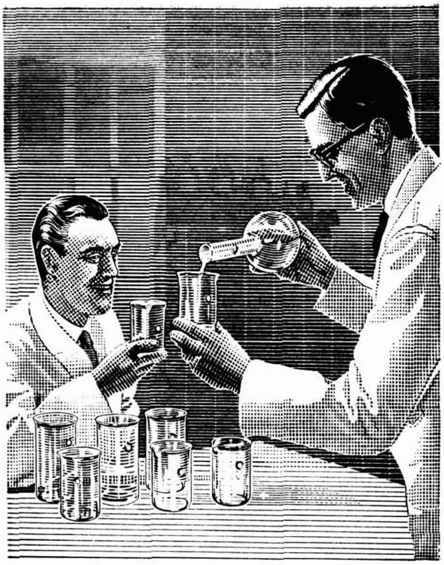

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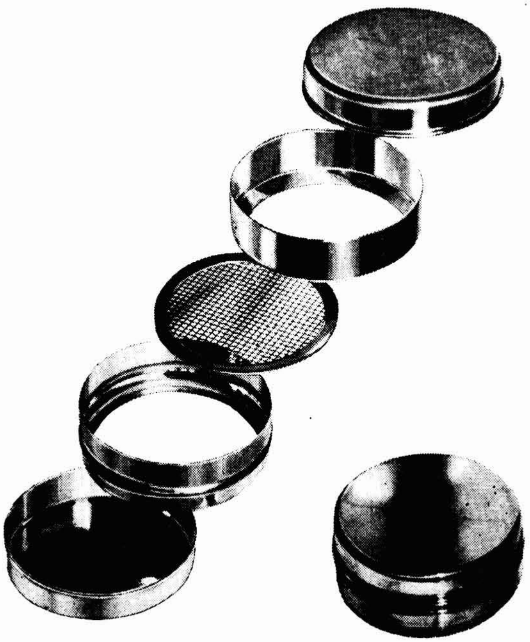

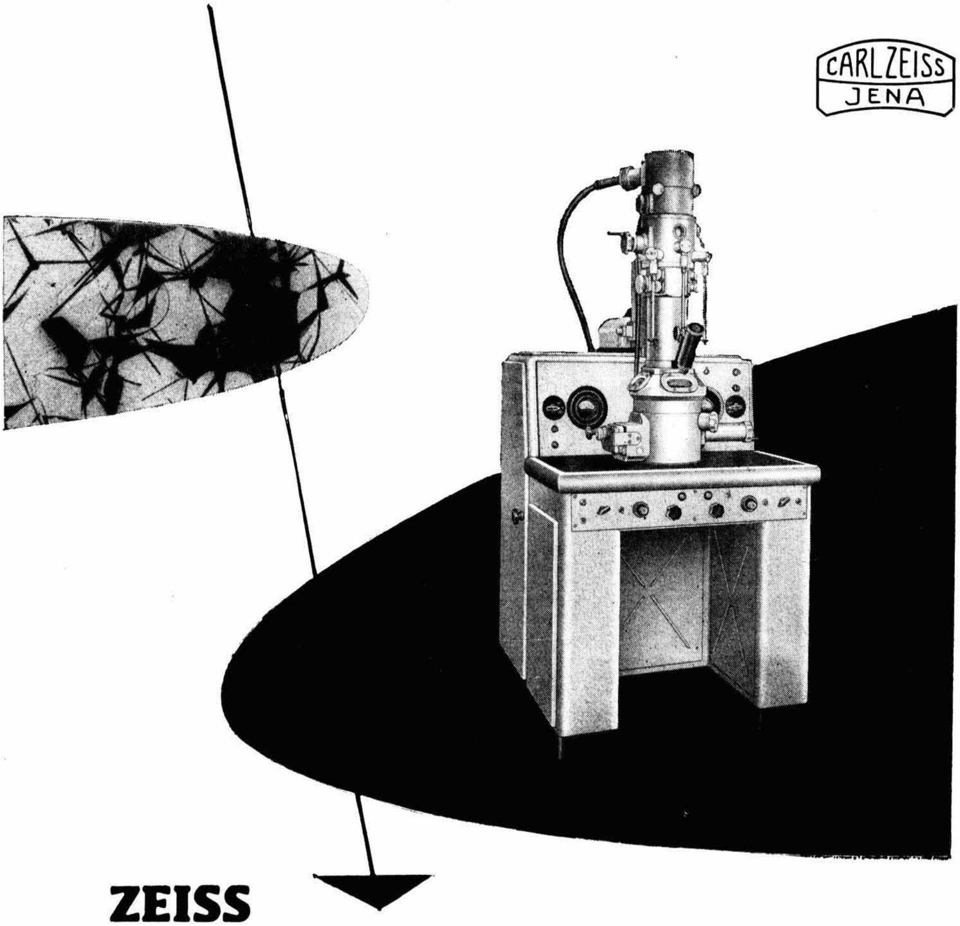

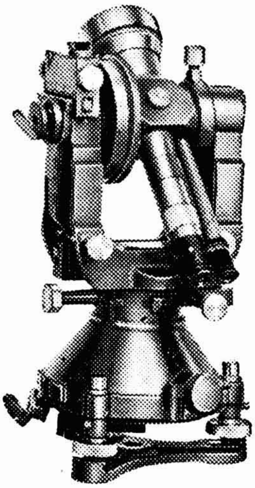

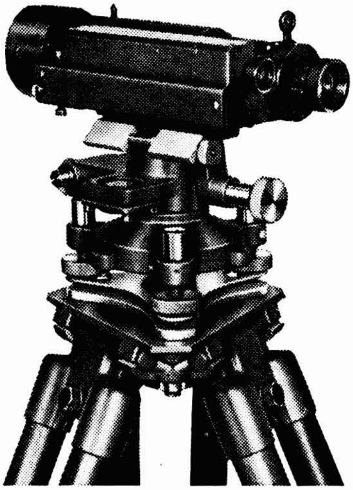

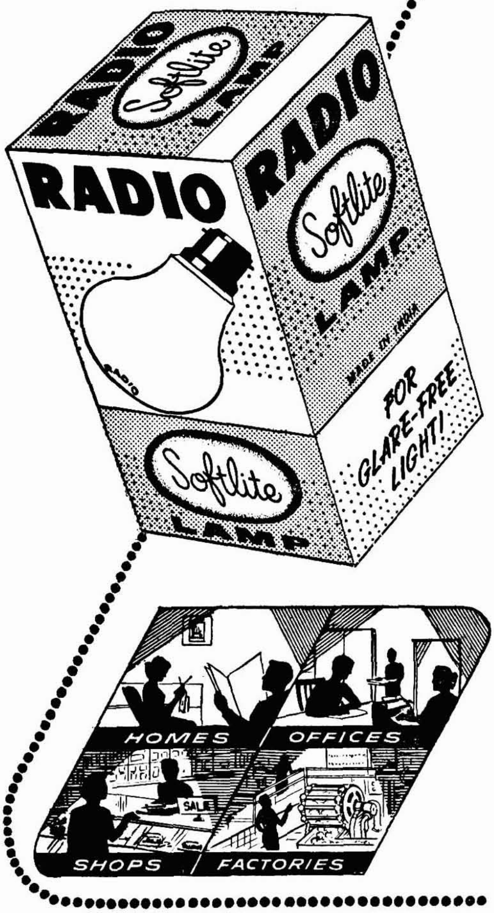

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In this brief monograph we are stepping outside the limits of the series to discuss an entirely new microanalytical technique which is not basically chromatographic. Unlike chromatography, the Weisz "Ring-Oven" method of estimating inorganic substances is independent of the rate at which ions migrate. On the other hand, the technique does involve the migration of ions *in* rather than *across* the plane of a filter paper: it thus compares closely with chromatography.

The Apparatus—simple in design

The Weisz "Ring-Oven" is an electrically heated hollow cylindrical aluminium block which supports the filter paper. The heat precipitates in a narrow ring the ions extracted from a drop of the test solution. The paper recommended is a Double Acid-Washed Paper (Whatman No. 40 or 540) incorporating an absolute minimum of soluble inorganic material.

The technique—speedy and precise

It has been shown that as many as 14 ions from a single drop (1.5 μl) of test solution placed in the centre of the filter paper can be resolved and identified in about 15 minutes. Only a few simple operations are required:—(i) gaseous H_2S is drawn through the drop on the filter paper to precipitate certain of the ions as insoluble sulphides (ii) in the "Ring-Oven" the spot is washed with solvent to extract soluble ions into a sharply defined ring zone (iii) after drying, the central spot is punched out, suitably treated to redissolve the precipitated ions and then transferred to the centres of first one, then another filter paper for further solvent extractions. To identify the ions the discs are cut into segments and treated with appropriate reagents to give characteristic coloured arcs. For some ions quantitative methods are applicable.

Wide scope for microanalysis

The Weisz "Ring-Oven" Technique is being used for investigating the composition of ceramics, bronzes and pigments from paints. It is also used for assaying precious metal specimens and determining trace metals in organic materials or in biological specimens. Although the technique has mostly been applied to the analysis of inorganic substances in dilute solution, there seems no reason why, with judicious choice of solvents, reagents and filter papers, it could not be used for organic substances as well. It has also been adapted for the extraction of minute quantities of solid test material.

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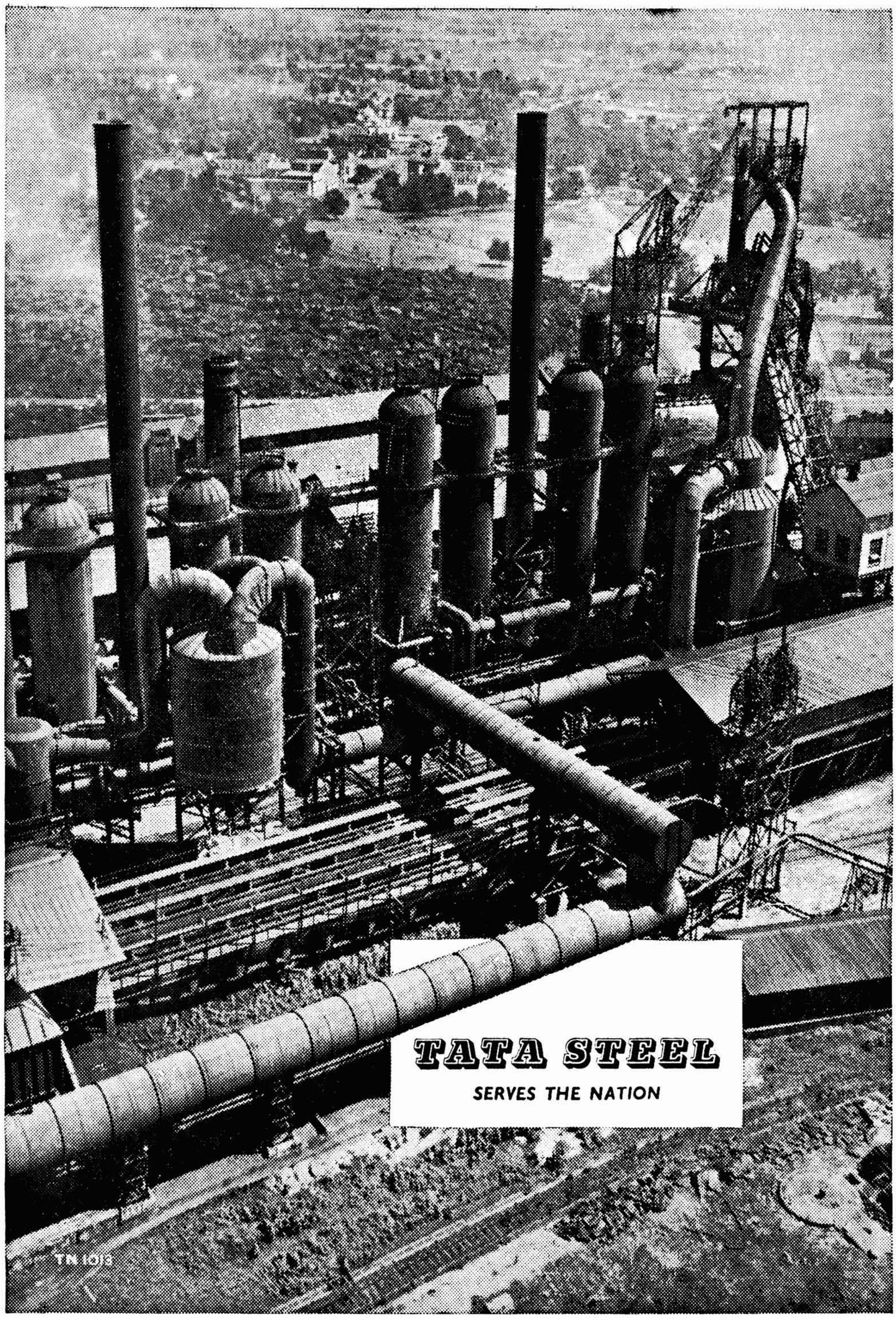
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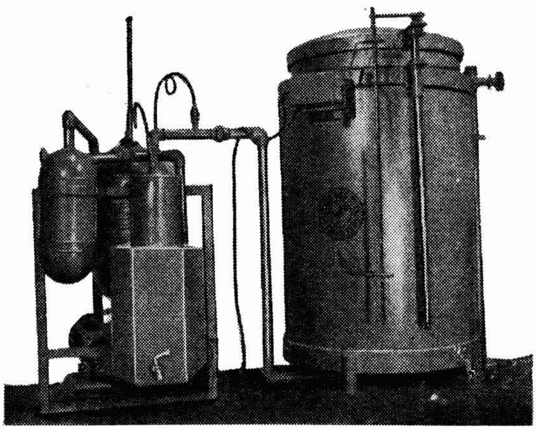

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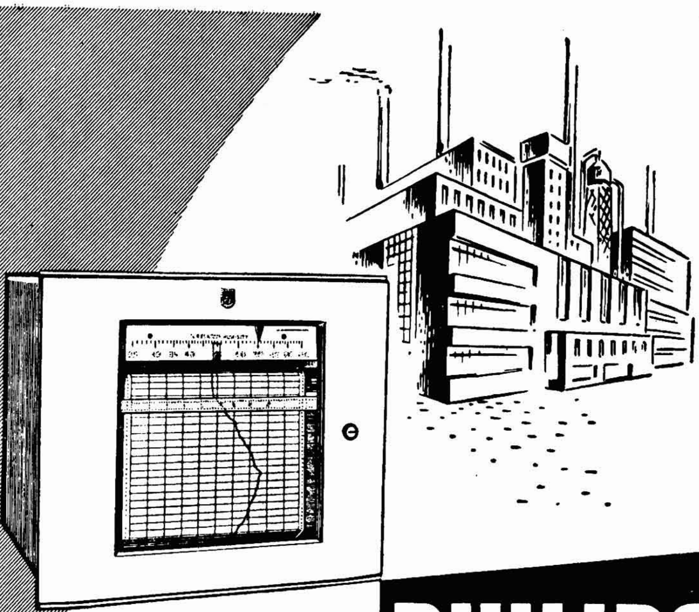

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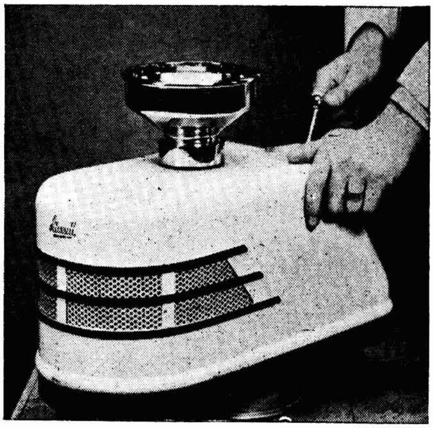

The Making of Free-flowing Table Salt*

G. I. FINCH
National Chemical Laboratory of India, Poona

THE following is an illustration, in terms intelligible to the layman, of how even a simple technical problem should be attacked and solved.

The empirical approach does not pay.

The first step is to restate the problem in scientific terms and to dissect it into its component parts, with due regard to all known relative facts; next where information is missing, it must be sought by experiment and critical observation.

Once these steps have been taken, the technical solution will follow, in most cases almost as a matter of course.

Restatement and scientific analysis of the problem

1. To be free-flowing a table salt should be non-hygroscopic and have a low critical angle of repose.

2. Pure salt is itself hygroscopic. Its hygroscopicity is, however, much increased when impurities such as magnesium salts or other inherently hygroscopic compounds are adsorbed on the surface of the salt crystals; and also, though to a lesser extent, when the impurities are occluded within the salt crystals.

3. It follows that the primary requirements of a free-flowing salt are that it should be pure, or nearly so, and that the crystal surfaces should not be contaminated with magnesium or other hygroscopic salts.

4. The next requirement is that, in view of the inherent hygroscopicity of pure salt, the crystal surfaces should be coated with a substance which can absorb or give off moisture, according to atmospheric conditions; or, better still, with a thin layer of a moisture-repellent material.

5. It might be supposed that this is the end of the matter, but this is far from being the case.

6. The smaller the crystal size the greater is the specific surface exposed to hygroscopic attack and surface contamination. On the other hand, too large a grain size is, for obvious reasons, not acceptable. Hence the crystals of a free-flowing salt should in size approach to the largest acceptable. The usual dispensing orifice consists of a short cylindrical channel, the diameter of which is not likely to be less than 1·5 mm. The maximum particle size diameter which can be relied upon not to jam in such a channel is about 1 mm.

7. A wide distribution in crystal size reduces the ease of flow and increases the specific hygroscopicity. The crystal size should, therefore, be reasonably uniform; it can be shown that a linear size distribution of about 3:1 has relatively little effect on the critical angle of repose or on the specific hygroscopicity, provided the mean crystal size is not too small. This desired crystal size and degree of uniformity in crystal size should be achievable by controlling the rates of seeding and growth of the crystals, followed by removal of the crystals from the crystallization zone at the appropriate time.

***In this paper the author outlines, step by step, the lines along which he proceeded towards the solution of a fairly simple technical problem, namely the making of free-flowing table salt, which had defied solution for over two years, because it had not been attacked in a scientific manner. The problem yielded with surprising ease to a simple scientific analytical approach. The emphasis is on the method of approach to the problem rather than on the result itself [Editor].**

8. The sharp edges and corners of the normal salt crystal are sites of high potential energy and thus favour the adsorption of water vapour and the formation of discontinuities in any hydrophobic coating. Also, sharp corners and edges resist easy flow, and large flat crystal surfaces promote caking through coalescence of vicinal faces (Fig. 2b).

9. It follows from the above that, in addition to freedom from hygroscopic contaminants and a suitably limited range of grain size, the salt crystals should have no sharp corners or edges.

10. This last requirement is equivalent to saying that the most favourable crystal habit is one which approaches spherical shape. This is the shape which minimizes the inherent hygroscopicity of the salt itself, requires the least amount of protective coating and has the lowest critical angle of repose.

11. The crystals in the commercial brands of free-flowing salts which I have examined are of cubic habit. They retain their free-flowing properties sufficiently well for most practical purposes, provided the relative humidity of the atmosphere is below about 50 per cent; but with higher humidities associated with temperatures well above 30°C., such as are frequently encountered in India, they cake so rapidly that they soon cease to flow readily.

12. A consideration of the nature of the ionic field distribution on the surfaces of a salt crystal indicates how the crystal habit can be changed from the normal cubic form to one approximating to spherical shape.

13. On the cube faces each anion is closely screened by the strong repulsive field of four nearest-neighbour cations, and each cation by the repulsive field of four anions; consequently, growth on the cube faces is slow. On the other hand, the octahedral faces, which truncate the corners of the cube, contain when perfect only negative ions or positive ions, but not both; thus, the rate of growth on the octahedral faces is rapid. Consideration of the ion distributions in all other possible crystal faces, and which can be read out of the atomic model of the sodium chloride crystal, leads to the conclusion that all crystal faces must grow faster than the cube faces.

14. The normal crystal habit of salt is cubic because, owing to their more rapid growth, the octahedral and other faces of the salt crystal soon become extinguished, with the result that only cube faces remain. On the other hand, if by some means growth on the octahedral faces is sufficiently strongly inhibited, the cube faces will eventually be extinguished and the final crystal habit will be octahedral.

15. If, instead of being largely inhibited, growth on the octahedral faces is reduced to a rate similar to that of the cube faces, the resulting crystal habit will be cubo-octahedral, i.e. cubes with their corners truncated by octahedral faces. Further, by appropriately reducing the rate of growth on the dodecahedral faces the remaining cube edges can be cut off. The habit is then octahedral-dodecahedral-cubic. The resulting crystal with its 26 suitably developed faces then approximates in shape to a sphere.

16. Since we wish our crystals to approach even more closely to spherical shape, all possible crystal surfaces should be caused to grow at similar rates of outward growth. A well-known way of reducing the rate of growth of a selected face or faces, and thus controlling the habit, of an ionic crystal is by adding a suitable impurity to the solution. This procedure cannot, however, be adopted here as the amount of impurity required is too large; furthermore, these impurities are either physiologically harmful or impart an undesirable flavour or colour to the salt. There are, however, reasons for believing that a uniform rate of growth of all crystal faces can be achieved by a suitable control of the rate and manner of crystallization.

17. The commercial brands of free-flowing table salts which I have examined are coated with so-called dryers, such as finely divided dusts of zeolites, phosphates, carbonates, sulphates or stearates. These materials are not intrinsically hydrophobic; they act rather as reservoirs for water vapour, absorbed under conditions of high humidity, and which can be readily desorbed when the humidity falls.

18. At first sight, one would expect that a hydrophobic coating would afford more protection than a dryer. Consideration of the surface ionic field distribution and crystal habit in relation to the nature of the hydrophobic material reveals that this is not necessarily the case.

19. Well-known hydrophobic materials are the normal straight long-chain hydrocarbons. Their end-substituted compounds, such as alcohols, acids, esters and soaps, are hydro-

FIG. 1 — ELECTRON DIFFRACTION PATTERN OF A MONOMOLECULAR LAYER OF PARAFFIN WAX ON A SALT CRYSTAL [pattern shows that the surface is covered with a coherent layer of straight long-chain hydrocarbon molecules, closely packed together and standing vertically upright on the salt crystal surface]

phobic only if their unsubstituted ends are opposed to the approach of moisture. But the ionic field distributions on the surfaces of a salt crystal are such that, depending on the nature of the charge at the point of attachment, the substituted end may be either attracted or repelled by the surface. In the latter event the hydrophobic end of the chain becomes attached to the surface; the hydrophilic substituted end is then exposed to attack by moisture.

20. Electron diffraction studies confirm these views, but also reveal that although a straight long-chain hydrocarbon coating of only molecular thickness suffices to protect the flat surfaces of a cubic salt crystal, the sharp edges and corners are still left open to attack by moisture (Fig. 1). On the other hand, when the crystals are spherical, electron diffraction pattern shows that the hydrophobic layer is complete over the whole surface and thus affords maximum protection.

Technical procedure

21. In the light of the above analysis of the problem, it becomes a simple matter to translate into practice the findings outlined above.

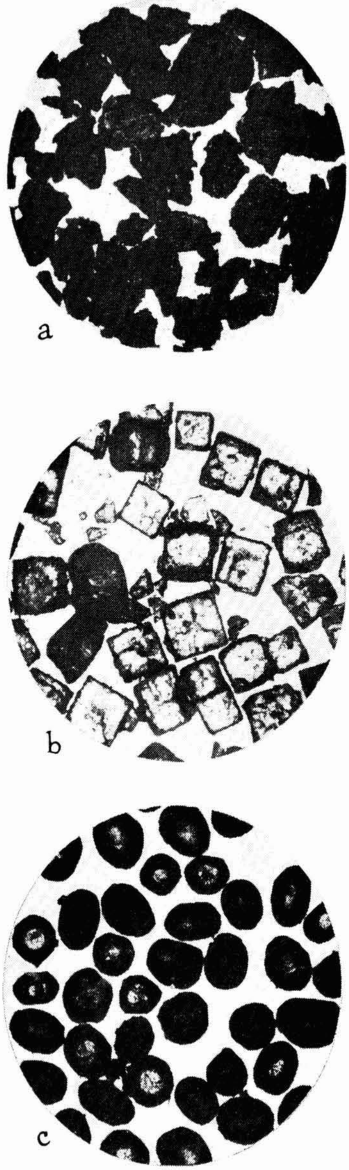

FIG. 2 — (a) BHAVNAGAR SOLAR SALT [note irregular crystal shapes and sizes; critical angle of repose 45°]; (b) BRITISH FREE-FLOWING SALT [note cubic crystal habit, relative uniformity of crystal size, and coalescence of vicinal faces; critical angle of repose 35°]; AND (c) C.S.R.I. FREE-FLOWING TABLE SALT [note the absence of corners and edges and general approach to sphericity and relative uniformity in size of the crystals; critical angle of repose 25°]

22. Experiment reveals that a salt purity of 99·8 per cent or above suffices for practical purposes. The impurities in crude solar salt brine can readily be removed to this extent by precipitation with lime and sodium carbonate.

23. Crystals of the desired size and approximately spherical in shape can be obtained by evaporation of the purified brine in open or vacuum pan crystallizers (Fig. 2c). With suitable control of the crystallizing conditions, the yield of crystals passing B.S.S. 14 and remaining on B.S.S. 72 amounts to about 96 per cent. The rejected fines are added to the next brine batch.

24. The crystals are now given a physiologically inert and protective hydrophobic coating by warm rumbling in an atmosphere containing sufficient paraffin wax vapour to form a coherent hydrocarbon layer of molecular dimensions.

25. The Central Salt Research Institute (C.S.R.I.) is now producing 30-lb. batches of free-flowing table salt by this process. No difficulty is to be anticipated in converting this batch process into a continuous one.

26. For purposes of comparison, microphotographs (×20) showing the crystal sizes and shapes of (a) Bhavnagar solar salt, (b) a proprietary British free-flowing table salt and (c) the C.S.R.I. free-flowing table salt, as now made in 30-lb. batches, are reproduced in Fig. 2.

The critical angle of repose of (a) is 45°, of (b) 35° and of (c) 25°.

27. The estimated cost of processing Bhavnagar solar salt to the C.S.R.I. free-flowing table salt is 3 annas per pound.

' Science in the Service of Industry ' Exhibition

THE SCIENCE EXHIBITION ORGANIZED BY THE Council of Scientific & Industrial Research as one of the series of educational, scientific and cultural exhibitions in connection with the ninth General Conference of Unesco held at New Delhi was inaugurated by the Vice-President of India on 8 November 1956. The exhibition was open to the public from 11 November to 5 December.

Twenty-two prominent research institutions, including the National Laboratories, participated in the exhibition. The exhibits numbering about 300 were displayed in a well-planned pavilion with a floor space of 18,000 sq. ft. Surveys of raw material resources of the country, evolution of substitutes and alternatives for materials which are imported or scarce, processing and beneficiation of raw materials, utilization of waste products and byproducts of industry, and development of improved processes of manufacture were some of the themes covered. Arrangements had been made for the demonstration of the technical processes developed in the laboratories. Films depicting the activities of some of the participating institutions were shown in the specially built auditorium. An illustrated brochure giving a brief account of the activities of the institutions and the exhibits displayed by them was also brought out on the occasion.

A variety of instruments and testing equipment developed in the research laboratories, e.g. primary time and frequency standard including a quartz clock, Finch-type electron diffraction camera, a new primary wet cell system, conducting sheet analogue computer, simultaneous intercommunication unit, ultrasonic tester for testing concrete, cart wheel tester, equipment for strain measurement, apparatus used in radioactive tracer studies, etc., were on display.

This exhibition was perhaps the first attempt made in India to display the results of research on a comprehensive scale and in a manner designed to convey precise information to industrialists, students of science and technology, and others. It has succeeded, in a great measure, in demonstrating that science in India has acquired both direction and purpose. Much thought, labour and time has been spent in organizing the exhibition which has fully served the dual purpose of furthering liaison between research and industry and scientific education.

The Ionospheric F_2 Layer over Ahmedabad, Delhi & Tiruchirapalli during the Sunspot Minimum Period (1953-54)

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THE ionosphere of low latitudes presents many interesting special features. Appleton[1] and Maeda *et al.*[2] first reported on the existence of a minimum in the values of F_2 noon critical frequencies near the geomagnetic equator. Skinner *et al.*[3] and Osborne[4] have described some of the features of the F_2 layer observed by them at Ibadan (7°26'N, 3°54'E) and Singapore (1·3°N, 103·6°E). In South Asia, the ionospheric sounding station at Ahmedabad (23°02'N, 72°38'E) located at geomagnetic latitude 13·6°N forms an important addition to the existing chain of stations near longitude 75°E. Even the first year's observations[5] showed that Ahmedabad was near the ridge of the F_2 noon critical frequencies on the northern side of the equator.

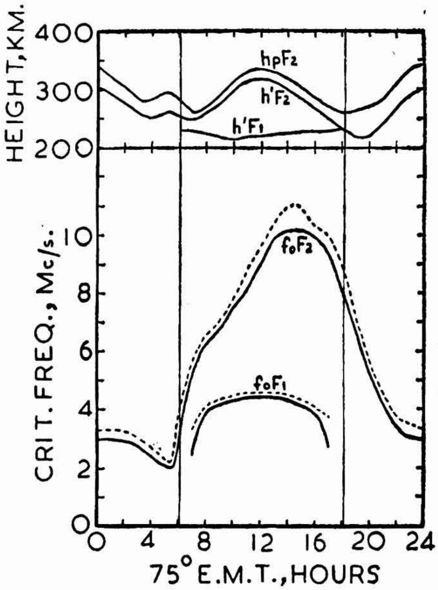
In the present communication the general features of the F_2 layer over Ahmedabad are compared with those of the F_2 layer over Delhi (28°35'N, 77°05'E) and Tiruchirapalli (10°50'N, 78°50'E). The vertical soundings at Ahmedabad were made with a recorder of the British N.P.L. design with a frequency range 0·6-25 Mc/s. and a sweep time of 5 min. The pulse power of the transmitter varies from about 1700 to 250 W. as the recorder sweeps from low to high frequencies. The aerial system consists of vertical rhombics and regular observations are taken every integral hour of 75° E.M.T. Monthly summaries of the data were previously published in the *Journal of Scientific & Industrial Research*, India (February 1953 to May 1955), and are now included in a separate publication of the Radio Research Committee of the Council of Scientific & Industrial Research.

Diurnal and seasonal variations

The mean diurnal variations of foF_2, $h'F_2$ and hpF_2 (i.e. $h'F_2$ at 0·834 foF_2) averaged over a whole year for 1953 and 1954 are shown in Fig. 1. foF_1 and $h'F_1$ are also included in the figure.

As at other places, the heights exhibit a semi-diurnal variation having minima shortly after ground sunrise and sunset and maxima at about noon and midnight. Whereas the minimum value of $h'F_2$ near sunset is less conspicuous than that near sunrise, the minima of hpF_2 are almost equal. The difference $(hp-h')F_2$ is largest at about 20.00 hr. and least at about 08.00 hr.

foF_2 has a pronounced diurnal variation having on the average a maximum at about



---- 1953; —— 1954

FIG. 1 — MEAN DAILY VARIATION OF F_2-LAYER ORDINARY WAVE CRITICAL FREQUENCIES AND HEIGHTS AT AHMEDABAD

15.00 hr. and a minimum at about 40 min. before ground sunrise. The maximum of foF$_2$ has thus a mean lag of 3 hr. behind that of height while the minimum in foF$_2$ occurs before ground sunrise and corresponds to a temporary pre-sunrise rise in the height of the layer. It was found from special observations made at short intervals in midsummer and midwinter that the early morning increase in foF$_2$ began about 45 min. after the layer-sunrise in summer and at almost the same time as the layer-sunrise in winter. The effect is always observed *before ground sunrise* and not after, in contrast to what was observed by Wells[6] at Washington. The sunrise effect is clearly visible in the h′-f record as a smoothed-out cusp of foF$_2$ and it sometimes appears as a forked cusp. Although the height continues to fall for a short time after the early morning rise, foF$_2$ strengthens rapidly till about 08.00 hr. and the height also increases. Another point of interest is that there occurs a temporary pause in the rate of rise in foF$_2$ between 08.00 and 09.00 hr.; this is followed by a rapid rise till the afternoon maximum is reached. It is probable that this 08.00-09.00 hr. steadiness corresponds to the forenoon maximum observed near the equator.

As the relative sunspot numbers during the period 1953-54 were minimum, the seasonal variations in foF$_2$ and in height can be regarded as truly seasonal without being influenced by solar activity which otherwise might be different in the different months. In Fig. 2, the mean noon values of hpF$_2$ and foF$_2$ at Ahmedabad, Delhi and Tiruchirapalli are plotted, together with the sunspot variation. It is clear that whereas foF$_2$ shows a semi-annual variation having maxima at the equinoxes and minima at the solstices, hpF$_2$ shows only an annual variation with a maximum at midsummer. The noon foF$_2$ during the year 1954 had at Ahmedabad a range of variation of 5 Mc/s. while noon hpF$_2$ varied by about 125 km. Similar curves for 1953 showed higher values of foF$_2$ and hpF$_2$ corresponding to the slightly higher sunspot number. The mean noon separation of F$_1$ and F$_2$ was minimum in December-January (about 40 km.) and maximum in June (about 170 km.).

In Fig. 3 are given the diurnal variations of h′F$_2$ from November 1953 to November 1954. The base for each curve is shifted by 100 km. along the ordinate-axis and the level of 250 km. for each month's curve is indicated on the ordinate scale. The times of mean sunrise and sunset at the level of 250 km. are shown by vertically running dotted curves.

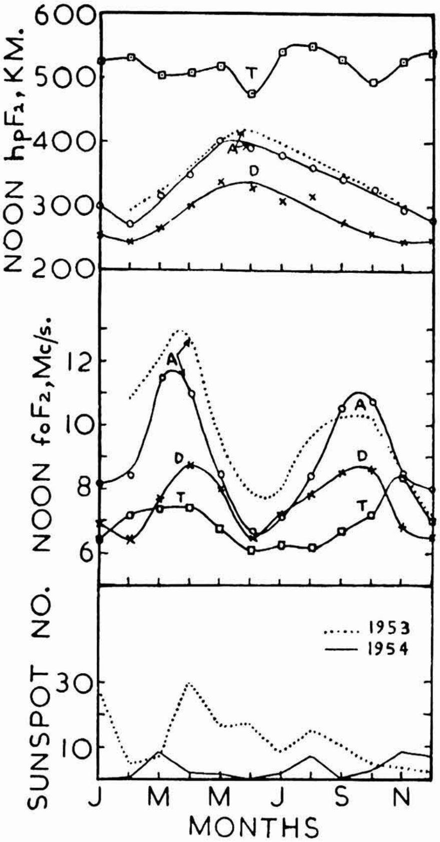


FIG. 2 — SEASONAL VARIATION OF foF$_2$ AND hpF$_2$ IN 1954 AT DELHI (D), AHMEDABAD (A) AND TIRUCHIRAPALLI (T)

It is interesting to note that the two maxima in h′F$_2$ in winter occur, one about an hour after noon and the other near midnight, the night maximum being higher. In contrast to this, the maxima in h′F$_2$ in summer occur a little *before* noon and *before* midnight, the former being higher. The morning and evening minima are closely linked with the times of ground sunrise and sunset and occur before the separation and after merging of F$_1$ and F$_2$. Besides, there are short-period rises in height in the early morning and at about 20.00 hr. in the winter months, the one at 20.00 hr. being similar to the characteristic observed at equatorial

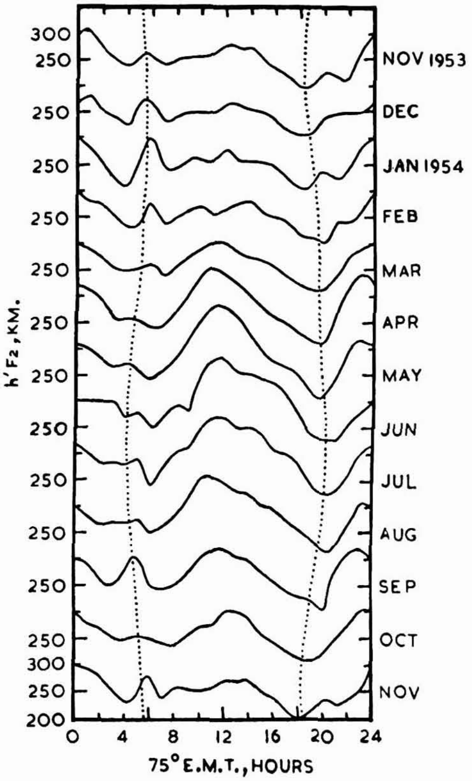


FIG. 3 — DAILY VARIATION OF h'F_2 AT AHMEDABAD IN EACH MONTH FROM NOVEMBER 1953 TO NOVEMBER 1954

stations in summer (e.g. Huancayo, Singapore). In both these temporary upward motions, hpF_2 rises first and then h'F_2. This process takes place when the layer has already descended to the lowest height (as low as 200 km.) and contracted sufficiently. Apparently, when recombination in the lower part becomes rapid, the upper part appears as a new stratification at a greater height and a decreased critical frequency. In this process, it has been observed that the electron distribution changes from parabolic to a nearly straight line characteristic or takes the form of two boundaries with a hump or clear ridge. (Osborne calls this a thick F_2 layer when the h'-f trace shows an intermediate hump). Further, it is noticed that the beginning of the early morning rise in height and the time of lowest foF_2 coincide with the layer-sunrise except in summer when it is delayed. Similarly, the evening minimum of height corresponds to the layer-sunset. Bhargava[7] has reported that at Kodaikanal ($\Phi = 0\cdot6^\circ$N), the old night F_2 layer disappears in the early morning and a new one appears at a great height and then descends rapidly. This joins the old one if the latter has not vanished. Some instances have been recorded at Ahmedabad when the old completely disappeared and a new one appeared at a great height. Such an occurrence is only found on some days in winter. Whether the old layer disappears or not, a temporary rise in height is invariably observed daily in the winter months. Some records show that the rise in height is due to the wearing away of the lower part of the layer, leaving only the ionization at a greater height which does not disappear. They also show that if the F_2 layer is maintained at a height greater than 250 km., stratification of the layer and vanishing of the lower part do not take place even in winter months. This rise in height is not observed in other months.

The critical frequency of the F_2 layer has a secondary maximum at about 03.00 hr. followed by a sharp drop in winter. This is probably due to the descending and contraction of the layer after midnight. The daytime maximum in foF_2 takes place at 13.00 hr. in winter and shifts to about 16.00-17.00 hr. in summer. In winter, daytime maximum in height and critical frequency occur at the same time in higher latitudes and foF_2 variation approximates to that given by Chapman[8].

As against the irregularities in height and critical frequency observed in winter during night, very often stratifications in the form of clear ridges are observed between 08.00 and 11.00 hr. in summer and these do not seem to be associated with magnetic activity. The lower part of the stratified layer descends to join F_1 or appear as $F_{1\cdot5}$ (as some call it) and the upper part takes control of the main F_2 layer after this unusual occurrence. In Fig. 4b, the mean diurnal variation of the occurrences of stratifications for the year 1954 is given, which shows three peaks, (i) in the early morning, (ii) at 20.00 hr. and (iii) at 10.00-12.00 hr., the former two being frequent in winter and the last in summer. Thick layer occurrences in Singapore happen to be maximum at 14.00-15.00 hr. in June solstice and at 10.00 and 14.00 hr. in December solstice. Osborne says that the diurnal variation of foF_2 at Singapore agrees with that at Huancayo, but it is significantly different when the thick-layer phenomenon is frequent.

F_2-scatter occurrences

The occurrences of F_2-scatter echoes in the hourly records were also analysed. F_2 scatter occurs in the form of (i) forked h′-f curve or scatter near the critical frequency, (ii) two or more slightly displaced h′-f traces, and (iii) spread echoes with no sharp boundary or clear critical frequency of the F_2 layer. The results of an analysis of these occurrences are given in Figs. 4 and 5. The peak frequency of occurrence is at 03.00 hr. and the echoes are most frequent in summer. Reber[9] has found from an analysis of the data in temperate and middle latitudes that spread-F occurrences are more frequent in winter, but Osborne[4] at Singapore found them to be most frequent in local summer. At Ahmedabad, scatter echoes, usually of the first two types, occur in winter, while spread echoes are common in summer, so that there is one major maximum in summer and a minor one in winter. Wells[10] has shown that in years of minimum sunspot activity, F_2-scatter echoes show two maxima in the course of a year, a major maximum in local summer and a minor one in winter, but only one maximum in summer during years of high sunspot activity. Thus Ahmedabad falls in the category of equatorial zone so far as spread-F echoes are concerned. It is an interesting fact that the seasonal variation of F_2 scatter and of F_2 stratification are in anti-correlation. The former appears to be due to irregularities of electron density at varying heights during night-time when there is very little change of electron density with height, while the latter is caused by downward movement of the layer and strong height-gradient of the recombination coefficient. The spread-F echoes disappear immediately after sunrise when a well-defined layer is formed. Although the height is great during day, F_2 scatter is rarely observed. Maxwell[11] has suggested that the non-appearance of F_2 scatter during day-time may be due to inhibition of turbulence by larger rises of temperature with height, by lower drift velocities or by increase in the

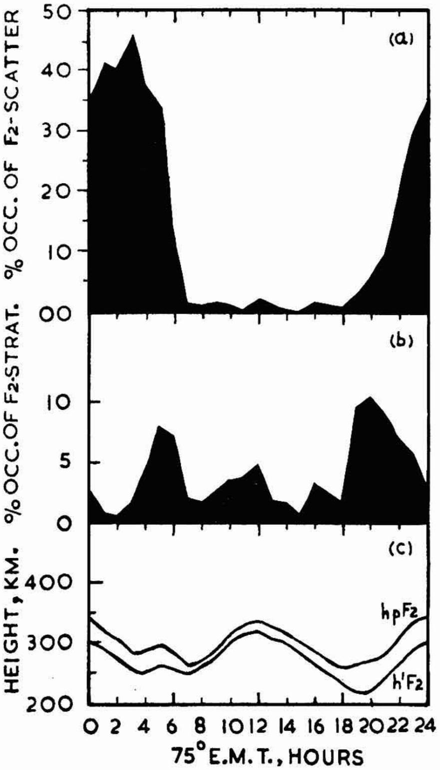


FIG. 4 — MEAN DAILY VARIATION OF (a) OCCURRENCE OF F_2-SCATTER ECHOES, (b) OCCURRENCE OF STRATIFICATION IN F_2 LAYER AND (c) hpF_2 AND $h'F_2$ DURING 1954

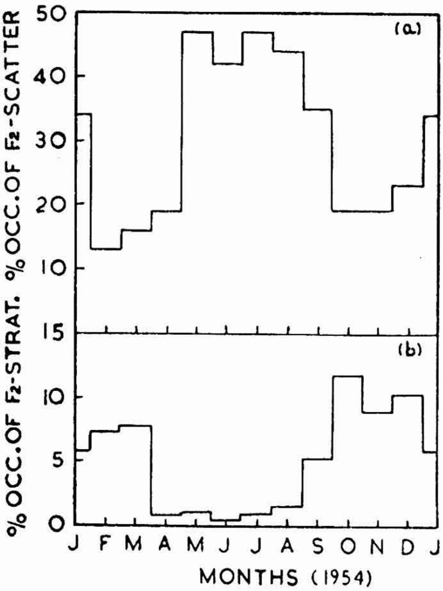


FIG. 5 — SEASONAL VARIATION OF (a) OCCURRENCE OF NIGHT-TIME F_2 SCATTER (20.00-05.00 HR.) AND (b) F_2 STRATIFICATION (18.00-05.00 HR.) IN 1954

kinematic viscosity. Dieminger[12] has discussed extensively the various mechanisms of scattering.

Diurnal and seasonal variations at different latitudes

We shall now compare the diurnal and seasonal variations of foF$_2$ and hpF$_2$ at Delhi, Ahmedabad and Tiruchirapalli whose geomagnetic latitudes are 18·8°N, 13·6°N and 1·3°N respectively. In Fig. 6 are shown the diurnal variations at the three places of foF$_2$ and hpF$_2$ for winter solstice, equinox and summer solstice of the year 1954. The L.M.T. of ground sunrise and sunset is marked by short vertical lines projected on the curves of the relevant places. It is interesting to note that the height at Tiruchirapalli is very great and no tendency is observable of a semi-diurnal variation as at higher latitudes. A temporary rise in height at 20.00 hr. is observed both at Ahmedabad and Delhi in winter, but for Tiruchirapalli data from 21.00 to 06.00 hr. are not available. The early morning rise is pronounced at Ahmedabad. At both the places, the midnight maximum in height is more pronounced in winter and the midday maximum more pronounced in summer. Retardation due to lower layers does not account for these unequal midday and midnight heights. The height minima near sunrise and sunset are found to be of nearly the same magnitude. While the noon value of hpF$_2$ has maxima in summer and winter near the equator, there is only one maximum at higher latitudes.

It is further to be noted that the variations in foF$_2$ in winter at Delhi which is at a higher latitude than Ahmedabad approximates more closely to those of a Chapman layer. This variation gets disturbed in summer. A point of importance is that the forenoon fall in the rate of increase of electron density commences at a definite time after sunrise at all these places and in all the seasons. This is clear from the difference between the times of sunrise and the bend in the foF$_2$ curve. This feature gets more pronounced at lower latitudes and in local summer. That this depression in foF$_2$ is short-lived at higher latitudes and extends for a longer duration near the equator is remarkable. The subsequent rise takes place most rapidly at Ahmedabad. This can probably be explained as due to circulation in the higher atmosphere from equator towards higher latitudes and convergence at a place like Ahmedabad.

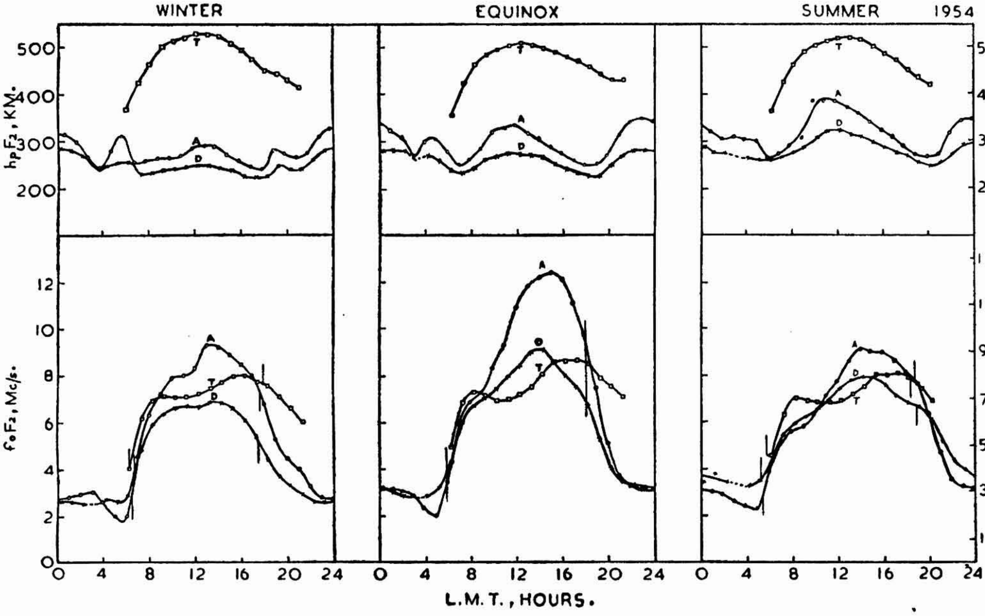


FIG. 6 — MEAN DAILY VARIATION OF foF$_2$ AND hpF$_2$ AT AHMEDABAD, DELHI AND TIRUCHIRAPALLI IN DIFFERENT SEASONS OF 1954

From Fig. 2 it is found that in the annual variation, two maxima in foF$_2$ are observed at about the equinoxes at Ahmedabad, Delhi and Tiruchirapalli, those at Ahmedabad having the highest amplitude. In contrast to this, there is only one maximum of hpF$_2$ in June at Ahmedabad and Delhi, while there are no clearly marked maxima or minima at Tiruchirapalli. Thus near the geomagnetic equator, the F$_2$ layer follows more or less the zenith distance of the sun which is also true for the F$_1$ layer.

Appleton[13] has recently shown that the midday depression of foF$_2$ observed near the geomagnetic equator turns into a crest if midnight values are considered and the anomaly of low foF$_2$ belt disappears. A preliminary study of the variation of foF$_2$ with latitude at Indian and Japanese stations of the Asian zone shows that the equatorial trough begins to develop at 09.00 hr., reaches a maximum in width and depth at 14.00-15.00 hr. and turns into a smooth crest rising towards the equator after 21.00 hr. This is true for all the months in the year. Details of this study will be communicated in a later paper.

An idea of the range of variation in foF$_2$ and h'F$_2$ during 24 hr. at Ahmedabad is obtained from Fig. 7 which gives the difference between maximum and minimum values of the daily variation. The range of variation in foF$_2$ undergoes a seasonal change. The early morning minimum of foF$_2$ is lowest in midwinter and highest in midsummer. Thus the value of foF$_2$ swings through about 11 Mc/s. in equinox against a swing of only about 5·4 Mc/s. in summer in the course of a day during minimum solar activity. As against this, the range of variation of h'F$_2$ oscillates from 160 km. in summer to only 75 km. in winter.

The low value of foF$_2$ in summer may be the result of temperature and inflation of the F$_2$ layer and the low value in winter may be a consequence of the greater zenith distance of the sun. Eckersley[14] explained the equinoctial maxima in foF$_2$ as being due to the shorter distance of the earth from the active areas on the sun which lie between 7° to 20° north and south of the sun's equator and come opposite to the earth on 5 March and 7 September.

With a view to give a general picture of the variations of foF$_2$, hpF$_2$ and h'F$_2$ throughout the year 1954 (lowest sunspot numbers) and for ready use in radio communication, Fig. 8a-c has been prepared as contour

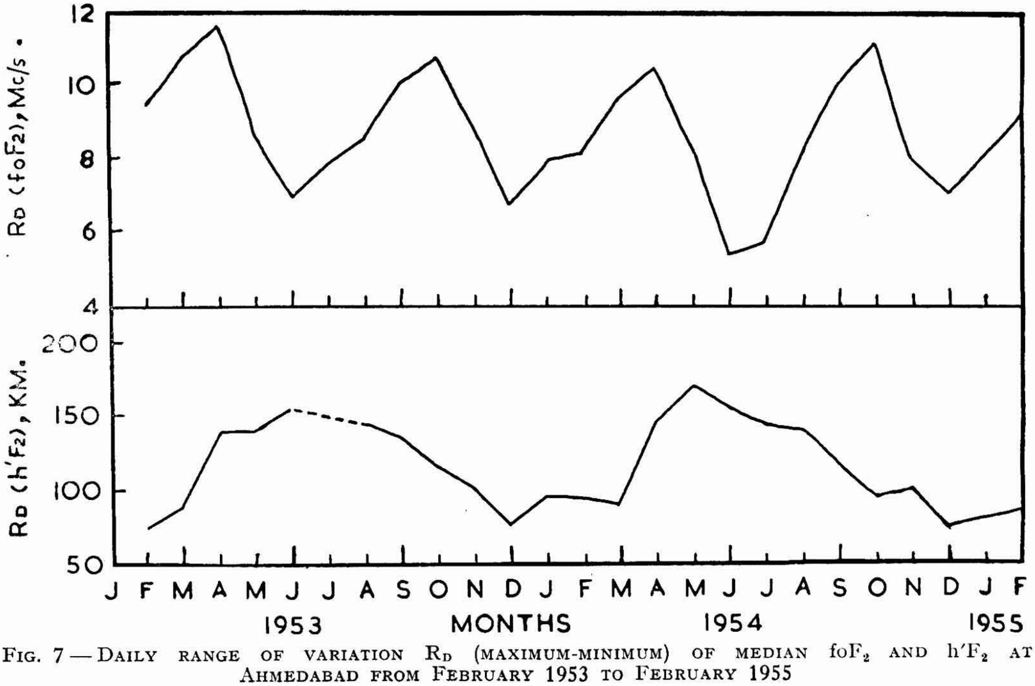


FIG. 7 — DAILY RANGE OF VARIATION R$_D$ (MAXIMUM-MINIMUM) OF MEDIAN foF$_2$ AND h'F$_2$ AT AHMEDABAD FROM FEBRUARY 1953 TO FEBRUARY 1955

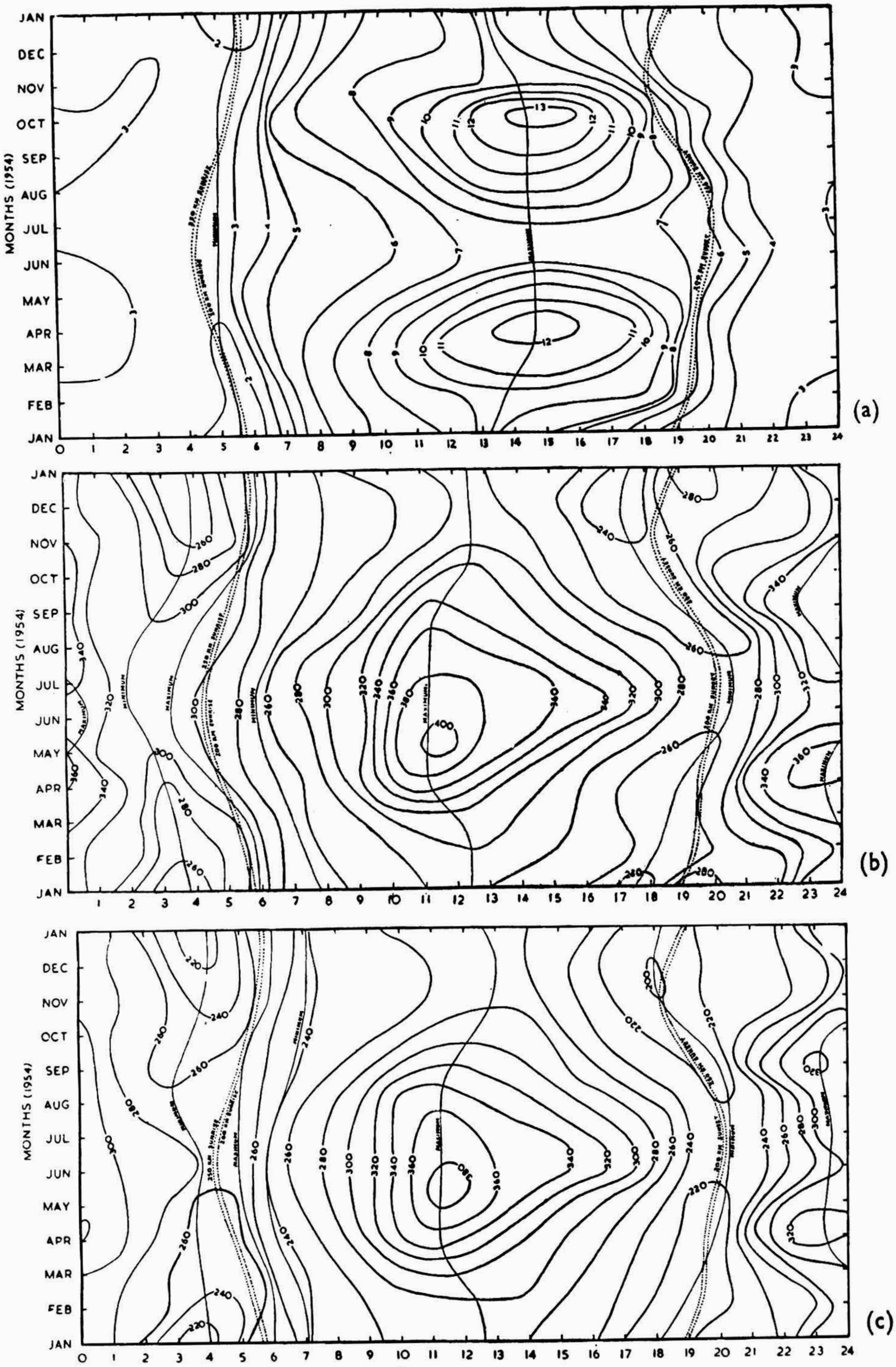


FIG. 8 — CONTOUR MAPS OF (a) foF_2, (b) hpF_2 AND (c) $h'F_2$ SHOWING SEASONAL AND DAILY VARIATIONS AT AHMEDABAD DURING 1954

maps. Minimum and maximum values have been shown by thin continuous lines. The dotted lines give the sunrise and sunset times at 200 and 250 km. levels. All the diurnal and seasonal features, the early morning effect and the changes at 20.00 hr. are brought out clearly. The line of midday maxima of height seems to follow the line of sunrise, although not quite parallel.

Summary

The general characteristics of the ionospheric F_2 layer over Ahmedabad (India) during the sunspot minimum period 1953-54 are described and compared with those at Delhi and Tiruchirapalli. The geomagnetic latitudes of the three places are 13°6′N, 18°8′N and 1°3′N. The sunrise effect on F_2 at Ahmedabad is delayed by about 45 min. after the layer-sunrise in summer, and takes place almost at the time of layer-sunrise in winter. Subsidiary maxima of the height of the F_2 layer are observed to occur early in the morning, and at 20.00 hr. in the winter months. Analysis of F_2 scatter shows that it is maximum at about 03.00 hr. and in summer. F_2 stratification has maximum occurrence at 05.00 and 20.00 hr. and in equinoctial months. Seasonal variations of F_2 scatter and F_2 stratification show anti-correlation.

The critical frequency of the F_2 layer shows maxima in equinoxes at all the places, the amplitude being highest at Ahmedabad. While the height of maximum electron density shows only one maximum in summer at middle and high latitudes, it shows two maxima near the equator, one in summer and the other in winter. The range of daily variation of foF_2 at Ahmedabad was found to be about 11 Mc/s. in the equinoxes, and only 5·4 Mc/s. in summer. The range of daily variation in $h'F_2$ was found to be 160 km. in summer and 75 km. in winter.

Acknowledgement

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Programme for Radio Research in India

THE Radio Research Committee of the Council of Scientific & Industrial Research has been developing centres of radio research in this country with the object of (1) developing radio industry in India on a sound basis, (2) conducting synoptic studies of atmospheric phenomena which affect radio propagation, e.g. atmospherics and (3) carrying out fundamental investigations which may have long-range application to radio development. The Committee has sponsored about 38 research schemes on a number of subjects, like ionospheric investigations, development of radio valves and microwaves. Active schools of radio research have been created in Calcutta, Ahmedabad, Waltair, Banaras, Allahabad and Lucknow.

The Committee has been feeling for some time the necessity for drawing up a planned programme of radio research in India during the next five years on the basis of the present research and development trends in the field and the requirements of the country, keeping in view the commitments of India in regard to co-operation with International Scientific Radio Union (URSI), International Radio Consultative Committee (CCIR) and the Special Committee for the International Geophysical Year (CSAGI). A subcommittee was, therefore, formed for this purpose, in March 1953, consisting of Dr. K. S. Krishnan, Mr. B. V. Baliga, Dr. M. B. Sarwate, Prof. K. Sreenivasan and Prof. S. K. Mitra. Two reports, one by Prof. K. Sreenivasan and another by Dr. A. P. Mitra, were drawn up and the Committee requested Mr. T. V. Ramamurti, Dr. Sarwate and Mr. Baliga to prepare a detailed programme of research on the basis of the recommendations contained in the two reports, which is outlined below.

The following fields of radio research have been assigned first priority in the programme: (1) Atmospheric radio noise and atmospherics, (2) Radio wave propagation through the ionosphere, (3) Radio wave propagation through the troposphere, and (4) Development of raw materials for radio components.

Problems which should be taken up next are those connected with (1) Waves, circuits and electronics, and (2) Radio astronomy.

A number of these problems are now being tackled by research organizations and universities independently or through schemes sponsored by the Radio Research Committee. In the programme given below, the subjects covered by items 1, 2, 5-10 and 14 under first priority group and items 3, 12, 14, 16, 17, 20 and 21 under second priority group fall in this category. The remaining items have not so far received adequate attention in India. The programme outlined is flexible and can, if required, be revised at a later stage.

First priority problems

Atmospheric radio noise and atmospherics — (1) Atmospherics produced by lightning flashes located by goniometers; (2) Study of the relationship between the enhancement of atmospherics on 27 kc/s. and solar chromospheric eruptions; (3) Lightning flash counters; and (4) Measurement of atmospheric noise level.

Ionospheric radio wave propagation — (5) Measurement and interpretation of ionospheric data; (6) Co-ordination, analysis and publication of ionospheric data; (7) Short-term and long-term predictions; (8) Ionospheric absorption measurements, using pulse reflection methods and radio star scintillations; (9) Study of fading; (10) Ionospheric drift measurements; (11) Ionospheric propagation at frequencies below 1500 kc/s.; (12) Ionospheric propagation in the band 30-300 Mc/s.; (13) Pulse transmission at oblique incidence; (14) Solar terrestrial relationships; (15) Propagation paths between U.S.A. and India, Hawai and India using WWV and WWVH transmissions; and (16) Scattering of radio waves.

Tropospheric radio propagation — (17) Tropospheric propagation well beyond the horizon in the frequency range 30-400 Mc/s.; (18) Effect of meteorological conditions on tropospheric propagation; and (19) Use of radar for weather observations and forecasting with special reference to clouds, rain and storms.

Development of raw materials for radio components — (20) Investigations on ceramics; (21) Improvement in mechanical properties of low-loss low-permittivity dielectrics; (22) Increase of dielectric constant; (23) Low-loss thermosetting materials; (24) Nature of effects of water on dielectrics; (25) Magnetic materials; and (26) Semi-conductors.

Second priority problems

Waves, circuits and electronics — (1) Antennas and transmission lines; (2) Radiation from (a) dielectric cylinders, (b) dielectric cones, (c) linear arrays of dielectric cones, (d) linear arrays of dielectric cylinders and (e) slot radiators; (3) Dielectric properties of substances in the microwave region; (4) Characteristics of microwave lenses at 10 cm.; (5) Electric semi-conductors, crystals diodes and transistors; (6) The manufacture of germanium diodes and diodes using other semi-conductors; (7) Study of silicon and the manufacture of silicon p-n junctions; (8) Properties, uses, circuitry and manufacturing processes of transistors; (9) Effect of discontinuities in microwave transmission lines and waveguides; (10) Power measurements at microwavelengths; (11) Microstrips, their circuitry and manufacture; (12) R.C. coupled F.M. oscillator; (13) Properties of magnetic materials in the ultra-short and microwave regions; (14) Magnetic amplifiers; (15) Microwave spectroscopy; (16) Millimicrosecond pulse study; and (17) Development of small-scale electronic computer.

Radio astronomy — (18) Study of the solar radio frequency radiations at 3000 Mc/s. and at lower frequencies; (19) Cosmic radio noise and radiation from discrete radio sources; (20) Ionospheric absorption using cosmic radio noise at vertical and oblique incidence; and (21) Ionospheric drifts using extra-terrestrial radio noise.

Vitamin B_{12}—Its Chemistry, Production & Assay

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NO single substance in the post-war period has evoked as much interest as vitamin B_{12}. Its importance in health as well as in the treatment of certain diseased conditions of human beings cannot be over-emphasized. Further, its usefulness in animal nutrition has given an added impetus to its manufacture.

Investigations on the possibility of producing vitamin B_{12} by fermentation processes employing vitamin B_{12} producing micro-organisms have been initiated in some laboratories in the country. It was, therefore, considered of interest to review the existing literature on the subject.

Historical

The usefulness of whole liver in the dietary treatment of pernicious anaemia was established in 1926 by Minot and Murphy[1]. The isolation of the active principle responsible for the anti-anaemic activity was, however, not possible till 1948 due to lack of a suitable experimental animal or a biological technique for assaying the haemopoetic potency of liver extracts. Earlier attempts to prepare various liver concentrates and to isolate this anti-anaemic factor have been summarized by Subba Row *et al.*[2].

The anti-pernicious anaemic factor was isolated in a pure form in 1948 simultaneously by Rickes *et al.*[3] of Merck Laboratories Inc., U.S.A., and Smith *et al.*[4,5] of the Glaxo Laboratories, U.K., in 1948. The U.S. group of workers was aided by an important observation of Shorb[6,7] that there was a linear relationship between the amount of growth factor for *Lactobacillus lactis* Dorner in liver extracts and the potency of the latter for curing patients suffering from pernicious anaemia, while the British workers made an exclusive use of clinical assay in their work. The newly isolated deep-red crystalline substance, designated vitamin B_{12}, was found to give response in the clinical treatment of pernicious anaemia in a daily dosage of 0·5-5 micrograms.

Isolation

It is not known whether the first isolation of vitamin B_{12} was made from liver or from fermentation liquor[8]. The multi-stage purification procedures used in U.K. and U.S.A. cannot be compared due to lack of details in published literature but it is certain that chromatographic adsorption technique must have played an important part in the isolation of vitamin B_{12}. The active principle, from liver or fermentation liquor, can be adsorbed on activated carbon or fullers' earth and eluted with 65 per cent ethyl alcohol, aqueous phenol or an aqueous pyridine mixture. The active principle can be recovered by diluting the phenol solution with an inert organic solvent like ether and extracting it with water. Partition chromatography on damp silica using *n*-butanol containing 11-12 per cent water has also been successfully utilized for purification. In the fractionation by these methods the pink colour of vitamin B_{12} is helpful.

Starch columns have been tried with some success. More recently, kieselguhr has been employed in isolating factors related to vitamin B_{12} and its hydrolytic products[8]. Paper chromatography with *n*- or *sec*-butanol has also proved valuable. In Germany[9,10] cellulose columns have been used.

Charcoal has been largely displaced by synthetic resins. Amberlite IRC 50 (carboxylic acid resin) can, for example, be used in the acid stage of the cycle and vitamin B_{12} can be recovered from the resin by washing it with dilute alkali[8]. Crude vitamin is crystallized first from aqueous acetone and subsequently from hot water.

While liver extracts were being investigated for the isolation of the anti-pernicious anaemia factor, it was reported[11,12] that rats required, for normal growth, an unidentified factor present in casein, liver extract, dried skim milk, eggs, etc. An active factor capable of influencing chick growth and hatchability of eggs was also reported. This factor was designated 'Animal Protein Factor' (A.P.F.). Its presence was reported in whey, meat scraps, distillers' dried solubles, milk powder, fish byproducts, alfalfa, cow manure and hen faeces[13]. Crystalline B_{12} was later found to exhibit similar properties for chicks[14,15] and rats[16]. Hence, it was suggested that A.P.F. and B_{12} were either identical or closely related to each other. However, it is not yet conclusively proved that B_{12} can completely replace animal protein from natural sources[17,18]. Supplementation of feed with antibiotics[19,20] and vitamin B_{12} has, however, become a well-established practice in the feeding of poultry and other animals.

The presence of vitamin B_{12} has been reported in the culture broths of *Mycobacterium smegmatis*, *Lactobacillus arabinosus*, *B. subtilis* and of several actinomycetes, viz. *Streptomyces rosecochromogenus*, *S. antibioticus*, *S. aureofaciens*, *S. erythrens*, etc. Vitamin B_{12} was isolated in a crystalline form from the culture broths of *S. griseus* and this proved to be identical with the material isolated from liver. In view of the difficulties involved in the isolation of vitamin B_{12} from liver, its isolation from the culture broths of several micro-organisms, particularly *S. griseus*, has become a commercial practice.

Microbial production of vitamin B_{12}

Micro-organisms capable of vitamin B_{12} production have been isolated from soil[21], chicken faeces[22] and bovine faeces[23]. In 1948 Stockstad *et al.*, for the first time, reported the production of vitamin B_{12} as a fermentation product from *Flavobacterium solare*[23], a rod-shaped non-motile bacterium isolated from chicken faeces[22]. Successful production of vitamin B_{12} by bacterial fermentation was reported by Setty[23]. Merck & Co.[24] announced the same year production of vitamin B_{12} by primary and secondary fermentation in large fermenters. Subsequently, production of vitamin B_{12} from primary bacterial fermentation was announced[25].

An extensive search for vitamin B_{12} producing micro-organisms was undertaken at the Northern Regional Research Laboratories, U.S.A.[26], and recently in India[27]. In this process some 5000 micro-organisms including moulds, yeasts, actinomycetes and bacteria were screened. Of these isolates, *Flavobacterium devorans* was found to be the most productive while none of the moulds or yeasts were found to produce vitamin B_{12}. Several hundred actinomycetes collected and screened for antibiotics[28,29] have also been screened for vitamin B_{12} production. Of these a considerable number showed B_{12} activity; in some cases the yields of vitamin B_{12} were as high as 2 γ/ml.[29]. Micro-organisms reported to produce vitamin B_{12} are recorded in Table 1.

Also, quite a large number of antibiotic producers have been found to produce vitamin B_{12}[80]. In another survey of actinomycetes, four isolates grown on a soyabean meal medium supplemented with cobalt were found to give yields of >1 γ/ml. of vitamin B_{12}[81].

Though vitamin B_{12} has been isolated from fermentation broths during the production of other antibiotics, e.g. Grisein[16,39,40,77], Streptomycin[24,63,67,71-73,76], Aureomycin[52-55,82] and Neomycin[58,59], the optimum conditions for the production of antibiotic and vitamin B_{12} are not identical[59]. Hence, it is of interest to note that in a combined fermentation reported by Sakai and Tsunoda[72], the curve for vitamin B_{12} production was found to run parallel to that of the antibiotic production.

Chemistry of vitamin B_{12}

Vitamin B_{12} crystallizes from water or aqueous acetone solutions as bright red needle-shaped crystals which darken at 210°-20°C. but fail to liquefy below 350°C. It normally contains 12 per cent moisture and is odourless and tasteless. Electrometric

TABLE 1 — VITAMIN B_{12} PRODUCING MICRO-ORGANISMS

No.	
1	*Aerobacter aerogenes*[30,31]
2	*Ashbya gossypii*[24,32,33]
3	*B. megatherium*[34-38]
4	*B. subtilis*[30,37,39]
5	*Clostridium butyricum*[24,40]
6	*Cl. cochlearium*[24,40]
7	*Cl. flabelliferum*[24,40]
8	*Cl. tetanomorphum*[24,40,41]
9	*Ermothecium species*[24]
10	*Ermothecium ashbyii*[40]
11	*Escherichia coli*[30,37,40,42]
12	*Flavobacterium acetylicum*[43]
13	*Flavobacterium aquatile*[43]
14	*Flavobacterium arborescens*[43]
15	*Flavobacterium devorans*[29]
16	*Fl. esteroaromaticum*[43]
17	*Fl. flavescens*[43]
18	*Fl. solare*[23,43]
19	*Fl. suaveolens*[43]
20	*Lactobacillus arabinosus*[39]
21	*Lactobacillus casei*[42]
22	*Mycobacterium phlei*[44]
23	*Mycobacterium smegmatis*[44]
24	*Mycobacterium tuberculosis*[44,45]
25	*Nocardia* sp.[46]
26	*Propionibacterium* sp.[47]
27	*Propionibacterium freudenreichii*[48,49]
28	*Propionibacterium shermanii*[48]
29	*Propionibacterium zeae*[48]
30	*Proteus* sp.[50]
31	*Pseudomonadaceae*[37,46,50]
32	*Serratia marsescens*[51]
33	*S. aureus*[30]
34	*Streptococcus faecalis*[42]
35	*Streptomyces albidoflavus*[24,40]
36	*Streptomyces antibioticus*[24,39,40]
37	*Streptomyces aureofaciens*[52-57]
38	*Streptomyces fradiae*[58,59]
39	*Streptomyces olivaceous*[60]
40	*Streptomyces colombiensis*[24,40]
41	*Streptomyces griseus*[31,39,40,51,56,57,61-77]
42	*Streptomyces roseochromogenus*[24,39,40]
43	*Rhizobium species*[78,79]
44	*Torula species*[24,40]

titrations do not reveal any basic or acidic groups in it but in acetic acid it behaves as a polyacidic base. The molecule is moderately large having molecular weight of 1350 for the anhydrous material. It is a cobalt co-ordination complex with a replaceable cyano group which can be removed by photolysis, catalytic reduction or treatment with sulphurous acid. These replacements, either with acid radicals or by a hydroxyl, give rise to a number of cobalamins, e.g. nitritocobalamin (vitamin B_{12c}) and hydroxocobalmin (vitamin B_{12b}). The cobalt atom has also been co-ordinated with ammonia, amines and some amino acids giving rise to a series of ' Cobalichroms '[83].

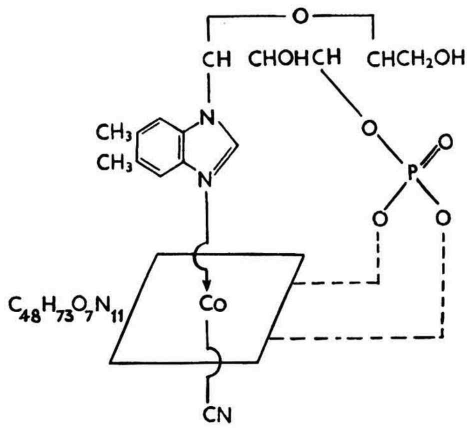
Early in the chemical investigation of B_{12}, modifications of this molecule were discovered. B_{12a}, first obtained as a result of catalytic hydrogenation and reoxidation of vitamin B_{12}, was later isolated from culture broths of *S. griseus*; B_{12b} has been obtained from liver and culture broths of *S. aureofaciens*[53,54]; and B_{12c} by Anslow *et al.*[61] from *S. griseus*.

By heating vitamin B_{12} with concentrated hydrochloric acid for several hours, ammonia (5-6 mols per mol of vitamin) phosphoric acid, a red gummy mass containing cobalt, a base which gave blue colouration with ninhydrin and which was later identified as D-1-amino-2-propanol (1 mol per mol of B_{12}), and 5-6-dimethyl benziminazole, were obtained[84].

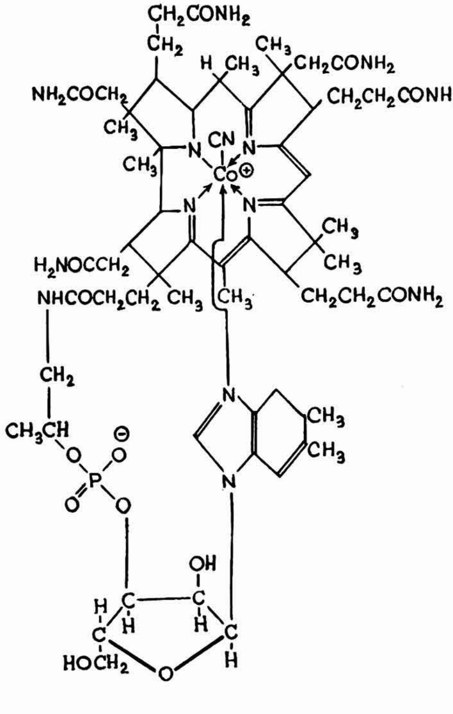
Milder hydrolysis of the vitamin gave the nucleotide 5-6-dimethyl benziminazole[85] which was isolated and identified as 5: 6-dimethyl-1-(α-D-ribofuranosyl) benziminazole-3-phosphate. The unusual α-configuration of the riboside is noteworthy[8,85].

Addition of excess cyanide to vitamin B_{12} results in the formation of a dicyano complex, and it was shown by ultraviolet absorption studies that the second nitrogen of the benziminazole ring is connected to the cobalt atom by a co-ordinate bond[84].

On the basis of this evidence, the following partial structure for the vitamin was formulated:



The red resinous mass containing cobalt, obtained as a result of acid hydrolysis of the vitamin, was shown by electrophoresis to be a mixture of acids[85]. This mixture was shown to contain two series of acids — one lacking the nucleotide and containing one to seven carboxyl groups (derived from Factor B) and the other retaining the nucleotide and containing one to six carboxyl groups[84]. A mixture of penta and hexacarboxylic acids obtained by the hydrolysis of the vitamin with 30 per cent aqueous sodium hydroxide at 150°C. was subjected to anion-exchange chromatography and a pure hexacarboxylic acid, as its monochloride monocyanide and lacking in the nucleotide ($C_{46}H_{60}O_{13}N.CoCl.2H_2O$), was obtained and crystallized[86]. The structure of this molecule has been determined by X-ray analysis[87]. Once this structure was established, the electron density patterns for vitamin B_{12} crystals became easier to interpret. And based on the X-ray analysis and the chemical evidence collected over the past few years, the complicated structure of vitamin B_{12} was determined except for few minor aspects which need some clarification[88].



Other factors related to vitamin B_{12}

It was observed by Coates *et al.*[17] that the vitamin B_{12} activity of natural products by the chick assay methods gave values higher than those obtained by microbiological assay which, according to them, may be due to the growth-promoting effect of other constituents of the animal protein factor present along with vitamin B_{12}. However, when the gut contents and faeces of ruminants were tested, higher values were obtained by microbiological assay as compared with the chick growth assay[89]. When chromatograms of these materials were tested microbiologically, zones of activity were observed for substances other than vitamin B_{12} as well, indicating the presence of substances to which only *E. coli* and *Lb. leichmanni* respond. Subsequently, following the same procedure as that adopted for the isolation of vitamin B_{12} from liver, Factors A and B were isolated in addition to B_{12} from calf faeces and rumen contents[90]. Later on, a third substance, Factor C[91], was also isolated. These factors could not be converted to cyanocobalamin by treatment with cyanide[92,93]. Other vitamin B_{12} factors, e.g. vitamin B_{12m}[94] from the faeces of pigs, cattle and horses, Factor W.R. from liver, and pseudo-vitamins B_{12} and B_{12b} from a rumen anaerobe[95,96], have also been reported.

As a result of a thorough analysis of all the reported B_{12}-like factors Ford *et al.*[97] concluded that the established vitamin B_{12}-like compounds were only Factor A (vitamin B_{12m}), Factor B, Factor C and pseudo-vitamin B_{12}. However, since then many more have been included in the list of vitamin B_{12}-like factors. As can be seen from Table 2[94], these vitamin B_{12}-like substances differ in their nucleotides and in their non-convertibility to cyanocobalamin on treatment with cyanide.

Factor B — This is the fundamental substance of B_{12} vitamin and related products characterized so far and links the cobalamin series with vitamin B_{12}-like factors. It was first reported by Ford *et al.*[90] in 1951. The removal of nucleotide from cyanocobalamin has been reported to yield Factor B[85]. It has been found in sewage sludge[10,98], marine algae[99] and *S. aureofaciens* fermentation broth[100].

TABLE 2 — CHARACTERISTICS OF VITAMIN B_{12} AND RELATED PRODUCTS

	APPEARANCE	BASE OF NUCLEOTIDE	IONOPHORETIC MOBILITY (*sq. cm.* $\times V^{-1} \times sec.^{-1} \times 10^{-5}$)
Factor B	Amorphous	nil	5·0
Pseudovitamin B_{12}	Crystalline	Adenine	1·5
Factor A	do	2-Methyl adenine	3·9
Factor C_1	?	?	1·4
Factor C_2	?	?	?
Factor E	?	?	0·0
Factor F	Crystalline	?	0·3
Factor G	do	Hypoxanthine	—
Factor H	do	2-Methyl hypoxanthine	—
Vitamin B_{12iii}	do	?	nil
Cyanocobalamin	do	5: 6-Dimethyl benziminazole	nil

Pseudovitamin B_{12} was isolated as a product of anaerobic fermentation by an unidentified organism isolated from rumen contents[95] of sheep. It was shown to contain adenine as the nucleotide[96]. On hydrolysis pseudovitamin B_{12} yields Factor B[101].

Factor A was detected by Ford *et al.*[90] in 1951 simultaneously with Factor B. It has been shown to be same as vitamin B_{12m} isolated by Wijmenga[94] as a crystalline substance from pig manure. It has been shown to contain 2-methyl adenine as the nucleotide[102,103]. This structure has been confirmed by biosynthesis of the factor from Factor B and 2-methyl adenine[104]. According to Pfiffner *et al.*[103], there are two Factors A, which they call pseudovitamins B_{12d} and B_{12f}, both containing 2-methyl adenine but differing in refractive indices and also in the response of *L. acidophilus*[94]. Factor A has also been obtained from sewage sludge[10,98], from *S. aureofaciens*[100] fermentation broth and marine algae[99].

Factor C (C_1 and C_2) was first noticed by Ford and Porter[91] in 1952 as the slowest moving electrophoretic zone of bioautographic activity in extracts of calf gut contents and faeces, and was also obtained by these authors when *E. coli* was grown in a medium containing Factor B. These two have been shown to have different ionophoretic mobility[97,101]. It has also been isolated from sewage sludge[98] and from marine algae[99].

Factor E was isolated from extracts of calf and pig faeces[101].

Factor F was obtained in a crystalline form from pig faeces by Brown *et al.*[101] in 1955.

Factor G was obtained by deamination of pseudovitamin B_{12}[101-103]. It has also been isolated in minute amounts from calf and pig faeces in a crystalline form.

Factor H — Deamination of Factor A yields this product. It has also been isolated from calf and pig faeces.

Factor I was isolated from pig and calf faeces by Brown *et al.*[101] and has been found to be identical with vitamin B_{12iii} of Friedrick and Bernhauer[9].

Production of vitamin B_{12}

Improved yields of vitamin B_{12} have been obtained by the modification of the growth medium, selection of optimum conditions for the fermentation process and use of high vitamin B_{12} yielding strains of micro-organism. The majority of the investigations reported in the literature are those dealing with submerged aerated fermentations which distribute the growth of the organism evenly throughout the medium. However, anaerobic fermentations[24,105] and the use of different kinds of brans[24,43] have also been reported. Equipment and procedures for industrial fermentations by submerged methods have been described in a number of publications[106-110].

Selection of high yielding strains is important in industrial fermentation processes employed for the production of vitamin B_{12}. Increase in yields from 0·1 γ/ml. to 2·0 γ/ml. and more have been reported[111] by the use of improved strains. Different temperature ranges have been reported for actinomycetes (optimum being in the region of 25°-30°C.)[24,30,40,69,70,72,81,112] and bacteria (when the maximum may be 40°C.)[24,35,36,40,43,44,110].

The following carbon sources have been employed for vitamin B_{12} production: Beet molasses[26,34-36], cane molasses[26,35], corn syrup[24,35,40], dextrin[43,113], dextrose[24,26,35,36,40,43,46,49,70,72,11,114], fructose[35], galactose[43], glycerol[35,46], lactose[49], malt extract[43], maltose[24,26,35,36,40,43,115], mannitol[35], mannose[43], soluble starch[35,43], sorbitol[35,43], sucrose[33,35,36,43] and xylose[24,40].

Nitrogen sources reported by various workers for the production of vitamin B_{12} are ammonium nitrogen[24,26,34-36,40,44,70], animal stick liquor[112], asparagin[35,44], beef extract[24,40,43,65,72,116], blood meal[24,40], casein and casein hydrolysates [24,36,40,43,49,65,114,116], copra meal[50], corn meal[43], corn steep liquor[26,111,112], cotton seed meal[43,50], distillers' solubles[24,40,43,112], dried yeast[24,40,43,50,117,118], fish meal[27,37,40,43], fish press liquid[51,56,57], fish solubles[24,40], grain alcohol stillage[33], protein hydrolysates[24,35,43], nitrates[43,117], oats[24,40], peptone[26,37,43,116], protein, meat and bone scraps[24,40,50], salmon waste meal[24,40], skim milk[47], soyabean meal[24,26,40,43,50,79,111,112,116,117], urea[35,43], whey[47], yeast extract[24,30,34-36,40,43,49,116] and yeast hydrolysate[26].

Precursors of vitamin B_{12}

Percursors of vitamin B_{12} have been investigated to a limited extent. The presence of cobalt in the proportion of 0·1-2·0 p.p.m. of the nutrient medium has been found to be an important factor in the production of vitamin B_{12} by fermentation processes[40], and the addition of cobalt to the initial fermentation medium is now a standard procedure[24,26,28,30,35,36,44,56,57,59,70,114-116]. Increased yields of vitamin B_{12} due to intermittent addition of cobalt to a synthetic medium inoculated with an unidentified strain of streptomyces has also been reported[110].

Cobalt-60 has been employed in experiments on the biosynthesis of vitamin B_{12} by *Streptomyces griseus*[119]. An increase of vitamin B_{12} in the faeces of rats fed with diet containing higher proportion of cobalt-60 has also been demonstrated[120].

Lactic acid bacteria and some algae which require vitamin B_{12} have been shown to respond[121] to 1, 2-dimethyl-4, 5-diaminobenzene[122], a product of acid hydrolysis of vitamin B_{12}. This product has, therefore, been considered as a possible precursor[38] of vitamin B_{12}. 1, 2-Dimethyl-4, 5-diaminobenzene is reported to increase vitamin B_{12} production by *B. megatherium* twofold and also exhibit vitamin B_{12} activity in rats[123]. Hendlin and Soars[124] have shown that 1, 2-dimethyl-4, 5-diaminobenzene does not possess any of the properties claimed, but on the contrary it inhibits the growth of *L. lactis* (Dorner). The growth response reported by earlier workers has been attributed to the presence of vitamin B_{12} in traces, sufficient to initiate cell growth and neutralize the toxic action of 1, 2-dimethyl-4, 5-diaminobenzene. The vitamin B_{12}-like activity of 1, 2-dimethyl-4, 5-diaminobenzene in rats has been attributed to its inhibitory action on the B_{12}-dependent organisms in the intestines which in turn make available greater amounts of vitamin B_{12} for the host.

Several structural analogues of 1, 2-dimethyl-4, 5-diaminobenzene have been reported to cause marked decrease in the production of vitamin B_{12} by *B. megatherium* when used in concentrations not inhibitory to the growth of the bacterium[125]. This decrease was noted with the analogues which were non-competitive antagonists as well as those which were competitive antimetabolites to 1, 2-dimethyl-4, 5-diaminobenzene. Growth response was noted with *Serratia marsescens* when the organism was grown in a medium containing B_{12} degradation products but the organism showed total absence of any such activity when grown in a medium devoid of the degradation product[51].

Addition of cobalt to the medium used for inoculum as well as for fermentation has been reported to be advantageous[26,36,72]. *S. griseus* inoculum grown in meat extract is reported to yield more vitamin B_{12} than when it is grown in soyabean-yeast medium; this may be due to the presence of precursors structurally similar to vitamin B_{12} in meat extract.

Addition of *p*-aminobenzoic acid, nicotinic acid and pantothenic acid to the fermentation medium has been reported to increase vitamin B_{12} production by *Flavobacterium devorans*[26]. Recently, it has been shown that pseudovitamin B_{12} or B_{12b} exert the same effect[126] as vitamin B_{12} on the mutant strains of *E. coli* in which the specific effect of PAB on the synthesis of B_{12} has been studied in detail. In view of the finding that riboflavin helps rats to overcome avitaminosis when fed with B_{12} deficient diet, it has been suggested[127] that riboflavin may be utilized by the microflora of the intestinal tract for conversion to vitamin B_{12}.

Vitamin B_{12} assay

Available chemical and microbiological methods have been reviewed earlier[128,129]. The main difficulty with all the assay methods reported seems to be the inability of these techniques to discriminate between vitamin B_{12} (cyanocobalamin) and other B_{12}-like compounds.

Of all the methods available at present, the microbiological method appears to be the most practical as it responds to minute quantities of vitamin B_{12}.

Chemical methods — (1) Spectrophotometric assay (U.S.P. XIV) may be used for concentrated solutions of cyanocobalamin free from other interfering substances. The method is based on the absorption of vitamin B_{12} in wavelength range 360-548 mμ. In the control and standardization of vitamin B_{12} during manufacture, where the test materials contain only cyanocobalamin, this method is speedy and accurate.

(2) *Counter-current distribution assay* — Distribution coefficient of vitamin B_{12} in water-benzyl alcohol is 1·2. The method of assay is dependent on the distribution of the vitamin in this solvent system. The utility of this method is limited due to the interference of other coloured substances.

Measurement of cyanide liberated from cyanocobalamin by photolysis[130,131] — This method is based on the liberation of cyanide radicle from cyanocobalamin and its colorimetric estimation.

Another purely chemical method is based on the estimation of 5, 6-dimethyl benzimidazole liberated from vitamin B_{12} on acid hydrolysis. These methods are, however, limited in their application due to the fact that they are not specific for cyanocobalamin.

Radioactive tracer assay — This 'isotope dilution' method of Bacher *et al.*[132] consists in adding a known amount of cobalt-60 labelled cyanocobalamin to the test extract which is then subjected to the rigorous purification procedure required to isolate cyanocobalamin in pure form. The specific radioactivity of this purified extract serves as a measure of the cyanocobalamin content of the test extract. The method is not useful in routine practice.

Microbiological methods: *Lactobacilli* — The first microbiological assay with *Lactobacillus lactis* Dorner for vitamin B_{12} was reported by Shorb[6,7]. However, this test was found to be non-specific and required elaborate precautions. The organism has now been replaced by a strain of *Lactobacillus leichmanii* (which is employed in the official U.S.P. method). This organism also responds to thymidine and other deoxyribosides, but in general, if the test extract is not rich in nucleotides and low in vitamin content, interference is eliminated simply by dilution. As little as 4 μμg./ml. of the vitamin can be measured employing this organism. The organism also responds to most of the B_{12} vitamin except Factor B. Berman *et al.*[133] have described a method for the differential assay of vitamin B_{12} and pseudovitamin B_{12} based on the difference in the response of *Lactobacillus leichmanii* and *Lactobacillus acidophilus* to these products.

A B_{12} requiring mutant of *B. coli* No. 113-3 isolated by Davis and Mingioli[134] has been widely adopted as a test organism for the assay of vitamin B_{12} by cup-plate or serial dilution technique. The test is subject to interference by methionine. This organism responds for almost all the known naturally occurring forms of vitamin B_{12}. With the help of this mutant, a number of forms of vitamin B_{12} have been microbiologically synthesized by combining Factor B with different nucleotides[94].

Another interesting method is based on the ability of vitamin B_{12} to reverse the inhibitory action of sulphanilamide on the growth of wild strains of *B. coli*[135].

Euglena gracilis — A highly sensitive method based on the B_{12} requirement of *E. gracilis* var. *bacillaris* has been reported by Hutner *et al.*[136] and has been successfully employed by several workers[114,137,138]. However, in spite of the fact that the organism does not respond to deoxyribosides or other compounds unrelated to vitamin B_{12}, it is not widely used as the method is time-consuming and the results are subject to wide variations.

Ochromonas malhensis — The main advantage of using this organism is its high and specific requirement of cyanocobalamin[139]. Only cyanocobalamin and vitamin B_{12} III[9] elicit high response in this organism. Assay by this organism is also subject to interference by methionine. The main disadvantage is the long incubation (72 hr.) period required in the assay and many workers[140] are not familiar with this organism.

Several other micro-organisms have also been used for vitamin B_{12} assay. Among these are certain marine organisms which facilitate the measurement of the vitamin in sea water[141,142].

Cobalt deficiency in sheep and role of vitamin B_{12}

It was recognized long ago that cobalt deficiency leads to a serious diseased condition in ruminants[143,144]. It has been shown recently that in such conditions administration of cobalt is effective only when it is given by mouth[145]. The site of action of cobalt seems to be in the rumen where it is concentrated by micro-organisms[146]. It has also been reported that for cobalt-deficient sheep the amount of vitamin B_{12} required is about twenty times greater than the amount used in the treatment of pernicious anaemia in man[147]. Synthesis of vitamin B_{12} in the rumen of sheep has also been reported[148]. The hypothesis of Monroe *et al.*[149] that vitamin B_{12} is synthesized in the rumen as well as the tissues of sheep is not based on sufficient data.

Though vitamin B_{12} cures the cobalt deficiency condition in ruminants, it has not yet been proved that it is the only essential cobalt containing compound responsible for it, as several other vitamin B_{12}-like factors have been isolated from the rumen of sheep.

Intrinsic factor — From clinical trials carried out with patients suffering from pernicious anaemia and fed with lean beef, Castle[150] came to the conclusion that there was an extrinsic factor present in beef muscle and an intrinsic factor in normal human gastric juice. This extrinsic factor, now identified as vitamin B_{12}, when administered along with gastric juice to patients with pernicious anaemia[151], has been found to be effective. As cobalamins are effective when given parenterally it is clear that the intrinsic factor helps only in the absorption of the vitamin in the intestines. The exact nature of this factor is not yet clear. Some workers believe it to be a proteolytic enzyme[152,153], while others claim it to be a prolinase[154], an α-amylopeptidase[155] and lysozyme[156]. But these claims have been subsequently refuted since various dietary constituents known to contain these substances proved ineffective in the treatment of pernicious anaemia.

Vitamin B_{12} in animal metabolism

In view of the presence of vitamin B_{12} in large variety of foodstuffs, severe deficiency of this vitamin is not known. Vitamin B_{12} deficiency in man is generally associated with the appearance of symptoms of pernicious anaemia characterized by an abnormal or megaloblastic type of erythropoiesis. Though the haematological symptoms appearing in cases of vitamin B_{12} deficiency are very similar to those resulting from lack of folic acid, and both are essential for normal erythropoiesis, only vitamin B_{12} is effective against the neurological conditions often associated with pernicious anaemia. Severe vitamin B_{12} deficiency affects different animals in different ways. It causes kidney damage and perosis in chicks and high mortality rate in rats immediately after weaning. Vitamin B_{12} has been shown to influence the metabolism of protein, nucleic acids, carbohydrate and fat. However, the main function of vitamin B_{12} in animal metabolism seems to be the biosynthesis of labile methyl groups and reduction of thiol compounds, viz. glutathione and homocystine. Other compounds such as coenzyme A may also be activated by reduction to the sulphahydryl group[157].

Conclusions

The above review indicates the important place vitamin B_{12} occupies in human and animal nutrition. Vitamin B_{12} is already finding extensive use as a supplement in mixed feeds for farm animals and poultry. In the United States of America, out of 35,000,000 tons of animal feed manufactured in 1952, 23,000,000 tons were supplemented with 200 kg. of vitamin B_{12} valued at $10,000,000. During the same period, 42 kg. of the pure vitamin valued at $ 5,559,000 were used for therapeutic and other purposes.

In view of our development programmes aimed at improving the nation's health and increasing and improving the animal wealth of the country, special attention has to be paid to indigenous production of various vitamins, in particular vitamin B_{12}. With this objective in view, the Central Drug Research Institute has initiated work on the development of an economic process for the production of vitamin B_{12}.

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Nuclear Reactor Instrumentation

NUCLEAR reactor technology requires a variety of special measuring instruments. These instruments relate mainly to three specific aspects of nuclear reactor practice, viz. the control, operation and health monitoring. In routine reactor operation, the important measurements to be made regularly are the fission rate, flux distribution and amount of radioactivity.

The fission rate and its rate of change in a reactor must be under control at all times from shut-down sub-critical state to full-power operating level. A satisfactory direct method of measuring fission rates has not been found. However, heat output measurements can be taken as an indirect indication of the fission rates; but the two are proportional only over a small range near the maximum operating level. For fission rate measurements during shut-down and start-up a method which is applicable over a wider range is necessary. The neutron flux pattern throughout the reactor core does not vary greatly with power level. Hence from neutron flux measurement at one position in the core (usually the neutron-sensitive detector is located just outside the core) the operating power level can be evaluated. This is the method employed in all existing reactors. This method is suitable at full power level also and has the advantage of a much shorter response time than is possible in calorimetric measurements. At high power levels the equipment can be calibrated in terms of power output against calorimetric determinations.

For control purposes in reactor operation, e.g. to ensure correct fuel element loading for satisfactory operation and efficient use of fuel, the measurement of the flux distribution throughout the core is necessary. Such flux-scanning equipment, now being widely manufactured in Britain, usually consists of d.c. ionization chambers filled with boron trifluoride gas or an inert gas but having elemental boron deposited on the electrode system. With d.c. amplifiers and suitable differentiating circuits they can be used to record power level and its rate of change by means of pen recorders. Suitable electronic trigger circuits for automatically shutting down the reactor if the power level exceeds a predetermined safe level, are also usually included. The latest type of logarithmic d.c. amplifiers cover a range of 7-8 decades of power level. At low power levels, the use of pulse counters in association with suitable amplifiers, power level indicators, period meters, etc., may be necessary.

These neutron-detecting instruments can be used for flux distribution measurement. But they have a limited life under high neutron irradiation and so cannot be satisfactory for continuous operation. Hence a neutron activation technique is employed for flux measurement. In this method, a suitable material, in the form of a wire, is introduced into the core, irradiated for a specified time and withdrawn and the induced β- or γ-ray activity measured by an external counter. This method is being used in the Calder Hall reactor and is proposed to be employed in the U.K. Central Electricity Authority's nuclear power stations to be built.

Sensitive equipment is now available to detect and locate faulty fuel elements during operation resulting from chemical incompatibility between fuel and the coolant, before they become sources of serious contamination. The apparatus used involves detecting the presence of minute quantities of fission products in the coolant circuits. For precise location of the fault, an elaborate arrangement of sampling is necessary to permit samples from each fuel element channel, in turn, to be checked by the detector. Geiger counters and scintillation counters (as in the latest instruments) are employed for this purpose.

It is essential to monitor the working space around the reactor, especially during loading and unloading operations, to ensure that safe radiation limits are not exceeded. Such monitoring instruments are of different types using radiation detectors which may be ionization chambers, Geiger, proportional, or scintillation counters and are designed according to the detector capabilities required for β-, γ-, or fast neutron-monitoring. They may be either of the stationary type meant for remote indication in the control room or of the portable kind for personal monitoring (*British Information Service, Release No. BFY* 7).

Study of Surface Layers Using Eddy Currents

THE effects produced by the eddy currents induced in a conducting material can be detected by the influence of their magnetic field on the impedance of a search coil placed on the surface of the material. The coil itself may be used as the source of the applied field by passing an alternating current through it. The distribution of the eddy currents and hence their effect on the search coil depends on the electrical resistivity and magnetic permeability of the conducting material and on the geometry of the coil/conductor system. The form of the coil is important as on that depends the coupling between the coil and the conductor which determines the manner in which the changes are reflected in the coil. The resistivity and permeability of the material, in turn, depend upon a number of factors like the physical and chemical properties, dimensions of the conductor, and the presence of defects in the path of the eddy currents. By making electrical measurements on the coil to determine resistivity, it is possible, in simple cases consisting of a single variable, to relate them to these properties and measure them quantitatively. The method is non-destructive as the currents are confined to surface layers only and is also flexible due to the fact that the depth of penetration can be altered to suit particular applications by the selection of an appropriate frequency of the applied magnetic field. Further, no special preparation of the test piece is needed. However, it should be ensured that changes in properties being measured are not brought about by the thermal effects due to the dissipation of the eddy currents.

An experimental investigation was undertaken by the Department of Physics of the British Iron and Steel Research Association [*J. Iron St. Inst.*, **183** (1956), **415**], with a view to ascertain the usefulness of the eddy current method for the study of the physical properties of metals, measurement of surface coating thicknesses and detection of defects.

Study of physical properties

The impedance of a search coil placed on the surface of a flat conducting surface depends on the properties of the conductor and the spacing of the coil from the sheet and can be made independent of the thickness of the conductor by using a sufficiently high frequency. The effects of spacing and those of properties can be separated by employing special circuits. Thus, unknown metals can be identified by measuring the resistivity, though the surface is wrapped in non-conducting material. Conversely, thickness of insulating coatings on known metallic bases can be estimated. Differences in chemical composition and the thermal and mechanical treatment of a surface also affect resistivity and can be studied by this method, e.g. the examination of cylindrical bar stock for slight changes in composition by comparison with a standard sample. Resistivity increases with hardness. The hardness of a uniformly hardened steel can be measured by placing a coil around or on the surface of the specimen. The trends of variation of both inductance and resistance were observed to be closely similar and could be represented by the same graph. Differences in carbon content were found to produce marked effects, particularly at low hardness numbers, on the resistance-hardness curves, necessitating a knowledge of the composition for the measurement of hardness. It is possible to measure the carbon content of plain carbon steels in the annealed state from the resistivity measurements.

Another study of the influence of mechanical treatment on the properties of a metal concerns with the extent of cold work needed to improve the behaviour of a sheet of metal which is annealed after rolling. In this case, the inductance was correlated with the percentage elongation produced. The inductance was found to decrease as the elongation increased. Eddy current measurements may give a better indication of the temper of the sheet than do the percentage elongation values.

Measurement of surface thickness

The impedance of a search coil placed on a specimen consisting of a layer of one material on a base of a different material is affected by the thickness of the coating, the properties of the coating material, the properties of the base material and any grease or dust on the surface. For good sensitivity, firstly, there should be sufficient difference between the properties of the coating material and those of the base. For a given frequency, there is an upper limit to the coating thickness which can be measured and a lower limit to the thickness of the base which is permissible, if the current distribution were to be independent of the thickness of the base and were to be determined in accordance with the coating thickness. The coil is wound to suit the form of the specimen ensuring a maximum coupling between the coil and the specimen.

Three kinds of specimens have to be considered:

Non-conducting coating on a conducting base — This kind of coating acts as a spacer between the coil and the base. The inductance increased and the resistance decreased with increasing coating thickness. Either of the two components of the impedance, viz. resistance and inductance, may be used to determine the coating thickness, the choice being governed by the nature of the base.

Conducting coatings on a non-conducting base — In this case, the electrical effects produced on the coil can be considered to be almost entirely due to the coating. Measurements of resistance with the search coil placed on an aluminium foil as the coating showed that the resistance-frequency curves exhibit a peak in the region of 1 mil thickness. The actual value of the thickness at which the peak occurred decreased as the frequency was increased, so that the peak can be made to occur at very nearly zero thickness by using a sufficiently high frequency; but this limits the range of measurement. On the other hand, inductance decreased smoothly with increasing thickness and the effect of varying the frequency and the coil/specimen spacing is small. So, inductance measurement gives more accurate indication and is to be preferred.

Conducting coatings on a conducting base — The main requirement to be satisfied in achieving a sensitive measurement is that there should be a sufficient difference in the properties of the coating material and the base. It is then easy to measure the thickness of a non-magnetic coating on a magnetic base. The most widely used magnetic material is steel which is frequently given a coating of another metal to improve its corrosion resistance or to give an attractive appearance. Resistance and inductance measurements on aluminium coatings on a steel base gave a variation similar to the one in the previous case and again indicated that for obtaining accurate values, inductance measurement is to be preferred. Experiments with a series of mild steels and a sample of gauge plate showed that inductance is less sensitive than the resistance to changes in the base. Using these principles, an instrument has been developed to measure the thickness of commercial tin coatings (which lie in the range of 15-300 microinches) on steel. The resistance peak is shifted very near zero thickness to avoid any ambiguity in the readings, by using a much higher frequency than is required for such a thickness range. The inductance and resistance change in the same direction permitting the total impedance to be taken as a measure of the coating thickness. This resulted in considerable simplification of the apparatus.

Detection and measurement of mechanical defects

Mechanical defects such as cracks, inclusions, or a pipe in a conducting material, can be detected by the distortion of the flow of eddy currents in the neighbourhood of the defect. From the effect of these distortions on the impedance of the search coil, the defects can be measured. For sensitivity, the region of distorted current flow should be appreciable compared to the region in which undistorted flow takes place. The coil should be placed such that a large area of the defect is normal to the current flow occurring in the absence of the defect. Coil dimensions should thus be commensurate with the expected size of the defect. A small flat circular coil placed on the surface is suitable for specimens with large cross-sectional areas, to detect and follow individual cracks immediately below the coil. A coil wound around the specimen, when its cross-sectional area is small, makes rapid examination possible, though the indication will be an integrated effect of all the cracks under the coil. For quantitative measurement of defects, the flat coil should be used. In ferrous materials crack depths in the range 0·001 in. to 0·025 in. have been estimated. In fault detection what is generally required is an indication of the deviation from a desired specification. A comparison method is commonly used. Two coils, one embracing the test specimen and the other placed over a standard, are connected in a bridge circuit. The bridge is balanced initially using two identical standards. Any deviation observed is due to the test specimen. Rapid inspection is possible in this way if there is no interference from other likely sources of deviation like differences in shape, dimensions or physical properties. Care must be taken in the interpretation of the results. Unambiguous results are obtained only when one of the parameters varies while the other remains constant.

Antarctic Geology

As part of the programme for the International Geophysical Year (I.G.Y.), the Russians have been, in recent years, carrying out considerable oceanographical and geological research, particularly in the Antarctica. The Russian oceanographic programme to be carried out by ship-borne expeditions includes: study of antarctic atmospheric pressure as it affects the common separation of global weather; geological history, geological frontiers and geophysical peculiarities of the Antarctica; study of the ice-cap and, in particular, glaciological dynamics. Researches from the sea, now being carried out along the Antarctica coast, will be continued and extended to other regions like the Pacific. Continental traverses to be undertaken during 1956-59 are also planned. They have established, since the beginning of 1956, two Russian antarctic bases, first at Mirney and later at Pionerskaya. These bases are functioning in active co-operation with bases established by America, France, Australia and other countries by regular exchange of meteorological data, geological samples and other information and discuss problems of common interest, e.g. mining minerals, gold, etc., in Antarctica. These two bases have been established with the efforts of the crew and scientist parties of two specially built ships, the *Ob* and the *Lena*, which are well-equipped with research laboratories for polar oceanographical research. One more base is proposed to be established in future.

Voyage of the *Ob*

The research ship *Ob* made a 5000-mile cruise in antarctic waters and set up 76 oceanographic stations. A greater part of the voyage was made along the eastern coastal regions of Antarctica between 91° and 162°E, keeping close to the ice-shelf and passed through Knox Coast, Southern Coast and the ' Outpost Land of Discovery ' near the North Coast. The expedition also visited some islands near the South Coast (area near 110°E off Wilkes Land) which was reached for the first time in history by ANARE party only a few weeks before the *Ob* expedition's arrival. The *Ob* will complete the oceanographic cross-section through the Eastern Sea and return to Leningrad. The material collected in this part of the journey will be studied in detail at the Oceanographic Institute.

Expedition's findings

The echo soundings along the ship's course yielded valuable material for the future study of antarctic shelf beyond 70°E. Already, the observations on one line of sounding clearly indicated that, in this region of the continental shelf, on the sea-bottom there are two ' walls ' which are divided from each other by a big fault, trough or *graben*. It is thought that these ' sea-walls ' which have a tectonic basis, stretch parallel with the Ice-barrier throughout the Davis Sea and also farther east up to Terre Adélie (135°E). The northernmost of these ' walls ' coincides with the position of the extreme end of shelf glaciers at those places where there has been maximum movement of these glaciers oceanwards. From an analysis of the systematic study of ocean-bottom samples and borings of sediment core, the presence of rock showed a correlation with certain petrographical provinces belonging to coastal waters, thus pointing to the possibility that there have been two main provinces, one in the region of the coast from Cape Darnley up to the Helen Glacier, the other round the Shackleton Ice-shelf. Studies on ice movement suggested that there are petrographical regions belonging to the South and North Coasts. The evidence regarding sea-ice movement which the collection of rock deposits along the Eastern Coast is likely to yield contributes much to an elucidation of Antarctica's continental geology. Examination of the bottom cores from the continental shelf of the Southern Coast clearly showed the siting of the different geological structures. In the area from Banzare Coast up to William II Land, layers of gravel-pebble detritus and diatomaceous silt have been observed in the cores. Irregularities observed in the changes of bottom sediment revealed important features of the continent's palaeogeography during the Quaternary period. Collection of further material should enable a clear geological history of Antarctica to be drawn up. Analysis of sedimentary material suspended in sea water using a special ' membrane ultra-filtration ' method and the mapping of the palaeogeographic sections across the ' zone of divergence ' in the Davis Sea, Knox Coast and Terre Adélie have also been made during the *Ob*'s voyage. Meteorological, aerological and zoological (both qualitative and quantitative) work also formed part of the programme of investigations. Interesting results have been obtained by Russian marine-biologists from dredgings down to 4000 m. in deep waters off the Balleny Islands. Some new specimens of crustacea have been observed in these deep sea dredges.

Conclusions

The Soviet scientists' preliminary conclusions regarding the ice-cap of East Antarctica seem to confirm the opinion held by some British geologists based on the evidence provided by soundings, dredgings, moraines, perched erratics and topographic, structural and tectonic features. This view holds that in the past, probably during the Quaternary period, the ice-cap extended much farther seaward than at present by about 20 or more miles. It is generally agreed that in the early Quaternary period there were minor fluctuations of climate and precipitation, resulting in advance and retreat of the ice-cap and that the ice-cap is now in a state of decadence. The observations of previous expeditions that in the past the level of the inland ice in South Victoria Land and the level of the Ross Barrier were several hundred feet higher than at present as well as the results of seismic surveys also point to the same conclusion.

Along various parts of the Antarctica coast, particularly in the south-western Graham Land (West Antarctica), differential recession of the ice-cap due to active deglaciation has been found to be evident. It was known that, between 1940 and 1949, the ice of the northern and western limbs of King George VI Sound and Wordie Ice Shelf has receded some 25 miles. The primitive ice-caps (formerly submerged beneath the ice) of islands which have risen 100 ft. above sea level or more are now well exposed. Some of these are separated by at least 30-40 miles from the nearest ice shelves. It is believed that they served as pegs to hold the ice-edge in position. Though the Russian conclusions on the previous extent of the ice-cap are not entirely original the means they used to ascertain their facts has never previously been adopted on so large a scale in antarctic research [*Discovery*, **17** (1956), 339].

REVIEWS

REPORT OF THE CALENDAR REFORM COMMITTEE (C.S.I.R., New Delhi), 1955. Pp. xii + 280. Price: unbound volume, Rs. 9; bound volume, Rs. 11

This volume has been prepared by the Committee in accordance with its terms of reference. The report is divided into three parts. The first part gives the minutes of the meetings, while the second part comprises mainly the reformed calendar for five years together with a list of religious holidays for the different states based on this calendar. The last part is a valuable historical account of the calendar in various countries through the ages.

In the introductory chapter we are informed that " the new solar calendar is scientific, applicable to all parts of India and follows the *Surya Siddhanta* in all its essential points and is absolutely sound as regards its astronomical basis ". While there appears to be general agreement that the commencement of the year in the *Vedic* and *Vedanta Jyotisha* periods was associated with the seasons, the question can be raised whether that should be the case for the whole of India now. For instance, *Varsha Ritu* corresponding to the rainy season is not the rainy season in all areas. Similarly *Grishma Ritu*, the hot season, also varies considerably from place to place. When this is the case, it is essential to associate the commencement of the year with either the equinoxes or the solstices. Equality of day and night do not occur on the same day throughout the country and any such fixation can at best be arbitrary.

The Committee recommends the regular publication of an Ephemeris but they do not seem to be aware of an Ephemeris published by Swamikkannu Pillai with the support of the Government of Madras in 1922. Though this does not deal with each day of the year, it gives a planetary almanac at intervals of ten days till the year 2000 A.D. This Ephemeris is also based on the *Surya Siddhanta* but has taken the sidereal year instead of the tropical year for its standard. An annual publication like the Nautical Almanac is, however, desirable.

There is the remark in the report that, for some unknown reason, astronomers in the south chose to adopt a different convention from those in the north in naming months. The method is not unique and should have been the practice in North and Central India as well. We find in the well-known work of the Buddhist lexicographer, Amarasimha, *Namaliganusasana*, a work of the fourth century A.D., that Visuvan is referred to as the day when day and night are equal, and the months are associated in their names with the *nakshatra* on the *Pornima* day of the solar month. The reformed Calendar does not bring out this relationship but the Calendar using the sidereal year for a luni-solar months, as is the practice in Tamilnad, conforms to this picture.

The Committee's recommendations can, however, form a basis for a rational consideration of the calendar for civil and for religious purposes. The report is a useful document and the Council of Scientific & Industrial Research has done a useful service in bringing it out. It is reasonably priced.

S. V. ANANTAKRISHNAN

EUROPEAN BREWERY CONVENTION — PROCEEDINGS OF THE CONGRESS, BADEN-BADEN, 1955 (Elsevier Publishing Co., Amsterdam; available through Cleaver-Hume Press Ltd., London), 1955. Pp. xi + 358. Price 55*s*.

The publication under review is a record of the papers and discussion presented at the fifth convention of scientific workers and technologists from Europe, England and Canada engaged in the fields of brewing and malting. Unlike the previous Congresses no specific subject was fixed for discussion and papers on all aspects were presented. These have been grouped broadly under the headings: Carbohydrates, Yeasts, Proteins; Hops; Barley and Malt; and Miscellaneous. The papers in the first group discuss the constitution of starch; the barley gum; assessment of carbohydrates in malt, wort and beer. In the next paper Hopkins suggests that an enzyme present in certain yeasts, de-branching the outermost branches of limit dextrin, allows further action of amylase thus accounting for ' super attenuation '. Factors influencing yeast flocculation, detection of wild yeasts and yeast strains and beer quality are discussed in the next three papers. Two interesting papers following, treat the purification of barley proteins from phytic acid and polysaccharide by calcium and cadmium ion precipitation and the composition of chill haze. The higher cystine content of the haze proteins compared to barley protein suggests that sulphydryl groups may be involved in chill haze formation.

The papers on hops are of great practical significance. Detailed account of utilization of hops during the brewing process, the nature of β-soft resin of hop varieties, transformation of hop constituents on boiling, the possibility of using hops to greater advantage by oxidation with alkaline water and extraction of spent hops or by pretreatment of hops and finally studies on hop storage are presented.

In the section on barley and malt, factors affecting germination, dormancy in barley, early evaluation of malting quality of new varieties of barley and the technological importance of husk in brewing have been discussed. A discovery of practical importance reported was the removal of dormancy in barley by the addition of small amounts of hydrogen sulphide to the steep water.

Other papers read were: Balance of sulphur compounds from wort to beer; Flavonoid compounds in beer; Comparative wholesomeness of beer and dilute alcohol; Proteolytic activity and heat stability of malt enzymes; Stability of flash-pasteurized beer; and Survival of pathogenic bacteria in beer. The last paper showed significantly that pathogenic bacteria do not grow in beer, and that unless a beer has been exposed very recently to infection, absence of *E. coli* may be taken as a sound indication of the absence of pathogens.

The book also includes two short communications on the ' Nature and micellar size of beer proteins ' and ' Estimation of free terminal groups of hordein ', reports of the Analysis Committee and the Barley Committee of the European Brewery Convention, which will be of great value to brewing industry, and the scholarly opening address by Prof. Lüers on ' Research and Creative Work '.

The publication maintains the excellent get-up characteristic of Elsevier's publications.

V. S. GOVINDARAJAN

TRANSACTIONS OF THE AMERICAN SOCIETY OF METALS: Vol. 48. Edited by Ray T. Bayless (Published by the Amercian Society of Metals, Cleveland, Ohio), 1956. Pp. xlviii + 1061

This volume of the Transactions contains 51 important research papers and the text of Edward de Millo Campbell Memorial Lecture on Low Carton Martensites delivered by Mr. R. H. Aborn, Director of Fundamental Research Laboratory, U.S. Steel Corporation. The lecture covers a wide field including martensite in low alloy constitutional steels and type 403 straight chromium and 0·1 per cent carbon stainless steels.

Temper embrittlement of alloy steels has been discussed including the loss of impact properties at sub-zero temperatures in plain carbon alloy steels. The influence of tungsten and molybdenum has been examined on temper brittleness in the case of 0·1 per cent chromium steels and 1 per cent manganese steels after ageing for 1000 hr. at different temper-embrittling temperatures. The influence of tensile stresses on isothermal decomposition of austenite to ferrite and pearlite has been reported. The effect of boron on the hardenability of alloy steels, though as yet unexplained, has been investigated and it is shown that maximum hardenability is obtained at an optimum boron concentration which corresponds to the limit of solid solubility. However, in commercial steel making, it is difficult to control the effective boron content of a steel and bring it down to the required optimum level. In practice, 0·001-0·003 per cent boron is added to steel to give it the decided hardenability but care is necessary to protect boron from the action of nitrogen in the steels; this is effected by the addition of titanium, aluminium, etc. When boron, in amounts less than 0·005 per cent, is added to steel, the hardenability of steel becomes unpredictable. The papers on stress corrosion cracking and hydrogen embrittlement of martensitic steels are of interest.

Work on iron-chromium-carbon and nitrogen austenitic stainless steels described in the volume is of special interest as India has no nickel resources of her own to produce steels of this type, which have so far been made with nickel. The work on these steels opens up a fertile field for research. The effect of cold working on high temperature properties of type 347 stainless steels, influence of strain rate and temperature on the ductility of austenitic stainless steel, and high nitrogen austenitic Cr-Mn steel discussed in some of the papers make significant contributions to our knowledge on alloy steels.

Rolling textures of tantalum, ductile molybdenum; titanium-chromium-molybdenum alloys; indium-arsenic-antimony alloys; rate of diffusion of α- and β-titanium; metallography of titanium; zirconium and zirconium-base creep resistant alloys; zirconium-germanium alloys; aluminium and magnesium alloys; notch ductile high-duty nodular iron; behaviour of steels at elevated temperatures; and graphitization in steels and its inhibition by nitrogen, form the subjects of other interesting papers in this volume.

B. R. NIJHAWAN

CERTIFICATES OF RATING WITH SPECIAL REFERENCE TO SUPPLEMENTARY PROVING TESTS OF CIRCUIT-BREAKERS (Association of Short-circuit Testing Authorities Inc., London), 1956. Pp. 7. Price 10*s*.

This is one of a series of publications issued by the Association of Short-circuit Testing Authorities Incorporated (A.S.T.A.), London. The publication has two sections: the first one deals with the composition of a Certificate of Rating and the second one with the Supplementary Proving Tests for various types of circuit-breakers.

Testing of circuit-breakers in respect of short-circuit ratings is a highly specialized job involving costly equipment. These tests are usually conducted in accordance with publications IEC-56/1 (1954) and B.S.S. 116-1952. At times, however, minor deviations in testing procedure, necessitated by plant limitations, are found necessary.

The A.S.T.A. have found it desirable to include the following supplementary proving tests in addition to those specified in the existing specifications:

1. Tests applicable to oil circuit-breakers being tested in accordance with B.S.S. 116-1952.
2. Tests applicable to oil circuit-breaker being tested in accordance with publication IEC-56/1 (1954) and B.S.S. 116-1952 and to Air-Break Circuit-breakers being tested in accordance with A.S.T.A. Publication No. 16.
3. Tests applicable to large circuit-breakers which cannot be tested with rated making current and rated voltage together.
4. Tests applicable to circuit-breakers so constructed that the direct path from the contacts through the arc extinguishing medium to earth or between phases in oil or air is not symmetrical.
5. Tests applicable to circuit-breakers in which the opening may be impeded by electromagnetic forces and which have been pre-tripped during the 100 per cent symmetrical breaking test duty.
6. Tests applicable to large circuit-breakers suitable for unit testing.

It is hoped that the above supplementary tests would be incorporated in the revised specifications.

H. N. RAMACHANDRA RAO

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY: VOL. 8 — PRODUCTION TECHNOLOGY OF THE MATERIALS USED FOR NUCLEAR ENERGY (United Nations, New York), 1956. Pp. 627. Price $ 10.00

This volume, which is the eighth in a series of 16, covers the whole subject of materials required for the development of atomic energy programmes. The book records 95 technical papers which were submitted to the Conference on this subject and includes verbatim reports of the proceedings.

The treatment of uranium and thorium ores and ore concentrates is covered in 27 papers, the production metallurgy of metallic uranium and thorium in 7, analytical methods for raw material production in 31, heavy water in 10, graphite and zirconium in 6 each, and beryllium in 8.

It is apparent from the proceedings that the technology of uranium has absorbed many new ideas in recent years. For the first time, complete details are given of techniques such as pressure leaching, cyclic electrolysis, ion-exchange and solvent extraction including R.I.P. (resin-in-pulp) and S.I.P. (solvent-in-pulp) processes as applied to uranium recovery. The proceedings show that although a great amount of study has been undertaken towards developing physical beneficiation methods for uranium-bearing minerals, the attempts generally have been unsuccessful. Flotation of unwanted gangue minerals, such as sulphides, has had some success. Other possibilities include the flotation of a carbonaceous uranium concentrate from asphaltic ores, and flotation of a calcite fraction from high limestone ores. Other physical methods such as wet attrition grinding, electrostatic separation, gravity separation, etc., have been attempted but success, except in a few cases, has not been marked. Nevertheless, as has been suggested in the volume, there is no reason to believe that physical beneficiation is not an economic possibility and efforts are continuing to develop commercially attractive techniques.

The calcio-thermic process for uranium production is now well established and the volume gives the practices followed in United Kingdom, France and Belgium. Among the improvements suggested, there is an interesting possibility of employing fluo-solid technique for the ' dry ' stages in the process, namely conversion of uranyl nitrate into uranium fluoride, wherein high throughputs can be obtained for a small plant. The high price of nuclear purity calcium is still a deterrent and, therefore, the feasibility of using a magnesio-thermic reduction of uranium tetrafluoride is discussed in great detail. Here the comparatively low exothermicity of the reaction requires the initial supply of extra heat, and the high vapour pressure of magnesium at the operating temperatures necessitates the use of sealed bombs. These difficulties have not proved insuperable, and it has been demonstrated that the process lends itself to commercial production of uranium.

The production of thorium powder by fused-bath electrolysis and the powder metallurgy of thorium are discussed in two Soviet contributions. In assessing the relative efficiencies of the alternate extraction processes, a knowledge of the thermodynamic properties of the materials involved would be essential, and in this context the paper by Kopelman (U.S.A.) is an excellent compilation.

In the evaluation of radioactive ores for their uranium and thorium content, and in the operative control of the extraction and refining processes, entirely new standards of accuracy are called for. The demands of quality control to rigid and exacting specifications have led to extensive application of very sensitive physico-chemical techniques such as gamma radiation analysis, neutron activation, radiochemical methods, emission spectroscopy, X-ray spectrum analysis, polarography, chromatography, spectrophotometry, and fluorimetry, among others. These techniques are covered in 31 papers. The American contribution on the analysis of uranium and thorium raw materials, and the Soviet contribution on physico-chemical methods of uranium production control are the highlights of this section.

The last four sections of the volume deal with the production technology of heavy water, graphite, zirconium and beryllium which have varied applications in nuclear reactors. The major emphasis is on the purity of these materials from the point of view of neutron economy. Information has been declassified on (a) the concentration of heavy water by catalytic exchange and rectification, (b) production of reactor grade graphite, (c) new methods for the separation of hafnium from zirconium, and (d) purification and sintering of beryllia. Comprehensive summaries are presented by Currie (U.S.A.) on graphite, by Benedict (U.S.A.) on heavy water, by Shelton (U.S.A.) on zirconium, and by Kaufmann (U.S.A.) and by Meyerson (U.S.S.R.) on the present status of beryllium metallurgy.

Printed on art paper and neatly bound, the present volume is an example of tidy execution, and considering the wealth of information it offers, it is very moderately priced. There is no doubt that this volume will remain a standard book of reference for many years to come.

BRAHM PRAKASH

NOTES & NEWS

Furfural from Indian gums

MESSRS K. G. MATHUR AND S. C. Banerjee of the National Chemical Laboratory of India, Poona, have determined the furfural content of some Indian gums and have communicated the results in this note.

Vegetable gums are rich in pentosans, which, on hydrolysis and subsequent elimination of water, yield furfural. The yield of furfural from eight Indian gums, obtained through the kind courtesy of the President, Forest Research Institute, Dehra Dun, and the Forest Range Officer, Taloda, are presented in Table 1.

TABLE 1 — YIELD OF FURFURAL FROM DIFFERENT GUMS

GUM	FURFURAL CONTENT (ON DRY BASIS) %
Gum arabic (*Acacia arabica*)	20·1
Ghatty or Ghati (*Anogeissus latifolia*)	28·2
Karaya (*Sterculia urens*)	12·3
Siris (*Albizzia lebbek*)	16·5
Cashew (*Anacardium occidentale*)	4·2
Mango (*Mangifera indica*)	1·8
Bijasal (*Petrocarpus marcipium*)	nil
Palas (*Butea monosperma*)	nil

The gums were distilled with 12 per cent hydrochloric acid and the distillate collected at the rate of 3 ml./min. Furfural was estimated in the distillate as phloroglucide by the A.O.A.C. method. Crude gum was used in all cases except in the case of gum arabic which was a purified sample.

The results indicate that ghati gum is a richer source of furfural than corncobs or oat hulls which are commonly used in the production of furfural. The yields from corncobs and oat hulls are 23 and 22 per cent respectively as compared to 28·2 per cent from ghati gum.

Thermonuclear reactors

THE SWITCHING ON OF THE nuclear power station at Calder Hall, Cumberland, England, is an impressive achievement in the history of nuclear power production, but the problems facing the development of a reactor producing power from thermonuclear reactions are formidable. New fundamental advances and technological developments are necessary to achieve it.

Two recent and new developments hold promise for realizing the thermonuclear reactor. The first is the demonstration of the feasibility of bringing about of thermonuclear reactions on the earth, as evidenced from the successful explosion of the hydrogen bomb. The second is the disclosure of Academician I. V. Kurchatov's that unprecedentedly high temperatures, of the order of a million degrees centigrade, have already been attained. With this, a further comparatively small increase in temperature would enable the detection of thermonuclear reactions — the next landmark to be reached. If the liberated heat is to be usefully utilized for the generation of electricity, the attainment of temperatures about hundred times as great as are now achieved is essential. This is necessary for the following reasons: (1) for such a reactor to be practical, the rate of heat liberation should far exceed the rate of heat loss; (2) the losses arising from conduction and radiation, at these temperatures, increase very rapidly and (3) the loss due to radiation cannot be avoided, in spite of all the measures taken to conserve heat in the design. The difficulty of handling a temperature of 100 million degrees centigrade will be evident when it is recalled that tungsten, a metal having one of the highest melting points, melts at less than 3400°C.

For producing high temperatures, the Russian and the British scientists have used pulsed electric discharges through gases, yielding currents up to 300,000 amp. It is thought that the possible limit of development of this method has been reached with this and new methods are being sought. The American scientists tried the use of shock waves from explosions. But no indication of any significant achievement has been reported yet and the target of 100,000,000°C. is not even in sight.

The report of the British Atomic Energy Organization gives some idea of the form such a reactor might take. A mixture of deuterium and tritium would be used as fuel. Deuterium would be obtained, as at present, by separating it from ordinary water. The method of producing tritium utilizes an idea used in the design of hydrogen bombs. For initial 'priming', tritium can be produced in existing nuclear reactors. Working supplies could be obtained thereafter by providing a 'blanket' of lithium in which more tritium would be formed by interaction with the products of the deuterium-tritium reaction. Producing and maintaining high temperatures is a formidable problem, and major advances are required in this direction for further progress (*BIS Release No. BFY* 6).

Free neutrino

THE EXISTENCE OF *neutrino*, AN atomic particle postulated by Fermi and Pauli to account for the disappearance of energy from beta-decay, has been established experimentally at the United States A.E.C. Laboratories.

Since the neutrino interacts only very weakly with matter, a detector of extraordinary design was used. More than 100 gal. water containing a dissolved cadmium salt serve as the target and detection was made by a scintillation system of over 1000 gal. sensitive liquid and 330 photomultiplier tubes. Despite the size of the target water and the many billions of neutrinos from the reactor passing through per second, only a few neutrino captures were observed each hour. Normally, stable protons absorb a neutrino, emit a positive electron and become neutrons [*Chem. Engng. News*, **34** (1956), 3252].

Electromagnetic sodium pump

AN INVESTIGATION SPONSORED BY the Atomic Energy Commission, U.S.A., has resulted in the development of electromagnetic pumps for moving liquid sodium and the sodium potassium alloy. Operation of these pumps is based on the high electrical conductivity of sodium. The pump operates on the same principle as an electric motor, but instead of iron moving in an electric field, sodium moves in a similar electric field. Thus, the sodium stream acts as the moving part of the motor and is pumped forward.

The advantages of an electromagnetic pump are: they can be totally sealed; have no moving parts; can be mounted in any position and permit easy flow control [*Industr. Engng. Chem.*, **48**(6) (1956), 76A].

Capturing and storage of free radicals

A TECHNIQUE FOR CAPTURING AND storage of free radicals has been developed at the National Bureau of Standards, Washington, thus facilitating the study and analysis of the free radicals by spectroscopic techniques. Possible applications of the technique include the study of the arrangement of atoms and molecules in solids and the forces acting on them, and following the mechanism of diffusion of atoms and of reactions between atoms and molecules. The high reactivity of free radicals obtained is also likely to open up field for the synthesis of new chemical compounds.

Gases (nitrogen, hydrogen, oxygen or water vapour) are passed through a high frequency electric discharge and then frozen instantaneously to 4·2°A. The discharge is maintained in a wave-guide resonator by a 2450 Mc. power supply. A glass tubing leading from the resonator guides the molecular fragments of the gases into an evacuated metal vessel containing a cold surface in contact with a liquid helium bath. On reaching the cold surface, the gases freeze into solid form. To prevent solidification of the discharge products at temperatures above 4·2°A, the passage-way is kept near room temperature by contact with warm helium gas [*Chem. Engng. News*, **34** (1956), 3756].

Synthesis of vasopressin

THE SYNTHESIS OF VASOPRESSIN, an antidiuretic and blood pressure regulating polypeptide hormone from the pituitary gland, has been carried out by Vincent du Vigneaud of Cornell University, U.S.A. Vasopressin exists in two forms, lysine-vasopressin and arginine-vasopressin, and the difference between their chemical structures and that of oxytocin lies only in the amino acids contained in the molecule.

The method used for the synthesis of vasopressin is similar to that used for oxytocin.

The use of synthetic vasopressin in place of natural extracts of the hormone for treatment of conditions such as diabetes insipidus has been found to obviate allergies caused by natural contaminants in the extracts [*Chem. Engng. News*, **34** (1956), 2754].

New synthesis of oxalic acid

A NEW PROCESS FOR THE SYNTHESIS of oxalic acid based on the irradiation of aqueous solutions of bicarbonates with beta or gamma radiation has been reported. The mechanism of the reaction involves the presence of water and possibly also oxygen to effect the carbon to carbon bondage of the carbon dioxide moiety.

Solutions of ammonium, calcium and sodium bicarbonates are irradiated at room temperature in polyethylene bags with β-radiation from a 2 Mev. van de Graff electron accelerator at a rate of 2·10 Mrep. per pass. The total dosage to which the samples are exposed ranges from 2·10 to 52·5 Mrep. The samples are withdrawn from the polyethylene bags and the oxalic acid which precipitates as calcium oxalate regenerated. Irradiation with gamma radiation has also been observed to produce similar results [*Science*, **123** (1956), 1038].

New anti-heparin drug

A NEW ANTI-CLOTTING DRUG, polybrene, has been discovered at the North-western University Medical School. Like the other two anti-clotting drugs, protamine sulphate and toluidine sulphate, polybrene counteracts the anti-clotting effect of heparin which normally occurs in the body and prevents the blood from clotting. Polybrene is more potent than the other two drugs, is stable and can be stored for long periods [*Science*, **124** (1956), 113].

High porosity anion-exchange resin

DUOLITE A-100, A NEW TYPE OF high porosity, high capacity anion-exchange resin developed by the Chemical Process Co., California, is useful for such jobs as making ultra-high quality boiler feed water, decolourization of sugar, recovery of uranium from acid leach liquors and purification of pharmaceuticals.

The conventional means of achieving high porosity in the resins, necessary for the complete removal of polymeric molecules, are based on the use of smaller amounts of divinyl benzene in the resin phase (usually styrene-divinyl benzene) thereby reducing the degree of cross-linking in the resin phase, expanding it and increasing its 'apparent porosity'. This, however, weakens the resin physically. The new product is a two-phase resin containing a heterogeneous labyrinth of microchannels throughout. This achieves true porosity without sacrificing physical strength. The resin has longer life, greater ability to handle large molecules, greater resistance to organic fouling and gives more reproducible results than conventional products. The use of the two-phase resin eliminates 'skin effect' of hard polymer surrounding the active interior and needs regeneration less often than other resins under similar conditions. In some cases, sodium chloride alone is sufficient for regeneration [*Chem. Engng. News*, **34** (1956), 3296].

New arsenic-siloxane compounds

THE SYNTHESIS OF ARSONO-SILOXANES possessing the water-repellent property of silicones and the fungicidal properties of the arsenicals has been reported from the laboratories of the American Smelting & Refining Co. The arsono-siloxanes (prepared by condensation of chlorosilanes with arsonic acids) will be of particular value for protecting electrical insulations, canvas enclosures, leather products, etc., from deterioration due to moisture and insect attack under humid conditions [*Chem. Engng. News*, **34** (1956) 3608].

Smokeless fuels

THE BRITISH COAL UTILIZATION Research Association has reported the production of smokeless fuels by solvent extraction of high volatile coals with coal-tar oils. Preliminary trials have indicated that smokeless fuel can be produced economically by this process.

Finely ground coal is mixed with high boiling tar oils containing naphthalene, naphthols or phenanthrene and heated to 100°C.

The mixture is then treated with ultrasonic vibrations for a few seconds and filtered. The residue is washed with low boiling coal-tar oil and then with a dilute solution of detergent in water and briquetted. The coal extract, obtained as a byproduct on removal of the solvent oil, is a valuable binder and can be used in the manufacture of moulded carbon refractories [*Chem. Tr. J.*, **139** (1956), 139].

Natural flavour in processed foods

THE ADDITION OF 'FLAVORESE' enzymes is reported to restore natural flavour of foods which have been processed. The addition of these enzymes in the form of extracts results in an action similar to the natural ripening of foods such as bananas and tomatoes.

The natural fresh flavour of raw cabbage can be imparted to dehydrated cabbage by treating the latter with an enzyme preparation made from mustard seeds. However, the process is not specific for cabbage only. Flavour improvement has also been achieved in such diverse processed foods as peas, bananas, strawberries, carrots and dried skim milk. Mustard seed is not the only natural source of flavorese enzymes and enzymes from botanically related foods can be used as flavour precursors.

A major problem to be solved is the control of flavour-restoring reaction. In the same manner as natural ripening, the enzymatic reaction can go too far thereby causing undesirable flavour changes, identical to over-ripe flavours. Initiating the reaction is simple but stopping it is, as yet, an unsolved problem [*Chem. Engng. News*, **34** (1956), 3103].

Odour control in chemical industry

THE PROBLEM OF ODOUR IN CHEMICAL industries and the ways devised for its measurement and control were discussed at the Eleventh Industrial Waste Conference held at Purdue, U.S.A.

The first prerequisite for odour control is its quantitative measurement in terms of odour units. One odour unit is the amount of odour necessary to contaminate 1 cu. ft. of clean air to the barely perceptible or threshold level. The best among the methods developed for odour measurement is the syringe technique. Samples are withdrawn from a duct in 100 ml. hypodermic syringes and taken to an odour-free room. Small quantities of the odorous sample are then added to a syringe into which odour-free air is drawn. An observer holds the syringe to his nostrils and pushes the plunger to drive the mixture into his nasal passages. The operation is repeated until the threshold dilution is reached.

Osmo, another equipment developed for odour measurement, is a 100 lb. unit consisting of a cylinder with 528 holes and covered by an outer cylinder. The equipment can deliver 10-20 cu. ft. odour-free air per min. to an operator. An increasing quantity of contaminated air gives a direct measure of odour intensity.

Odours can be eliminated by any of the following ways: changes in operational technique, process changes, or treatment with specialized equipment. Changes in operational procedures and alterations in existing equipment can give reductions in odour at negligible cost. Treatment with specialized equipment is, however, expensive. Stacks are among the most effective and economical corrective measures. Other anti-odour equipment in use includes centrifugal separators or cyclones, air filters, activated carbon filters, venturi scrubbers, packed scrubbers, spray condensers, odour furnace and enclosed vent system [*Chem. Engng. News*, **34** (1956), 2794].

New colour test for thiols

A NEW COLOUR TEST FOR THIOLS and thiolesters has been reported jointly by workers at the Institute for Enzyme Research, University of Wisconsin and Schwarz Laboratories, New York. When the products of the reaction between N-ethyl maleimide and thiols are made alkaline, a red colour develops which is much more stable than that given with nitroprusside and, in contrast to the iodine-azide reaction, is not given by disulphides or thioethers. Hydroxides and alcoholates of alkali metals also produce violet colour with N-ethyl maleinimide and other unsaturated imides but since the colour reaction with thiols is much more sensitive than that with alcohols, interference by alcohols can be eliminated.

The reaction provides an excellent means of identifying sulphydryl compound on paper and stabilizing thiols during chromatography. It also makes possible to combine the advantage of protecting the sulphydryl group during chromatography with that of identifying the compounds by a reaction specific for this group. In this way, sulphydryl-containing amino acids and peptides can be distinguished from other amino acids and peptides of the same R_f, which is not possible with ninhydrin. The reaction should serve as a useful tool for distinguishing and detecting sulphydryl compounds, especially those in which the thiol group is the only functional group in the molecule [*Science*, **123** (1956), 981].

Technique for phase transformation studies

A HIGHLY SENSITIVE THERMOMAGNETIC apparatus, based on the same principles as Akulob's anisometer, has been used for the determination of changes in the amount of ferromagnetic phase in a standard steel specimen undergoing martensitic transformation. The design of the apparatus also permits study of a number of phase transformations like thermal dissociation of austenite, transformation on tempering, dispersion process of ageing, etc. The high precision possible with this instrument may help in making observations which would not be possible with the instruments and methods now available, and thus extend our knowledge of phase changes.

In this apparatus, the specimen is hung inside a cylindrical Dewar flask by means of a fine metal band or wire (which is introduced through the wall of the flask, at the top, to reach the inside and then sealed off) of an external suspension system. The assembly is held between the poles of an electromagnet which gives a field strength of 4000-5000 oersteds. The Dewar flask is partly filled with liquid nitrogen and can be raised or lowered by a movable mechanism consisting of a d.c. motor and a reduction gear. By varying the applied voltage to the d.c. motor, the degree of reduction and the amount of liquid nitrogen in the flask, the rate of cooling of the specimen can be controlled from 0°1 to 125°C./min. The formation or presence of a ferromagnetic phase is revealed by a torque on the specimen. Temperature is measured by a copel-platinum thermocouple (made of 0·2 mm. wire) placed in a small transverse hole at the top of the specimen. A potentiometer fitted in the thermocouple circuit and a mirror galvanometer to which the potentiometer is connected enable variation, within wide limits, of the sensitivity with which the temperature of onset of martensitic transformation is detectable. Temperature and angle of rotation of the specimen in the magnetic field are photographically recorded continuously by connecting the system to a cylinder-type camera whose cylinder is kept rotating by means of two coupled, synchronized electric motors through a reductor capable of giving a number of speeds of rotation from $\frac{1}{64}$ to $\frac{1}{2}$ rev./min. Temperature of the specimen is measured in terms of the deflection of a ray of light from the mirror galvanometer to the surface of the film, in conjunction with an auxiliary precalibrated scale on to which a spot of light is reflected from the galvanometer mirror.

The sensitivity of the apparatus may be enhanced by (1) adjusting the optical system, (2) adjusting the original angle between the axis of the specimen and the direction of the magnetic field and (3) increasing the sensitivity of the suspension (sensitivity = amount of ferromagnetic phase causing deflection of the light ray on the scale of 1 mm.). Of these, only the third method can effectively increase the sensitivity. The normal expression theoretically derived giving the volume V_M of the ferromagnetic component is subject to considerable error when high sensitivity necessary to determine very small amounts of the ferromagnetic phase is used. After incorporating the necessary correction, the expression for V_M becomes

$$V_M = V_1 \frac{\Delta\phi_1}{\Delta\phi_2} \cdot \frac{\phi_o - \Delta\phi_2}{\phi_o - \Delta\phi_1}$$

where V_1 is the total volume of the specimen, ϕ_o, the angle between the direction of the magnetic field and the direction of the vector I_o (the intensity of magnetization per unit of volume of the products of the dissociation of austenite at magnetic saturation) where H (the magnetic field intensity) is zero. $\Delta\phi_1$ and $\Delta\phi_2$ are respectively the angle of displacement of the specimen and that of a specimen containing 100 per cent ferromagnetic phase.

Suspensions of different sensitivities, enabling detection of $2 \cdot 5 \times 10^{-3}$ to $4 \cdot 1 \times 10^{-8}$ g. of the ferromagnetic phase were investigated, the sensitivity being determined with specimens of standard dimensions (length = 30 mm.; ϕ = 3 mm.) made of paraffin wax (a weak paramagnetic) with varying quantities of iron powder. By comparing the sensitivities of the suspension systems with the mass of a single martensite crystal (assumed to have the shape of a round lamella 4×10^{-3} mm. thick and 0·01 mm. in diam.), it is possible to detect a quantity of ferromagnetic phase equal to the mass of a single lamella of martensite or clusters of martensite crystals in some suspensions and only the total quantity of ferromagnetic phase in others.

The photographic records obtained showed that the kinetic curves at the onset of the martensitic transformation of austenite had a stepped appearance in accordance with theory. The onset temperature is determined by the deflection of a ray registering the temperature at the point where the first jump occurs in the kinetic curve. Knowing the deflection and emplying a graduated graphic representation, the onset temperature can be ascertained. The rate of cooling of the specimen can also be determined knowing the time of one revolution of the camera cylinder [*Research*, **9** (1956), 302].

Transient chemical process behaviour and control

A SYMPOSIUM ON TRANSIENT CHEMICAL Process Behaviour and Control was arranged by the Chemical Engineering Section of the American Chemical Society at its Twenty-second Annual Meeting held during December 1955. The integration of the instrument and process into a single system for process control ultimately leading to the completely automatic process plants has been a significant recent development. The purpose of the symposium was to bring to the attention of chemical and process design engineers the advantages of this new philosophy of instrumentation, its techniques and its applications. A number of papers on various aspects of process control, especially on the determination of the dynamics of common unit operations and of control hardware: control dynamics of heat exchangers, distillation, liquid flow and dynamics of controllers, were presented at the symposium.

The automatic control system design is, in general, made up of a minimum of five parts — the process, the measuring element, the error detecting mechanism, the controller and the final control elements. The general procedure of system design consists in drawing a process sheet and a block diagram, deriving transfer functions for each part of the system, writing the system equations, selecting the transient and frequency responses desired, calculating the controller parameters, determining any system changes that will improve the response and finally determining the effect of additional feedback loops on the response.

A typical example of automatic control is afforded by combination distillation. The control of a radically varying feed composition in continuous distillation is possible if proper precautions are taken in the choice of column sampling locations, the type of control and the magnitude of the controller constants employed. In the petroleum industry, automatic fractionation is employed for the separation of hydrocarbons in the C_4 and C_5 fractions of straight run and natural gasolines. This separates additional fractions of high and low octane number hydrocarbons for economic blending of aviation, premium and household gasolines, as well as for sales of hydrocarbon chemicals and solvents.

The performance of automatically controlled process plants depends on the dynamic interaction of all the components in the control loop. The methods of dynamic prediction are based on simple mathematical models and passive electrical network analogues. Applied to a specific example from the heat transfer field — a concentric double-pipe heat exchanger — the dynamic performance of an exchanger may be characterized by the solution of four simultaneous non-linear partial differential equations based on the following assumptions: (1) the fluid temperatures and velocities are uniform across the cross-section normal to the direction of flow; (2) the thermal conductivity in the longitudinal direction of inner wall is constant and in the transverse direction is infinite, a condition valid for thin metal walls; and (3) the thermal conductivity in the outer wall in the longitudinal direction is zero and in the transverse direction is finite, a condition valid for thick insulated walls.

To obtain products of desired purity at minimum cost, the rate of conversion at strategic process stages must be monitored and controlled. While control instruments for flow rate, temperature, pressure and other physical properties relate their measurements to these requirements, they cannot always account for basic changes or fluctuations. Analytical instruments like the infrared analysers are made to function directly in the process stream and provide a continuous and automatic composition analysis to mitigate against sampling and laboratory time delays. They do not replace existing environmental controllers, but provide the means for resetting the controls of temperature, flow rate or pressure.

Frequency response methods for determining the dynamic characteristics of systems have recently been applied to processing apparatus and process control instruments for determining the dynamic properties of such systems. The pulse method employing transient response to a known input is employed for determining values for the equation coefficients for a specified set of operating conditions exactly as prescribed by the basic concept. Pulse methods for testing system have been employed to test aircraft while in flight and also to test military fire control systems. The pulse method has been shown to produce detailed curves of the experimental heat-exchanger frequency response. The control of many processes has been shown to be improved by the use of a cascade control system, the extent of improvement depending on the nature of the process [*Industr. Engng. Chem.*, **48** (1956), 999-1079]

Use of radiations in chemical industry

THE USE OF RADIATIONS IN INdustrial chemical reactions is proving a valuable tool in industry especially with regard to polymerization and chlorination reactions in plastics and rubbers. The criterion for the usefulness of the application of radiations in a particular reaction is the G value (the number of molecules of products formed for each 100 e.v. of energy absorbed) of the reaction.

Polymerization — The combination of a number of molecules of the monomer to form a molecule of the polymer is generally initiated by short-lived and highly reactive free radicals whose formation is usually promoted by a catalyst. The general effect of radiation on a molecule is to produce free radicals. Radiation can, therefore, initiate polymerization. Unlike chemical polymerization, free radicals are produced by radiation at almost any temperature and not only in the liquid state but also in solids. Since no catalyst is used in radiation polymerization, instability to heat, widely attributed to the presence of residual catalyst, will be much less. Emulsion polymerization, used for the production of many synthetic rubbers including GRS rubber, has its efficiency enhanced by radiation.

A recent development in the field of polymerization is graft copolymerization: the grafting of one polymer on to another. This technique of combining the physical effects of two different polymers may have important implications where extreme ranges of temperature must be met, e.g. in supersonic flight where materials have to withstand temperatures from 60° to over 200°C. It is possible that a suitable combination of high temperature fluorine rubber with a low temperature silicon rubber might be satisfactory over the whole range.

Plastics — By irradiation of polyethylene containing antioxidants, a material capable of withstanding a temperature of 150°C. for several days has been obtained. In general, however, the effect of radiation on (already formed) plastics has not given encouraging results. In one case only, that of polyethylene, an improvement in the properties of the product has been observed.

Rubbers — The normal process of vulcanization with sulphur is one of cross-linking, in which the polymer chains are joined together by bridges of sulphur atoms. If unvulcanized rubber is irradiated, the same process of cross-linking takes place, but bonds between carbon atoms are stronger than those between sulphur atoms. A radiation vulcanized rubber is, therefore, likely to be more stable to heat than the sulphur-vulcanized material. An experimental acrylate rubber showed embrittlement after 8 hr. at 175°C. in oil when chemically vulcanized, whereas the same degree of embrittlement was achieved after 36 hr. on irradiation.

Chlorination — Ultraviolet light can initiate chlorination but the commercial exploitation of the photochemical process has been hindered by the difficulties involved in using ultraviolet light on an industrial scale. Gamma radiation is also capable of initiating chlorination and very high G values have been obtained.

Industrial plant — Radioactive isotopes can be used either as packages, which may be taken away from the reactor, or as circulating systems associated with it. To make a useful package source a radio-isotope should have a long half-life so as to provide a steady output and the period of irradiation needed to produce sources of adequate strength should not be excessive. Cobalt-60 provides a good compromise between these requirements and is also readily available in metallic state.

Fission product circulating systems are possible in conjunction with such reactors as the homogeneous aqueous reactor. In this case it might be convenient to make use of a circulating reactor core to provide a steady source of radiation. Radio-isotopes with short half-lives are suitable for use in circulating systems. The half-life of the isotopes should be long relative to the circulating time, so that the energy of the radiations is not lost before it reaches the part of the circuit in which it is to be used. Sodium-24 and indium-116, which emit gamma radiation, are suitable for this purpose.

Protection — To work with such large sources of radiation, fairly massive shielding is necessary. Suitable shielding materials are lead, concrete or water and the thickness of shield required varies approximately inversely as its density. Lead, although convenient, is expensive and can be used in small operations only. The most satisfactory material is concrete. The arrangement made for protection is such that when an operator enters the irradiation chamber, the source is temporarily withdrawn into a massive shielding block at the side and later on adjusted to its position by a suitable mechanical device [*Times sci. Rev.*, Autumn 1956].

Production of chlorine dioxide

OLIN MATHIESON CHEMICAL Corpn., New York, have developed an improved method for the manufacture of chlorine dioxide required for bleaching paper pulp. At present chlorine dioxide is generated by reduction of sodium chlorate with sulphur dioxide or methanol in an acid medium. In the improved process, which is covered by a patent, sodium chloride is introduced into the reaction mixture in the ratio of 0·06-0·08 lb. per lb. of sodium chlorate, resulting in almost quantitative yield of chlorine dioxide and the amount of free chlorine is reduced from 2 to 5 per cent. Reduction in the cost of chlorine dioxide may result in making the chlorine-bleaching method obsolete, as the former bleaches the cellulosic fibres to a maximum whiteness with little or no loss of fibre strength [*Industr. Chem.*, **32** (1956), 330].

Recovery of sulphur dioxide

THE TAIL GAS SCRUBBING PROCESS for the recovery of sulphur dioxide from acid plants, also known as Cominco sulphur dioxide recovery process, is available for use under licence from the Consolidated Mining & Smelting Co. of Canada Ltd.

Tail gas from acid plants, containing about 1·0 per cent sulphur dioxide, is collected in a steel flue which discharges into the base of the sulphur dioxide recovery scrubbing tower in which the gas is scrubbed with 1000 gal./min. of ammonium sulphite-bisulphite solution, circulated by means of a centrifugal pump. As the solution leaves the bottom of the tower, its relative bisulphite content increases by the absorption of sulphur dioxide.

To bring the ratio back to its original point, aqueous ammonia is added to the solution as it leaves the circulation pump. A small stream of solution is continuously drawn from the base of the tower and pumped to an acidifier unit where it is treated with strong sulphuric acid (93 per cent) to free the sulphur dioxide as a gas and to convert the ammonia to ammonium sulphate. Sulphur dioxide thus generated goes to the acid plants. Ammonium sulphate solution is pumped to a crystallizer or is used in fertilizer production.

It is important to keep the temperature of the scrubbing system as low as possible in order to minimize ammonia losses. Even at low temperatures, ammonia loss can increase tenfold or more if the incoming gas is dirty thus causing the formation of an ammonium sulphite fog as a dispersed phase in the tower, which is not caught by the scrubbing solution [*Chem. Canad.*, **8** (1956), 116].

Hydrogen reduction process for iron

CONSIDERABLE INTEREST IS BEING evinced by the American steel industry in a process by which metallic iron can be produced from ores by treatment with hydrogen at low temperatures (about 900°F.) and high pressures. The process is applicable only to iron ores which contain small quantities of manganese and iron (e.g. Venezuelan ores) and, therefore, cannot replace the blast furnace process. The metallic iron produced by this process is in the form of a fine powder [*Chem. Tr. J.*, **139** (1956), 256].

Use of ion-exchange resins in atomic energy processes

THE USE OF ION-EXCHANGE RESINS at different stages of release and utilization of atomic energy have been reviewed [*Industr. Engng. Chem.*, **48**(8) (1956), 30A].

Uranium recovery — The ion-exchange processes developed for the recovery of uranium from ores take advantage of the fact that uranyl ion is capable of forming both anionic and cationic complexes. By absorbing uranium as anionic complex, separation from major impurities and concentration can be accomplished at the same time.

In the R.I.P. (resin-in-pulp) method clarified sulphuric acid leach liquor is passed through a column of resin at a moderate flow rate until the presence of uranium is detected in the effluent. The column is rinsed and backwashed with water. Uranium is eluted with a chloride or nitrate solution at a flow rate considerably lower than the loading flow rate. Finally uranium is precipitated from the eluate with ammonia or other alkaline agent and the precipitate filtered, dried and calcined.

In the case of ores with high limestone content, leaching is carried out with a solution of sodium carbonate and bicarbonate. The uranium present in the leach liquor as $UO_2(CO_3)_3^{-4}$ is adsorbed on quaternary ammonium anion-exchange resins like Amberlite IRA-400 and eluted with a salt solution. Since uranium can be directly precipitated from carbonate leach liquors into a high purity product, this process is specially suitable for ores with low uranium content.

Water — Water used for stripping during refining of uranium and recovery of radioactive fuel, as coolant in nuclear reactors and for generation of steam, has to be of extremely high quality. This is achieved by means of deionization of raw water with ion-exchange resins.

Radioactive wastes — The radioactivity in coolant water is removed by passage through an ion-exchange bed. Ion-exchange membranes are finding use in the treatment of radioactive wastes. The fuel element is dissolved in nitric acid and the nitric acid raffinate passed into the cathode compartment of a two-compartment membrane cell in which an anion permeable membrane separates the anode and the cathode. During electrolysis the nitrate ion is transported across the membrane resulting in recovery of nitric acid in the anode compartment, thereby causing the *p*H to rise in the cathode compartment. Electrolysis is continued until the aluminium present is precipitated. By this time the nitric acid used to dissolve the fuel element is recovered in the anode compartment and the bulk of the long half-life radioactivity is adsorbed on the precipitated alumina and this activity can be eluted with water and fixed on clay pellets for use as a γ-radiation source.

Low pressure polymerization of ethylene

A NEW PROCESS HAS BEEN DEVELoped at the RVR Academy, Bucharest, for the low pressure polymerization of ethylene, avoiding the use of high pressures (1000-2000 atm.) necessary in other processes. The development is based on Ziegler's discovery that ethylene may be polymerized at normal pressures and lower temperatures by the use of aluminium alkyls with titanium tetrachloride as activator or cocatalyst.

In this process, isoamyl chloride at a temperature of −10°C. is added dropwise to finely divided sodium under petroleum fraction (b.p. 150°-200°C.) and cooled to maintain the mixture at the low temperature. The temperature is raised to 20°C. and titanium tetrachloride dissolved in petroleum fraction is added. The resulting solution is transferred to a polymerization vessel, diluted with solvent and ethylene introduced. The temperature rises rapidly and is maintained at 70°C. by external cooling.

The mechanism suggested for the reaction postulates the formation of free radicals and a compound of trivalent titanium by thermal decomposition of the unstable titanium compound as shown below:

$$R-TiX_3 \longrightarrow R_{\bullet}+TiX_3$$
$$R_{\bullet}+CH_2 = CH_2 \longrightarrow R-CH_2-CH_{2\bullet}, \text{ etc.}$$

[*Chem. Age*, **75** (1956), 107].

Electrochemical recovery of uranium

AN ELECTROCHEMICAL PRECIPITATION method for the recovery of uranium from acid and alkaline leach liquors, and from ion-exchange recovery systems has been developed in the laboratories of Rohm & Haas Co., Philadelphia.

Precipitation of uranium is carried out in permselective membrane cells which are so constructed and operated that they permit the transport of sodium or sulphate ions. While the ions are being transported, uranium is reduced to the tetravalent state from the hexavalent state. The cells are constructed from Plexiglass and consist of two symmetrical half-cells bolted together with the membranes clamped between them. The membranes function as permselective electrochemical barriers and in them current is carried by anions in the case of the anion-exchange membranes (Amberplex A-1) or by cations in the cation-exchange membranes (Amberplex C-1).

In the acid systems, sulphate, nitrate and chloride ions are transported from the cathode to the anode chamber. This transport results in a removal of acid across the membrane. On electrolysis, uranium is reduced at the cathode and gets precipitated as either uranium dioxide or as uranous phosphate. Precipitation occurs in the cathode chamber as the *p*H rises. Sodium ions are transported from the anode into the cathode chamber in the alkaline system. At the same time uranium is reduced and precipitated as UO_2 or as a mixture of UO_2 and sodium diuranate.

The precipitates are granular, fast settling and are readily filtered and washed whereas chemical precipitates of uranium are gelatinous and difficult to handle [*Chem. Engng. News*, **34** (1956), 3496].

Particle bank

A PARTICLE BANK HAS BEEN established at the Stanford Research Institute, California, to supply samples of many types of particles ranging in size from 5 to 100 microns. The bank will have in the near future such diverse items as corn smuts, coral, coffee roast soot and silica-alumina catalyst. When a sample is not in stock, the bank will give information about the samples it has in stock which closely approximate the desired one or where the required sample is available. Samples of particles left over after finishing the work may be returned to the bank with the data collected. Samples can be had on request, the charge being about $ 5 to cover handling expenses.

Indian Oilseeds Journal

THE PUBLICATION OF THIS NEW quarterly *Journal* by the Indian Central Oilseeds Committee should be welcomed.

India is one of the chief producers of oilseeds in the world and this commodity has an important place in the economy of the country. Oilseed crushing is still largely done in the country in small units and on a cottage industry basis. Cultivation of oilseeds and oilseed crushing is still carried on with old-fashioned methods and not much attention is paid to the introduction of modern practices and methods. This is largely due to the fact that the results of researches carried out on the cultivation of oilseeds and the utilization of oils and byproducts of oilseed crushing industry are scattered over a number of technical journals, and much of the information is not readily available in a form needed by the cultivator and the small-scale industrialist. The main object of the *Journal* is to remedy this handicap by presenting under one cover not only the results of researches—agricultural and technological — carried out in India and abroad on oilseeds, in a form intelligible to the cultivator and the small-scale industrialist, but also statistics relating to the production of oilseeds, market rates and other information.

The first number of the *Journal* (October 1956) contains a number of interesting articles. The following titles indicate the wide range of subjects covered: role of oilseeds in Indian economy; K2, an improved strain of linseed; pilot plant processing of cottonseed; future of oilseeds research; special chemical components of sesame oil; and village oil industry in India. There is a section entitled " Oilseed Notes " which presents, under four heads, data on area and production, exports, export control orders, and prices. The information is presented largely in the form of tables. The issue also includes reports of the meetings of the Indian Central Oilseeds Committee and its activities.

This attractively brought out journal should prove extremely useful to the cultivator, the trader, the industrialist and the research worker. Considering the vast volume of research that has been done and is being done on oilseeds and their products, both in India and abroad, it may not be long before the Indian Central Oilseeds Committee will be required to increase the frequency of the *Journal* to keep its readers posted with up-to-date information.

The *Journal*, which is being issued from the Indian Central Oilseeds Committee's headquarters at Hyderabad (Dn.), is priced at Rs. 2 per copy.

Tobacco Science

THE U.S. DEPARTMENT OF AGRICULTURE, in association with the Land Grant College Association and the tobacco industry, propose to bring out a new journal on tobacco entitled *Tobacco Science*. The *Journal*, which will form a part of the trade journal *Tobacco*, will report developments in the fields of chemistry, botany, agronomy and engineering as applied to tobacco [*Science Newsletter*, **70** (1956), 69].

Announcements

■ *Botanical Research Institute, Kashmir* — The Government of Jammu and Kashmir propose to set up under the State's Second Five-Year Plan a Botanical Research Institute to conduct botanical surveys and investigations in the State in co-ordination with the Forest, Agriculture and Sericulture Departments. The work of the Institute will include investigation of diseases of forest trees; decay of timber and forest fungi; diseases of fruit trees and avenue trees; diseases of crop plants; and die-back of mulberry trees in plantations.

Dr. K. Bagchee has been appointed Director, Botanical Research, in the State.

■ *All India Plastics Manufacturers' Association* — The following office-bearers have been elected for the year 1956: Mr. B. D. Garware (*President*), Messrs B. M. Thakkar and B. P. Himmatsingka (*Vice-Presidents*), Messrs M. B. Gidwani and B. L. Pachisia (*Hony. Secretaries*) and Messrs R. C. Shah, R. N. Desai, G. N. Parikh, S. M. Gupta, G. Khemani, S. R. Podar and I. M. Mehta (*Members*).

■ *The Third Congress on Theoretical and Applied Mechanics* will be held in October-November 1957 at the Indian Institute of Science, Bangalore. The following office-bearers have been elected for the sessions 1957-59: Dr. S. R. Sen Gupta (*President*); Shri V. Cadambe and Prof. N. R. Sen (*Vice-Presidents*) and Prof. B. R. Seth (*Secretary-Treasurer*).

■ *Award of Doctorate degree*—The following has been awarded Ph.D. degree by the University of Poona: M. S. Narasinga Rao (*A study of the interaction of metal ions with bovine serum albumin*).

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Progress Reports

RAILWAY TESTING & RESEARCH CENTRE, LUCKNOW

THE FIRST ANNUAL REPORT OF THE RAILWAY Testing & Research Centre, Lucknow, for the year 1954-55 reveals the diverse nature of the research problems undertaken by the main institution at Lucknow and the sub-centres at Chittaranjan and Lonavala, in addition to a large amount of routine testing work. At the Lucknow centre, which was established in 1952 under the Railway Board, problems connected with track, bridges and steel structures, mechanical engineering and instrumentation are investigated. Chittaranjan and Lonavala sub-centres deal with chemical and metallurgical problems, and concretes, mortars, soil mechanics and foundation engineering respectively.

A notable achievement of the Chittaranjan centre has been the development of paints, varnishes and enamels based on bhilawan and cashewnut shell liquids, which are now being manufactured on a pilot plant scale. A variety of testing gadgets, such as weighbars and accelerometers, have been manufactured in these centres. It is also proposed to undertake the manufacture of bearing testing and rubber fittings testing machines, and 50 oscillographic units.

An account of the important activities of the institutions during the year is given below.

Civil engineering — A sedimentation method has been developed for rapid determination of clay content of soils in the field based on the well-known principle that the settling of clay particles in a suspension is accelerated by the presence of an electrolyte in the solution. Powdered clay (5 g.) and 50 ml. of distilled water, to which 1 ml. of N/2 sodium chloride solution is added, are shaken together in a measuring cylinder and the volume of the sediment is measured. The weight of clay corresponding to the volume of the sediment is calculated from a standard graph.

The effect of different types of coarse aggregates on the strength of concrete has been determined and it has been shown that the strength of concrete is not a simple function either of the strength of the material from which the aggregate is made or of the mortar.

Studies on the laying of foundations on shrinkable black cotton soils have led to the following conclusions on the design of foundations: (1) The foundation soil should be loaded up to *c.* 1½ tons/sq. ft. pressure and the foundation should be built in dry weather; (2) some light reinforcements should be used in the foundation concrete of the walls to offset the effects of swelling of the soil; and (3) to give flexibility to the structure, lime mortar and dry joints should be used at certain vulnerable points.

Studies on the utilization of loco coal ash, of which over a million tons are reported to be available per annum, have shown that when it is finely ground it forms a good puzzolana and can be used to replace cement, up to about 20 per cent, in cement concrete mixes for ordinary constructions.

Mechanical engineering — The results of boiler performance and engine indicator tests on the YL prototype locomotive, designed for operating light passenger and goods services, showed that, besides the lap and lead of the valve gear, the ratio of the piston value diameter to cylinder bore (steam port factor) plays an important part in the efficiency of the steam cycle. The YL engine has been found quite suitable for hauling a load of 8 bogies at 40 m.p.h.

Chemical — A method has been developed for the treatment of loco feed water in which a mixture of tannin extract and soda ash (60: 40) is introduced into the feed water stream. While soda ash coagulates the dissolved lime and magnesium salts in the form of a sludge, tannin removes the dissolved oxygen and forms a protective coating on the metal surface. The adoption of this method of water treatment has resulted in enhancing the washout mileage by about 50 per cent.

A black Japan paint for locomotives and underframes of carriages has been developed which compares favourably with imported materials in durability and resistance to kerosene and lubricating oil. The paint is made up of: coal-tar pitch (hard), 100 g.; cashewnut shell liquor (CNSL), 148 g.; CNSL resin, 71 g.; polymerized CNSL, 8 g.; gilsonite, 48 g.; solvent naphtha, 106 g.; cobalt acetate, 1·8 g.; litharge, 7 g.; manganese rosinate (3 per cent manganese), 10 g.; white spirit, 214 ml.; and vegetable turpentine, 214 ml.

A quick drying wagon black for exterior protection of railway wagon stock, based on cashewnut formaldehyde resin dehydrated castor oil gilsonite and carbon black, has been developed.

An anti-corrosive coating composition has been prepared for rails from polymerized CNSL, 150; bitumen (mexphalte 85/25), 250; manganese dioxide, 5·3; litharge, 4·0; cobalt acetate, 2·3; and white spirit, 600 g.

The following two products have given good performance as cold-setting cements for filling blow holes in foundry castings:

(1) CNSL (heated to 315°C. and cooled), 5; Portland cement, 15; manganese dioxide, 5; and paraformaldehyde, 1 part.

(2) Polymerized CNSL, 10; Portland cement, 20; manganese dioxide, 14; and paraformaldehyde, 3 parts.

The following Products have been developed as general purpose cements: (1) polymerized CNSL, 20; formaldehyde (40 per cent) 3: 4 hexamine, 2; and oxalic acid, 1 g.; (2) polymerized CNSL, 20; oxalic acid, 1; paraformaldehyde, 4; red mud, 4; and manganese rosinate (3 per cent manganese), 1·5 g.; (3) cashew furfural resin, 25; manganese rosinate (3 per cent manganese) dissolved in a little white spirit, 2·5; paraformaldehyde, 4·0; boric acid, 0·6; copper carbonate, 1·25; and zinc oxide, 10·0 parts; and (4) sulphuric acid polymerized CNSL, 25; hexamine, 10; zinc oxide, 5; manganese rosinate (3 per cent manganese) dissolved in a little white spirit, 2·5; copper carbonate, 1·25; and boric acid, 0·5 parts. Compositions (1) and (2) give good adhesion between wood, masonite and steel; compositions are good for fixing iron parts one another.

A Bosch tank mixture prepared for locomotive cleaning is free from the drawback of precipitating insoluble salts of calcium and magnesium on the surface to be cleaned. The composition of the mixture is: sodium hydroxide, 100; trisodium phosphate, 200; sodium silicate, 200; wetting agent (Teepol or Anisol N), 40 lb.; and water, 3200 gal.

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

THE ANNUAL REPORT OF THE LABORATORY, FOR the year 1955, records significant contributions in the fields of standardization and instrumentation. Notable among these is an atomic beam standard of frequency and time intervals, which gives values to an accuracy of a few parts in one thousand million in a period of minutes, a precision never so far achieved. This should enable the precision of frequency measurements to be increased by 10 times by eliminating the errors which non-uniform rotation of the earth introduces into astronomical measurements. A caesium atomic-beam chamber incorporating the focusing system of Rabi is used in the standard, and electromagnetic waves generated by a highly stable oscillator of a frequency capable of very fine adjustment are fed into the chamber. The frequency is observed at which the atoms show transitions between two ground-state energy levels, associated with the interaction between electronic and nuclear spins. This frequency, being characteristic of the structure of the caesium atom, serves as a primary reference standard for all measurements of frequency and time intervals.

A project has been initiated in the Physics Division for the distribution of liquid helium, prepared in the Collins liquefier, to other laboratories which do not have liquefying plants.

The main research activities of the different divisions during the year are summarized below.

Aerodynamics — Investigations on high-speed flow and low-speed studies on swept-back wings and methods of boundary layer control to provide increased lift form the greater part of the work carried out in this Division. Studies on boundary-layer separation in supersonic flow have revealed that the pressure gradient at separation is not greatly affected by heating or cooling the surface. However, cooling has a beneficial effect which appears as an increase in the pressure ratio at the separation point. Calculations of subsonic pressure distribution on a series of two-dimensional aerofoils have indicated that changes in thickness to chord ratio, Mach number and incidence can be taken into account by approximate methods based on calculations for one aerofoil at zero lift in incompressible flow.

A polyester resin has been used successfully for the insertion of surface-pressure leads in model wings of aircraft. The process employed in giving this resin coating is rapid and gives exceptionally smooth surface finishes. Work is in progress on a new technique for high-speed wind tunnel liners made of a reinforced resin. The resin is reported to be highly suitable for this application.

Electronics — The work of this Division is mainly concerned with the development of computers and data deduction devices. The design of the A.C.E. (Automatic Computing Engine) has been completed. The computer will use mercury delay lines circulating at 1·5 million pulses per sec. for its high-speed store. Twenty-four delay lines having a maximum access time of one millisec. will store a total of 768 words of 48 binary digits. Another 20 short delay lines storing one, two or four words each will have a total capacity of 40 words. In addition 32,000 words will be stored in magnetic drums with an access time of less than 10 millisec.

Electricity — A new secondary coil for the original Campbell primary standard of inductance has been completed. The new coil differs from the old in being wound on a former built up from plate glass, instead of being turned in marble, and in having the turns spaced with mica strip into uniform layers, instead of being bedded into the formation giving closest packing. The special advantage of the new arrangement is that it permits inspection and measurement of the internal layers after winding, in addition to the detailed measurements made during the winding operation.

A method has been worked out for the calibration of voltmeters at radio frequencies. A basic reading near 0·5 V. is first obtained by reference to a vacuo-junction of measured impedance (100 ohms), practically free from capacitance and inductance, carrying a measured current (5 mA.). The relative values of voltage required to produce any two readings on the voltmeter scale at any radio frequency are then determined by the use of a comparator incorporating a linear frequency mixer followed by a calibrated attenuator, an amplifier and output voltmeter, all working at a fixed intermediate frequency. The attenuator is always adjusted to give a fixed reading on the output meter, so that the ratio of the two voltages under comparison is determined as the ratio of two attenuator readings.

Light — Research on the properties of the average eye, to re-establish the basic data for all measurement of light and colour, has been the main work of this Division. Work on another basic project, i.e. finding objective criteria for assessing the performance of image-forming instruments, has resulted in the development of a new method of interferometry, particularly applicable to gas analysis and process control. From studies undertaken to obtain an exact comparison of the direct and indirect colorimetry of fluorescent lamps, it has been established that the maximum uncertainty in the results by direct colorimetry is equal to about two-thirds of the smallest chromaticity difference that is just perceptible in the Donaldson colorimeter field (about 10°).

Two types of thin-film bolometer have been developed to meet the industrial need for sensitive non-selective detectors of infrared radiation. One of these, in which the sensitive element is a narrow strip of thin gold film evaporated upon a plastic pellicle, is robust enough for monochromators used is chemical control. The other makes use of thick and stable films of amorphous or glassy antimony having a very high resistivity and large temperature coefficient of resistance, as the thermally sensitive material.

A modified Jamin interferometer, in which the percentage of trichloroethylene delivered by an inhaler for inducing anaesthesia in patients is indicated directly on a screen, has been developed.

New methods of replication in plastics have been developed which make possible the preparation of accurate diffraction gratings up to several feet in length for engineering instruments. A theoretical and practical study of the production of moire fringes by crossed gratings has led to important developments in the use of gratings for linear measurement and automatic control of machine tools.

Metallurgy — Investigations have been undertaken to verify the theory regarding the nature of fatigue failure in crystals, i.e. that repeated slip within the crystal causes the production of vacant lattice sites and these vacancies come together to produce small cavities which eventually develop into fatigue cracks. Since the presence of an abnormal number of vacant lattice sites increases the speed of diffusion processes taking place within the metal, the rate of self-diffusion in silver in the unstressed state and when exposed at the same temperature under alternating stresses sufficiently high to produce repeated slip leading to fracture by fatigue was determined. An increase in diffusion rate much smaller than demanded by theory was observed. A high resolution auto-radiographic method developed has shown that accelerated diffusion takes place principally at the grain boundaries and not equally at all boundaries since no exceptional diffusion took place at twin boundaries. This clearly indicates that production of vacancies at slip bands is not the cause of the accelerated diffusion.

Studies on notch sensitivity in fatigue have shown that the ability of a material to deform plastically under cyclic stressing results in reduced notch sensitivity.

An approximate but quick method for determining the latent heat of transformation of titanium (and other metals) has been evolved. The method is based on the constancy of the products of the rates of heating and the times of transformation and requires a knowledge of the specific heat near the transformation temperature.

A calorimeter suitable for the determination of endothermic and exothermic heats of alloying at high temperatures has been constructed. A powder compact of two different metals such as iron and chromium is enclosed in a steel shell which is heated and then held at constant temperature. Reaction is allowed to proceed to completion at a convenient rate (in about 2 hr.). The temperature difference between the shell and the compact is measured as the reaction proceeds. The calorimeter is then allowed to cool to room temperature and the outer shell again electrically heated in such a way as to follow the same temperature, time sequence. In the latter case, there is no heat absorption due to the reaction, and the heat energy equivalent to the area between the two curves is the required heat of alloying.

Metrology — An instrument for rapid measurement of the pitch of the serrations on the 'fir-tree roots' of gas turbine blades has been constructed. The design centres on a special strut which provides a fine adjustment between a measuring stylus and an indicating mechanism permitting the use of a motorized turret, in one revolution of which the errors of pitch of all the serrations on one side of the blade are measured. Stylus points carried by the turret engage the serrations in turn and the pitch errors are read on a single measuring indicator to an accuracy of $\pm 0{\cdot}00005$ in. ($\pm 1\ \mu$).

A method of measuring the progressive errors of a screw to an accuracy of a few millionths of an inch (*c.* 0·1 μ) has been devised. The advancement of the screw is measured interferometrically when it is rotated through angular intervals measured by means of a calibrated steel polygon and an auto-collimator.

Accurate bore measuring machines and apparatus for measuring fine wires have been developed. These devices, which work on the principle of autocollimation, are proving very useful in industry for standardizing reference ring gauges and for measuring the thickness of lamp filaments.

Physics — A new method for precise determination of high pressure has been evolved. The method depends on the use of a principle of similarity as applied to the distortions under pressure of two piston-cylinder assemblies of the same dimensions but of materials having different elastic constants. With this, it is possible to establish the effective areas of pressure balances with an accuracy of few parts in 10^5 over a wide range of pressure.

Ground mufflers for use in pre-flight and maintenance testing of jet-engined aircraft have been devised. The muffler works on the principle that the jet is directed into a sound absorbing diffuser and from there it is discharged to the atmosphere at comparatively low velocity.

INDIAN PATENTS — *continued from page* 586

Miscellaneous

53369. Solar heating device: *Consisting of a reflector of mirrors inclined one to another to produce coincident image from the mirrors, the mirrors mounted on portable framework and the focal length of the reflector is at least twice the maximum dimension of the reflector surface and the reflector provided with the support such as a hinged leg to adjust the reflector to maintain the image at a fixed focal position* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

54040. Composition for testing of wool: *Consisting of a solution of Lactophenol cotton blue prepared by mixing phenol, lactic acid glycerine, water and cotton blue* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

INDIAN PATENTS

[A few of the Patent Applications notified as accepted in the *Gazette of India*, Part III, Section 2, 29 September to 27 October 1956, are listed below.]

Chemicals, plastics, rubber, paints and allied products

53541. Conchiceine compounds: *Alkylthiocolchiceines are produced by reacting an alkyl mercaptan with a conchiceine or an isocolchiceine* — Uclaf

54026. Heterocyclic compounds containing nitrogen and sulphur and compositions containing such compounds: *By reacting a* 1, 2 *or a* 1, 3 *substituted or unsubstituted amino alcohol with carbon disulphide* — Diamond Alkali Co.

54209. Production of substituted 1·2-diphenyl-3·5-dioxo-pyrazolidines: 1-*Hydroxyphenyl*-2-*oxy or unsubstituted phenyl*-4-*hydrocarbyl pyrazolidones are prepared by usual methods* — J. R. Geigy A.G.

54896. *Manufacture of* 1-*nitrophenyl*-2-*acylamino-propan*-1, 3-*diols and their* O_1- *or* O_3-*monoacyl derivatives* — C. F. Boehringer & Soehne G.m.b.H.

55155. Production of alcohols: *Producing primary alcohols by autoxidizing an aluminium hydrocarbon containing aluminium bound to the group* -CH_2-$CHR'R''$, *where* R' *and* R'' *are selected from hydrogen and hydrocarbon radicals*— Ziegler

55397. Monoethylenically unsaturated ethers and homopolymers and copolymers thereof: *An aminovinyl ether of the formula* $CH_2=CHOANHR$ (R = *hydrogen or hydrocarbon radical*) *is reacted with an alkyl allophanate and the product is polymerized* — Rohm & Haas Co.

55753. Liquid oxygen explosives: *The explosive consists of a combustible material consisting of starch* — L'Air Liquide, Societe Anonyme Pour L & Etude Et L'Exploitation Des Procedes Georges Claude

55869. New composite antioxidants: *Treating n-butyraldehyde with* 2: 4 *and* 2: 5 *dimethyl phenols in presence of acid condensing agent* — I.C.I. Ltd.

55949. N-arylkyl-N-(2-carbamyl-alkyl)-halogenated-alkanamides: *A compound of the formula,* Ar-X-NH-Y-$CONHR$ *is reacted with* Ac-*halogen or* $(Ac)_2O$, Ar, X, Y, R *and* Ac *being aryl alkylene, alkylene, hydrogen or hydrocarbyl, and halogenated alkanoyl respectively* — Sterling Drug Inc.

56122. Fertilizers: *Comprising a fertilizer admixed with an antibiotic compound* — Fisons Ltd.

57167. Novel pentachlorophenol compositions: *The composition comprises up to* 30 *per cent of pentachlorophenol,* 1-15 *per cent of aliphatic alcohol,* 3-20 *per cent of polar organic substance,* 3-20 *per cent of an emulsifier of the group of polyoxyethylene sorbitan fatty acid esters and aromatic hydrocarbon mixture as base oil* — N.V. De Bataafsche Petroleum Maatschappij

53486. Synthesis of steroids: 9β, 11β-*Oxido*-18, 21-*unsubstituted steroid is treated with hydrogen halide and, if desired, the* 11-*hydroxy compound is oxidized to the keto derivative* — Olin Mathieson Chemical Corp.

54332. 1, 4-Di-caffeyl-quinic acid: *A decoction liquor of the acid is treated with an excess of soluble barium or lead compounds and the acid is liberated from the resulting precipitate* — Farmaceutici Italia S.A.

54394. Boron-free ground coat enamels: *Comprising a composition of one or more refractory oxides, one or more fluxing oxides and fluorides, one or more adherent oxides, wherein barium oxide is incorporated*—Council of Scientific & Industrial Research

54682. Water-soluble high molecular weight condensates and coating of materials therewith: *Comprising condensate of mixture* 2: 1 *of formaldehyde and* 3: 5: 1 *of dicarbamate having viscosity of* 2-25 *poises at* 25°*C. at concentration of* 60 *per cent in water* — Rohm & Haas Co.

54094. Optically active alkylcolchiceine compounds: *By oxidizing a thio derivative of the chlochiceine series to produce the corresponding sulphoxide and separating the two isomers resulting thereby* — Uclaf

54714. Preparation of higher alkenes or mixtures of alkenes, or their derivatives, particularly surface-active alkylaryl sulphonates suitable for detergent compositions: *Cracking heavy cycle oil, obtained by fractional distillation of product of catalytic cracking of hydrocarbons, from which aromatics are removed by solvent extraction* — N.V. De Bataafsche Petroleum Maatschappij

55591. New phenothiazine derivatives and their preparation: *Substituted phenothiazine is treated with an amine of the formula* Q-B-NR_3R_4, Q *representing an halogen atom or acid residue or the group* N-R_1R_2 (R_1 *and* R_2 *being alkyl*), B *representing a divalent hydrocarbon chain and* R_3 *and* R_4 *representing hydrocarbyl group* — Societe Des Usines Chimiques Rhone-Poulenc

55777. Phenothiazine derivatives and process for their manufacture: N-(*piperidyl-ethyl*)-*diphenylamine is reacted with sulphur dihalide and the isomers are separated* — Sandoz A.G.

56115. New diarylmethane derivatives, their manufacture and application: *One molecular proportion of p-ethyl phenol is combined with one molecular proportion of an alkylcyclopentene or an alkylcyclohexane and two molecular proportions of the product are condensed with one molecular proportion of formaldehyde* — I.C.I. Ltd.

53488. New 5: 6-dihydro-benzo (C) cinnoline derivatives and their preparation: *Reacting cinnoline derivative with malonic acid* — HACO GESELLSCHAFT A.G.

53964. Manufacture of halogen-pregnanes and dehalogenation products thereof: *A 3: 20 diketo-pregnane compound, which contains in 21-position a free or functionally converted hydroxyl group, in 17-position a hydroxyl group esterified with a perhalogenated aliphatic carboxylic acid, or a corresponding 3-enol or 3-keto-2-halogen/4 halogen derivative thereof with a halogenating agent* — CIBA LTD.

54262. Preparation of phenothiazine derivatives: *A phenothiazine is reacted with a nitrogen-containing heterocyclic bromide or iodide in the presence of a basic condensing agent* — CHEMISCHE FABRIK PROMONTA G.M.B.H.

54433. Enamel compositions for use on copper metal: *Comprising* 15-25 *per cent* $Na_2O + K_2O$; 10-20 *per cent one or more of* BaO, CaO, MgO, ZnO; 0-5 *per cent* PbO; 2-6 *per cent* Al_2O_3; 0-5 *per cent* AS_2O_3; 30-45 *per cent* SiO_2; 0-8 *per cent* TiO_2; 0-8 *per cent* Sb_2O_5; 5-10 *per cent* F_2 *and* 0-15 *per cent* B_2O_3 — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

55292. Esters and process for their production: *An alkyl reserpate with a free hydroxy group is converted into a diester of the O-(O′-carboxy syingoyl)-reserpic acid or an acid addition salt thereof* — CIBA LTD.

55301. New unsaturated ureido ethers and homopolymers and copolymers thereof: *By reacting an isocyanate* ($R'NCO$) *with an aminoalkyl vinyl ether* ($CH_2\colon CHOANHR$), *and subjecting the product to polymerization, if desired* — ROHM & HAAS CO.

56076. Tachysterol and dihydro tachysterol: *To a neutral or weak alkaline solution of a precalciferol or an ester thereof is added a catalyst, iodine or eosine under the action of light and if desired the product is reduced* — N.V. PHILIPS' GLOEILAMPENFABRIEKEN

57197. Di-imidazole derivatives: *Condensing aromatic orthodiamine with thiomalic or aspartic acid* — CIBA LTD.

Chemical processes, engineering and equipment

55740. Improvements in treatment of flexible cellular material: *Treating cellular structure formed by casting liquid mixture of active hydrogen containing polymeric materials polyisocyanate and water with ammonia* — THE GOODYEAR TIRE & RUBBER CO.

56774. Process for halogenating compounds having a tetraza-porphin structure: *The compound is heated in an anhydrous halogenating agent which contains a compound of the Friedel-Crafts type and* SO_3 *or anhydrous* H_2SO_4 *or a compound of the formula* $R\text{-}SO_2$*-halogen,* R *being an -OH or -O-metal group or an organic radical*—CIBA LTD.

56956. Treatment of wood pulp to render it resistant to fungal attack: *Incorporating therein halogen substituted 1-halo-4: 6-dinitrobenzene*—I.C.I. LTD.

56970. Magnetic separator: *Consisting of a rotor which is rotatable between magnetic poles and a table on to which a slurry of the material to be treated is fed, a section of said table passing between the rotor and one of the poles* — SVIRSKIS

57209. Apparatus for the lubrication of machines or other equipment driven by compressed air: *A hollow member embraces an oil container so arranged therein that oil is drawn from container into the stream of compressed air* — BECKMANN

53528. Pyrochemical process for the metallization of non-conductors: *Wherein the binder employed consists of a compound stable up to 300°C., namely tricresylphosphate, triethanol amine oleate or castor oil* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

57130. Improvement in or related to the separation of sulphur from sulphur ores, flotation concentrates or originally refined pure sulphur contaminated by waste: *Sulphur is treated with calcium chloride solution* — ELLIOTT

54264. Process for the preparation of new desiccants and dehumidifiers: *Preparing an ion-exchanger product and activating it by heating* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

55773. Vacuum pans: *Having a discharge valve in which the valve member is operated by a piston working in a fluid pressure cylinder* — GEORGE FLETCHER & CO. LTD.

Physics — general

55311. Magnetic devices for controlling electric signals: *Magnetic body having two apertures which provide at least two flux paths which have a common portion and separate portions and means being provided adjacent the respective apertures for providing magnetic flux in the respective paths* — RADIO CORPORATION OF AMERICA

55811. Improvements in or relating to goniometers: *One of the movable members has ferromagnetic core with two mutually perpendicular windings wound round the section, each winding composed of winding portions in magnetic opposition and constituting means for producing a magnetic field diametrically across the core and threading the two halves of said core in opposite directions* — MARCONI'S WIRELESS TELEGRAPH CO. LTD.

56016. Methods of making anisotropic permanent magnets: *Hardened in a magnetic field and containing up to* 42 *per cent of* Co, 10-20 *per cent* Ni, 6-10 *per cent of* Al, 2-8 *per cent of* Cu *and* 4-10 *per cent of* Ti *and* Fe — N.V. PHILIPS' GLOEILAMPENFABRIEKEN

57961. Improvements in electromagnetic relays: *Knife edge provided by a member which serves also as a retaining clip* — AUTOMATIC TELEPHONE & ELECTRIC LTD.

54091. Improvements in or relating to magnetrons: *Of the kind having an anode structure defining an even plurality of cavity resonators spaced round, and opening on to, a cylindrical electron or bit space within which is located the cathode* — THE M-O VALVE CO. LTD.

Drugs and pharmaceuticals

54064. Improvements in processes of fungi or mushroom-like cultures and industrial fermentations: *Fermentation in one or more primary vats and one or more secondary vats is characterized by choosing the total volume of flow in unit time into the primary vats, the total volume of the contents of the secondary vats, and modifying the ratio of the volume of flow and each of the other volumes* — LEFRANCOIS, MARILLER & MEJANE

53426. New pesticidal compositions containing new phosphorus esters: *Comprising a phosphorothiolic acid ester and a carrier* — I.C.I. LTD.

53696. Antibiotic recovery: *Treating aqueous solution of tetracycline or chlortetracycline with water-soluble salts of at least* 2 *metals of II group* — CHAS PFIZER & CO. INC.

53764. Process for the recovery of tetracycline or chlortetracycline: *Treating tetracycline antibiotic solution with amines or quaternary ammonium salts in presence of metallic ions* — CHAS PFIZER & CO. INC.

54202. Biocidal preparations comprising novel amido amine salts and process for preparing the said salts: *Comprising amidoamine* (R: $CONR'.X.NR^2R^3$) *where* X *is divalent aliphatic radical,* R^1, R^2, R^3 *are* H_2 *atom or hydrocarbon radical* — 'SHELL' RESEARCH LTD.

54524. Insecticides and process for the production thereof: *By chlorinating* 4, 5, 6, 7, 10, 10-*hexachlor*-4·7-*endomethylene*-4, 7, 8, 9-*tetrahydrophthalene to yield chlorination products containing from* 6·5 *to* 10 *g. of chlorine per mol* — RUHRCHEMIE AKTIENGESELLSCHAFT

55883. Antistatic compositions: *Comprising a resin selected from the group consisting of polyvinyl chloride, polymerization product of a mixture of vinyl chloride and vinyl acetate and a polyoxyalkylene compound* — ARMSTRONG CORK CO.

55860. Producing neutral tetracycline from chlortetracycline: *Prior to precipitation of tetracycline the* pH *of reduced solution is adjusted to* 4·5-7·5 *and one or more alkali metal sulphites and/or ammonium sulphite are added to the solution* — AMERICAN CYANAMID CO.

Fuels and lubricants

55758. Regenerators of coke ovens: *Having a bus flue beneath regenerative space and inserts arranged to divide the bus flue into two parts, the two parts are interconnected by a multiplicity of curved ducts between the inserts* — SIMON-CARVES LTD.

56747. Improvements in or relating to kerosene gasifying apparatus: *Heating the gasifier both in the operational condition of one or more main burners, the gas burner being constructed in the form of a tube surrounding the gasifier coaxially*— N.V. PHILIPS' GLOEILAMPENFABRIEKEN

55746. Briquetting fine-grained caking coals: *By heating the fine-grained coal continuously and directly in suspension in hot gases in a plurality of cyclones and then briquetting the same in a briquette press* — F. J. COLLIN AKTIENGESELLSCHAFT

57327. Hydrogenation of a solid carbonaceous material: *Admixing carbonaceous material with vaporizable liquid, passing said mixture through heating zone, separating vapour from solid particles and subjecting separated solid particles to hydrogenation* — TEXACO DEVELOPMENT CORPN.

Metals and metal products

57474. Manufacture of steel: *Passing molten iron through a tower containing packing material in countercurrent flow to a stream of oxygen* — THE INDIAN OXYGEN & ACETYLENE CO. (PRIVATE) LTD.

55154. Electrolytic deposition of aluminium: *Electrolytic deposition of aluminium in an electrolyte which is homogeneous melt of organic compound* $AIR(R^1)_2$ *in which* R *represents an alkyl radical and* R^1 *represents an alkyl radical or a hydrogen or halogen atom, together with a complex compound with an alkali metal compound of formula* MeR^1, *where* Me *is an alkyl metal, or a quaternary ammonium compound* — ZIEGLER

55711. Method of and apparatus for depositing metal on a work-piece: *Inert gas shielded welding arc is produced between wire electrode and work-piece and molten metal is sprayed within the gas shield* — AIR REDUCTION CO. INC.

54134. Manufacture of metallic thorium: *Calciothermic reduction of thorium compound simultaneous with reduction of volatile alloyable metal compounds to form liquid alloy thereof* — DEUTSCHE GOLD-UND SILBER SCHEIDEANSTALT VORMALS ROESSLER & LEYBOLD HOCHKVAKUUM ANLAGEN G.M.B.H.

55609. Reducing iron ores at low temperatures: *Powdered iron ore, carbon dust, and Co containing gas are continuously mixed and whirled in a furnace at a temperature of* 200°C., *and then the temperature raised to* 350°-540°*C. for final reduction* — KURD VON HAKEN & FA. ERZ. REDUKT G.M.B.H.

55806. Improved method for recovering manganese from manganese-containing materials: *Roasting the manganese-containing material with ammonium chloride and a compound like ammonium sulphate, at a temperature of* 850°-1000°*F. and then bleaching the roast with water* — WILLIAMS

56683. Process for separating niobium and tantalum from materials containing these metals: *Treating the material by means of chlorine gas and a reducing agent and then extracting the metal with an inert solvent with exclusion of moisture* — CIBA LTD.

Glass and ceramics

53462. High dielectric constant ceramics: *Mixing ceramic materials consisting of titanium dioxide, alkaline earth oxides, stannates of alkaline earth oxides and sintering at* 1400°*C.*— COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

54263. Manufacture of titanium dioxide ceramic bodies or titanate ceramic bodies: *Wherein grinding is carried out in ball mill made of titanium dioxide* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

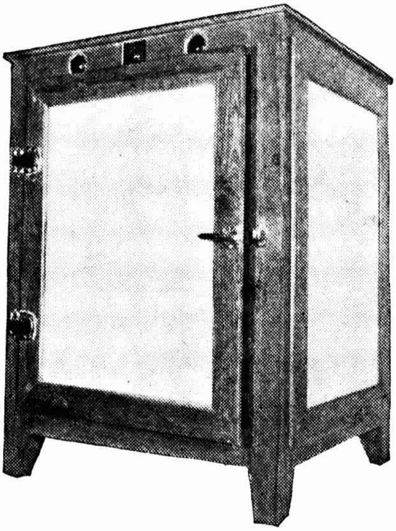
54690. A glass neutralizing composition and method of neutralizing glass articles with same: *Consisting of sodium hydrogen phosphate in admixture with calcium carbonate, sulphur, gum acacia and water* — DALAL

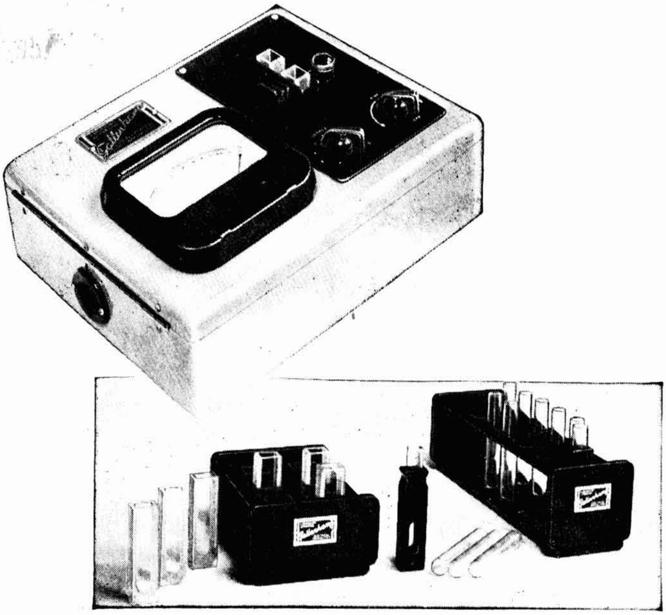
55997. Chemically resistant glass: *Comprising* 61-66 *per cent of* SiO_2; 7-10 *per cent of* H_3BO_3; 6-10 *per cent of* Al_2O_3; 12-17 *per cent of* Na_2O *and* K_2O; *and* 3-6 *per cent of* K_2O — JANAER GLASWERK SCHOTT & GEN

Leather and leather products

53798. Improvements in or relating to leather manufacture: *Impregnating hides and skins with protein liquor made by digesting lined hide and skin trimmings or fleshings with an acid* — COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

(*Continued on page* 583)





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