Journal of Scientific & Industrial Research

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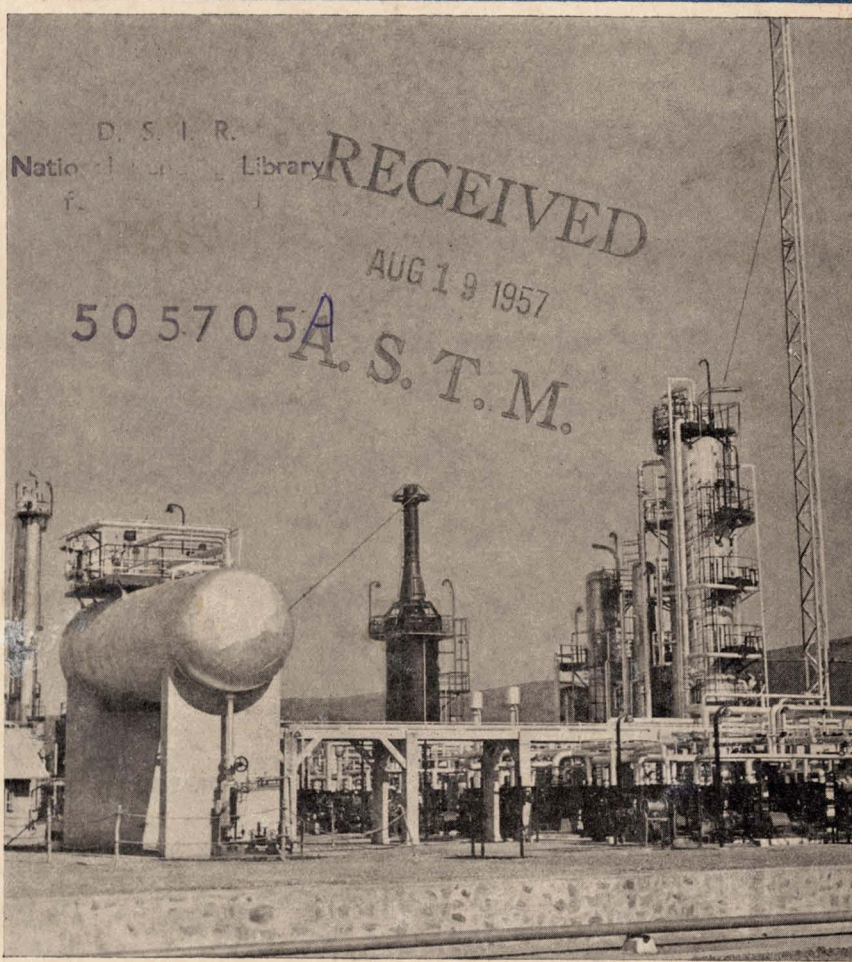

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COVER PICTURE

The crude oil distillation unit of India's third refinery, being installed by Caltex Oil Refining (India) Ltd. at Visakhapatnam, went into operation recently. The refinery will produce motor gasoline, different grades of kerosene, diesel oils and other useful products. The picture on the cover shows the propane decarbonizing unit of the refinery (*see* page 230).

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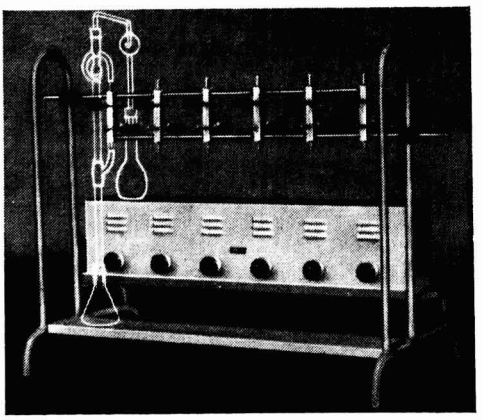

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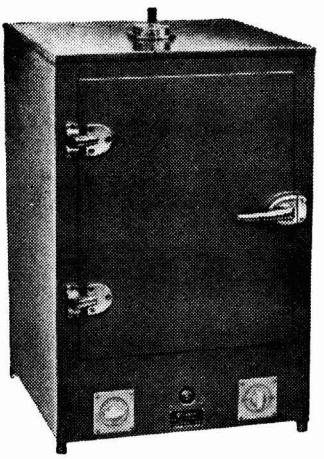

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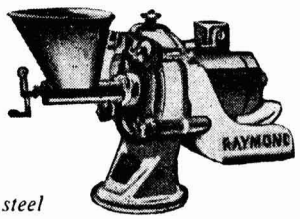

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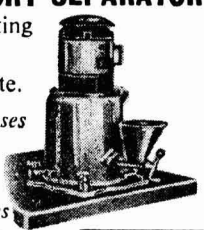

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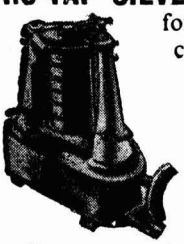

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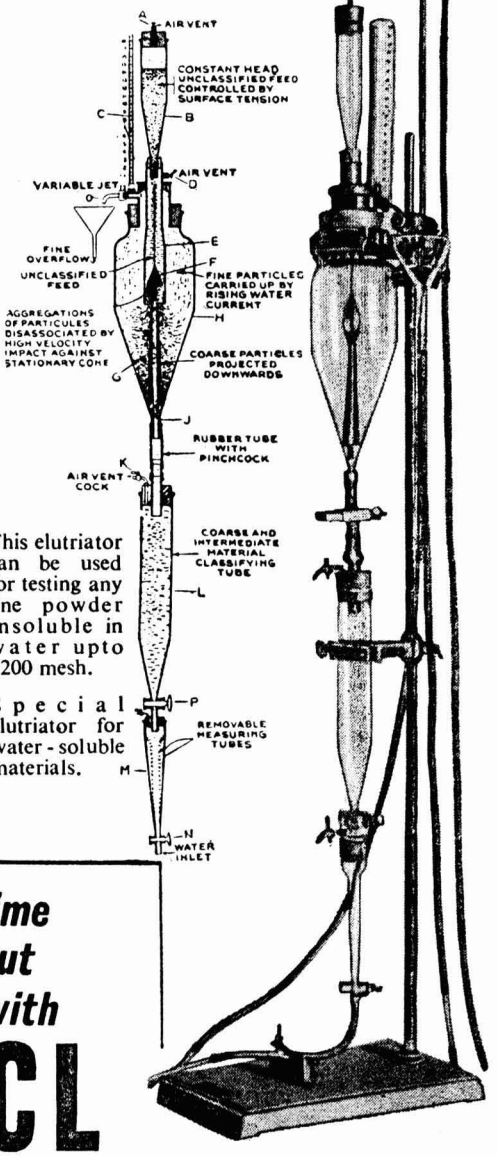

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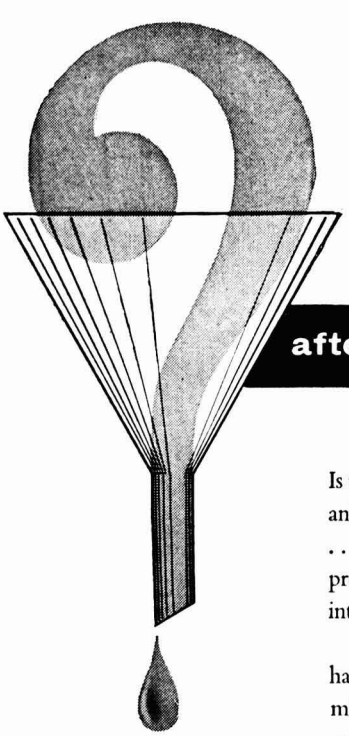

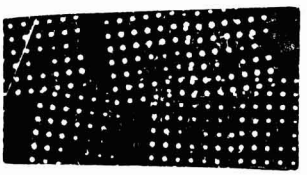

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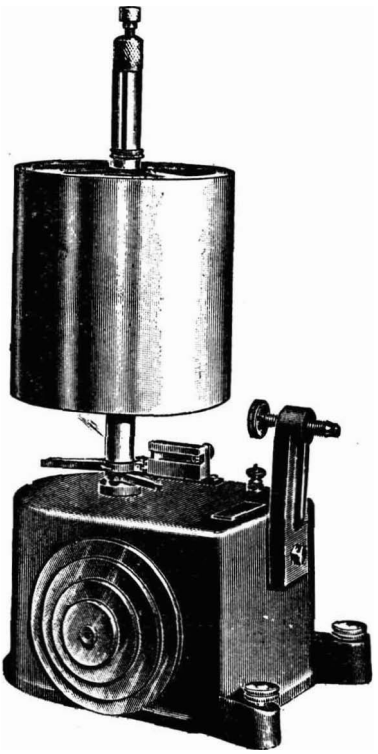

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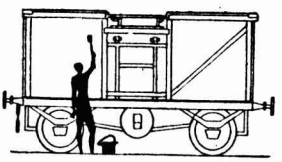

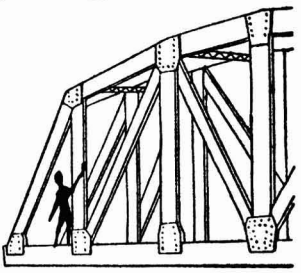

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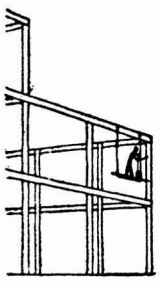

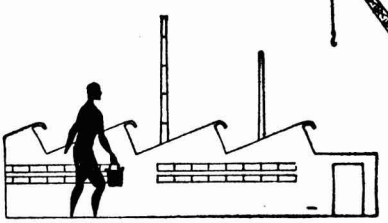

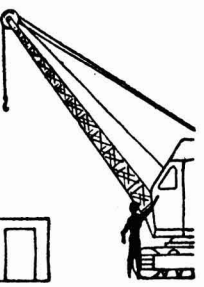

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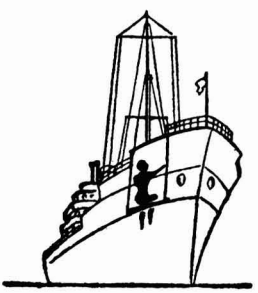

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Electron Scattering Phenomena*

IN recent years there has been a resurgence of interest in the investigation of scattering of relatively low energy electrons in solids, due essentially to the introduction of new experimental techniques. With the application of these methods it was found that the information already available was not comprehensive, and many new effects or details have been brought to light, necessitating the revision, in part at least, of the present conception of the mechanisms involved in scattering. The most important single improvement was the introduction of more powerful methods for the energy analysis of the electrons after scattering. Better vacuum techniques and improved preparation of the scatterers themselves have also contributed to our increased knowledge.

Resonance scattering has been known to occur in the interaction of free electrons in gases and vapours, which was studied at some length 20 to 30 years ago. The resonance losses in gases and vapours have been identified with atomic transitions. The study of characteristic losses in solids, however, did not receive much attention till recently when it emerged as a major field of investigation, though the very first observation that some quantum transitions of well-defined values exist in solids was made about 30 years ago. Although prior to World War II there had been some exhaustive investigations of a few substances these measurements were carried out at rather low electron energies of the order of a few hundred electron volts. During the early years of World War II the transition was practically re-discovered in the kilo-electron volt range — up to about 50 keV.; but only the last 5-6 years, major effort for study has been devoted to this subject in several institutions throughout the world.

On examining the energy distribution of the electrons issuing from a target bombarded by 800 eV. electrons, roughly three regions can be distinguished. The first of these regions shows a maximum at very low energies. This maximum is commonly called the true secondary emission. The energy region on enlargement shows, besides a rather flat distribution, a few maxima which have been identified as Auger-transitions. More important is the third region which shows several distinct maxima, whose positions are independent of the primary energy. In the curves obtained with 200, 500, 1000 or 2000 eV. primary electrons, the location of these maxima is always the same, i.e. at 26·8 or 58 eV. or some other fixed value. These maxima are called characteristic energy losses and form the main subject of this paper.

If we consider these energy losses as a kind of characteristic spectra, we find three different types of spectral distributions. The first of these shows, besides the maximum which is the primary, a certain number of peaks which characterize the energy losses of electrons in a thin film of magnesium. The most important single effect is that the first energy loss at 10 eV. has a line width which is roughly identical with the line width of the primary beam, and that the following lines are equidistant, indicating that an elementary energy loss which occurs in magnesium is repeated. In other words, the higher losses are integral multiples of the first loss.

*Lecture delivered by Dr. L. Marton, National Bureau of Standards, Washington, at the Forty-fourth Session of the Indian Science Congress, Calcutta, on 15 January 1957.

The second type of characteristic energy losses as observed in aluminium shows the primary intensity followed by several peaks. The first low intensity peak at about 7 eV. is followed by a much more intense peak close to 15 eV. Despite the fact that the peaks appear equidistant, further data lead to the conclusion that multiples of the first peak do not appear, whereas integral multiples of the second peak at 15 eV. do occur. This more complex type of spectrum is characteristic of certain elements.

The third type of spectrum as seen with carbon shows a very weak line at roughly 5 eV. followed by a rather broad band centred round 22 eV. Summing up, the observed spectra, as in optics, can be characterized either by narrow lines, by broader lines, or by diffuse bands. This variety in appearance of the spectral distributions justifies the name ' characteristic losses ' instead of ' discrete losses ' which had been proposed at one time, ' discrete ' having a connotation of very narrow line width.

Experimental data for a number of elements and their simple compounds are shown in Figs. 1-3. The arrangement follows, more or less, the periodic system and for each element, where several lines are indicated, the observers are indicated by code numbers shown in Table 1 together with their method of observation.

A rather important observation from these synoptic data (Figs. 2 and 3; Table 1) is the wide discrepancy between observations on the same substance. It is difficult to explain this wide discrepancy without understanding the methods of observation used and the methods of preparation of the specimen. It is, therefore, necessary to describe briefly the instrumentation used in obtaining these results.

All observations at lower energies — energies below 1 keV. primary energy — use relatively conventional systems for the ana-

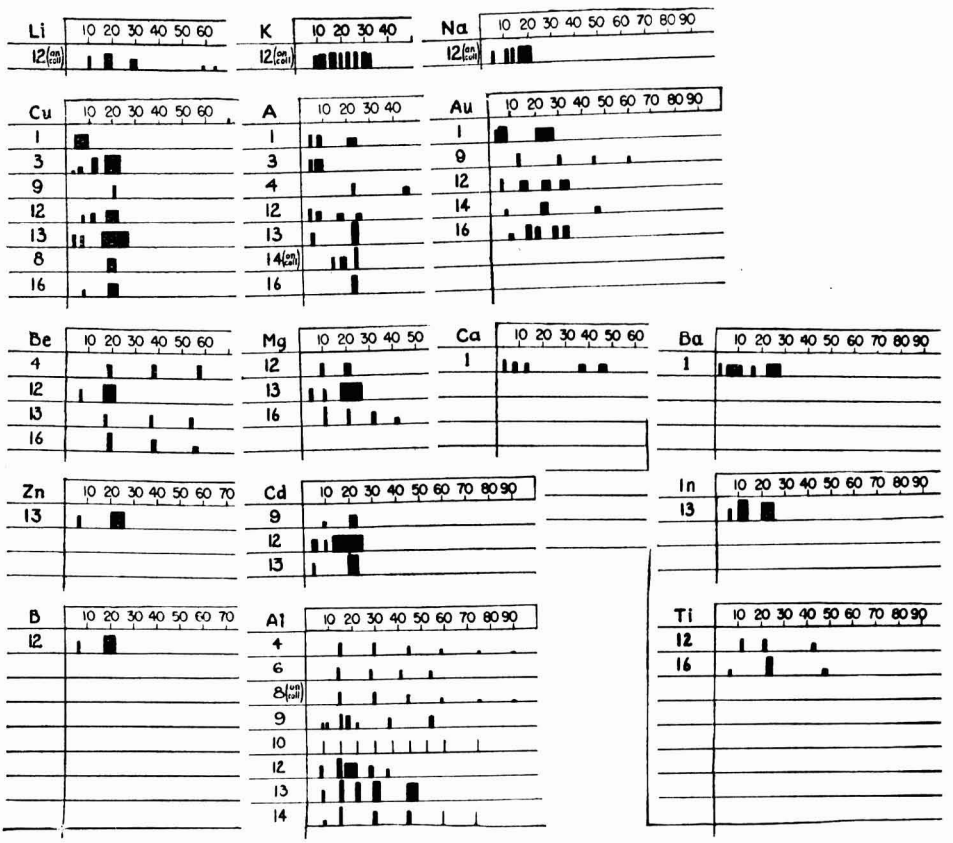


FIG. 1 — SECONDARY SPECTRA OF ELECTRON ENERGY LOSS FOR SOME ELEMENTS

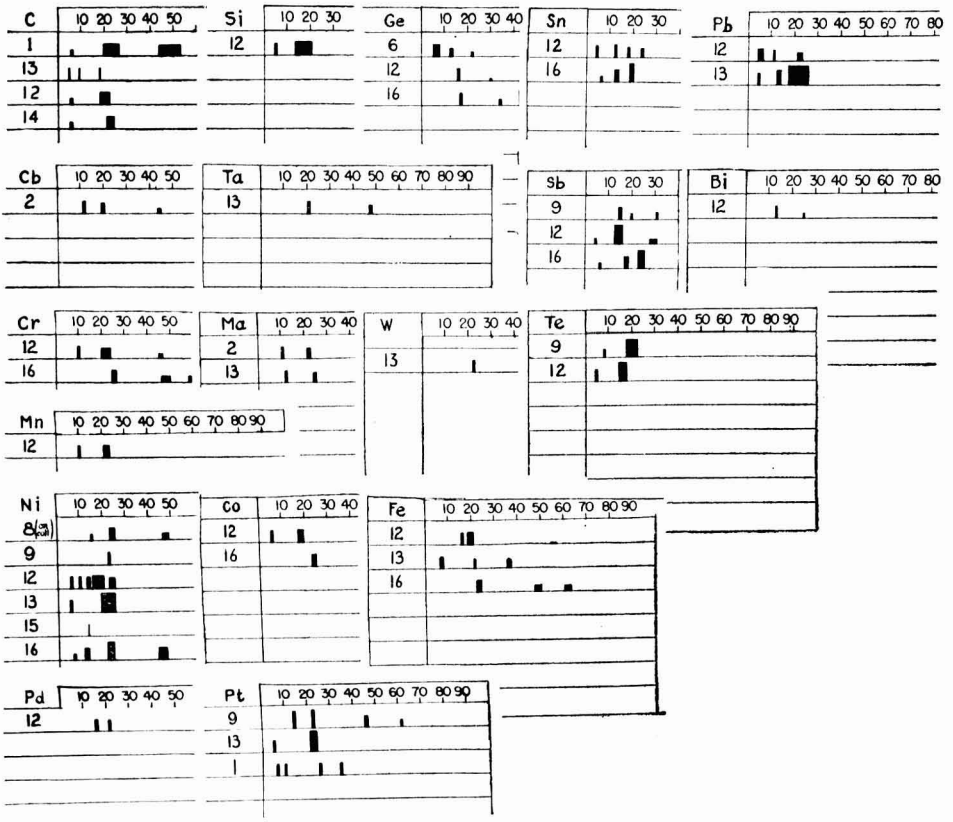


FIG. 2 — SECONDARY SPECTRA OF ELECTRON ENERGY LOSS FOR SOME ELEMENTS

lysis of electron energies. These methods are either electrostatic or magnetic and are characterized by the use of relatively simple deflecting fields for the observation of the energy spectrum. In recent years more refined methods have been devised. These new methods have been necessitated since higher energy resolutions were needed, and only a more refined electron optical arrangement could give the required energy resolution. The first of these is due to Mollenstedt. The experimental arrangement of this method is shown in Fig. 4. It is characterized by the use of very high chromatic aberration existing in an electrostatic electron lens used in off-axis conditions. The electrodes of a three-element electrostatic lens, commonly called the Einzel-lens, form the image of a slit onto an image plane. The slit is off-set from the axis, and the rays enter the lens far away from the optical axis and form as a result of chromatic aberration, separate images for different electron velocities. The energy resolution of this type of system is relatively high. This resolution is commonly defined in terms of $\Delta V/V$ and values varying from 1 to 3 parts in 100,000 can be achieved without much difficulty. Theoretically, this device should be capable of a resolution of one part in 10^6.

A practical application of this type of analyzer is shown in Fig. 5. The analyzer itself is shown as part of a kind of electron microscope where the objective lens projects the image of the scatterer onto the slit of the analyzer. This type of operation has serious disadvantages as the first lens has its own chromatic aberration, and as a consequence, the different velocity electrons are focussed in different horizontal planes. The intensity distribution, therefore, cannot be a true intensity distribution in the plane of the slit, and the analyzer gives a distorted presentation of the intensity relation. A further limita-

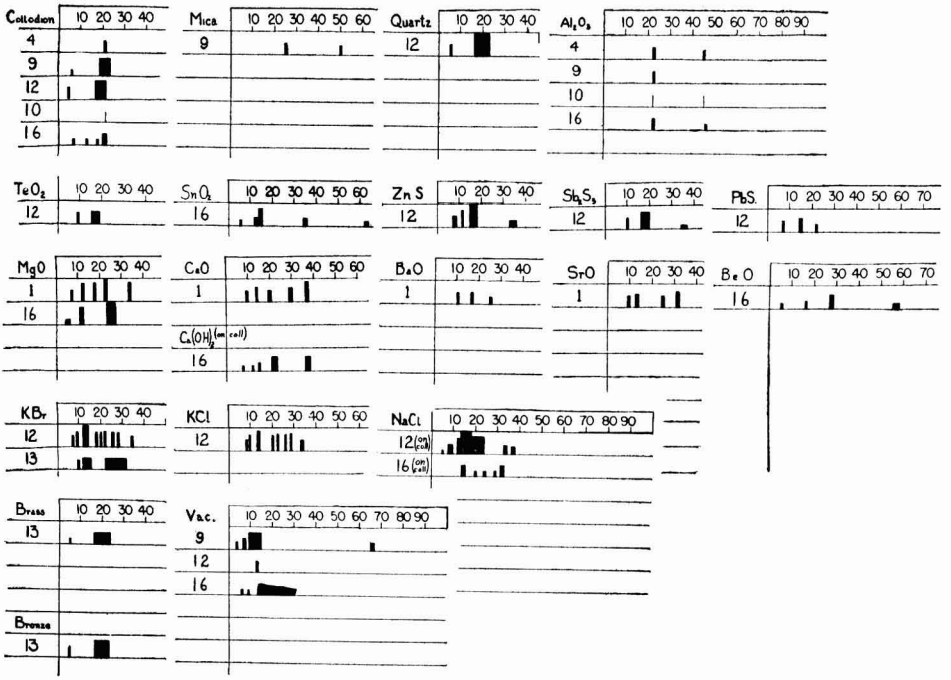


FIG. 3 — SECONDARY SPECTRA OF ELECTRON ENERGY LOSS FOR SOME SIMPLE COMPOUNDS

TABLE 1

CODE No.	INVESTIGATOR	YEAR	ENERGY* RESOLUTION ΔV	PRIMARY ENERGY *keV.*	METHOD OF OBSERVATION	METHOD OF ANALYSIS
1	Pudberg	1930-36	3	0·1-0·4	Reflection	Magnetic
2	Haworth	1935	1	0·02-0·2	do	do
3	Farnsworth *et al.*	1938	3	0·01-0·1	do	do
4	Puthemann	1941-48	1 (?)	2-8	Transmission	do
5	Hillier and Baker	1943	5	0·25-70	do	do
6	Moore	1950	1·6 (?)	8	do	do
7	Marton	1944	3	70	do	do
8	Iang	1948	1 (?)	7·6	do	do
9	Mollenstedt	1950	0·5	35	do	Electrostatic
10	Gschlossl	1951	?	5-7	Transmission-reflection	?
11	Lenz	1951-53	6 (?)	60-95	Transmission	Magnetic
12	Marton and Leder	1953	0·65	30	do	Electrostatic
13	Kleinn	1954	1 (?)	35	Reflection	do
14	Gabor	1954	1	10	Transmission	do
15	Shulman and Myakinin	1954	?	0·5	Reflection	Retarding potential
16	Watanabe	1954	1	22	Transmission	Electrostatic
17	Blackstock, Birkhoff and Slater	1954	1·8	45	do	do
18	Gauthe	1954	1·5	18	do	do

*In many cases the values for energy resolution are estimates since the authors do not explicitly state their values.

tion of this type of arrangement is that the spectra are recorded on a photographic plate. Photographic plates are not proportional devices, and the intensity relations which can be extracted from such a record are incomplete and require considerable amount of labour. A modified set-up is shown in Fig. 6. In this, the objective lens with the imaging is eliminated and the photographic plate is replaced by a recording system based on a fluorescent layer as a detector coupled with a photomultiplier. This system can be calibrated in terms of the absolute number of electrons falling onto the fluorescent layer.

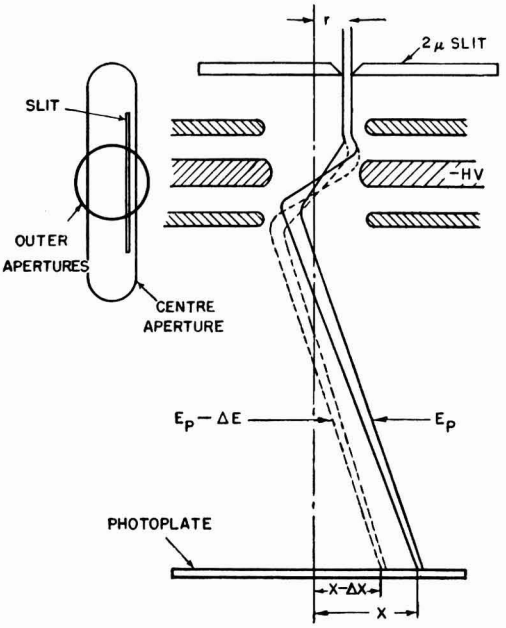


FIG. 4 — CONSTRUCTIONAL FEATURES OF A MOLLENSTEDT LENS

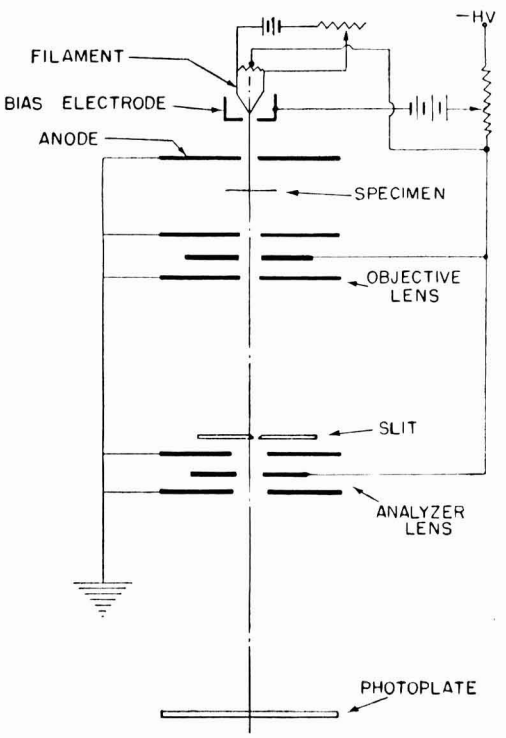


FIG. 5 — EXPERIMENTAL ARRANGEMENT USING A MOLLENSTEDT LENS FOR OBTAINING ENERGY SPECTRA

The use of this type of analyzer is limited essentially to giving information about the energy distribution of the electrons scattered in the forward direction. By forward it is meant that if we have a specimen which is observed in transmission, the total information is obtained in direct continuation of the primary beam within a small solid angle. The solid angle is not too well defined. Attempts have been made with success, both in Germany and in Japan, to extend this method to give somewhat larger angles, and an angle of up to about 3° off the optical axis has been achieved. To investigate the intensity and energy distribution at still larger angles, the experimental set-up shown in Fig. 7 has been adopted. The electrons which are scattered through the specimen enter a small magnetic analyzer of more or less conventional design. The analyzer deflects one selected velocity to the detector formed by a fluorescent layer coupled with a photomultiplier. The energy distribution is observed by varying the excitation of the analyzer magnet and thus letting different energy electrons enter the detector slit. After scanning an energy spectrum, the analyzer and detector, which are mounted on a common turntable, can be moved to a new

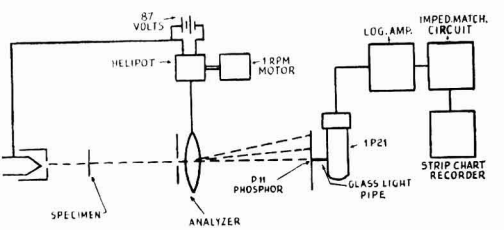


FIG. 6 — MODIFIED EXPERIMENTAL SET-UP EMPLOYING A FLUORESCENT LAYER DETECTOR AND PHOTOMULTIPLIER FOR RECORDING THE SPECTRA

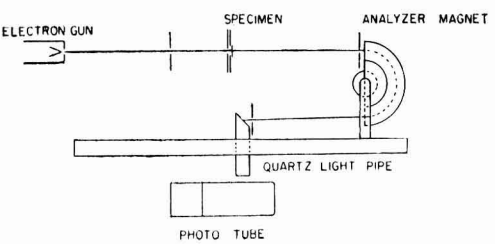


FIG. 7 — EXPERIMENTAL SET-UP FOR DETERMINING THE ENERGY LOSS DISTRIBUTION AT OFF-AXIS ANGLES LARGER THAN 3°

angular position and the energy scan repeated. In relatively short time, complete energy and angular distributions can be obtained by moving through as many angular positions as required.

In the latest version of this type of instrument, an electron source throws a collimated beam of electrons onto the scattering sample. The scattered electrons enter a decelerator which reduces the primary energy from about 20 keV. to 0·2 keV. The electrons thus reduced in energy enter a magnetic analyzer similar in design to some modern beta-ray spectrographs. The analyzer focuses one selected velocity group of electrons on its exit slit, after which the electrons enter the detecting system consisting again of a fluorescent layer coupled with a photomultiplier. An important feature of this instrument is that the analyzer receives the electrons at a considerably reduced energy and, as its resolving power is uniquely dependent on the radius of curvature of the electrons in the magnetic field, its relative resolving power is much enhanced, while the absolute value remains constant. This, however, is dependent upon the design of the decelerator. The decelerator should be such that it does not alter the composition of the electron beam entering it. In other words, whatever the energy distribution, the electrons should not encounter any field which can introduce a lateral component of velocity. If this condition is satisfied, the decelerator will transmit an electron beam where the relative distribution remains constant while the absolute energy is reduced by a constant amount. A view of the instrument is shown in Fig. 8. Though the instrument has not yet been completely investigated, its present performance is comparable to, if not better than, that of the best Mollenstedt analyzer, and it is expected to achieve, with improvement, an ultimate relative resolving power 10 times that of a Mollenstedt analyzer.

Fig. 9 shows the angular energy distribution of electrons scattered by a single crystal of gold. The curve in Fig. 9(A) marked 0 angle has a maximum centred on 0 velocity loss, i.e. centred entirely on the primary energy of the electrons transmitted through the layer. There is also a very slight maximum at 24 eV. loss which in this presentation of intensities does not appear at all.

The next curve marked $0{\cdot}53 \times 10^{-2}$ radian represents a low intensity level that is almost

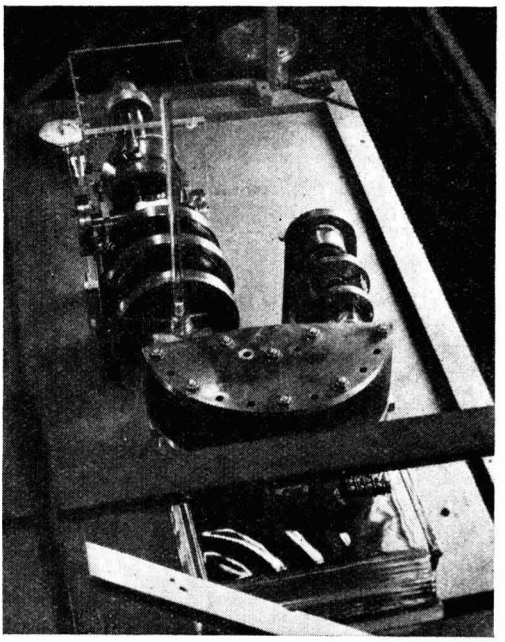


FIG. 8 — GENERAL VIEW OF THE APPARATUS INCORPORATING A DECELERATOR DESIGNED FOR OBTAINING HIGH RELATIVE RESOLVING POWER

invisible. The curve has, therefore, been drawn on a magnified scale. By doing so the maximum is shown to appear entirely centred on the 24 eV. loss and we can hardly see any more evidence of elastically scattered electrons, i.e. without having lost any energy. In the case of larger angles (1·5 or more times 10^{-2} radian), the zero energy loss maximum reappears. Both are present up to 4×10^{-2} radians. A different presentation of the same is shown in Fig. 9(B). The solid line represents the intensity distribution of the electrons versus angle of elastic scattering, that is, without any energy loss. The dotted line represents the intensity distribution of those electrons which have lost 24 eV. energy. At zero angle the intensity of elastically scattered electrons is far above that of the inelastically scattered ones. At higher angles, say, $0{\cdot}5 \times 10^{-2}$ radian, the decrease in intensity for the inelastically scattered electrons is less than that for the elastically scattered electrons, and at 0·5 the two curves cross. Here the intensity decreases for both so much that scales have to be changed again, and beyond this point, the inelastically scattered elec-

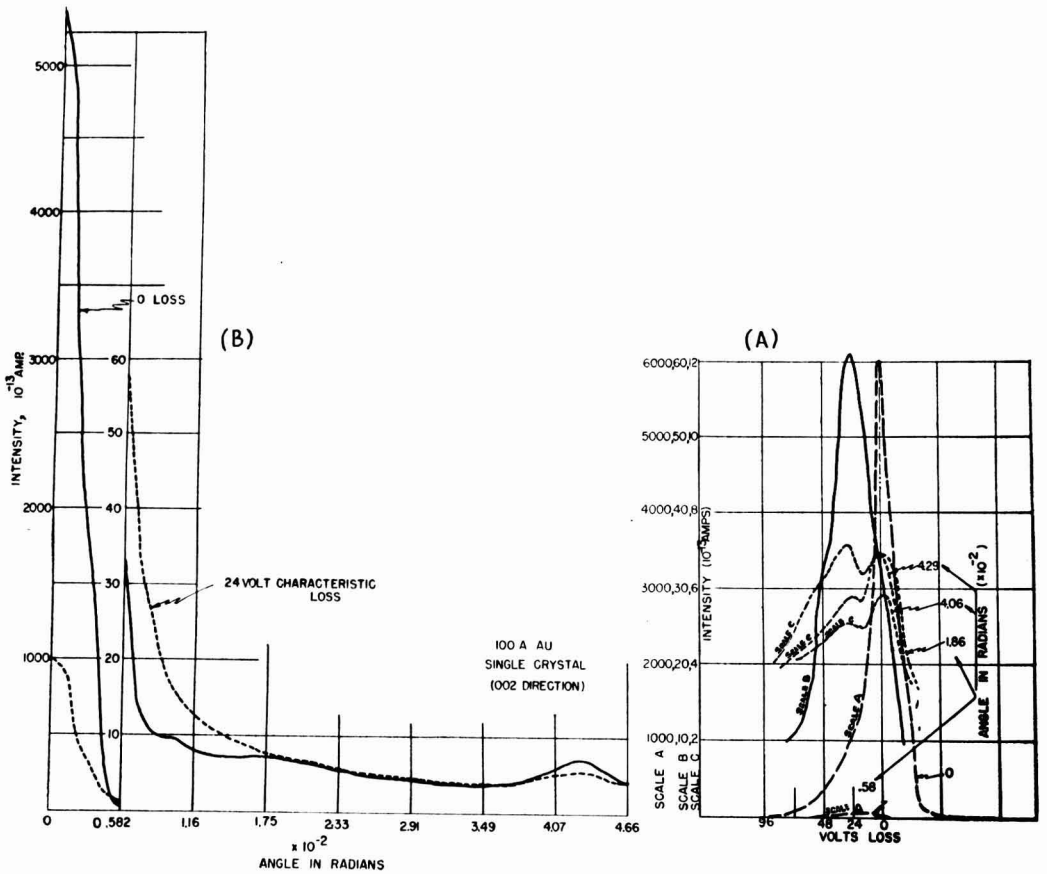


FIG. 9 — ANGULAR DISTRIBUTION OF ENERGY OF ELECTRONS SCATTERED BY A SINGLE CRYSTAL OF GOLD

trons predominate. At larger angles the two curves come together and there is a flat region up to about 4×10^{-2} radian, at which point the elastically scattered electrons predominate again. This occurs at a diffraction maximum corresponding to a Laue-spot.

The two types of observations can be presented cartographically taking the angle as abscissa, and energy loss in electron volts as the ordinate, and plotting in a third direction, out of the plane of the paper, the intensity which is represented by constant intensity contours. The interval of these constant intensity contours is logarithmic. The dynamic range is so large that it has to be plotted not as constant differences in I, but as constant differences in log I. In the case of aluminium, the elastically scattered electrons having lost no energy, are represented by a maximum corresponding to about 300,000,000 arbitrary units. If we start with angle at zero energy loss, the intensity decreases very rapidly and within 4 or 5 milliradians the intensity decreases by a factor of 100,000. Almost equally rapid is the decrease of intensity with energy loss. At a distance corresponding to about one or two volts from the primary maximum along the zero angle, the intensity decreases by a factor close to 10,000. However, the intensity distribution of the elastically and inelastically scattered electrons at angles greater than zero is not as simple as expected. The elastically scattered electrons decrease in intensity much more rapidly than those which are inelastically scattered; and in some recent records there are regions where the inelastically scattered electrons, say the

14·8 eV. characteristic loss in aluminium, may considerably exceed, at certain angles, the intensity of those which are elastically scattered.

Regarding the discrepancy between different types of measurements, if we take into account how much the intensity depends on the angle, it becomes clear that there is a variation of the intensity relations of the various energy losses depending on the acceptance angle of the analyzer. Moreover, if we have an analyzer which encompasses a much larger solid angle than another one, the intensity ratios will be so different that with a little misalignment, we may or may not observe one line or another depending upon its angular dependence. Other discrepancies probably are due to differences in preparing specimens. At present we do not know much about either the effect of impurities in the specimen, or the influence of specimen thickness. Presumably, specimen thickness should affect only the occurrence of multiple losses and not the value of the energy losses.

A number of theories have been put forth for explaining these characteristic losses. One of the recent theories is the plasma oscillation theory of Hohm and Pines. It involves setting up a convenient mathematical model consisting of a collectivity of electrons which the originators of the theory called the plasma. In its original form the theory accounted for the formation of such a plasma by taking all the free electrons. These electrons could be excited to execute collective oscillations under the impact of an incoming fast electron. The frequency of such an oscillation can be easily calculated and amounts to

$$\omega_p = \frac{4ne^2}{m}$$

where e and m stand for the charge and mass of the electron, n is the number of free carriers per unit volume, and ω_p is the frequency. Experimental investigations have shown that characteristic energy losses occur not only in very good conductors, but also in very good insulators. To account for this fact the theory has been modified. In its most recent form the collective plasma no longer is considered to be formed by free electrons alone, but it consists of the ensemble of all electrons which, the proponents of the theory assume, can participate in any such collective event. Based on this assumption, Pines has calculated values for a number of characteristic energy losses, not only for simple elements, but also for simple compounds.

Two more types of experimental observations are considered to be proofs of the plasma oscillation theory by its advocates. One is the dispersion relationship. An expression can be derived on the basis of the plasma oscillation theory showing that the value of the characteristic loss, or, to be more precise, the plasma oscillation energy, should vary with angle. Watanabe has observed such an angular variation, and has shown that the observed data are very close to the predicted variation with angle. His observations have been recently confirmed at the National Bureau of Standards on aluminium and other materials.

In aluminium the calculated value for the mean free path for plasma oscillation excitation has been given as 190A for 7 keV. electrons and from measurements by Lang an experimental value of 180A may be deduced. A more careful investigation has been carried out on aluminium, magnesium and copper by Blackstock, Ritchie and Birkhoff. The agreement is reasonably good for aluminium, considerably less so for magnesium and definitely non-existent for copper.

The interpretation of the characteristic energy losses as being due to collective plasma oscillation is not accepted by all. In sharp contrast to the collectivity theory are the views of Sternglass who considers all the events to be individual atomic excitations. Recent observations at the National Bureau of Standards by Leder on vapours of different elements such as cadmium, zinc and potassium, show that the energy losses observed in the vapour, which are calculable from known energy transitions, in many cases, lie surprisingly close to some of the lines observed in the solid state.

Another interesting investigation is the comparison between characteristic energy losses and the fine structure of the X-ray absorption edges in solids. Many investigations have been carried out in different laboratories wherein the X-ray fine structure near the absorption edge has been measured for many substances (Fig. 10). Recently, Leder, Mendlowitz and Marton compared a

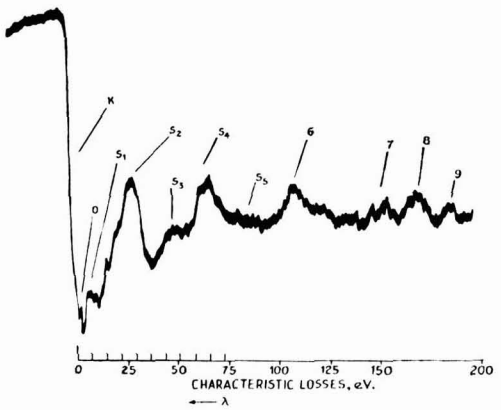


FIG. 10 — X-RAY FINE STRUCTURE NEAR THE K ABSORPTION EDGE

number of characteristic energy loss spectra with the fine structure, and have shown surprising numerical coincidence between the values observed by the two methods. This leads to similar interpretations like those by Kronig and Hayasi based on energy band scheme for solids.

Another interesting aspect of the theoretical investigations is the angular dependence of both the elastically and inelastically scattered electrons. Fig. 11 shows the angular dependence of intensity calculated for elastically scattered electrons using different approaches. Since the classical theory of Rutherford, different theoretical approaches have been made for the calculation of the angular relation. In all these, the slope is an inverse power of the square of the angle, whereas the absolute value of intensity at zero angle or close to zero angle depends on which theory is adopted. When these data are compared with the experimental findings, a marked discrepancy is noted in the angular distribution and energy distribution in aluminium. It has been pointed out that the intensity decreases by a factor of 10^5 within an angular range of less than 5 milli-radians. This is a much steeper decrease than that expected from theoretical considerations. This slope is significant and merits further investigation.

The angular distribution of intensity of the inelastically scattered electrons also shows considerable deviations from the theoretical values and further theoretical investigations are necessary for its complete elucidation.

On comparing the different interpretations, it is seen that the plasma oscillation theory fails to explain all the spectral lines observed. It picks one particular line out of a complex spectrum and explains it as a unique feature without attempting to explain the more complex aspects of the spectrum. The available proof is not complete to enable us to assume that there are a certain number of lines which are definitely plasma oscillation lines whereas other lines may be of a different origin. The basic expression for frequency is not specific for the collective oscillation theory, but appears in other theories of electron scattering by Bethe and others also. Similarly, the dispersion relation is not unique for the plasma oscillation theory. Fano has shown that by treating electromagnetic interactions in dense media, similar relations can be derived. The success of the comparison of the observed characteristic energy loss lines with the X-ray fine structure may not be entirely significant, because the

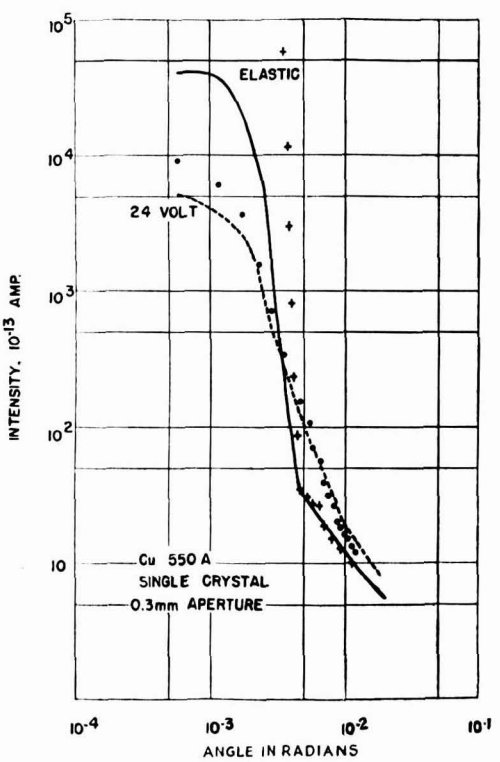


FIG. 11 — ANGULAR DISTRIBUTION OF INTENSITY FOR ELECTRONS SCATTERED ELASTICALLY AND INELASTICALLY

abundance of lines in both cases may lead easily to purely haphazard comparison of numerical values, although these values seem to be coinciding rather surprisingly in many cases. This comparison in conjunction with the vapour measurements leads to a consideration of free atom-like excitation in solids.

It follows that both better experimentation and better explanation are required. Better experimentation is needed for the absolute values to be compared with the accuracy required for the theoretical interpretation. Further a more embracing detailed theory is needed to explain all the transitions on a quantitative as well as qualitative basis.

In the past, interpretation of the energy degradation of electrons in solids was based entirely on statistical considerations where average values of energy losses per individual collision were assumed. On the basis of the recent results, we know that an electron interacts with a solid in definite quantum jumps, and these quantum jumps give the microscopic structure of the energy degradation. When more is known about it, we will have a complete interpretation of the interaction of fast electrons with solids.

Oil Refinery at Visakhapatnam

THE FIRST PHASE IN THE ERECTION OF INDIA'S third oil refinery being installed at Visakhapatnam by the Caltex Oil Refining (India) Ltd. was completed on 15 April 1957 when its two-stage crude distillation unit went into operation. The refinery, which is expected to cost Rs. 15 crores, would go into full production by the middle of 1957.

Crude petroleum is charged to the distillation unit where it undergoes the first in a series of processes eventually converting it into refined products such as straight-run naphtha (used in the blending of petrol), kerosene, aviation turbine fuel, light and heavy diesel oils, gas oil and a heavy residuum.

The tank section of the refinery comprising 68 tanks (of varying capacities) with an aggregate storage capacity of 65,000,000 imperial gal. of crude oil and refined products was completed during January 1957, in a record time of 12 months.

The refinery will produce annually motor gasoline, 74,000,000 gal.; superior kerosene, 21,257 gal.; inferior kerosene, 8,177,300 gal.; diesel oils, 31,631,000 gal.; and fuel oils, 26,495,000 gal. The other units under construction besides the two-stage crude distillation unit are a 175 ft. high fluid catalytic unit with gas recovery facilities, the polymer plant, the propane decarbonization unit, and the treating and blending plants. These are expected to be completed by the middle of 1957 and the refinery set into full operation.

The refinery, spread over 515 acres, has been equipped with most modern machine shops for repair work and laboratory for research and testing facilities.

The International Geophysical Year — Indian Programme

INDIA was one of the first to join (in 1953) in the planning of the International Geophysical Year (IGY), a comprehensive programme of international co-operation by about 70 nations to augment the basic knowledge of a variety of geophysical disciplines. The IGY commences at 00 hr. U.T. on 1 July 1957 and ends at 24 hr. U.T. on 31 December 1958. Extensive plans for systematic observations, through the Indian National Committee (INC) [see *J. sci. industr. Res.*, **14A** (1955), 162], have been prepared. The programme has been issued (in April 1957) by the INC in their Bulletin (No. 1), the first of a series to be issued from time to time covering the results obtained on specific aspects of geophysical studies, commencing from 1 July 1957. Their Bulletin No. 2 deals with auroral observations in middle and low latitudes.

The *Journal of Scientific & Industrial Research*, with the co-operation of the Indian National Committee, hopes to publish, commencing from September 1957, monthly summaries of the activities of the various participating institutions in India and intends to follow them with a consolidated account at the end of the IGY detailing the overall contribution of India to this unprecedented international scientific co-operative enterprise.

Besides the existing network of meteorological stations and observatories in India, over 60 organizations are participating in this data-gathering programme and they comprise Government Departments like the Ministries of Education & Scientific Research, Information & Broadcasting, Communications, Defence, Council of Scientific & Industrial Research; semi-governmental and private institutions and universities. Chief among these are: the Physical Research Laboratory, Ahmedabad; the Institute of Radiophysics and Electronics, Calcutta; Bose Institute, Calcutta and Darjeeling; Institute of Nuclear Physics, Calcutta; National Physical Laboratory of India, New Delhi; All India Radio, New Delhi; Cosmic Ray Research Station, Gulmarg; the Kodaikanal Observatory and the U.P. Government Observatory, Naini Tal; the Survey of India; the Geological Survey of India; the Hydrographic Department and the Naval Laboratory, Cochin, of the Indian Navy; the Central Marine Fisheries Research Station, Mandapam; and the Poona, Banaras, Andhra, Osmania and a few other universities. There will be an advance trial period commencing from 00 hr. U.T. on 1 June 1957 for testing of procedures and final adjustments of the collaboration programme. The observations will be intensified during the previously agreed World Days and Special World Intervals, in particular, during World Meteorological Intervals for meteorological observations.

The important details of the finalized programme in the different subjects are given below:

Meteorology — The India Meteorological Department (IMD) with its wide network of observatories and meteorological stations will play a prominent role in the IGY data collection. At ten stations surface meteorological observations and atmospheric balloon soundings will be regularly made; ozone measurements will be undertaken at Gulmarg, Mt. Abu, Delhi and Kodaikanal; the stations at Poona, Delhi, Calcutta and Madras will undertake radiation and thermal balance measurements at the earth's surface. The stations at Delhi and Calcutta will follow the paths of storms with the help of long-range radar and another two or three low power stations will study reflection patterns of thunderstorms and precipitation patterns associated with depression and storms. Electrical potential gradient and conductivity in the free atmosphere will be measured at two stations by means of radiosonde equipment carried by balloons. Sferic observations will be made at Delhi and Calcutta with Lugeon equipment while waveform analysis will be made at the Banaras and Poona Universities. About a dozen stations will be established to maintain evaporation records.

Geomagnetism — The observatories at Alibag, Kodaikanal and Dehra Dun will maintain continuous magnetic records (of H, D and Z) and analyse the daily variation of the magnetic elements with which some upper-air phenomena are connected. The IMD will maintain two additional stations at Trivandrum and Chidambaram, south and north of Kodaikanal between the geomagnetic latitudes 1°S. and 2°N., a region of extreme scientific interest. Quick run records will be made on World Days and Special World Intervals at Alibag and Kodaikanal. The Survey of India will occupy repeat stations in India for absolute magnetic observations during the IGY. The Navy's Hydrographic Department will take observations of magnetic declinations at sea on their various cruises.

Aurora and airglow — Auroral watches will be kept at Srinagar, Jodhpur, Alibag, Kodaikanal and Shillong by the IMD, at Naini Tal by U.P. Government Observatory and at Mt. Abu and Srinagar by the Physical Research Laboratory, Ahmedabad. Airglow measurements will be made at Mt. Abu, Gulmarg, Haringhata (to be operated by the Institute of Radiophysics and Electronics, Calcutta), Dharwar (to be conducted by the Karnatak University) and Poona University. The Physical Research Laboratory, Ahmedabad, will undertake photometric studies of night airglow at 5577 and 6300A and on the near infrared OH bands, to find their seasonal, diurnal and inter-diurnal variations, in addition to the measurements on twilight glow with photo-multipliers and narrow band filters.

Ionosphere — Ionospheric soundings will be made by eight stations — Delhi, Bombay, Madras, Tiruchirapalli, Trivandrum, Haringhata, Ahmedabad and Kodaikanal. Calcutta and Ahmedabad will act as ' key centres ' for India. A station sponsored by the Radio Research Committee is being set up at Trivandrum. The IGY programme of the key centres includes f plots, E and h′ plots, $f_0F1\frac{1}{2}$, studies of various types of Es and true height analysis.

Two additional stations, besides the existing two at Ahmedabad and Waltair, are planned for the IGY at Haringhata (operated by the Institute of Radiophysics and Electronics) and at Delhi (to be operated by All India Radio) for ionospheric drift measurements in E and F regions using the spaced-receiver technique.

The sferic stations of the IMD at Delhi and Calcutta will detect storms, using Lugeon narrow-sector equipment at 27 kc/s. and will also study the sudden enhancement of atmospherics at this frequency. Their waveform analysis will be taken up by the Banaras and Poona Universities.

Ionospheric absorption measurements will be maintained and intensified at Delhi, Ahmedabad, Waltair and Haringhata using the pulse and the cosmic noise techniques.

Solar activity — At Kodaikanal, the normal routine programme of obtaining photo- and spectroheliograms, observation of H_α, D_3 prominences, flares, sunspots, eclipses, etc., will be maintained and intensified using specially designed or procured apparatus like the automatic attachment to the spectrohelioscope for photographing spectra of flares, prominences, etc., and the 3-prism spectrograph for eclipse observations, which are being made ready. The Nizamiah Observatory, Hyderabad, has also a programme to continuously observe prominences, flares and dark markings with the spectrohelioscope and measure the effective wavelengths of the flares and radial velocities, the observation timings being chosen to supplement those at Kodaikanal.

Cosmic rays — Neutron monitor stations will be set up for cosmic ray observations at Ahmedabad, Kodaikanal and Gulmarg (by the Physical Research Laboratory, Ahmedabad) and cubical meson telescopes at Ahmedabad and Kodaikanal (by the Physical Research Laboratory), Darjeeling (by the Bose Institute or the Institute of Nuclear Physics), Gulmarg and Hyderabad (by the Physical Laboratories, Osmania University). Narrow angle counter telescopes are also proposed to be set up at Gulmarg, Ahmedabad, Kodaikanal and Trivandrum. The data will be supplemented by ionization chamber studies by the Bose Institute at Calcutta and Darjeeling.

Latitudes and longitudes — The Survey of India will carry on latitude and longitude measurements with transit instruments fitted with impersonal micrometers and shutters, Universal Wild T_4 theodolites and Reifler Shortt clocks. In this connection, an up-to-date automatic registering equipment to receive long and short wave rhythmic time signals by the semi-automatic extinction method to measure time accurately is being acquired by the Survey. The National

Physical Laboratory of India, New Delhi, will undertake a standard frequency and time service. Photographic observations of the moon by Markowitz camera will be undertaken by the U.P. Government Observatory, Naini Tal.

Glaciology — The Geological Survey of India will make a study of the points left by parties who visited earlier (1901) in the three glaciers — Gangotri, Shigri, Via Manali and Machhoi (near Zoji La). Parties will also be sent to new glaciers with appropriate trig-control and facilities for large-scale mapping of these new glaciers to help studies on the behaviour of snouts.

Oceanography — The Survey of India will maintain the existing automatic tide-gauges functioning at about 15 Indian ports and new ones at Navalakhi, Bhavnagar, Minicoy, mouth of Mahanadi River and Moulein are to be installed during the IGY. Temperature and salinity observations at high and low waters will be made in the neighbourhood of the harbours of Cochin, Visakhapatnam and Madras. Systematic tidal stream measurements in the Gulfs of Kutch and Cambay will also be maintained by the Survey of India and Hydrographic Department of the Indian Navy. A long wave recorder and a pressure wave recorder are likely to be set up off Trivandrum by the Oceanography Wing of the Naval Laboratory, Cochin. The Central Marine Fisheries Research Station, Mandapam, with the assistance of the Naval Laboratory, Cochin, will undertake a drift card programme.

Rocket and satellite observation — The artificial satellites and the rockets launched during the IGY by the U.S.A. and U.S.S.R. will be tracked regularly in India by the U.P. Government Observatory, Naini Tal.

Seismology — Seismograph stations function at Shillong, Bombay, Calcutta, New Delhi, Kodaikanal, Poona, Dehra Dun, Tochlai (Assam), Bokaro (Bihar), Hyderabad, Chatra and Vizianagaram. A seismological-*cum*-microseismograph station will be opened at Port Blair in the Andaman Islands. A long period electromagnetic seismograph offered by the Columbia University will be installed at New Delhi or Poona and the existing single unit microseismographs at Madras and Bombay (Colaba) will be modified to the tripartite set up during the IGY.

Gravity measurements — 31 days hourly observations of gravity using the Worden gravimeter, to be calibrated against European or American calibration base (or with the more precise Askania gravimeter if available in time) will be undertaken at Bombay, Madras, Dehra Dun, Calcutta and Bangalore. Simultaneous observations will be made at Bombay using available gravimeter when observations will be made in U.S.A. working with the La Coste Romberg gravimeter. Some observations will also be attempted in the Bay of Bengal and the Arabian Sea. Besides, normal gravity programme of establishing sub-standard bases and gravity observations in chosen areas will be taken up as time permits.

Commonwealth Standards Conference, 1957

THE third Commonwealth Standards Conference, attended by over 100 experts from Australia, Canada, India, New Zealand, Pakistan and United Kingdom, was held at New Delhi from 21 January to 3 February 1957. Besides general sessions on policy and administration, technical sessions on the alignment of Commonwealth Standards in the fields of (1) electrical equipment of machine tools, (2) electric cables, (3) safety requirements for domestic electrical appliances and (4) steel, were the special features of this Conference, to which the Indian Standards Institution played the host.

Inch-metric problems

One of the most important subjects discussed was the effect of India's adoption of the metric system on intra-Commonwealth trade. The Indian delegation, while stressing upon the urgency of this change-over, assured the participating countries that India will adopt standards which are as far as possible in line with those of inch-pound system and, in particular will choose its international ' preferred ' numbers (on which are based ranges of sizes) as closely as possible in agreement with the standards on the inch system. In the standards of Commonwealth countries both inch and metric values will be given wherever possible; the conversion factors to be used will be those of B.S. 350 (revised) to which a new Indian Standard (IS: 786) corresponds.

Modular co-ordination

Modular co-ordination in building raises the problem of inch and metric dimensions. India is working to a 10 cm. module in building design and construction. The possibility of interchangeability of components made to this module and those made to a 4 in. module (in use in Britain) was examined. It was recognized that adoption of the two modules would effect great simplification within the two systems. Recommendations were also made for close collaboration among the Commonwealth standards organizations on a glossary of terms, principles for the application of a modular system, a system for expressing tolerances on modular components, preferred sizes for components, symbols for use on drawings of modular components and buildings designed on a modular basis.

A review was also made of the progress achieved by the ' A.B.C.' countries (America, Britain and Canada) on fundamental engineering standards and of the association of other Commonwealth countries with this work.

Public purchasing organization

The Conference recommended that public purchasing organizations should take advantage of the guarantees afforded by certification marking schemes run by standards organizations.

The other items which received consideration at the general session were certification marking, approval schemes, standards for consumer goods and general procedure for Commonwealth co-operation. The Conference endorsed a number of recommendations made at the 1951 meet in London. Some of the recommendations were modified in the light of present conditions and practices. It was observed that the extent to which the CSO could protect or recognize each other's standard marks depended largely on bilateral discussions. It was urged that approval schemes should be based on national standards and their operation carried out in close collaboration with national standards organizations. The B.S.I.-C.S.A. arrangements for approval of British electrical and other goods exported to Canada were noted as a model. The following important recommendations were made:

A periodical news bulletin should be issued by each Commonwealth standards organization at regular intervals, at least once in a quarter. The bulletin should contain, *inter alia*, the following information: New standards and revisions issued, new standards and revisions received from other Commonwealth standards organizations, draft standards issued for comments, draft standards received from other Commonwealth standards organizations for comments, proposed new subjects and new subjects started by

other Commonwealth standards organizations.

The Universal Decimal Classification numbers should be assigned to each standard issued by Commonwealth standards organizations.

The technical session on electrical equipment of machine tools resolved that B.S. 2771 as amended should form the basis for the national standard of the Commonwealth countries.

The session on cables decided to set up a Committee in Britain to work in close collaboration with an Indian Committee to arrive first at metric equivalents of existing inch dimensions for all cables, indicating certain preferred sizes, and then on the definite metric sizes. It was also recommended that cables might be designated by suitably rounding numbers corresponding to cross-section area or by resistance per unit length.

Some fundamental aspects such as limiting temperatures of insulating materials aroused considerable interest in the technical session on safety requirements for domestic electrical appliances. It was agreed that a revised memorandum should be prepared to be taken into account by Commonwealth countries in preparing or revising safety specifications for electrical appliances.

In the technical session on steel the other Commonwealth standards organizations expressed their appreciation of the basic work undertaken in India on re-design of hot rolled structural sections.

The Conference discussed the items of industrial equipment which should be subjected to detailed technical consideration. It was agreed that the standards for air receivers and cranes should be so framed as to ensure co-ordination of testing procedures and design criteria. Chemical pressure vessels were earmarked for discussion. Following discussion on the desirability of bringing terminology in the Commonwealth and the United States into line, it was agreed that a special study should be made by B.S.I., in co-operation with other Commonwealth standards organizations, of the terminology in welding and building design and construction.

International Conference on Scientific Information

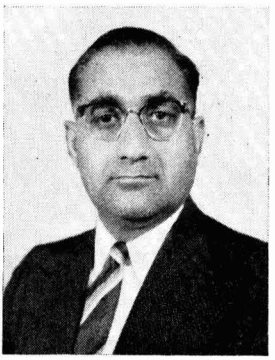
THE NATIONAL SCIENCE FOUNDATION, THE National Academy of Sciences, the National Research Council and the American Documentation Institute are jointly sponsoring an International Conference on Scientific Information in Washington D.C. in November 1958. At the conference special emphasis will be laid on storage and retrospective search in the organization of scientific information, and assessing the requirements of scientists for literature and information services, reviewing the existing systems and considering the conceptual and mechanical problems in the design of new systems. Other subjects to be discussed include: development of a general theory of storage and search, responsibilities of government bodies, professional societies, universities and industrial research organizations for research and training in scientific documentation, and for the operation of scientific information services.

Dr. B. R. Nijhawan, Ph.D., F.I.M., F.N.I.

DR. B. R. NIJHAWAN has been appointed as Director, National Metallurgical Laboratory, Jamshedpur, from 8 March 1957.

After early education in Lahore, and graduation in Metallurgy from the Banaras Hindu University in 1936, Dr. Nijhawan joined the Tata Iron & Steel Co. Ltd., Jamshedpur. In 1938 he was awarded a Federal State Scholarship for advanced metallurgical studies and research in U.K., which enabled him to work with Prof. J. H. Andrew and obtain the Doctorate degree in Metallurgy from the University of Sheffield in 1941. He was recalled by the Government of India to work as Research Officer in the Government Metallurgical Inspectorate, Tatanagar, where his researches included investigation of service failure and cracking of bullet-proof armoured carriers, boiler plates, railway material, etc. He joined N.M.L., Jamshedpur, as Assistant Director in 1948 and was appointed Deputy Director early in 1953.

Dr. Nijhawan is the author of about a hundred technical and research papers on diverse metallurgical subjects. Important among them are his contributions on austenitic grain-size control of steel and the role of aluminium nitride in grain growth inhibition of steel. At the National Metallurgical Laboratory his research interests have been largely, but not exclusively, on iron and steel, including grain-size control, strain-ageing, temper brittleness in steels and the development of indigenous stainless steels, and investigations on alloy-cast-irons and foundry materials, powder metallurgy, aluminizing and production of ferro-chrome and aluminium-silicon alloys under Indian conditions. He is co-patentee of a number of patents on metallurgical processes.



DR. B. R. NIJHAWAN

He was selected a United Nation's Fellow in 1951, in which capacity he toured research laboratories and metal production centres in U.K. and Europe. He also visited Australia in 1953 as Government of India delegate to the Fifth Empire Mining and Metallurgical Congress.

Dr. Nijhawan is a Fellow of the Institution of Metallurgists (London) and National Institute of Sciences of India. He is a member of the British Iron and Steel Institute; British Institute of Metals; Indian Mining, Metallurgical and Geological Institute; and a Council member of the Indian Institute of Metals and Indian Institute of Foundrymen. He is associated with the C.S.I.R. Metals Research Committee and with many technical consultative bodies. He is actively associated with several committees of the Indian Standards Institution and is the Vice-Chairman of the Institution's Structural and Metals Division Council.

Development of Science in Bulgaria

A. I. HADJIOLOFF
Bulgarian Academy of Sciences, Sofia, Bulgaria

THE establishment of popular government after World War II has given a great fillip to the development of science in the People's Republic of Bulgaria. Scientific research and developmental work in the country are at present carried out in institutions of higher education, departmental research institutes attached to various ministries, and the Bulgarian Academy of Sciences.

Institutes of higher education

The University of Sofia (founded in 1888) had been till recently the seat of practically all scientific research in the country. This university comprising a large number of faculties, departments and chairs has lately expanded considerably; several of the older faculties, such as medicine, agronomy and forestry, and veterinary science, have been separated from it and are now functioning as independent institutions of higher education.

During the past 12 years many new institutes of higher education have been set up. In 1944 there were only 8 such institutions with a total of 11 faculties, and 25 departments; at present there are 22 institutions with 42 faculties and 138 departments. The strength of the teaching staff and students has increased from 520 and 14,260 in 1944 to 2800 and 33,000 respectively in 1956. Some of the important institutions of higher education are the Higher Medical Institute, Sofia; the Higher Institute of Agriculture, Sofia; the Higher Institute of Veterinary Medicine, Sofia; the Higher Agronomical Institute, Sofia; and the Higher Institute of the Food and Tobacco Industries, Sofia.

There are four higher technical institutes for organizing research, namely the Institute of Civil Engineering; the Institute of Mechanical Engineering and Electro-technics; the Institute of Chemistry, Technology and Metallurgy; and the Institute of Mining and Geology. Other higher institutes and the Research Institute of Nuclear Physics are in the process of development.

The institutes train specialists in all branches of science and technology. During the First Five-Year Plan (1948-1952) over 25,000 students took their degrees, while over 17,000 have done so during the first 3 years of the Second Five-Year Plan (1953-57). It may be mentioned here for comparison, that the number of students taking degrees was 1491 in 1944 and 857 in 1945; the number of students graduating in 1954 was 7097.

The research activities of the institutes of higher education are planned and co-ordinated by the Bulgarian Academy of Sciences.

Departmental research institutes

Research institutes and laboratories have recently been developed and attached to industrial works and trusts, experimental stations, hospitals and clinics, ministries, etc. There are now about 106 of them working under the general guidance of the Bulgarian Academy of Sciences.

The Ministry of Agriculture has the largest number of departmental research institutes. They may be considered under three categories: (1) Agricultural research institutes, e.g. the Central Institute of Agricultural Research, Sofia; the Maritsa Institute of Agricultural Research; the Tobacco Research Institute, Plovdiv; the Cotton Research Institute on Plant Protection; (2) Centres of animal husbandry, e.g. the Stock-breeding Institute, Kostinbrod (Sofia dt.) which administers the Stock-breeding Institute at Stara Zagora and a number of research groups at other stations; and (3) Veterinary Medicine, e.g. the Veterinary Research Institute, Sofia; the Institute of Veterinary Hygiene and Control of Products of Animal Origin, Sofia; the Research Institute of Diseases of Breeding and Artificial Insemination.

There are 12 research institutes in the field of public health, among which are the Institute of Sanitation and Hygiene, the Institute of Industrial Hygiene and Occupational Diseases, the Institute of Balneology, the

Institute of Tuberculosis, the Institute of Haematology and Blood Transfusion, the Institute of Oncology, and the Institute of Pharmaceutics.

Among the research institutes attached to other ministries, mention may be made of the following: the Institute of Fuel Technology, the Institute of Chemical Industry, the Institute of Metallurgy and Mining, the Institute of Forestry, the Institute of Textile Fibres, the Institute of Food Industry, the Institute of Fishing and Fishing Industry, the Institute of Transport, and the Institute of Construction.

Achievement

A brief survey of the achievements of the research institutes attached to the various ministries is given below.

Research carried out at the Central Institute of Agronomic Research has yielded new and better varieties of maize, potato and sorghum. A process for the production of citric acid from cotton leaves has been evolved.

The Institute of Agronomic Research, General Toshevo, conducts researches on new varieties of wheat, land amelioration, agrotechnics and measures for combating drought. The new variety of winter wheat No. 109 developed by the Institute yields large crops and ripens early.

The Institute of Animal Husbandry at Kostinbrod has obtained good results in cross-breeding local mares with stallions of the Hunul race. Considerable success has also been achieved in breeding fine-fleeced sheep in Dobrudja and Stara Zagora; semi-fine fleeced breeds have been evolved in the western part of the Balkan range and in Sofia district.

The race of Kula cows is being improved and the milk yields have considerably increased. In the herds of the Sofia brown race, the improvement in milk yield has been remarkable.

The Veterinary Research Institute at Sofia has studied problems of considerable economic significance, e.g. prophylaxis of swine erysipelas and anaerobic infections and abortion in sheep and investigated the efficacy of new biological products. Synthetic tuberculin, mallein and allergen have been prepared and used for the diagnosis of brucellosis in animals. Many diseases of poultry, more particularly leukaemia and neurolymphomatosis, have been studied and methods for their control have been worked out. Investigations on fluke and its snail carriers have helped in the promulgation of measures, e.g. sanitation of pastures and meadows, for controlling the pest. Methods of diagnosing tuberculosis in farm animals have been investigated.

The Radio Research Institute has developed a method for grid modulation of radio transmitters.

The Institute of Fuel Technology has carried out valuable investigations on anthracite, and a coal-dressing plant has been designed.

The distribution of *Evonymus europaeus* in Bulgaria has been studied in the Institute of Forestry & Forest Exploitation with a view to utilizing this species as a source of rubber. The possibilities of producing pit-props from oak coppices have been explored.

Investigations on local wools have been carried out at the Institute of Textile Fibres and a scheme of classifications has been worked out to assist the textile industry and to serve as a guidance to sheep breeders.

A method has been developed for the production of synthetic glue for use in plywood manufacture. The bark of young oak trees has been found to be a good tanning material. The technology of wine production has been improved and Bulgarian champagne is now being produced on an industrial scale.

Research in the field of public health is directed to the treatment of diseases like tuberculosis and the diagnosis of diseases in their early stages. Methods for the treatment of lupus, cancer in the breast, and leucoplakia have been investigated. Among the important contributions in the field of industrial hygiene, mention may be made of studies on ventilation in workshops and prophylactic measures against food poisoning. The curative effect of mineral waters of Bankya and Ovcha-Koupel has been investigated and processes for the synthetic production of norephedrin and ephedrin have been worked out. New products have been obtained from the hydrazide of isonicotinic acid. An ethereal oil with a strong spasmodic effect, which is less toxic than papaverin, has been obtained from *Pimpinada saxofraga*.

Bacteria causing dysentery in Bulgaria have been systematically studied. The spread of brucellosis and methods of combating the disease have been investigated. A

variety of ticks have been studied with a view to establish the relationship between them and encephalitis. Prophylactic measures against caries and pyorrhoea have been investigated in detail.

Bulgarian Academy of Sciences

The scientific institutions of the Bulgarian Academy of Sciences in the field of natural sciences may be grouped under four categories or divisions, namely physics, mathematics and technical sciences; geology, geography and chemistry; biological and medical sciences; and agricultural sciences. The Bulgarian Academy of Sciences has also a number of Research Institutes for Social Sciences. The institutes carry out research on basic and crucial problems in their respective fields of knowledge, guide the activities of research institutes and organize meetings, discussions and conferences, and co-ordinate the activities of departmental research institutions and institutes of higher education. Almost all institutes of the Bulgarian Academy of Sciences publish Izvestia (Proceedings) once or twice a year.

Organization — A Scientific Secretariat and a Scientific Co-ordination Council (S.C.C.) are attached to the Presidium of the Academy. The Council is aided in its work by co-ordinating commissions of the departments and the institutes of the Academy. The departmental research institutes are, according to the nature of their work, connected with the respective commissions of S.C.C. which are also responsible for co-ordinating the work of the respective institutes of the Academy. The S.C.C. holds regular and extraordinary plenary sessions for considering questions relating to the co-ordination of the entire research work in the country and to make recommendations.

An Editorial and Publishing Council, which has its own publishing house and press, is in charge of the publications of the Academy. The Academy publishes the following periodicals: *Reviews of the Bulgarian Academy of Sciences, Bulletin of the Bulgarian Academy* (published in 4 languages: Russian, French, German and English), *Nature*, and *Philosophical Thought*.

Achievements of the Academy

Some of the achievements of the institutes of the Academy in different fields are given below.

Physics — It has been established that photo-conductivity of sulphur depends on the spectral composition of light. A photographic method has been developed for the measurement of the ultraviolet part of the sun's radiation. The growth of crystals has been studied and photo-sensitive emulsions have been developed. The rate of formation of crystal nuclei in electrolysis has been worked out. An apparatus for measuring the humidity of soil has been built at the Institute of Physics. An experimental centre for nuclear physics is under construction.

Thirty-four original papers were published in 1955, five of which appeared in foreign reviews.

Chemistry — Among the important problems being studied at the Institute of Chemistry are: synthesis of organic compounds of lithium, production of high grade fuel for metallurgical plants and ferro-coke, improved techniques of fat production, particularly dolphin fat, construction of an universal blast furnace for simultaneous production of iron and steel, glass making, etc.

Geology and geography — Extensive surveys of natural resources, particularly of iron, coal, petroleum, phosphates, bauxite and potassium-containing minerals, have been undertaken. The possibilities of discovering rare metals, erosion in the basin of ' Studen Kladenets ' and ' Kardjali ' dams, hot mineral springs, and geomorphology of Vidin and Lom regions and of the basin of river Arda, are among the problems being tackled. With the assistance of the Institute, a new geological map of the country has been prepared for the guidance of prospectors of ores and minerals.

Mathematics—Valuable contributions have been made to the theory of real functions, diophantine approximations, irreversible thermodynamic processes, analytical dynamics, theory of algebraic equations, etc. The Institute of Mathematics has undertaken several demographic studies.

Technical sciences — Work on land amelioration and power resources, problems relating to road traffic, heat losses from buildings, etc., are undertaken by institutes under government control. Investigations on periodical watering of rice-fields have led to considerable economy in the use of water and obviated the risk of salting rice-fields and turning them into marshes. The complex

relationship between power resources and power consumption has been worked out and deductions have been made which will facilitate the planning and construction of power plants in the country.

Biology — Among the biological problems studied in the institutes of the Academy of Sciences are the following: Vernalization of seeds, systematics of plants and animals for compiling Bulgarian flora and fauna, geobotanic studies, medical and veterinary microbiology, normal and pathological metabolism of lipids, luminescence analysis of tissues, histo-chemistry of nucleic acids, anthropological studies, higher and central nervous systems, silicosis and other occupational diseases, and helminthological investigations.

The scientific achievements of the People's Republic of Bulgaria during the last 12 years are varied and considerable: but they are as yet modest in comparison with what is in prospect considering that active organizations have been set up for investigation of the many problems relating to the economic and cultural growth of the country.

Sir John Simonsen, 1884-1957 — Obituary

WE REGRET TO RECORD THE DEATH ON 20 February 1957 of Sir John Simonsen, D.Sc., LL.D., F.R.I.C., F.R.S.

Born in 1884 Sir Simonsen was educated at Manchester Grammar School and University. In 1910 he was appointed to the Chair of Chemistry at the Presidency College, Madras. He was one of the founders of the Indian Science Congress and held the office of the honorary secretary from 1914 to 1926. He was also General President of the Congress in 1928. He served as Controller of Oils and Chemical Adviser to the Government of India during World War I and later as Forest Chemist at the Forest Research Institute and College, Dehra Dun. His original research work included extraction of the first naturally occurring representative of new complex hydrocarbons from Indian pines and grasses and its identification. During 1925-27 he was Professor of Organic Chemistry at the Indian Institute of Science, Bangalore.

In 1931, he took up the Chair of Chemistry of the College of North Wales, Bangkor, from where in the same year he published an authoritative treatise on *Terpenes*. A year later, he was elected to the Fellowship of the Royal Society. He served as the First Director of Colonial Products Research, as secretary of the Chemical Society and a member of the Agricultural Research Council, and presided over the Section of Chemistry at the British Association. Among the many honours conferred on him were the Royal Society's Davy Medal and the first Fritzsche Award of the American Chemical Society.

REVIEWS

AN INTRODUCTION TO CYBERNETICS by W. Ross Ashby (Chapman & Hall Ltd., London; *Distributors*: Asia Publishing House, Bombay), 1956. Pp. ix + 295. Price 36*s*.

Cybernetics is a subject which has very useful applications in biological and sociological sciences. Biologists and sociologists, on the other hand, do not possess the knowledge of mathematics necessary for full understanding of the subject. This book, as the author states in the preface, has been written to remove this need; but in doing so the author has done much more than he states he wishes to do.

The fashion of presenting a mathematical subject to people who do not know mathematics but have technical knowledge in some other subject in the so-called ' non-mathematical ' way often makes the subject lose not only its flavour but also its applicability. The style adopted by the present author is an exception to this. He has not avoided the technicalities of mathematics but has introduced the necessary mathematics through a series of definitions and exercises suitable for the subject.

The way in which the mathematical introduction is dealt also should attract special attention of the reader. The author has not detached a few chapters from text-books of mathematics and put them in the first few chapters of his book. He has rewritten mathematics in a way which makes the motivation clear to a careful reader (a character which even the books on mathematics sometimes lack) and has graded the exercises and definitions in a way suitable for his purpose and in doing so he has not lost the spirit of rigorous mathematics. Indeed, if one seeks the rigorous mathematics to the letter he will not find it in this book. For example, in exercise 2, page 13, the transformation is not unique. The author has made no attempt to go into this side of the question because it is the existence of formulae in general to which he wants to attract readers' attention.

The book is divided into three parts. In the first part, which contains five chapters, the author develops the concepts necessary to establish the link between cybernetics and some very broad aspects of a machine (living or non-living).

In the second part, which contains only three chapters, the author deals with the relation of machine with information. He has dealt rather with the logical aspect of ' information ' than its mathematical aspect. One would not find such a thing as the sampling or other usual theorems or formulae of ' information theory ' here. It may be mentioned in this connection that the third chapter of ' Cybernetics ' by Prof. N. Wiener contains considerable amount of mathematics in connection with information theory.

In the third part, which contains five chapters, the ideas of mechanism and information are applied to the study of regulation and control in biological systems. It gives a new account of the principle of ultrastability. The idea of homeostat is brought in as in the book *Design of the Brain* by the same author. Games and Strategy also have been touched upon. The author illustrates in the twelfth chapter of his book the isomorphism with the Game theory (the first book on this subject is by Neuman and Morgenstern) but there have been recently books by Mckinsey and Williams entitled *Introduction to the Theory of Games* and *The Compleat Stratogyst* respectively.

An excellent compromise between the abstract and the concrete is the characteristic of the book. The machine described with diagram on page 239 will show well how the author goes into details to illustrate the relation between the subtle and abstract concepts on the one hand and their application to the concrete on the other.

G. BANDYOPADHYAY

SURVEY OF ROSE GROWING CENTRES AND ROSE INDUSTRY IN INDIA by V. Narayanaswami & K. Biswas (Publications Directorate, C.S.I.R., New Delhi), 1957. Pp. viii + 113. Price Rs. 7.50

A survey of rose growing areas in India with the object of studying the existing conditions and suggesting measures for improving the

cultural and chemical aspects of the industry was carried out in a sponsored research scheme under the auspices of the Essential Oils Research Committee, C.S.I.R. The results of the survey have now been compiled and brought out in this publication.

The publication consisting of 7 chapters, a bibliography and two appendices is well illustrated with 7 black and white and 4 coloured plates of roses. Chapter I traces the history of the rose plant and its distribution. Chapter II deals with rose growing centres, area under cultivation and production of rose and rose products, and manufacturers in the States of U.P., Bengal, Madras and Mysore. Classification of roses and their description have been attempted in Chapter III. Chapters IV and V give in detail the soil, climate, irrigation, methods of cultivation, pests and diseases, harvesting, yield and prices of rose flowers in the various areas. Chapter VI is concerned with otto of rose and rose products made in these regions, uses and trade, and the summary and recommendations made as a result of the investigations are given in Chapter VII. A bibliography of the important publications on rose and two appendices, one giving a list of horticultural roses which have been collected and preserved at the Herbarium, Indian Botanic Garden, Calcutta, and the other giving a brief account of the rose industry in other countries, form useful additions to the publication.

HIGH CALCIUM LIMESTONES OF INDIA by H. C. Bijawat & S. L. Sastry (Publications Directorate, C.S.I.R., New Delhi), 1957. Pp. viii + 117

Limestone is an important basic raw material for the chemical industry apart from its use in the agricultural, building, ceramic and metallurgical industries. The information so far available on the limestones of India is not sufficiently detailed to be of much use to the chemical manufacturer. A comprehensive survey of the high grade limestones in terms of their significant chemical and physical properties in the interests of the rapidly developing chemical industry of the country was thus felt badly and the National Chemical Laboratory, Poona, undertook such a survey in 1953. Characteristic and typical samples from about 70 high grade limestone deposits were collected and their physical and chemical properties examined thoroughly. The results of this survey have been recorded by the authors in the form of an interim report in the book under review.

The book is divided into 6 chapters. In the introductory Chapter I are given the occurrence of limestone in India, methods of its calcination and scope of the survey. The testing procedures adopted for the study of the physico-chemical characteristics of limestones, quicklimes and hydrated limes are detailed in Chapter II. The following tests were adopted: (i) *Limestone* — Macroscopic and microscopic characters, crystalline form, colour, specific gravity, apparent specific gravity, porosity, hardness, compressive strength, physical change on calcination, calcination rate, nature of derived lime and chemical composition. (ii) *Quicklime* — Specific gravity, apparent specific gravity, porosity, bulk density, colour, angle of repose, strength, rate of hydration and slakability. (iii) *Hydrated lime* — Sieve analysis, bulk density, fatness, settling characteristics of caustic sludge and causticizing power.

A detailed account of the characteristics of 50 samples of limestones obtained from Rajasthan, Vindhya Pradesh, Bihar, Madhya Pradesh, Orissa, Saurashtra, Bombay, Hyderabad, Andhra, Madras and Travancore-Cochin and discussion of the results form Chapter III; Chapter IV is concerned with the characteristics of quicklimes and hydrated limes obtained from the limestone samples. Chapter V lists the specifications for limestones and limes for use in different chemical industries and Chapter VI attempts at an assessment of the quality of the limestones and limes in respect of their suitability for various chemical applications such as calcium carbide, soda ash, caustic soda, bleaching powder, bottle glass, paper, textiles, varnish, etc. Appendix 1 presents manufacturer's data relating to limestones and limes consumed in different chemical industries in India.

The publication is well got up containing 70 tables of useful data and 22 illustrations and is expected to serve as a handbook to the chemical industry in aiding for selecting the most suitable limestone for its particular need.

NOTES & NEWS

Origin of the solar system

A NEW THEORY ON THE ORIGIN OF the solar system, which accounts for some characteristics of meteorites (including the diamonds found in them) and for the varying densities of the planets, has been recently proposed by Prof. Harold C. Urey of the University of Chicago. According to this theory, solid objects about the size of asteroids or the moon accumulated in a dust cloud very early in the history of the solar system (about 4500 million years ago) and played an important part in the formation of the planetary system and possibly the sun. These solid objects clumped together and were then heated either by free radical reactions or by the fall of these objects through gases, to temperatures up to 1500°C., sufficient to melt silicates and iron. After tens of millions of years during which they cooled to about 500°C. they fell rapidly towards a gravitation centre when the sun was formed, with a gigantic disc composed of left-over gas and these solid objects. Melting of iron and silicates, the chief constituents of meteorites, could have occurred during this process. These primary objects were then broken up by intense collisions reducing the solid material to fragments varying from tiny particles to the sizes of meteorites. The gas and dust in the giant solar disc were dissipated by solar light pressure and turbulent gases and some of the solid material was removed by spiralling towards the sun. The planets and asteroids were formed during this time (4300 million years ago). The separation of the silicates and metals in varying degrees during the process of break-up and re-accumulation accounts for the different densities of the planets. Meteorites are the fragments resulting from a later break-up of the re-accumulated objects. It is proposed that the objects first formed must have clumped together before the formation of the solar system to account for the known properties of meteorites. Planets in the making, i.e. in the sense of large masses of gas and dust of the same composition as the sun, did not occur until after the separation of the metals and silicates in the primary solid objects. The moons circling the earth and other planets might also have been formed by a similar process [*Sci. News Lett., Wash.*, **71** (1957), 39].

Neutron powder diffraction photographs

A METHOD BASED ON THE USE OF neutrons in place of X-rays in the conventional X-ray diffraction technique has been devised for taking pictures of atoms faster (exposure times 100 times shorter than for X-ray diffraction) and more exact than is possible in the previous techniques. This development is particularly valuable for studying organic crystals which comprise 90 per cent of the known substances on earth and which are difficult to be detected by the X-ray method. In this method, a beam of neutrons allowed to pass through the material to be analysed is scattered or diffracted by the atoms of the substance. The diffracted neutrons strike a special fluorescent screen placed next to the film. The screen is made by embedding a phosphor in a thin layer of glass or plastic containing boron atoms. When the neutrons collide with the boron atoms, powerful atomic particles are released and cause light flashes on the screen. These flashes are recorded by the photographic film giving an exact picture of the diffracted neutrons [*Sci. News Lett., Wash.*, **71** (1956), 71].

Radio frequency methods in chromatography

A RECTIFIED RADIO FREQUENCY method of locating zones of paper chromatograms avoids chemical treatment of the chromatogram, so that it is possible to extract and estimate the metals quantitatively after they have been located.

A new solvent mixture, 2 ethylhexanol-methanol (3: 7) on Whatman paper number 3 has been used at the Department of Chemistry, University of Sydney, for the separation of lithium, sodium and potassium. The time of development which was 23 hr. can be shortened to 18 hr. by using tubes instead of a large tank to house the paper strips. The strips are dried and allowed to condition in a high humidity (R.H. 95 per cent) tank for *c.* 30 min. The radio frequency conductance increases markedly with the dampness of the paper.

The quantitative determination makes use of Blake's conductimetric tube which is a thin-walled glass tube with external sleeve electrodes. The oscillatory current passes through the solution in the tube and is then rectified and measured with a microammeter. In practice the microammeter is set at an arbitrary zero for distilled water in the tube. The chromatograms are then cut up so as to isolate the three bands. The separate pieces are then soaked in a known amount of distilled water and the rectified radio frequency conductivity of the resultant solutions measured. Standard chromatograms of pure alkali metal chlorides are prepared and measured in the same way. Quantities of the order of 1 mg. of each of the alkali metals have been determined with an accuracy of 1·0 per cent [*Chem. & Ind.*, (1956), 1474].

New solid-state oscillator

A NEW SOLID-STATE SPIN OSCILLATOR which oscillates at microwave frequencies and operates under entirely new physical principles has been developed by Dr. Derrick Scovil and his associates at the Bell Telephone Laboratories. The development represents the first successful application to the solid state of a new principle, called the MASER (standing for ' Microwave Amplification by Stimulated Emission of Radiation ') principle which was first demonstrated for molecular beams in gases at the Columbia University in 1954.

The principle on which the new oscillator operates is as follows: Normal electron spin states for the unpaired spinning electrons in a paramagnetic crystal lattice located in a magnetic field are such that the number in state 1 exceeds the number in state 2, which in turn exceeds the number in state 3. When irradiated with sufficient microwave power of the appropriate frequency, transitions from state 1 to state 3 take place until the populations of these two are nearly equal (power saturation). Under these conditions, the population of state 2 can be made

greater than that of state 1. If a small signal is applied at a frequency corresponding to the energy difference between these two, stimulated radiative transfer takes place and a power gain can be realized. In the Bell Laboratories experiment, the energizing frequency was 17,500 Mc/s. and the stimulated (signal) frequency was 9000 Mc/s.

Two pre-conditions for the above phenomenon to occur are the right choice of a single crystal of a solid-state material having certain specific characteristics and its dilution with an isomorphous diamagnetic substance to separate the metallic atoms sufficiently to reduce the electron spin interaction. Gadolinium ethyl sulphate was selected as the most suitable substance in this case, although other compounds from a whole group of " ionically bound paramagnetic salts " may serve even better for specific applications. Lanthanum ethyl sulphate was used as a diluent for the gadolinium salt and makes up about 99 per cent of the finished crystal.

The crystal was mounted in place in a waveguide cavity having two resonant frequencies, one equal to the frequency of oscillation and the other equal to the frequency of the energizing source. The sample occupied about 8 per cent of the cavity volume and was located at the point of maximum magnetic field intensity. The sample and cavity were immersed in liquid helium at reduced pressure at a temperature of 1·2°K. so that power saturation takes place with small amounts of energizing oscillator power and the population difference between the energy levels is increased. The 17,500 Mc/s. energizing oscillator signal was brought to the cavity through a rectangular waveguide and the stimulated radiation of 9000 Mc/s. was taken away by means of a strip guide mounted inside the rectangular waveguide. Measured power output was up to 20 W.

The necessary separation of the electron spin energy levels was brought about by the application of a magnetic field (2800 oersted in the present case) properly aligned with respect to the crystal. The frequency of the stimulated radiation can be tuned by altering the magnetic field, thereby changing the electron spin energies.

Though this device is in the research stage, potentialities appear to exist for adapting it to useful new microwave devices in the centimetre and millimetre wavelength regions. The working with electron spins in a paramagnetic crystal, basic to this type of operation, confers an advantage of very low noise compared to conventional microwave devices which depend on the motion of charged particles at high temperatures. Theoretical estimates indicate that a noise figure corresponding to thermal noise at 5°-10°K. should be attainable. This is hundreds of times better than is now possible with conventional microwave circuitry. The oscillator, with some modifications, can also be used, in principle, as an amplifier. If the low noise figure and the amplification, even by a small factor, of very feeble signals are realized in practice by using proper waveguide structure and adequate amount of the paramagnetic crystal, it is possible to amplify radio signals several hundred times weaker than those usable at present. Thus the range of radio astronomy may be considerably extended and marked improvements effected in long distance telephone and television communication across continents [*Bell Telephone Laboratories News*].

Half-wave plate property of commercial cellophane

In their experiments to produce colours in unstained microscopic sections of decalcified teeth using commercial cellophane in conjunction with a polarizer and analyser, E. F. Fahy and M. A. MacConaill of the University College, Cork, Ireland, noticed that commercial cellophane can behave like a half-wave plate which, it is suggested, may be due to a surface effect [*Nature, Lond.*, **178** (1956), 1072]. In practice, cellophane, when viewed between two 'polars', shows slight colouration (which becomes marked with increasing thickness) which can be explained as a thickness effect in conjunction with ordinary and extraordinary ray velocities. The thickness effect makes it difficult to verify the half-wave plate property of cellophane precisely. Nevertheless, it has been observed by them that cellophane equally satisfies the tests for a half-wave plate with light of any colour, suggesting that the achromatic half-wave plate property of cellophane is due to a surface effect. This property is being applied in some histological studies. Polythene sheets also exhibit similar properties to a lesser extent.

Three-dimensional and two-phase illustrations

The firm Industrial Photographs Ltd., Sutton Coldfield, England, has produced interesting three-dimensional pictures, called 'Vectographs', by a new method involving application of polarized light to produce the solid effect. In this method, the two component images of a stereoscopic picture are printed in superposition on either side of a transparent support. The nature of this support and the printing solution are such that two images are produced in which the original photographic densities are reproduced in varying degrees of optical polarization. The light passed by the first image is polarized perpendicular to that passed by the second. The composite picture is viewed through a small binocular analyser, the lenses of which are made of polarizing material with their directions of polarizations at right angles to each other; thus these two lenses act as filters, the left and the right images being visible only to the appropriate eye, producing a striking three-dimensional effect. The chemical structures of graphite, a shadowed carbon replica of pearlite and a cone of *Chamaecyparis lawsonia* have been illustrated with a marked effect in this way.

In another application of the process, well suited for educational purposes, pictures of two different aspects of the same subject suitably mounted in a frame are similarly superimposed. Each is visible by polarized light in one plane only and a polarizing filter is rotated to show either image or both, or transition from one to the other. Pictures, $4\frac{1}{4} \times 5\frac{1}{4}$ in. in size, of the human skull and its associated muscles and tissues individually or superimposed, as desired at will, have been visually presented by this method. Alternatively the pictures can be used as slides and projected on to a metallized screen, in which case each member of the audience will have to wear a polarizing viewer [*Nature, Lond.*, **178** (1956), 962].

Supermendur — an improved magnetic alloy

The Bell Telephone Laboratories, New York, have developed

a new magnetic alloy with some exceptional properties, e.g. higher permeability and lower hysteresis losses at higher flux densities, than those of any hitherto available material. This alloy, called 'supermendur', permits reduction in the size of the magnetic components without loss of performance and is ideally suited for use in such devices as magnetic amplifiers, pulse transformers, power transformers, etc., with improved performance.

Supermendur is similar in composition (49 per cent iron, 49 per cent cobalt and 2 per cent vanadium) to 2 V-permendur, another alloy developed by the Laboratories earlier, but has superior properties. The hysteresis losses are reduced by a factor of 10. Maximum permeability is 66,000 at 20,000 gauss; remanence, 21,500 gauss; coercive force, 0·26 oersted and saturation, 24,000 gauss. Core losses are below 6 W./lb. at 400 c/s. at 1,000,000 lines/in. flux density. The hysteresis loop is rectangular with a flux swing of 45,500 gauss from minus remanence to plus saturation.

These special properties have been achieved by melting highly pure commercial materials in a controlled atmosphere and subjecting the resulting alloy to a prescribed schedule of rolling and heat treatment in a magnetic field. The malleability of the material is such that it can be rolled from 0·09 in. to 0·0003 in. without intermediate anneals and without loss of ductility.

Supermendur tape, 0·002-0·004 in. thick, when used as power transformer core can provide 30 per cent more output than the hitherto best grain-oriented silicon steel cores and permits 30 per cent reduction in the core size and weight for the same output. A flux density of 140,000 lines/sq. in. can be used without excessive losses. The precipitous sides of the hysteresis loop indicate that the gain of a magnetic amplifier can be increased as much as 80 per cent over that obtainable with grain-oriented silicon steel. Other devices in which supermendur can be used with advantage include telephone receiver diaphragms and switching and memory devices [*Bell Telephone Laboratories News*].

Radiant heating of dispersed particles

THE RESULTS OF A THEORETICAL analysis of the temperature history of dispersion of small spherical particles subjected to a radiant flux, carried out at the University of Michigan, have application in the ignition and combustion of powdered coal and atomized fuels, and in the attenuation of thermal radiation from fire or a nuclear fireball. The temperature of non-volatile particles rises rapidly to a pseudoequilibrium value and finally rises more slowly as the finite amount of air associated with each particle is heated by conduction from the particle. The temperature difference within a particle is negligible at all times. Expressions are also derived for the rate of evaporation and for the effect of evaporation upon the temperature of volatile droplets.

Illustrative calculations are presented for dispersions of powdered coal, dodecane and fog oil. A dispersion of absorbing particles is very efficient in transferring radiant energy to the surrounding air [*Industr. Engng. Chem.*, **48** (1956), 1819].

C^{14} in sewer gas

DURING A STUDY OF THE SEWER gas an anomalous high content of C^{14} in the carbon dioxide fraction of the gas has been found at the Naval Research Laboratory, Washington.

Sewer gas samples piped directly into the laboratory from a sewage-treatment plant analysed methane, 65-70 per cent and carbon dioxide, 30-35 per cent, with low percentages of nitrogen, oxygen, carbon monoxide and other gases.

Carbon dioxide samples were obtained by passing the sewer gas through a sodium hydroxide solution. The remainder of the carbon dioxide was removed by suitable absorbers. The carbon dioxide-free methane was converted to carbon dioxide by passage over hot copper oxide, and the carbon dioxide was absorbed in another sodium hydroxide solution. The two fractions were further purified, converted to acetylene, again purified, aged to allow radon to decay and assayed for C^{14}.

The results indicated that the C^{14} content of the methane fraction of sewer gas is in reasonable agreement with that of wood. However, the carbon dioxide fraction has a C^{14} content about 14 per cent higher than has been found for contemporary biological carbon. Since both carbon dioxide and methane are presumably derived from biological decomposition, these results indicate an entirely unexpected enrichment of the carbon dioxide fraction of sewer gas [*Science*, **124** (1956), 1252].

Heat of neutralization of strong acids and bases

HEATS OF NEUTRALIZATION OF sulphuric and hydrochloric acids by sodium hydroxide have been redetermined at the University of Ottawa, using a microcalorimeter of the Tian-Calvet type. The range of concentration employed was 5×10^{-4}N to 3×10^{-2}N, which is sufficiently low to permit an accurate extrapolation to be made down to zero concentration. The extrapolated values obtained were: H_2SO_4-NaOH, 13·48 ± 0·05 k. cal. per g. equiv. and HCl-NaOH, 1352 ± 0·05 k. cal. per g. equiv. These values, which correspond to the process $H_3O^+ + OH^- \rightarrow 2H_2O$, are significantly higher than the values of 13·32-13·37 k. cal. obtained on the basis of previous calorimetric studies in a much higher concentration range. The values agree well with those calculated from electrochemical data [*Canad. J. Chem.*, **34** (1956), 1677].

Estimation of platinum

DIMETHYLPHENYLBENZYLAMMONIUM chloride prepared by mixing equimolecular amounts of benzyl chloride and dimethyl aniline and allowing the mixture to stand at ordinary temperatures until a crystalline mass is obtained, precipitates platinum quantitatively from tetravalent platinum bromide solutions. Complete precipitation is obtained in solutions varying widely in concentrated hydrobromic acid. The compound formed is a stable ammonium type salt, $(C_{15}H_{18}N)_2PtBr_6$, and from its weight, platinum can be calculated. Commonly associated base metals do not interfere. Platinum can be determined in filtrates from hydrolytic separation of other platinum metals [*Canad. J. Chem.*, **34** (1956), 1683].

Determination of nitrogen in coal and coke

DUMAS METHOD FOR NITROGEN estimation has been modified at the Central Fuel Research Institute, Jealgora (Bihar), to effect

complete oxidation of the combustible matter in coal so that no carbon monoxide or hydrocarbon collects in the nitrometer along with nitrogen. An active type of coprecipitated mixed catalyst and combustion aid are used. The method is simple to operate and takes only ½ hr. even in the case of hard coke. The packing material can be regenerated and used for a large number of tests.

About 0·25 g. of coal or 0·5 g. of coke which would give rise to 3-5 ml. of nitrogen is mixed thoroughly on a glazed paper with 10-15 g. of fine copper oxide and transferred to the combustion tube. Carbon dioxide of 99·98 per cent purity is swept through the apparatus to remove air. Careful control is exercised in raising the temperature of the furnace (which is in two parts) to the combustion temperature (800°-850°C.) to avoid vigorous evolution of nitrogen. When the combustion is complete, the apparatus is flushed with carbon dioxide until the evolution of nitrogen in the nitrometer stops. The volume of gas at atmospheric pressure, aqueous tension of 50 per cent potassium hydroxide solution used in the nitrometer at the temperature of the experiment and barometric pressure are noted for use in the calculation of nitrogen in the substance. A blank experiment is done without the sample with the same rate of flow of carbon dioxide for exactly the same time as taken for flushing the apparatus, after the experiment is over. The results with the modified method are closer to the theoretical values of per cent nitrogen in the samples than the results obtained by the conventional method [*FRI News*, **6** (1956), 49].

Estimation of potassium and sodium in coal ash

INVESTIGATIONS CARRIED OUT TO study the interference of aluminium, iron, calcium, magnesium, silicate and borate in the determination of sodium and potassium in coal ashes and related silicate materials by the EEL flame photometer have revealed that all these constituents except calcium cause negligible interference. The interference of calcium can be eliminated by adding aluminium in the hydrofluoric-sulphuric acid mixture used to decompose the sample. As the concentration of aluminium increases, interference due to calcium is reduced. A total aluminium concentration of 600-900 p.p.m. is sufficient to suppress interference of as much as 40 per cent calcium in 0·04 g. of sample. The method is extremely rapid and the determinations can be made in 1½ hr. as compared to 3 hr. in the spectrographic technique and 2 days in the gravimetric method [*J. appl. Chem.*, **6** (1956), 547].

Gibberellins for growth

GIBBERELLINS, EXTRACTED FROM the fungus *Gibberella fujikuroi*, when sprayed on plants or trees in aqueous concentration of 1-50 parts per million, double or even triple the elongation of the shoots within 3-4 weeks.

So far three chemically different compounds, Gibberellin A_1, $C_{19}H_{24}O_6$; A_2, $C_{19}H_{26}O_6$; and A_3, $C_{19}H_{22}O_6$ (also known as gibberellic acid), have been isolated and found effective in preliminary crop testing. Out of these, gibberellic acid has been found most effective in increasing growth of crops. Treated with gibberellic acid, either alone or in combination with the other two, ornamentals such as geraniums, sunflowers and roses have grown, according to initial experiments, from one-half to three times taller than comparable untreated plants. Heights of crop plants such as snap-beans, peppers and corn have doubled or tripled by similar application of the chemical. New growth of young forest trees such as willow, oak, tulip, poplar and maple was greatly increased by treatment with gibberellic acid [*Chem. & Engng. News*, **34** (1956), 4496].

Results of large-scale experiments carried out on a variety of swards at four different centres in England show that gibberellic acid increases the growth rate of all components of the swards. The nitrogen content of the grass was lowered by about 2 per cent after treatment with the acid, so that the yield per acre of crude protein did not increase to the same extent as the dry weight yields. The initial growth response to gibberellic acid was more rapid than that to nitrogenous fertilizers. The difference persisted longer in spring and autumn than at other times of the year. Eventually, however, the yields obtained with fertilizers became greater than those obtained with gibberellic acid. Experiments on arable crops showed that greater growth of aerial parts of the treated plants was not accompanied by increases in yield. For example, wheat treated in the early spring showed a rapid initial increase in growth rate, but the grain and straw yields at harvest were not greater than those of untreated plants. In other experiments the yield of root crops, including potatoes, turnips and carrots, even decreased in spite of stimulation of the growth of tops [*Nature*, **178** (1956), 1356].

Furfural from sunflower seed husks

A NEW ACID REDUCTION METHOD of obtaining furfural from sunflower seed husks, described in Russian literature, employs hydrolysis of the raw material in the presence of reducing agents, including sulphuric acid and sodium thiosulphate. The raw material analysed (on average): cellulose 34·6, pentosans 28·6, crude protein 4·8 and lignin 26·9 per cent besides moisture and ash.

The air-dried raw material (400 g.) is placed in a 3-litre autoclave heated over the oil bath to 180°-240°C., and then 9 g. of sulphuric acid added (with 391 g. water). Superheated steam is now introduced together with some thiosulphate (200 ml.) added gradually throughout the process. As the temperature in the autoclave dropped to 178°-80°C. the valve of the blow-out is opened, and the furfural blown into the cooler. After 8 or 10 min. another 9 g. of sulphuric acid is introduced into the autoclave with 191 g. water. Whilst the blow-out still continues the temperature in the autoclave is raised to 200°-210°C. The second stage of the process lasts about 10-12 min. with temperature gradually rising to 200°-240°C., where it is maintained for 5-8 min. Total time taken is 25-28 min.

The condensate (1270 ml.) is neutralized with soda, sodium chloride added (400 g.) and the mixture distilled. The distillate (452 ml.) is saturated with soda and the furfural ether extracted. It is then redistilled *in vacuo* (120 mm. Hg). The initial concentration of sulphuric acid in the autoclave declines gradually with the addition of thiosulphate. The results show that 4·6 per cent thiosulphate concentrate gives maxi-

mum yield (76·2 per cent of theoretical) [*Chem. Prod.*, (Feb. 1957), 84].

Antibacterial activity of chlorophyll

A FRESH 10 PER CENT SOLUTION OF sodium potassium copper chlorophyllin in sterile distilled water has been used to study the antibacterial activity of chlorophyll *in vitro*. The sensitivity of various organisms to chlorophyll was determined by the plate method and by making bacterial counts of organisms growing in fluid media.

Chlorophyll inhibited the growth of some Gram-positive bacteria but had no effect on the Gram-negative organisms. Of the thirteen strains of the common wound contaminant *Staph. aureus* streaked over chlorophyll-Levinthal agar, five were inhibited at a chlorophyll concentration of 1/800, seven at 1/400 and one at 1/100. After a period of bacteriostasis, bacterial multiplication proceeded in the case of all the concentrations of chlorophyll tested. The activity of some antibiotics was potentiated by the presence of sub-inhibitory concentrations of chlorophyll [*Brit. med. J.*, Feb. 2 (1957), 268].

Crystallographic apparatus and materials

AN INDEX OF THE MANUFACTURERS of apparatus and materials used in crystallography (24 pages) has been compiled and published by the International Union of Crystallography with the assistance of Unesco.

The index consists of two parts. Part I gives an alphabetical list of apparatus and materials commonly used in crystallographic work along with the names of the manufacturers. Part II contains addresses of the manufacturers.

"Science" Instrument Issue

THE 26 OCTOBER 1956 ISSUE OF the American scientific weekly, *Science*, is devoted to a series of articles reviewing some of the outstanding developments in a number of fundamental instruments and the techniques that made possible the vast progress in science and technology.

In the first article the possibilities of the electronic computers and other appliances in handling scientific and business data which are accumulating at a vast rate, and descriptions of some available machines for the purpose are presented.

The development of methods of producing low temperatures has led to the introduction of a new branch of technology under the name Cryogenics, with applications in bubble chamber, magnetic refrigerator, separation of hydrogen isotopes by distillation, etc. The problems and methods of instrumentation in this field are reviewed in the second article.

The principles and design of the fixed field alternating gradient accelerator, theory and techniques employed in some of the applications of sonics encompassing the analysis, testing and processing of materials and products in industry and technology and the recent developments in phase-contrast microscopy during the last two years are discussed in subsequent articles.

The advantages of solar furnaces in high-temperature research and the design of such furnaces form the subject matter of another article. Other interesting articles on recent techniques and instrumentation are: New principle of closed system centrifugation; Low-level counting methods for isotopic tracers; Electronics for measuring human motion; Design study of a mega-curie source and Bendix time-of-flight mass spectrometer.

Dielectrics Section of NBS

THE U.S. NATIONAL BUREAU OF Standards has recently established a new Dielectrics Section for fundamental investigation of the dielectric properties of matter. The primary purpose of this section will be to augment the present fund of knowledge in the field of dielectrics by conducting experimental and theoretical studies on substances which act as electrical insulators. The work of the new section will be complementary to that of the Radio Standards Division of the Bureau's Boulder Laboratories. Specific aspects of research to be taken up include the dielectric properties of polymeric systems, and of standard substances, the d.c. conductivity of dielectrics, methods of increasing the accuracy of dielectric measurements on solids at audio and lower frequencies and fundamental studies on molecular and ionic crystals. John D. Hoffman has been appointed head of the new section.

Award of Doctorate Degrees

THE FOLLOWING HAVE BEEN RE-cently awarded the Ph.D. degree by the Poona University: Lakshman Vinayak Agashe (*Dykes in Deccan Trap in a region between Poona and Khandala*); and (Mrs.) Violet Bajaj (*Phosphate metabolism of moulds*).

Announcements

Amir Chand Trust Prizes, 1957 — Indian Council of Medical Research, on behalf of *Colonel Amir Chand Trust*, have announced four junior prizes of the value of Rs. 300 each to be awarded in 1957 for the best research papers in medical sciences including clinical research published in 1956. These prizes, to be known as 'Shakuntala Amir Chand Prizes', are open to graduates (medical or non-medical) of not more than ten years' standing.

The award of the prizes will be announced in November/December 1957.

The candidates are required to submit 10 reprints of their papers published in 1956, to the Director, Indian Council of Medical Research, P.O. Box No. 494, New Delhi, so as to reach him *not later than* 1 *August* 1957.

The papers should be accompanied by a short biographical sketch and two copies of passport size photographs of the worker or workers concerned.

National Formulary of India — The National Formulary Committee recently constituted by the Government of India for compiling a National Formulary of essential drugs and their useful formulations have issued a questionnaire to elicit information to be included in the Formulary. The Formulary will be mainly confined to drugs and formulations of drugs covered by the Indian Pharmacopoeia. Replies to the questionnaire indicating which drugs and formulations should be included in the Formulary should be sent to the Secretary of the Committee, Directorate of Health Services, New Delhi 2.

The 7th International Colloquium on Spectroscopy, organized by the Association of Engineers of the Liege University, will be held in

Liège, Belgium, in the second week of September 1958.

INSTRUMENTS AND APPLIANCES

ASCO 8030 Microscope

The Andhra Scientific Co. Ltd., Masulipatam, have recently put on the market the ASCO 8030 interchangeable monocular-binocular microscope (Fig. 1) which is specially designed for use in modern laboratories and is suited both for photo-micrography and prolonged microscopical examinations. The design permits easy and convenient conversion from monocular to binocular body. The revolving nosepiece of the quadruple type is fixed in position and the tube guide ensures perfect alignment of both monocular and binocular bodies. The binocular body with inclined parallel eyepiece tube is suited for normal vision and the eyes are not strained even in the case of prolonged microscopic work. The binocular body has an arrangement for setting the eyepiece tubes to the correct interpupilary distance and provision is made in one of the eyepiece tubes for compensating for any difference in sight. A special time-saving stop makes it impossible to rack the objectives against the slides. For focussing the objective, the coarse adjustment is racked down to the stop with 10·3X objective in position and critical focussing is done by fine adjustment. The other objectives will be found para-focal in this position. The optical equipment comprises 10X and 15X eyepieces, achromatic objectives 10·3X, 44X and 105X, oil immersion and a low power objective and an Abbe condenser (N.A., 1·2) with iris and swing-out filter holder.

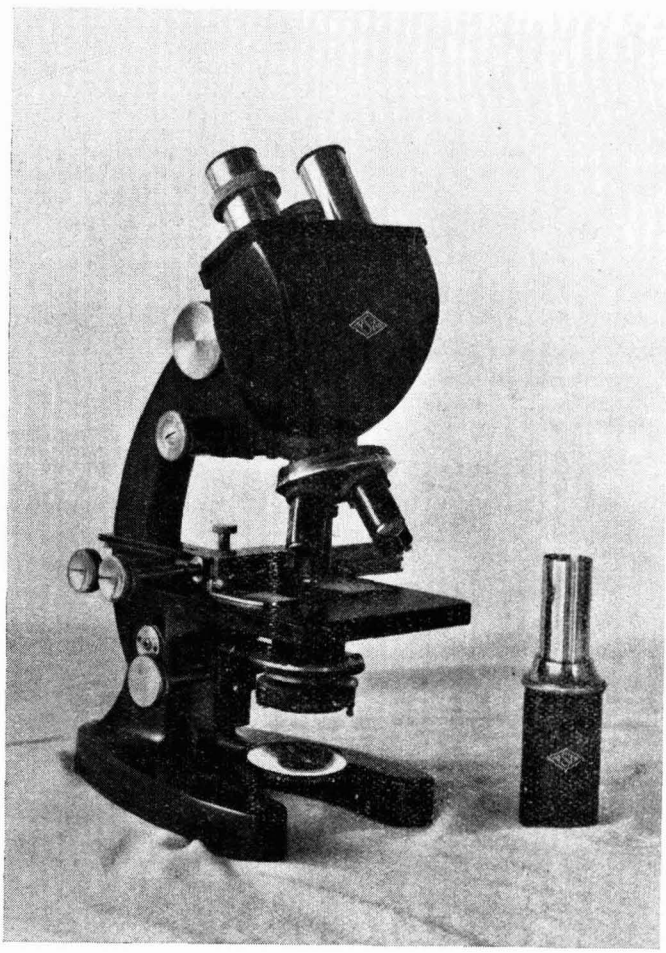


Fig. 1 — ASCO 8030 interchangeable monocular-binocular microscope

Microscope for Study of Cell Movements

The study of moving cells and the influence of their contacts with solid surfaces are important to understand phenomena like contact guidance and contact inhibition. The slight penetration of light waves into a less dense medium when totally internally reflected at a glass/water interface has been made use of in designing a 'surface contact microscope' for such a study.

Light from an intense mercury arc passes through a slit and strikes the upper surface of an equilateral triangular prism. A cell suspension in water is mounted between an ordinary microscope slide and a coverslip and is sealed with immersion oil on the upper face of the prism. The incident light strikes the upper surface of the glass slide at an angle greater than the critical angle and is totally reflected at the interface. Actually the beam penetrates the less dense medium slightly. If a cell of refractive index greater than that of water is moving on the surface, those portions which make close contact with the surface of the glass enter the penetrating beam and scatter light owing to the presence of minute inhomogeneities in their structure. When looked through the microscope from the top, the regions of the moving cells in close contact with the glass are seen brightly illuminated against a completely dark background, provided the incident beam is carefully shielded and the prism faces are clean.

Besides, the contours of the cell surfaces can be explored by changing the angle of incidence of the beam; this is possible because the degree of penetration of the incident beam decreases with increasing angle of incidence. In this way the areas of the cell which are illuminated are reduced eventually to those regions which are almost in molecular contact with

the glass surface. The effect is particularly well illustrated in the case of a filamentous mould. As the mould moves forward along the glass, bright waves of light move rapidly along its length, due to the continuous changes in the points of adhesion between the surface of the mould and the glass. Apart from its use in biological studies, the microscope may prove useful for studying many other phenomena connected with the cohesive forces between surfaces [*Nature, Lond.*, **178** (1956), 1194].

Dielectric Specimen Holder

The U.S. National Bureau of Standards has recently developed a versatile specimen holder (to be used in conjunction with a bridge or resonant circuit), which is useful in the precision determination of dielectric constants, dissipation factors and thermal expansions of insulating materials, particularly the new plastics and ceramics developed in recent years for high temperature applications, over wide ranges of temperature and frequency.

The device consists of a pair of gold-plated electrodes made of stainless steel (to minimize differential thermal expansion), *c.* 2 in. diameter, between which the specimen is placed. The lower electrode is stationary and the upper electrode is movable vertically to accommodate the specimen thickness. Covered with a silver electrostatic shield, the assembly is placed in an electrically heated oven whose temperature is regulated within 0·5°C. A thermocouple placed in a hole in the top electrode measures the temperature of the specimen. The instrument can also be surrounded by a cooling unit for measurements down to −40°C. The upper electrode moves only in a direction parallel to the axis of the electrodes. A micrometer at the bottom of the entire assembly measures the relative position of the upper electrode. This arrangement reduces the pressure on the specimen to that of the weight of the frame and the electrode. The pressure on the specimen, if considered still high, can be supported instead by the micrometer to avoid deformation of the specimen. Residual thermal expansion can be determined by resting the upper electrode on the lower one and noting the change in micrometer reading after equilibrium is established, at every operating temperature. Below 1 Mc/s. the errors arising from inductance of the leads in the dissipation factor and capacitance measurements are negligible and can be easily evaluated up to 10 Mc/s. The holder cannot be used above 10 Mc/s. in view of the vicinity of its resonant frequency. The holder can be used for d.c. measurements also [*Tech. News Bull., Nat. Bnr. Stand.*, **41** (1957), 14].

Apparatus for Surface Application of Liquids

A precision apparatus for applying known volumes of liquids in discrete droplets to fabrics, filter papers and other test surfaces has been designed at the Suffield Experimental Station, Defence Research Board, Ralston, Alberta. It is also of value to research workers in other fields. Its compact size permitting the whole assembly being fitted into a fume cupboard where it can be operated by remote control makes it particularly suitable for handling noxious chemicals.

The apparatus employs a 5 ml. syringe fitted with a No. 27 gauge hypodermic needle; around the latter is fixed an air nozzle. The plunger of the syringe is depressed automatically at a fixed rate and the droplet size, which can be from 0·32 to 1·6 mm., is controlled by varying the air flow through the nozzle. The syringe with needle and air nozzle is mounted on a carriage which is moved back and forth along a right- and left-hand threaded cam. When the carriage reaches either end of this cam, it is shifted forward by a small distance (0·3-0·9 cm.) by a shift and tripping device.

After filling the syringe with liquid and adjusting the plunger drive, the air is turned on. The test surface, fastened to a small table, is placed inside the fume cupboard beneath the spray assembly attachment which is moved to the extreme right-hand end of the threaded cam and the cupboard door is closed. The motor driving the spray assembly is switched on when the drop-laying proceeds automatically giving a rectangle of droplets in 12 rows over an area 20×7 cm. The rate of delivering the droplets is controlled by the variable speed transmission and the volume is measured by the revolutions of a counter. One ml. is delivered for every 111 revolutions of the counter. The same spray area is used for all volumes (0·2-5 ml.) of liquid delivered; hence the plunger is set to deliver the required volume in exactly 2 min. 21 sec. every time. With this arrangement, for the smallest volume the droplets fall 1·7 cm. apart and proportionately closer for larger volumes. Calibration is done by collecting and weighing the amount of distilled water delivered at a fixed setting of the variable speed transmission for 111 counter revolutions. The droplets delivered by the apparatus are very uniform. Standard deviation expressed as a percentage of the mean stain diameter varied only from 0·5 to 4·3 for the six different sizes of droplets [*Canad. J. Tech.*, **34** (1957), 399].

Counting Tube for Paper Chromatograms

Improvements have been made at the Brookhaven National Laboratory, New York, in the end-window counting tube used for directly assessing the activity of the radioactive compounds on paper chromatograms.

The end window is constructed from Du-Pont Mylar of 0·25-mil thickness which is stretched tightly across the end and clamped into position with a rubber 'O' ring. Mylar is porous, and air can diffuse into the tube, so that a slow flow of quenching gas is kept running through the counting tube via the copper inlet.

The male plug of an Amphenol connector is machined into the top of the tube. A tungsten wire is connected to the anode, and the brass casing of the tube acts as the cathode. The male plug is then attached to the female plug of the connector with a 3 or 4 ft. flexible cable to a scaler. With this convenient connector, several tubes can be kept in readiness and easily attached to the cable or scaler.

With 'P-10' gas (90 per cent argon and 10 per cent methane) as quenching gas, counting can be done in 2400 V. The tubes show a good plateau (3 per cent rise for 250 V.) between 2250 and 2500 V. If 'Q' gas is used, a good plateau is obtained around 1200-1500 V. depending on the individual tube. The tubes are unshielded and give a background count of

60-70 counts per min. With both C^{14} and S^{35}, a ratio of disintegrations to observed counts of about 10 is obtained. The tube has also been used successfully to count both P^{32} and tritium [*Science*, **124** (1956), 1253].

Magneto-resistance Displacement Gauge

The transverse magneto-resistance effect in indium antimonide has been successfully utilized at the Services Electronics Research Laboratory, Baldock, Hertsfordshire, England, for the measurement of small displacements.

The displacement gauge designed is based on the fact that the mean field over, and hence the resistance of a strip of indium antimonide crystal moving relative to a magnetic field with a strong field gradient in the direction of movement, is a function of its position. By making the antimonide strip take up the displacement to be measured and determining the resistance of the crystal, the magnitude of the displacement can be estimated.

To minimize errors due to temperature changes in this arrangement, two crystals are used which are rigidly connected together and so disposed that as the field in one increases, that in the other decreases. The two crystals form two arms of a Wheatstone bridge, the remaining arms of which consist of equivalent resistances. By adjusting one of these the bridge is balanced in the position of zero displacement.

With such an arrangement, using crystals of size $2 \times 2 \times \frac{1}{2}$ mm., a deflection of 5 mm. on a galvanometer for 1 μ of the stylus movement has been obtained, i.e. a magnification of 5000. The short-term zero stability is better than 0·25 μ.

Using an a.c. bridge considerable increase (10-100 times) can be attained in the sensitivity which will be limited only by perfection in the mechanical mounting and the avoidance of residual temperature effects. The gauge in its direct form is particularly simple where remote reading or continuous recording of results is required, e.g. in continuous monitoring of foil thickness. The sensitivity can be quickly altered by switching the feed current or by inserting shunts across the galvanometer [*Nature, Lond.*, **178** (1956), 1196].

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Erratum

Article entitled " Vitamin B_{12} & the Alkali-stable Vitamin B_{12}-like Factors in Palm *Gur* ", **16C** (1957), 68, L.H. column, line 4 in the Abstract, and line 10 under Materials and methods: *Escherichia gracilis* should be *read* as *Euglena gracilis*.

Progress Reports

CENTRAL RICE RESEARCH INSTITUTE

THE MAIN RESEARCH ACTIVITIES OF THE CENTRAL Rice Research Institute, Cuttack, during the year 1954-55 are presented below:

Agronomy — Yield performance of 121 varieties grouped according to duration was tested in five varietal trials during the main crop season and that of 36 varieties during the second crop season. In 85-110 days duration trial, variety Ch. 62 which gave a yield of 2328 lb. per acre was significantly superior to the control (1964 lb.). In 110-25 days trial, varieties PTB13, Cross-116, and MGL2 which gave 2899 lb., 2764 lb. and 2579 lb. respectively were significantly superior to the control (yield 2200 lb.). In 125-40 days duration trial, T. 1879 which yielded 3898 lb. rice was significantly superior to the control (3250 lb.). Among the 36 varieties tested for the second crop season, variety Mtu. 15 which gave the highest yield of 1744 lb. (cf. control 1092 lb.) matured 2-3 weeks later than the normal variety.

Crop sequence experiments showed that groundnut, cotton and gram are suitable for inclusion in the sequence of cropping with rice and groundnut crop and have a beneficial effect on the succeeding rice crop.

It has been possible to grow three crops in an year by adopting the following sequence of cropping and judicious manuring:

(1) First crop of a short duration variety (Ch. 45) planted by middle of April and harvested by last week of June.

(2) Second crop of medium duration variety (T. 141) planted in main season from July to December.

(3) Third crop of short duration rice planted by the middle of January and harvested by early April.

A total yield of 9298 lb. of paddy per acre could thus be obtained.

Botany — During the year the performance of 243 cultures in the F_5 generation belonging to 8 cross combinations between three early varieties (Ch. 2, *Sathika* and T. 1031) and four late varieties (T. 90, T. 812, T. 1145 and T. 1241) was studied in a randomized replicated layout with 5 replications. While the flowering duration of the high yielding late parents ranged from 110 to 130 days, the F_5 cultures flowered within 100 days of sowing, 43 of them being 30 days earlier in maturity. With regard to yield, all the cultures were significantly superior to the 3 early maturing parents but inferior to type 90 and 1242, the two best late maturing parents. The selections from the cross combinations of T. 90, T. 1031 and *Sathika* were mostly fine grained.

The inheritance of anthocyanin pigmentations in the different plant parts was found to be controlled by 1-4 genes and varying ratios of pigmented to non-pigmented genes were obtained in different crosses with respect to a particular plant part.

Chemistry — Periodical examination of soil for nitrogen status showed that after application of lime, NH_4N status of treated plots increased considerably both in low and in medium land. The increase in yield was, however, observed only on low land soil condition, resulting in more ear-bearing tillers per plant, increase in height and higher yield of both grain and straw.

Crops resulting from a manurial trial laid out in an area which had been continuously water-logged from the main crop season showed a stunted growth, poor tillering and stand. From the ammonification studies of soil from the area it is seen that the wet soil is incapable of ammonifying soil organic nitrogen and making it available to the crop. The soil from these fields when aerated, air-dried and again water-logged, produced far more NH-N than the wet soil without drying.

Studies on the relative efficiencies of urea and ammonium sulphate in increasing the yield showed that urea, sub-surface placed at 20 lb. N per acre, was as efficient as ammonium sulphate deep placed on equal nitrogen basis both giving significant increases in yield (10 and 8 per cent respectively), over a control yield of 3759 lb. per acre. Increase in protein content of grain was also obtained both with sulphate of ammonia and urea applications.

Working on the Japanese method of rice cultivation — effecting saline separation of underdeveloped and shrivelled seeds — the germination of most of the varieties was improved to the extent of 10-12 per cent.

Entomology — During the year the highest percentage of natural parasitization of gallfly grubs was during September-October (81·4 per cent). Soaking of seeds and irrigating the nursery with the organo-phosphorus insecticides was found to be superior to treating with chlorinated hydrocarbons for reducing the incidence of gallfly. Similar observations were made with respect to stemborers.

THE BRITISH HYDROMECHANICS RESEARCH ASSOCIATION

PRESENTED BELOW IS A BRIEF ACCOUNT OF THE research activities of the British Hydromechanics Research Association for the year 1955-56.

Seals and glands — During the year under review investigations have been continued with seals for both rotary shafts and reciprocating shafts to understand how they prevent leakage. Several types of rubber reciprocating seals were tested and with each type peculiar leakage behaviour occurred with varying pressure on alternate strokes. In some cases nagative leakage occurred. These effects have been shown to be due to the formation of a thin film of oil beneath the seal.

Flow — Tests on the flow of oil at high pressure through small orifices have shown that the discharge coefficient depends not only on Reynolds number but also on the cavitation number of the flow. Modified free streamline theory, when applied to calculate the effect of cavitation number on discharge coefficient, shows substantially higher values than the commonly quoted value of 0·61.

The determination of relative flow velocities in the transparent impeller test apparatus (by using a camera rotating on the same shaft as the impeller to photograph the paths of particles introduced into the water) has shown that the relative velocities are lowest near the pressure face of a blade and highest at the suction face. This difference in speed can become so great that, at lower deliveries, a fixed eddy can be seen attached to the pressure face of each vane with backward flow near the vane. Below about half the normal flow, the flow is unstable both in time and between different blade passages.

Some flow observations made in the volute of a centrifugal pump to provide data on the nature of the radial thrust forces that act on impellers at off-design duties have shown that the radial thrust is influenced by slight changes in the casing design. At deliveries greater than normal, most of the energy losses take place in the conical diffuser, while the losses in the volute itself are comparatively small.

Further studies on the prevention of swirl in the flow entering a pump intake have shown that measures designed to reduce angular momentum in the sump are effective in reducing both the swirl in the pipe and the tendency for air-entraining vortices.

Severe swirling in the suction pipe can also arise if the water flows through two bends in planes at right angles to each other. The resulting flow was found to be complicated, but consisted broadly of a main swirl and a subsidiary swirl both offset from the axis of the pipe. The maximum swirl angle was 10°-15°. By using suitable guide vanes in the second bend, swirl from this cause could be eliminated completely.

Transport of solid material — A three-cylinder reciprocating feeder has been designed for introducing coal into a pipeline under high pressure. It handles 50-100 tons/hr. of 3 in. feeding run-of-mine coal against low pressures.

A small rotary-disc feeder, suitable for 3 in. pipes, has been constructed and tested.

Alternative methods of feeding large solid particles into high pressure pipelines are being explored, and one promising solution is a storage-type feeder operating on a much longer time cycle than the conventional machines. Problems connected with flow of solid/water mixture into and out of the storage vessels have been studied by means of transparent models and these experiments have suggested suitable shapes and sizes of vessel. Such a feeder makes use of valves to direct the flow of solid/water mixtures and tests are now being carried out to determine whether commercially available rotary plug valves would be suitable for continuous operation under these conditions.

A new 1½ in. bore pipe circuit has been constructed for the study of the flow and pressure losses of mixtures containing relatively fine material in the range where particle size has a considerable influence on the pressure losses.

THE BRITISH CAST IRON RESEARCH ASSOCIATION

AN ACCOUNT OF THE RESEARCH ACTIVITIES OF THE British Cast Iron Research Association for the year ending 30 June 1956 is presented below:

Cast iron — A statistical interpretation of the defects in K-bar test pieces obtained from a large number of crucible melts has been carried out. The influence of understressing on fatigue properties was negligible in pearlitic and flake graphite cast iron of relatively high tensile strength and nodular cast irons. It has been shown that tensile strength decreases with increasing silicon content due to a transition temperature phenomenon. The effect of variations in heat-temperature on the ferrite grain size of pearlitic nodular cast irons has also been studied and the appropriate treatment for the production of a fine size has been worked out. By refining the grain it is possible simultaneously to raise the ultimate and proof stress and to lower the impact transition temperature. The influence of trace elements on the mechanical properties of nodular cast irons at elevated temperatures has also been studied.

Gases in cast iron — The influence of hydrogen in cast iron formed the major item of work during the period under review. The part played by hydrogen in the titanium/CO_2 process has been studied and the influence of the CO_2 has been shown to be due to the elimination of hydrogen.

Investigations on the factors influencing the structure of white cast iron have shown that superheating undercools the eutectic with the formation of an acicular white iron structure.

An apparatus has been built to study weight changes during the decarbonization of cast iron.

A theory has been developed to explain the structure of ordinary grey cast iron in terms of eutectic cell size and number.

Corrosion — In conjunction with the British Ship Building Research Association, a shrouded anode to fit to propeller tailshaft so as to minimize pitting attack on cast iron propellers by means of cathodic protection has been developed. The extent to which the shroud reduces the current output was also studied. A laboratory apparatus has been constructed to study the decomposition of ethylene glycol and the depletion of corrosion inhibitors under conditions similar to those in the cooling passage of an engine.

Moulding and core sands — Using the principle of dielectric heating for sands of high temperature, the following variables have been studied: the grading of sand grains, the replacement of coal dust and wood flour by peat, the expansion of moulding sand, and the high temperature properties of sands containing coal dust and wood flour. In connection with the CO_2 process, the technique for the preparation of test pieces and their subsequent treatment with CO_2 has been established, and using this technique the influence of moisture content, the inclusion of inferior sand, silicate ratio, clay content and gas evolution have been recovered.

Separation of Nickel & Zinc from a Mixture of Their Salts: Part II—Reduction of Nickel Oxide

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A systematic study of the reaction between nickel oxide and carbon has been taken to procure data to be used in separating nickel and zinc from their oxides mixture by carbon reduction. Effect of temperature on the reaction using varied amounts and different types of reducing agents and nickel oxide with different previous history of formation has been studied.

IN the pyrometallurgical extraction of zinc, zinc oxide is reduced by carbon at *c.* 1000°C. The reduction temperature being higher than the boiling point of zinc, the metal volatilizes and is recovered by condensation. Fine nickel powder may also be produced by the reduction of nickel oxide by carbon at 600°C. or above. It is, therefore, expected that on heating the mixed oxides with carbon at *c.* 1000°C., zinc would distil over leaving a residue of nickel (metal) powder.

Factors affecting the reduction of zinc oxide by carbon were extensively studied by Hopkins and Adlington[1]. The present investigation was, therefore, confined to the reduction of nickel oxide by carbon.

Berthier, Richter and Erdmann[2] prepared nickel metal in the laboratory by heating nickel oxide with charcoal in a covered crucible at high temperature. Siemens and Halske[3] reduced nickel oxide with carbon in an electric furnace.

To study the reaction mechanism, and the optimum conditions for the reduction, experiments were carried out for reducing nickel oxide with varying amounts and different forms of carbon at different temperatures, in a stream of nitrogen. The gases evolved during the reaction were analysed for carbon dioxide and carbon monoxide.

Experimental procedure

Apparatus — The apparatus used (Fig. 1) was so designed that the gases evolved were removed immediately from the reaction zone and continuously analysed. The reaction mixture was contained in a silica boat within a platinum-wound tubular furnace; the temperature was controlled by a Sunvic energy regulator. Purified nitrogen was used to remove the evolved gases from the reaction zone. Nitrogen from the cylinder was freed from oxygen by passing over heated copper gauze and through alkaline pyrogallate solution, and dried by passing through concentrated sulphuric acid, phosphorus pentoxide and anhydrone, and purified from carbon dioxide by passing through soda asbestos. Purified and dried nitrogen entered the furnace at a controlled rate of *c.* one-third litre/min. The reaction gases from the furnace were cooled and passed through anhydrone. Carbon dioxide was removed and estimated by passing the gas through weighed absorption bottles containing soda asbestos, after which oxygen was added and the gas mixture passed over heated platinized asbestos to oxidize carbon monoxide to carbon dioxide, which was subsequently absorbed in soda asbestos and estimated.

Two sets of absorption bottles for the estimation of carbon dioxide and carbon monoxide were connected to the furnace by three-way stopcocks, which enable either of the sets to be brought into the circuit. The length of the connecting tubes was kept to a minimum to limit the volume of gas left in the system when the carbon dioxide absorption bottles were being weighed.

Materials and methods

Two samples of nickel oxide were used: (1) B.D.H. nickel oxide, and (2) oxide produced freshly by roasting chemically pure nickel sulphate at 750°C. The mean particle size of sample (2) was —100 mesh B.S.S.

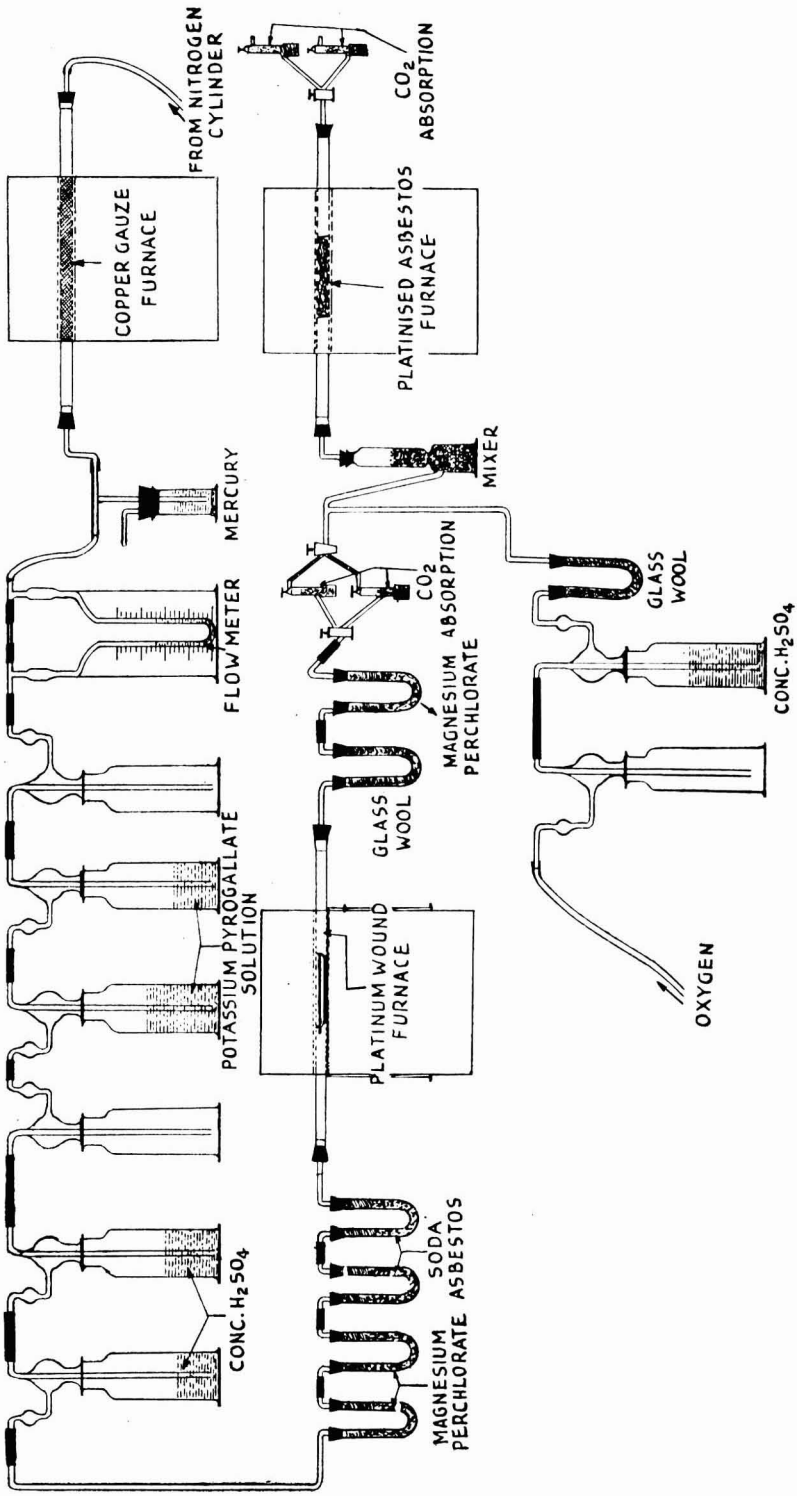

FIG. 1 — APPARATUS FOR THE REDUCTION OF NICKEL OXIDE

Three different forms of carbon were used for reduction: (i) ordinary wood charcoal powder, (ii) lamp black, and (iii) activated charcoal. They were dried before use. The weight of nickel oxide taken in the charge was kept constant (2 g.) while that of carbon was varied (0·25, 0·5 and 1·0 g.) in different experiments.

The furnace was heated to the required temperature and purified nitrogen passed through the system to remove the residual gases.

As the charge attained a high temperature, reduction started with the evolution of carbon monoxide and carbon dioxide. The reaction was continued till the carbon dioxide absorption vessels attained a constant weight indicating that no more carbon dioxide or carbon monoxide was evolved.

For determining the optimum conditions for reduction, the effects of different variables involved in the reaction on the reduction of nickel oxide and the ratio of CO : CO_2 were studied and are discussed below:

Effect of the form of carbon — Two g. of nickel oxide were used for each reaction. It was mixed with 0·5 g. of activated charcoal, lamp black or wood charcoal. The furnace temperature was maintained at 1000°C.

Table 1 gives the percentage of reduction achieved and the CO/CO_2 ratios for the different forms of carbon used. Wood charcoal was found to be most effective. The results obtained with lamp black are more or less similar to those with wood charcoal, but activated charcoal gives a very high ratio of CO/CO_2 and the reaction takes a longer time for completion.

Effect of the different types of oxides — The results in Table 2 show that freshly prepared nickel oxide is more reactive than the stored oxide, the CO/CO_2 ratio for the former being 0·17 and for the latter, 0·8.

Effect of temperature — The reduction of freshly prepared nickel oxide was studied at 900°, 1000° and 1100°C. At 1100°C. the reaction was complete within 15 min., while at 900°C. only 95·4 per cent of nickel oxide was reduced after 45 min. (Table 3).

The CO/CO_2 ratio also increased as the temperature was raised. The value of CO/CO_2 rose from 0·07-0·14 at 900°C. to 0·65 at 1100°C.

Though an appreciable amount of unreacted carbon was left at 900° and 1000°C., the rate of reaction slowed down considerably as reduction proceeded.

Effect of carbon content — Freshly prepared sample of nickel oxide (2 g.) was reduced at 900°, 1000° and 1100°C. using 1, 0·5 and 0·25 g. wood charcoal.

At 1100°C., the reduction was complete within 15 min. when 1·0 or 0·5 g. charcoal

TABLE 1 — REDUCTION OF NICKEL OXIDE USING DIFFERENT FORMS OF CARBON

(*Composition of mixture*: *NiO*, 2 *g.*; *carbon*, 0·5 *g.*; *flow rate of nitrogen, one-third litre/min.*; *temp.*, 1000°C.)

Time *min.*	CO/CO_2 ratio in the outgoing gas using			Percentage reduction of NiO using		
	Activated charcoal	Lamp black	Wood charcoal	Activated charcoal	Lamp black	Wood charcoal
5	11·390	1·207	0·844	59·73	79·96	87·25
10	10·090	1·199	0·845	61·89	81·26	89·11
15	—	—	0·845	—	—	89·11
20	8·399	1·155	—	64·53	83·16	90·00
25	—	—	0·834	—	—	90·90
30	6·320	1·085	—	65·27	86·66	—
35	—	—	—	—	—	93·30
40	5·416	1·059	—	71·89	87·96	—
45	—	—	0·788	—	—	95·18
50	4·501	1·034	—	75·93	89·41	—
55	—	—	0·777	—	—	96·08
60	4·174	1·031	—	77·72	89·51	—
65	—	—	—	79·73	—	—
70	3·881	—	—	80·16	—	—
80	3·820	—	—	—	—	—

TABLE 2 — REDUCTION OF FRESHLY PREPARED AND STORED NICKEL OXIDE

(*Composition of mixture*: *NiO*, 2 *g.*; *wood charcoal*, 0·5; *flow rate*, *one-third litre/min.*; *temp.*, 1000°C.)

Time *min.*	CO/CO_2 ratio (by vol.) using		Percentage reduction	
	NiO (B.D.H.)	Freshly prepared NiO	NiO (B.D.H.)	Freshly prepared NiO
5	0·844	0·150	87·25	96·94
15	0·845	0·166	89·11	98·10
25	0·834	0·181	90·90	99·45
35	0·804	—	93·30	—
45	0·788	—	95·18	—
55	0·777	—	96·08	—

TABLE 3 — EFFECT OF TEMPERATURE ON RATE OF REDUCTION OF NICKEL OXIDE

(*Composition of mixture*: *NiO*, 2 *g.*; *wood charcoal*, 0·5 *g.*; *rate of flow of nitrogen, one-third litre/min.*)

Temp. °C.	Time *min.*	CO/CO_2 ratio (by vol.)	Wt. of unreacted carbon *g.*	% reduction	Ni reduced / C consumed
1100	5	0·6500	0·283	98·57	6·94
	15	0·7000	0·274	100·00	7·30
1000	5	0·1987	0·332	95·85	11·40
	15	0·1996	0·329	97·23	11·37
	25	0·1990	0·328	98·46	11·45
900	5	0·0795	0·368	79·45	12·04
	15	0·1409	0·344	90·78	11·64
	25	0·1568	0·337	94·58	11·61
	35	0·1616	0·336	95·30	11·62
	45	0·1614	0·336	95·40	11·63

was used. At 900° and 1000°C., however, more than 60 per cent charcoal was left unreacted. Only 70-80 per cent nickel oxide was reduced when 0·25 g. charcoal was used.

At 1000°C. and above, the CO/CO_2 ratio is *c.* 3 when using 0·25 g. of charcoal, while at 900°C. the ratio is 0·5-0·7, indicating that more CO is evolved at a higher temperature. A similar trend was observed when using 0·5 and 1·0 g. of charcoal.

Using 0·5 g. of charcoal at 900° and 1000°C., 95·41 and 98·46 per cent reduction was achieved in *c.* 40 min. Further reduction occurred on prolonging the reaction time or if the mass is cooled, crushed and again reduced.

Discussion

The following reactions are involved during the reduction of an oxide with carbon:

$$XO+C = X+CO \quad \text{(i)}$$
$$2XO+C = 2X+CO_2 \quad \text{(ii)}$$
$$XO+CO = X+CO_2 \quad \text{(iii)}$$
$$C+CO_2 = 2\ CO \quad \text{(iv)}$$

In all these reactions, the rate of reaction increases with rise in temperature, and above 700°C. rate of formation of CO by reaction (iv) tends to increase with rise of temperature and consequently high temperature should favour them. According to Hopkins and Adlington[1], reduction of zinc oxide by carbon proceeds by reactions of types (iii) and (iv). It is expected that the reduction of nickel oxide also takes place mostly on these lines. Dannatt and Ellingham[4], while supporting this view, pointed out that the reaction of the type (i) between two solids is not important, as it usually proceeds slowly in the gaseous phase, and that the reactions (iii) and (iv) predominate, the instantaneous ratio of CO/CO_2 depending on these two reactions under a given set of conditions.

The results of the present study show that the rate of reduction of nickel oxide depends on the form and quality of carbon, quality of nickel oxide, and the temperature of reduction.

The efficiency of reduction is lower with active charcoal than with wood charcoal.

Freshly prepared nickel oxide is more reactive than stored nickel oxide which may be due to greater porosity of the former.

When the carbon content of the charge is adequate, the weight of CO evolved, the ratio of CO/CO_2 and the rate of reduction increase with rise in temperature. The increase in CO content of the evolved gases with rise in temperature is due to reaction (iv) being accelerated. The reaction between CO_2 and carbon being very slow at 900°C., most of the gas is evolved as CO_2, while at 1000°C., the reaction is sufficiently fast and CO_2 evolved by reactions (ii) and (iii) further reacts with carbon according to reaction (iv) to produce more CO. The CO evolved then reacts with nickel oxide producing CO_2 and nickel powder and the cycle continues.

At 900° and 1000°C. the rate of reduction slows down after 25-30 min. even though *c.* 60 per cent carbon is still present and complete reduction is not achieved. This is probably due to entrapment of nickel oxide particles in the reduced nickel, stopping further reaction. Further reduction is obtained when the incompletely reduced charge is crushed and heated.

The carbon content of the mixture also exerts an influence on the rate of reduction. When 0·25 g. of carbon is used, the total reduction does not exceed 70-71 per cent at 1000° and 1100°C. (Table 4). The unreacted carbon left at 1000° and 1100°C. when 0·25 g. of charcoal was used is *c.* 0·06-0·07 g. At 900°C., however, 88 per cent of nickel oxide is reduced though only 0·25 g. of charcoal was used. This is due to the greater proportion of CO_2 evolved at 900°C. than at higher temperature. The ratio of CO/CO_2 is 0·6 at 900°C. and *c.* 3 at 1000° and 1100°C. The higher ratio of CO/CO_2 at 1000°C. and above is due to the reaction of carbon with carbon dioxide leaving comparatively lesser carbon for further reaction. Using 0·5 g. charcoal the reduction is complete at 1100°C. and not at 1000°C. or below.

On decreasing the carbon-nickel oxide ratio, the reduction temperature in the range of 900°-1100°C. has no marked effect excepting that the reaction rate is faster at 1100°C. The presence of excess carbon at 1100°C. favours the reaction (iv) as is evident from the increase in the volume of CO evolved.

The increase in the rate of reduction at 900°C. with increase in carbon content of the mixture may be due to the solid phase reactions (i) and (ii), as the reduction of CO_2 to CO by carbon is not appreciably fast at this temperature as is indicated by the low CO content of the evolved gases. The presence of excess carbon helps the reaction to proceed in the solid state.

TABLE 4 — REDUCTION OF NICKEL OXIDE WITH VARYING AMOUNTS OF CHARCOAL

(Wt. of NiO, 2 g.; flow rate of nitrogen, one-third litre/min.)

Wt. of charcoal g.	Time min.	CO/CO_2 ratio (by vol.) at (°C.)			Wt. of unreacted carbon at (°C.)			% reduction at (°C.)			Ni reduced/carbon consumed at (°C.)		
		900	1000	1100	900	1000	1100	900	1000	1100	900	1000	1100
1·00	5	0·165	0·220	0·516	0·837	0·829	0·811	94·30	95·66	97·65	11·57	11·47	10·32
	15	0·184	0·230	0·519	0·831	0·820	0·806	97·20	97·02	100·00	11·48	10·77	10·80
	25	0·190	0·226	—	0·825	0·814	—	100·00	100·00	—	11·44	8·49	—
0·50	5	0·079	0·199	0·650	0·368	0·332	0·283	79·45	95·85	98·57	12·04	11·40	6·96
	15	0·141	0·199	0·700	0·344	0·329	0·274	90·78	97·23	100·00	11·64	11·37	7·30
	25	0·157	0·199	—	0·337	0·328	—	94·58	98·46	—	11·61	11·45	—
	35	0·162	—	—	0·336	—	—	95·40	—	—	11·62	—	—
	45	0·162	—	—	0·336	—	—	95·40	—	—	11·63	—	—
0·25	5	0·552	3·770	3·389	0·133	0·098	0·078	59·75	47·05	66·30	5·15	6·21	7·79
	15	0·655	3·380	3·138	0·084	0·082	0·073	82·90	63·49	69·00	10·10	7·75	7·45
	25	0·661	3·380	2·999	0·078	0·078	0·070	85·68	65·60	70·60	10·80	7·65	7·84
	35	0·661	3·290	2·958	0·075	0·076	0·007	87·15	66·64	71·60	11·18	7·68	7·82
	45	0·665	3·260	—	0·074	0·075	—	87·72	67·25	—	11·33	7·69	—
	55	0·667	—	—	0·073	—	—	88·15	—	—	11·45	—	—

At 1000°C. the increased rate of reduction with increase in carbon content was also due to the reduction of CO_2 evolved by the excess of carbon present. A greater part of the reduction may thus be taking place by the reaction (iii). At 1000°C. and above, however, the reaction (iv) is also fast.

Acknowledgement

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Beneficiation of Low Grade Fluorspar from Chandidongri Mines, Drug, Madhya Pradesh

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A fluorspar sample from Chandidongri Mines, Madhya Pradesh, assaying CaF_2, 46·25; SiO_2, 49·68; Pb, 0·68; Fe_2O_3, 0·33; Al_2O_3, 1·05; and S, 0·12 per cent with traces of $CaCO_3$, Zn and Ba has been tried for beneficiation. Quartz, constituting about 50 per cent by weight, was the principal gangue mineral and was intimately associated with fluorspar. Small amounts of cerussite, galena, ochre, felspar and clay were also present.

Hydraulic classification followed by tabling of the ground sample produced a concentrate assaying 83·81 per cent CaF_2 with 35·6 per cent recovery.

Flotation of lead employing xanthate followed by fatty acid flotation of fluorspar produced first a lead float assaying 15·15 per cent Pb with a recovery of about 82·5 per cent. Fluorspar was then floated. Four cleanings of the fluorspar rougher float yielded a fluorspar refloat concentrate assaying CaF_2, 96·6; Pb, 0·06; SiO_2, 3·6; Fe_2O_3, 0·13 per cent and traces of S, with an actual recovery of 77·9 per cent CaF_2 in the product and a higher expected recovery. By repeated cleanings, it is possible to further reduce the silica content to yield a refloat concentrate conforming to the specifications laid down for chemical and ceramic grades of fluorspar.

A SAMPLE of low grade fluorspar from Chandidongri Mines, Drug District, Madhya Pradesh, was received from the Director of Geology and Mining, Government of Madhya Pradesh, for beneficiation tests.

The U.S. National Stockpile specifications for the various grades of fluorspar are given in Table 1.

The sample which was received in lumps 5-6 in. in size was stage crushed to −8 mesh for various tests.

Petrologically, the sample consisted of fluorspar in various shades of colours, viz. violet, green, yellowish and white. Quartz, constituting about 50 per cent by weight, was the principal gangue and was finely interlocked with fluorspar. The −8 mesh sample was sieve analysed and sink and float tests performed separately with each of the fractions using acetylene tetrabromide (density, 2·9). The results are given in Table 2.

Study of various fractions under microscope indicated that fluorspar and quartz were interlocked in both the sink and float fractions up to 48 mesh. At finer sizes, better liberation was achieved with a correspondingly lesser number of interlocked grains.

The other gangue minerals present in small amounts were cerussite, galena, ochre, felspar and clay.

The sample assayed CaF_2, 46·25; SiO_2, 49·68; Fe_2O_3, 0·33; S, 0·12; Pb, 0·68; and Al_2O_3, 1·05 per cent. Besides, traces of $CaCO_3$, Zn, Ba and Cu were present.

The specific gravity of the −8 mesh sample was 2·84.

Pure fluorspar contains 51·1 per cent calcium and 48·9 per cent fluorine, and has a specific gravity of 3·18 and a hardness of 4 according to Mohs' scale. The difference between the specific gravities of quartz and fluorspar is not appreciable enough to produce high grade fluorspar concentrate by gravity methods. However, tabling test was first performed after hydraulic classification. In subsequent tests flotation methods were employed under varying conditions.

Results

Tabling — The −8 mesh sample was roll-crushed to −48 mesh and classified in a hydraulic classifier into 5 fractions, viz. coarse, medium 1, medium 2, fine and slime. Each of the four sand portions was separately tabled. The results are given in Table 3.

These concentrates, when mixed, assayed 83·81 per cent CaF_2 with a recovery of 35·6 per cent CaF_2 in the mixed product. Though

TABLE 1 — SPECIFICATIONS FOR FLUORSPAR

Grade	Assay, %							Size
	CaF_2 *min.*	$CaCO_3$ *max.*	SiO_2 *max.*	Fe_2O_3 *max.*	Pb *max.*	Zn *max.*	S *max.*	
Metallurgical								
Grade A	70*	—	—	—	0·5	—	0·3	−1 in. and not more than 15% − 16 mesh (U.S. sieves)
Grade B	60*	—	—	—	0·5	—	0·3	
Chemical								
Acid grade	97†	1·25	1·5	—	—	—	0·03	−100 mesh (U.S. sieves)
Cryolite grade	97‡	‡	1·1	0·25	0·2	0·2	0·03	
Ceramic	95-98	1·00	2-30	0·12	—	—	—	−100 mesh (U.S. sieves)

*Effective CaF_2 is calculated by deducting 2% from the contained CaF_2 for each 1% of silica present.
†CaF_2 may be 95% (min.) provided the available CaF_2 is not less than 91%. Available CaF_2 is calculated by deducting 4% from the total for each 1 in. SiO_2.
‡May be 95% (min.) provided $CaCO_3$ is 1% (min.) and $CaCO_3$ is not less than 1·5% for each 1% and CaF_2 is below 97 %.

TABLE 2 — SIEVE ANALYSIS AND SINK AND FLOAT TESTS

Size (*mesh*)	Sieve analysis (by wt.) %	Sink and float tests at sp. gr. 2·9	
		Sink %	Float %
+10	20·7	25·3	74·7
−10+14	19·2	28·9	71·1
−14+20	14·7	30·1	69·9
−20+28	11·3	33·3	66·7
−28+35	7·0	35·9	64·1
−35+48	5·8	41·7	58·3
−48+65	4·5	46·7	53·3
−65+100	3·8	51·1	48·9
−100+150	2·7	52·1	47·9
−150+200	1·9	53·9	46·1
−200	8·4	—	—
	100·0		

TABLE 3 — TABLING

Product	Weight %	CaF_2	
		Assay %	Distribution %
Coarse			
Concentrate	8·1	86·70	15·0
Middling	10·9	57·62	13·5
Tailing	7·2	22·06	3·4
Medium 1			
Concentrate	4·2	80·58	7·2
Middling	3·6	51·16	4·0
Tailing	11·3	18·69	4·5
Medium 2			
Concentrate	4·1	82·96	7·3
Middling	1·1	72·63	1·7
Tailing	13·5	25·19	7·3
Fine			
Concentrate	3·6	82·00	6·3
Middling	2·9	40·31	2·5
Tailing	15·3	38·96	12·8
Slime	14·2	47·66	14·5
Feed	100·0	46·67	100·0

TABLE 4 — SIEVE ANALYSIS

Size (*mesh*)	Wt. %
+35	0·3
−35+48	7·6
−48+65	17·2
−65+100	19·8
−100+150	13·3
−150+200	4·7
−200	37·1
	100·0

TABLE 5 — FLOTATION USING TAP WATER

Product	Wt. %	CaF_2	
		Assay %	Distribution %
Float	44·8	83·28	80·5
Tailing	55·2	16·35	19·5
Feed	100·0	46·33	100·0

some concentration was achieved by tabling, the grade of concentrate and recovery were not satisfactory.

Flotation (employing tap water)— The −8 mesh sample (500 g.) was ground with 500 ml. tap water in a rod mill and classified. The different fractions obtained are shown in Table 4.

The ground sample was floated in a 500 g. flotation cell using a solution containing sodium carbonate (1 lb./ton), sodium silicate (2 lb./ton) and a 1:1 mixture of oleic acid and sodium hydroxide (2 lb./ton) as the floating reagent. The conditioning and floating times were 2 and 6 min. respectively. The results are given in Table 5.

Flotation yielded nearly the same grade of concentrate as that obtained by tabling but recovery had considerably improved.

Microscopic examination of the tailing showed that it contained a fairly large amount of fluorspar grains interlocked with quartz.

Flotation after desliming (employing tap water)— Flotation was carried out under similar conditions as above except that the flotation feed was deslimed and the flotation time was 4 min. instead of 6. The results are given in Table 6.

In spite of removing 23 per cent by weight of slime with a loss of 24·8 per cent fluorspar in it, the fluorspar concentrate as well as tailing were of almost the same grades as obtained in the test without desliming. The fluorspar recovery in the concentrate was also very low indicating that desliming the feed does not lead to better flotation.

Flotation using finer feed (tap water) — The flotation conditions were the same as in the case of −8 mesh sample except that a finer flotation feed was used. The fractions obtained on sieve analysis of the ground ore are shown in Table 7.

The results of the test are given in Table 8.

Though finer grind yielded nearly the same grade of concentrate as from the coarser grind, the tailing loss was reduced from 19·5 to 10·5 per cent CaF_2.

Flotation employing distilled water — The test was performed under conditions similar to those in the previous test except that distilled water was used and the quantity of reagent added was less. Oleic acid-sodium hydroxide (1 : 1) mixture (1·5 lb./ton) was added and flotation time was 4 min.

The results are given in Table 9.

Flotation was much faster when distilled water was used and a larger quantity had floated in a shorter time in spite of the lesser quantity of the collector used. A much cleaner tailing was also produced with a loss of only 1·7 per cent CaF_2 in it. It should be possible to improve the grade of concentrate by repeated cleanings.

Effect of varying quantities of modifying agents on flotation — Flotation was carried out using different quantities of the modifying agents. In each case, the pulp was conditioned for 2 min. and the froth removed for 4 min. using the oleic acid-sodium hydroxide (1 : 1) mixture (1·5 lb./ton) as froth collector.

The results are given in Table 10.

The fluorspar loss in the tailing obtained when the sodium carbonate-sodium silicate ratios in the modifier was 2 : 2 and 1 : 3 was higher than with the ratio 1 : 2, though the concentrates were of slightly better grades. The optimum quantities of sodium carbonate

TABLE 6 — FLOTATION AFTER DESLIMING

Product	Wt. %	CaF_2	
		Assay %	Distribution %
Float	32·9	83·90	58·9
Tailing	44·1	17·38	16·3
Slime	23·0	50·71	24·8
Feed	100·0	46·97	100·0

TABLE 7 — SIEVE ANALYSIS

Size (*mesh*)	Wt. %
+65	0·2
−65+100	6·0
−100+150	18·3
−150+200	17·8
−200	57·7
	100·0

TABLE 8 — FLOTATION USING FINER FEED

Product	Wt. %	CaF_2	
		Assay %	Distribution %
Float	49·8	84·07	89·5
Tailing	50·2	9·82	10·5
Feed	100·0	46·79	100·0

TABLE 9 — FLOTATION USING DISTILLED WATER

Product	Wt. %	CaF_2	
		Assay %	Distribution %
Float	61·8	73·43	98·3
Tailing	38·2	2·07	1·7
Feed	100·0	46·17	100·0

TABLE 10 — EFFECT OF VARYING QUANTITIES OF MODIFYING AGENTS

Composition of the modifying agent		Product	Wt. %	CaF_2	
Sodium carbonate *lb./ton*	Sodium silicate *lb./ton*			Assay %	Distribution %
2·0	2·0	Float	58·2	76·67	97·2
		Tailing	41·8	3·08	2·8
		Feed	100·0	45·91	100·0
1·0	3·0	Float	58·9	76·10	97·4
		Taling	41·1	2·57	2·6
		Feed	100·0	45·99	100·0
1·0	2·0	Float	61·8	73·43	98·3
		Tailing	38·2	2·07	1·7
		Feed	100·0	46·17	100·0

and sodium silicate to be added are therefore, 1 lb. and 2 lb./ton of ore respectively.

Flotation at higher temperature — The −8 mesh sample was ground to 57·7 per cent −200 mesh and floated in a 500 g. flotation cell, maintaining the temperature of the pulp between 55° and 60°C. The modifying agent had the composition: sodium carbonate, 1; sodium silicate, 2; and oleic acid-sodium hydroxide (1: 1) mixture, 0·4 lb./ton. The conditioning and floating times allowed were 2 and 4 min. respectively.

The results are given in Table 11.

Flotation was much faster at the higher pulp temperature. The reagent consumption was also reduced from 1·5 to 0·4 lb./ton of ore. The tailing loss was slightly higher than before but it could be brought down to *c.* 1·7 per cent CaF_2 by slightly increasing the time of flotation.

Xanthate flotation followed by soap flotation — As the ore contained galena and cerussite, whose presence even in small amounts is undesirable in fluorspar concentrate, lead was first floated off using xanthate and subsequently a fluorspar concentrate was obtained employing fatty acid.

The −8 mesh sample was ground to 57·7 per cent −200 mesh and floated under the conditions shown in Table 12.

The results of flotation are given in Table 13. More than 85 per cent of the total lead was removed in the first float for the loss of 7·7 per cent of fluorspar therein.

Flotation was next tried under similar conditions except that 1 lb./ton of sodium silicate was added before flotation of lead and the remaining 1 lb./ton of sodium silicate was added before flotation of fluorspar. The flotation conditions are given in Table 14 and the results of flotation in Table 15.

The addition of sodium silicate prior to sodium sulphide addition produced a better grade of lead float. The loss of fluorspar in it was also reduced to 3·3 per cent. The fluorspar float was of almost the same grade as in the previous test and with an improved recovery of 95·3 per cent CaF_2.

Reflotation — Optimum conditions having been determined for flotation of lead and production of a rougher fluorspar concentrate, 4 reflotations of the rougher concentrate were done next to yield a high grade of fluorspar concentrate.

The conditions for the removal of lead and for primary flotation of fluorspar, were the same as in the previous test. The fluorspar rougher float was refloated for 2 min. using 0·5 lb./ton of sodium silicate. The first refloat concentrate was again cleaned under the

TABLE 11 — FLOTATION AT 55°-60°C.

Product	Wt. %	CaF_2	
		Assay %	Distribution %
Float	56·2	77·14	96·2
Tailing	43·8	3·95	3·8
Feed	100·0	45·08	100·0

TABLE 12 — FLOTATION CONDITIONS

Reagent	Quantity *lb./ton*	Conditioning time *min.*	Flotation time *min.*	Product
Sodium carbonate	1·00	5	—	—
Sodium sulphide	1·00			
Potassium ethyl xanthate	0·30	2	—	—
Pine oil	0·24	—	3	Lead float
Sodium silicate	2·00	2	—	—
Oleic acid-sodium hydroxide mixture (1: 1)	1·50	—	4	Fluorspar float

TABLE 13 — FLOTATION USING XANTHATE FOLLOWED BY FATTY ACIDS

Product	Wt. %	Assay		Distribution	
		CaF_2 %	Pb %	CaF_2 %	Pb %
Lead float	7·1	51·0	8·2	7·7	85·6
Fluorspar float	54·9	76·68	0·105	89·7	14·4
Tailing	38·0	3·12	(calculated)	2·6	
Feed	100·0	46·91	0·68	100·0	100·0

TABLE 14 — FLOTATION CONDITIONS

Reagent	Quantity *lb./ton*	Conditioning time *min.*	Flotation time *min.*	Product
Sodium carbonate	1·00	2	—	—
Sodium silicate	1·00			
Sodium sulphide	1·00	5	—	—
Potassium ethyl xanthate	0·30	2	—	—
Pine oil	0·24	—	3	Lead float
Sodium silicate	1·00	2	—	—
Oleic acid-sodium hydroxide mixture (1: 1)	1·50	—	4	Fluorspar float

TABLE 15 — FLOTATION USING XANTHATE FOLLOWED BY FATTY ACIDS

Product	Wt. %	Assay		Distribution	
		CaF_2 %	Pb %	CaF_2 %	Pb %
Lead float	3·6	42·00	14·27	3·3	75·3
Fluorspar float	57·1	76·67	0·15	95·3	12·6
Tailing	39·3	1·67	0·21 (calculated)	1·4	12·1
Feed	100·0	45·94	0·68	100·0	100·0

TABLE 16 — REFLOTATION

Product	Wt. %	Assay		Distribution
		CaF_2 %	Pb %	CaF_2 %
Lead float	3·7	37·20	15·15	3·0
Fourth refloat fluorspar concentrate	37·5	96·60	0·06	77·9
Fourth refloat tailing	3·5	73·20	—	5·5
Third refloat tailing	8·3	49·80	—	8·9
Second refloat tailing	5·9	19·50	—	2·5
First refloat tailing	3·3	5·95	—	0·4
Primary tailing	37·8	2·20	—	1·8
Feed	100·0	46·47	—	100·0

TABLE 17— SIEVE ANALYSIS

Size (*mesh*)	Wt. %
+65	0·1
−65+100	5·0
−100+150	17·7
−150+200	19·2
−200	58·0
	100·0

same conditions. The second and third refloat concentrates were also similarly cleaned yielding a final refloat fluorspar concentrate.

The results are given in Table 16. Four cleanings of the rougher float yielded a high grade of fluorspar concentrate assaying CaF_2, 96·6; Pb, 0·06; SiO_2, 3·6; Fe_2O_3, 0·13 per cent and traces of S, with a fluorspar recovery of 77·9 per cent. The recovery would be higher when the various refloat tails are returned to the flotation circuit. The results of sieve analysis of the concentrate are given in Table 17.

By repeated cleanings, the silica content can be reduced to yield a final refloat concentrate conforming to the specifications laid for chemical and ceramic grades of fluorspar.

About 82 per cent of the lead in the ore was recovered in the lead float assaying 15·15 per cent lead. The grade of lead concentrate can be improved by cleaning the rougher concentrate.

Summary and conclusion

The sample of low grade fluorspar from Chandidongri Mines, M.P., assayed CaF_2, 46·25; SiO_2, 49·68; Pb, 0·68; Fe_2O_3, 0·33; Al_2O_3, 1·05; S, 0·12 per cent with traces of $CaCO_3$, Zn and Ba. Quartz was the principal gangue mineral constituting about 50 per cent by weight and was found to be finely interlocked with fluorspar. Cerussite, galena, ochre, felspar and clay were the other gangue minerals present in small amounts.

Tabling after hydraulic classification of the sample ground to −48 mesh produced a combined table concentrate assaying 83·81 per cent CaF_2 with a recovery of only 35·6 per cent.

Flotation after grinding the ore to 37·1 per cent −200 mesh and using tap water produced a concentrate assaying 83·28 per cent CaF_2 with a recovery of 80·5 per cent. There was a loss of 19·5 per cent CaF_2 in the tailing. Desliming the flotation feed did not improve the results. When a finer feed (57·7 per cent −200 mesh) was employed, the tailing loss was reduced to 10·5 per cent CaF_2.

Use of distilled water and lesser quantity of reagent reduced the tailing loss to 1·7 per cent. Flotation was much faster than before and a larger quantity, though of a slightly poorer grade (73·43 per cent CaF_2), floated in lesser time. Flotation was still faster when the temperature of the flotation pulp was maintained at 55°-60°C. The reagent consumption was reduced considerably for almost the same grade of concentrate. One lb. sodium carbonate and 2 lb. sodium silicate per ton of ore were found to be the optimum quantities of modifying agents to obtain the best results.

Flotation of lead followed by flotation of fluorspar yielded a lead float assaying 8·2 per cent lead and 51·0 per cent CaF_2 with a recovery of 85·6 per cent lead. The loss of fluorspar was reduced to 3·3 per cent CaF_2 in a product assaying CaF_2, 42·0 and Pb, 14·27 per cent when sodium silicate was added in two stages, i.e. before lead removal and before fluorspar flotation. The rougher fluorspar float assayed 76·67 per cent CaF_2 and 0·15 per cent Pb with an improved recovery of 95·3 per cent CaF_2.

Flotation of lead followed by cleaning the rougher fluorspar concentrate four times yielded a refloat concentrate assaying CaF_2, 96·6; Pb, 0·06; SiO_2, 3·6; Fe_2O_3, 0·13 per cent and traces of S, with an actual recovery of 77·9 per cent CaF_2 and a higher expected recovery. By further cleanings it should be possible to reduce further the silica content to yield a final concentrate conforming to the specifications laid for chemical and ceramic grades of fluorspar.

The lead concentrate assayed 15·15 per cent Pb and 37·2 per cent CaF_2 with a lead recovery of about 82·5 per cent.

Acknowledgement

The authors' thanks are due to Dr. B. R. Nijhawan, Acting Director, for his interest, Shri V. S. Sampath of Chemical Division for chemical analyses, Shri N. N. Subrahmanyan for petrological studies and Shri R. Chandrasekharan, Government of India Trainee, and Shri G. P. Mathur for assistance.

Bonding Characteristics of Rajasthan Bentonite

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The bonding characteristics of a sample of bentonite from Rajasthan have been determined. Optimum strength, permeability and shatter index values are obtained by working at about 2 per cent moisture content for green sand moulding and at about 5 per cent for dry sand moulding.

Mixtures of bentonite and Rajmahal sand containing 5 per cent of the former are suitable for light and medium steel castings in the green and dried conditions.

A SAMPLE of Rajasthan bentonite was received from Messrs Tata Locomotive & Engineering Co. Ltd., Tatanagar, to study its bonding characteristics. The sample was in the form of lumps 2-3 in. in size. As received, the sample was pale yellow in colour and contained 7-7·5 per cent moisture. The sample was crushed to *c.* ½ in. size in a jaw crusher and then in a hammer mill. The −10 mesh product from the hammer mill was finely ground in the pulverizer. Bulk of the powdered product passed through a 200 mesh sieve. The finer fraction was used in the investigation.

Materials and methods

Standard methods specified by the American Foundrymen's Society[1] for sand testing were employed, using Dietert sand testing equipment.

Chemical analysis of the bentonite was carried out after sampling and drying at 110°C.

Refractoriness of the sample was adjudged by the standard Pyrometric Cone Equivalent test[2] and the fusion temperature was checked by the ' Pyro ' optical pyrometer.

The specific gravity of the sample was determined as per A.S.T.M. Standards[3].

Swelling characteristics of the sample were assessed by the Fullers' Earth Union method[4] which consists in vigorously shaking different quantities of bentonite with 10 ml. of distilled water in separate test tubes and allowing the contents to settle for 24 hr. The minimum weight of bentonite required to form a complete thixotropic gel was thus determined. The quotient obtained by dividing the volume of water by the weight is expressed as the swelling index.

The *p*H values were determined on suspensions containing 1·5 g. of dried bentonite in 100 ml. distilled water, the readings being taken immediately after suspension and after allowing them to stand for 24 hr. to obtain equilibrium values.

Bonding characteristics of the sample were investigated by preparing synthetic sand mixtures with washed Rajmahal sand as base, employing 5 per cent additions of the bentonite. The results of sieve analysis and cumulative gradings of the washed Rajmahal sand are given in Fig. 1. Grain shape of the base sand was mostly sub-angular to round (Fig. 2).

The synthetic sand mixtures were prepared by mixing washed Rajmahal sand (2000 g.)

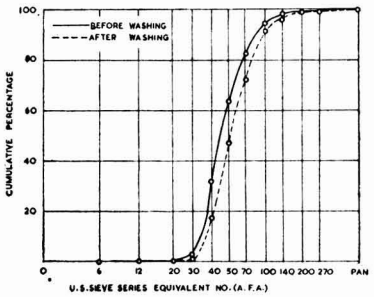

FIG. 1 — CUMULATIVE GRADING OF RAJMAHAL SAND

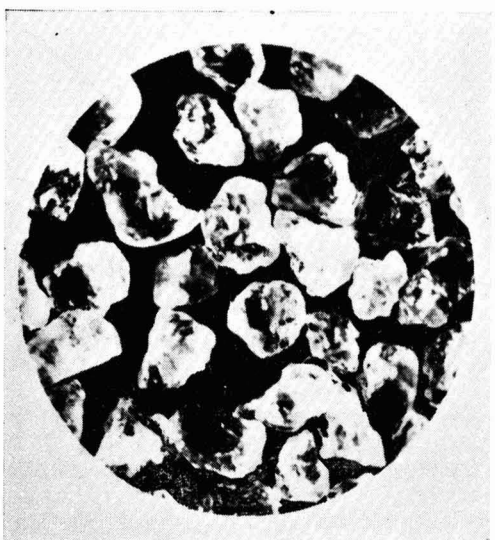

FIG. 2 — WASHED RAJMAHAL SAND RETAINED ON 50 MESH SHOWING SUB-ANGULAR TO ROUNDED GRAINS × 30

with Rajasthan bentonite (100 g.) in an 18 in. Simpson laboratory sand mixer.

The base sand was first milled dry with the bentonite addition for 2 min. with scraping after 1 min. The requisite quantity of water was then added to the sand mixture in the muller and milling continued for further 5 min. with scraping after 2 and 4 min.

The milled sand mixtures were aerated, allowed to stand in airtight jars for 3 hr. and then tested for different physical properties.

All physical properties are averages of three tests.

Casting characteristics of the sand mixture were studied by casting 3 × 3 × 3 in. test blocks in steel. The cast blocks were examined for surface characteristics and any other defects attributable to the sand mixture.

Results

The results of chemical analysis of the bentonite as received and after processing by the ore-dressing methods are given in Table 1.

The sample had a specific gravity of 2·428 and showed a swelling index of 5·56.

Suspensions of 1·5 g. samples of the bentonite in 100 ml. of distilled water were distinctly alkaline. The *p*H value immediately on preparation of the suspensions was 9·2 and after allowing to stand for 24 hr., 7·7. The values recorded were at 34°C. when distilled water showed a *p*H of 7·1.

The fusion point of the sample determined by standard P.C.E. test was 1180°C. corresponding to Orton Cone 5.

TABLE 1 — CHEMICAL ANALYSIS OF RAJASTHAN BENTONITE

CHEMICAL CONSTITUENT	AS RECEIVED	AFTER PROCESSING BY ORE-DRESSING METHOD
SiO_2, %	52·93	48·00
Al_2O_3, %	20·87	17·76
Fe_2O_3, %	8·80	8·20
TiO_2, %	—	2·24
CaO, %	0·75	1·20
MgO, %	2·38	1·20
Na_2O, K_2O, %	1·48	1·52
Loss on ignition, %	13·87	20·20

Bonding characteristics

The bonding characteristics of the sample were determined by making synthetic sand mixtures of washed Rajmahal sand of A.F.S. fineness No. 46 as the base sand with 5 per cent additions of Rajasthan bentonite as binder. Mixtures of this composition were susceptible to variations in moisture content. At 1·4 per cent moisture, a maximum green compressive strength of 8·9 lb./sq. in. was obtained, while at 5·2 per cent moisture the sand mixture possessed a green strength of only 3·2 lb./sq. in. Permeability was at its peak value (240) at 2·1 per cent moisture whilst at 5·2 per cent moisture it was 160. The flowability was fair throughout the moisture range studied. The shatter index was 49·39 at 1·4 per cent moisture and the value came down to 22·86 at 5·2 per cent moisture. The dry strength increased steadily from

TABLE 2 — BONDING CHARACTERISTICS OF RAJASTHAN BENTONITE

[5% *addition to washed Rajmahal sand* (*A.F.S. fineness No.* 46) *as base*]

Moisture content, %	1·4	2·1	3·0	3·6	4·8	5·2
A.F.A. green permeability, No.	230	240	220	195	170	160
Green compressive strength, lb./sq. in.	8·9	6·3	4·8	4·0	3·4	3·2
Green shear, lb./sq. in.	2·0	1·5	1·2	0·9	0·8	0·7
Mould hardness	87	83	80	78	73	66
Flowability	78	78	78·5	78	82	77
Shatter index	49·39	34·36	31·76	30·59	27·43	22·86
Dry compressive strength, lb./sq. in.	32	41	55	73	84	94
Dry shear, lb./sq. in	6·0	8·9	12·1	18·0	23·0	25·0
Relative density	1·524	1·524	1·553	1·553	1·592	1·621

A.F.S. standard 2×2 in. test pieces rammed by 3 blows were used for all the tests except in the case of the shatter test where the specimens were rammed by 10 blows.

The test pieces used for determination of dry strength values were dried in the Dietert core baking oven for 2 hr.

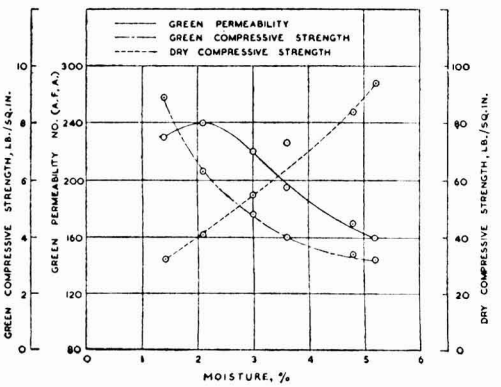

FIG. 3 — BONDING CHARACTERISTICS OF RAJASTHAN BENTONITE

TABLE 3 — CRUSHING STRENGTH AFTER EXPOSURE TO ATMOSPHERE

(*Results obtained on A.F.S. standard test pieces rammed by* 3 *blows*)

TIME OF EXPOSURE *hr.*	CRUSHING STRENGTH *lb./sq. in.*
0	4·8
½	7·0
1	8·0
2	9·3
3	14·1
4	19·0
5	25·0
24	46·0

Initial moisture content to which the above sand mixture had been tempered was 3·0%.

32 lb./sq. in. at 1·4 per cent moisture to 94 lb./sq. in. at 5·2 per cent moisture. The mixture rammed hard in the specimen tube, the maximum hardness being 87 at 1·4 per cent moisture.

The results are given in Table 2 and graphically represented in Fig. 3.

The sand mixture was also studied for the air setting properties of the bentonite by exposing the rammed test pieces to laboratory atmosphere and then testing them for compressive strength at regular intervals of exposure. The crushing strength values are given in Table 3.

The green strength of the sand mixture was nearly doubled after exposure to the atmosphere for 1 hr. and raised 10-folds the original value after 24 hr. exposure.

Casting characteristics

The sand mixtures containing washed Rajmahal sand as base and 5 per cent additions of Rajasthan bentonite, both in the green and dried conditions, gave cast test blocks with smooth surfaces. No signs of burning on were observed and the sand layers peeled off comfortably. The pattern stripped well from the mould, after ramming.

Summary

The bonding characteristics of a sample of Rajasthan bentonite from Rajasthan have been determined. After preliminary processing the sample assayed silica, 48; iron oxide, 17·76; and alumina, 8·2 per cent. The fluxing constituents present in the sample were lime, 1·2; magnesia, 1·2; and alkalies, 1·52 per cent.

The bonding characteristics of washed Rajmahal sand containing 5 per cent bentonite showed appreciable variation with moisture content. Optimum strength, permeability and shatter index values are obtained by working at about 2 per cent moisture content for green sand moulding and about 5 per cent for dry sand moulding. If knocked out sand is also incorporated in the sand mixture, as is generally practised in foundries, 3 per cent additions of the bentonite are sufficient to maintain strength of the sand mixture at the requisite level.

Test castings of steel obtained by using moulds of this mixture had smooth surfaces without having any signs of burning on.

The bentonite may, therefore, prove suitable for light and medium steel castings both in the green and dry sand practice. The green sand mould can be used to advantage after 2-3 hr. exposure to the atmosphere.

Acknowledgement

The authors wish to thank Messrs Tata Locomotive & Engineering Co. Ltd., Tatanagar, for providing necessary raw materials. Their thanks are also due to Mr. N. G. Banerjee of Chemical Division for doing the chemical analysis of the sample.

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Letters to the Editor

PROPAGATION OF *RAUVOLFIA SERPENTINA* IN JAMMU & KASHMIR

Rauvolfia serpentina (*Apocynaceae*), WELL-known for its hypotensive and sedative properties, is in great demand and the supply from the present wild sources, unless supplemented by organized cultivation in suitable areas, will be soon exhausted or become totally inadequate to meet the demand. The cultivation of *R. serpentina* on an experimental scale has been taken up in U.P., Bombay, Bihar, Bengal and Jammu and Kashmir State. In the last mentioned State, experimental cultivation was started in 1954 at Jammu (altitude, 900 ft.) from root cuttings procured from the National Botanic Garden, Lucknow. It is now proposed to extend the cultivation into other areas and for this purpose it has become necessary to propagate the plant from seed. However, as the percentage of seed germination is low, propagation from seeds on a commercial scale has not so far been successful.

To find the cause for the low germination, seeds were procured from 8 different sources and classified by the 'float-and-sink' method into (1) 'light' seeds: floating on water;

TABLE 1 — GERMINATION AND GROWTH BEHAVIOUR OF *R. SERPENTINA* SEEDS FROM DIFFERENT SOURCES

SOURCE	% OF EACH CLASS			% GERMINATION			TOTAL GERMINATION %	HEIGHT OF PLANTS *in.*
	Light	Medium	Heavy	Light	Medium	Heavy		
Calcutta (Indian Botanical Garden)	49·5	5·7	44·8	3·8	8·3	9·6	6·7	6·5
Haliyal (Research Range Officer, Haliyal)	36·3	7·3	56·5	4·0	9·8	12·0	8·9	11·0
Kulgi Range N.S. (Janara Div., Haliyal)	34·3	6·7	58·9	3·3	6·4	10·4	7·7	6·7
Dehra Dun (Pratap Nursery & Seed Stores)	16·2	25·9	58·0	5·3	24·0	27·1	22·8	12·6
Lalega (Range Officer)	62·4	32·8	4·8	1·1	14·3	35·9	7·1	16·3
Dehra Dun (Forest Research Institute)	28·0	10·7	61·3	9·5	16·1	15·2	13·7	16·7
Mungpoo (Medicinal Plantations)	52·0	17·0	31·0	—	—	13·7	13·7	19·2
Jammu (Drug Research Institute Nursery)	67·0	16·0	17·0	—	18·8	35·3	9·0	5·0

(2) 'medium' seeds: sinking in water, but floating on 10 per cent sodium chloride solution; and (3) 'heavy seeds': sinking in 10 per cent sodium chloride solution. The three categories of weight-classified seeds from different sources were sown separately and the percentage of seed germination and growth behaviour of seedlings were studied. The results are given in Table 1.

It will be seen from the tabulated results that about 44 per cent of the seeds floated on water; the floats were mostly empty seeds or shrivelled embryos and the percentage of germination was only 2. Seeds of the other two classes contained normal embryos. The percentage of germination was greatest (about 20 per cent) in seeds which sink in 10 per cent brine solution. The germination in seeds which floated on brine but sank in water was nearly 12 per cent. It would appear that besides sterility, there are also other causes which contribute to the low percentage of germination.

The roots of 1 year, 2 years and 3 years old plants were analysed for their total alkaloids. It was found that the alkaloid content of the roots of 1 year old plants (1·6 per cent) was only slightly less than that of 2 and 3 years old plants (1·7 per cent).

The results indicate that *R. serpentina* can be grown in Jammu and Kashmir State and its large-scale propagation from seeds is possible provided the seeds are properly selected.

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9 March 1957

CONCENTRATION OF PALM JUICE WITH SOLAR ENERGY

Date, palmyra, coconut and sago are the four varieties of sugar-yielding palms that are grown in India with a total palm population estimated at over 190 million trees[1]. Palm trees are grown on non-agricultural land, along river banks, on sandy lands, in coastal areas, etc. To check fermentation the farmer collects *neera* (palm juice) in limed pots. After lime removal the clarified juice has to be concentrated within 24 hr. of its collection by heating in flat shallow iron trays into jaggery or unrefined sugar of high mineral and vitamin content. On account of its habitation in regions deficient in fuel the farmer has to depend mostly on dried leaves and twigs and uses wood, coal or soft coke as additional fuel. However, in most places where palms grow in abundance, plenty of sunshine is available during the tapping season. Depending upon the quantity of juice available, sunshine may be utilized as a supplementary source of energy for concentrating clarified juice directly into palm *gur* or into a thick syrup of over 65° Brix, wherever cheap fuel is insufficient or in short supply.

Incident solar energy is too diffuse for practical heating processes and, therefore, it has to be concentrated before use. Of the three different methods of concentrating solar heat, namely lenses, glass mirrors and metallic reflectors, plane glass mirrors were preferred on account of cheapness and ease of availability and were used in the development of three different types of solar energy concentrators[2] in this laboratory. The multi-reflector type of concentrator with nine plane-mirror reflectors arranged in a semicircle has been used presently to concentrate solar heat for evaporating palm juice.

The results of concentrating palm juice by direct solar heating and with the help of concentrator are shown in Fig. 1. In the first experiment 6 lb. of palm juice were taken in a shallow open tray, 4 by 1½ ft. Area in contact with juice was painted black and the tray was kept in the open and was exposed to solar radiations with occasional stirring. The increase in percentage of sugar in the juice with time is represented by

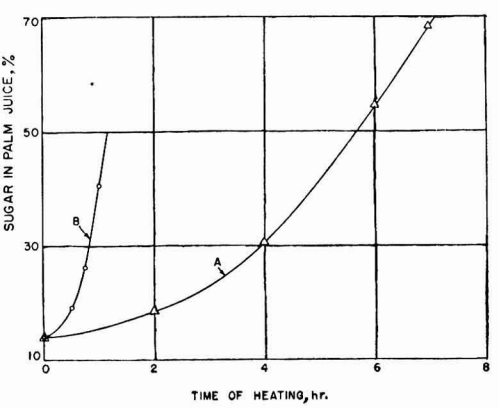

Fig. 1 — Evaporation of palm juice by (A) direct and (B) concentrated solar heat

TABLE 1 — EVAPORATION OF PALM JUICE BY CONCENTRATED SOLAR ENERGY

[*Ambient temp. (max.)*, 88°*F.*; *humidity*, 78-80%; *solar energy, approx.* 11000 *B.t.u./hr.*]

Date May 1955	Initial weight of palm juice *lb.*	Wt. of water evaporated *lb.*	Quantity evaporated *lb./hr.*	Time *hr.*	Remarks
26	20	15·3*	2·20	7	Clear day with occasional clouds
27	25	22·0	3·66	6	do
29	32	28·0	4·00	7	Clear day
30	50	34·5*	4·14	8	do
31	41	31·0*	3·87	8	Cloudy towards morning and afternoon

*Values for thickened syrupy fluid, which would require further concentration.

curve A. In the second experiment an equal quantity of juice in another tray of exactly same dimensions was heated from below with concentrated solar heat. The change in sugar content is shown by curve B.

From Fig. 1 it is clear that with collection of solar energy from a larger area and by the use of concentrators, palm juice is concentrated more quickly than by the direct solar exposure. This makes it possible to handle larger quantity of juice during the same period. The temperature in the tray can easily be controlled by putting one or more reflectors ' out of focus '. With slight extra care it is possible to obtain the final product free from ash, materials formed due to overheating and smoke smell.

Preliminary experiments on evaporation of palm juice were conducted at the Palm Gur Technological Institute, Dhanu. The evaporating pans used in the field trials were the same as commonly used in villages. Eight reflectors, each of 7 sq. ft. area, were used. The results of five field trials are given in Table 1.

The major source of heat loss in these experiments was high wind velocity. High humidity prevailing at the time of experiment also tended to reduce evaporation. A simple calculation shows that in the field experiments an overall efficiency of about 30 per cent was obtained. It compares favourably with the figures of fuel consumption obtained for juice evaporation using an improved type of furnace. With properly constructed furnace it should be possible to raise the efficiency to about 50 per cent.

The cost of a single reflector and of a multi-reflector type of concentrator, when used for processing clarified palm juice either to a thick syrup of over 65° Brix or directly into palm *gur*, has been discussed in detail earlier[3]. It is estimated that by working for three successive tapping sea of three months each and by processing 25-30 gal. of clarified juice the capital cost of concentrator can be recovered. In coconut areas the tapping season lasts about six months; the period for which the concentrator is to be used for recovery of its capital cost would be reduced to nearly one-half.

Fuller details about this type of concentrator are being published in a forthcoming paper.

The author takes this opportunity of thanking the Palm Gur Adviser to the Government of India for providing him facilities to conduct field trials at the Palm Gur Technological Institute, Dhanu.

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