

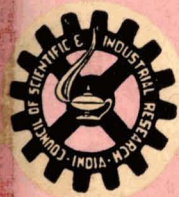
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PHYSICAL SCIENCES

Gamma-ray absorption
coefficients for Co⁶⁰

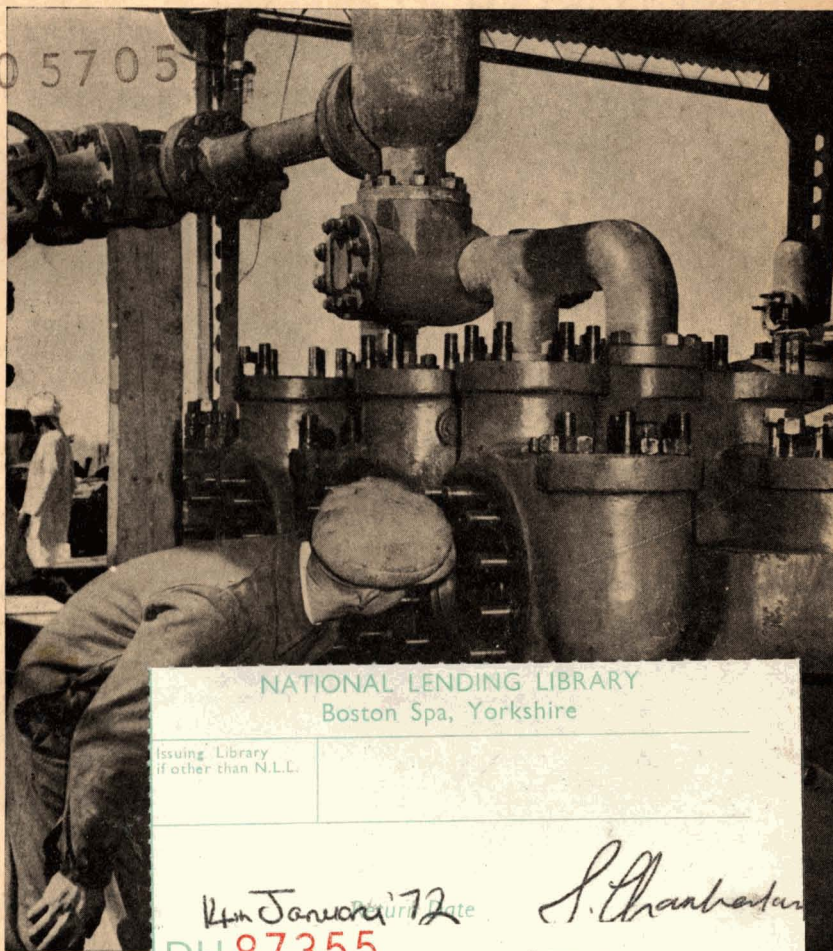
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C. BIOLOGICAL SCIENCES

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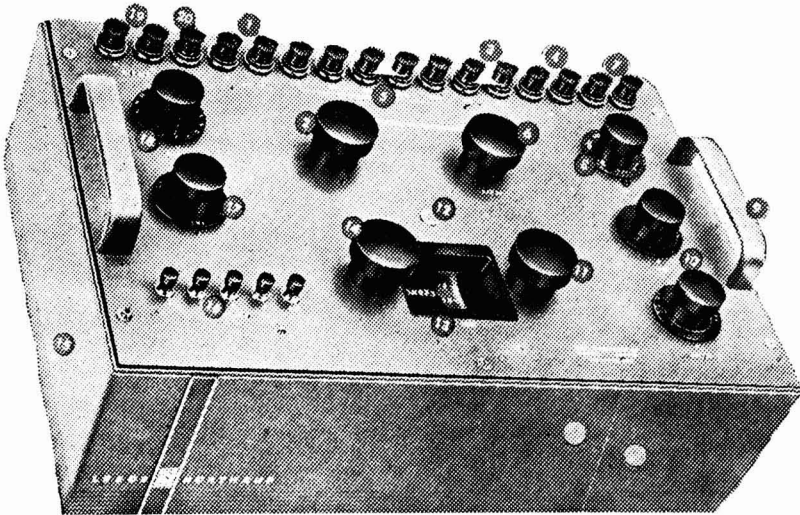
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Geological investigations and seismological surveys in various parts of India in connection with the exploration for petroleum resources indicated that Jwalamukhi area in the Punjab has oil-bearing rocks at a depth of 8 to 9 thousand feet. The cover picture shows a part of a drilling machine being used in drilling operations at Jwalamukhi.

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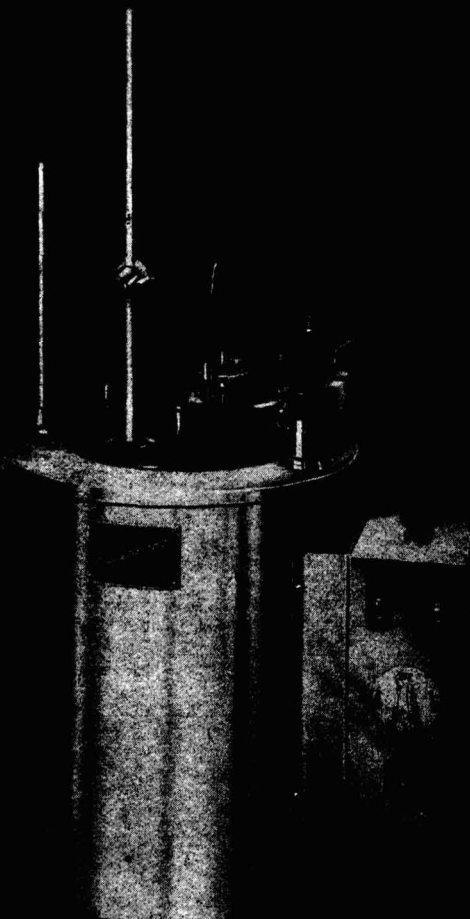
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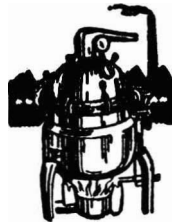
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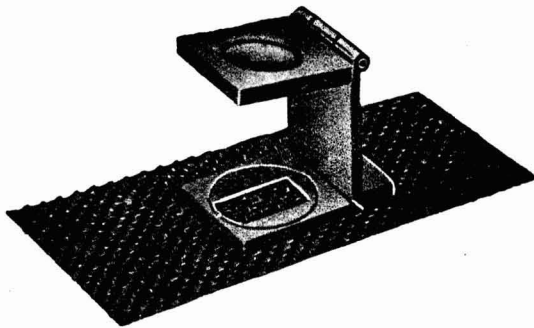
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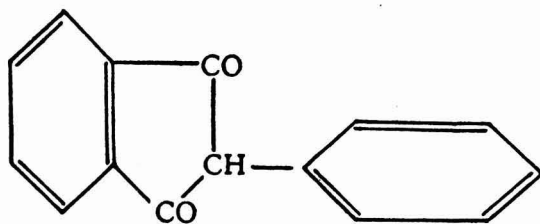
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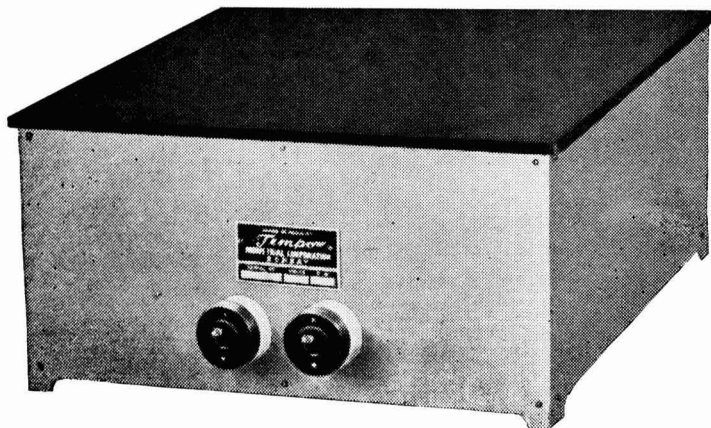
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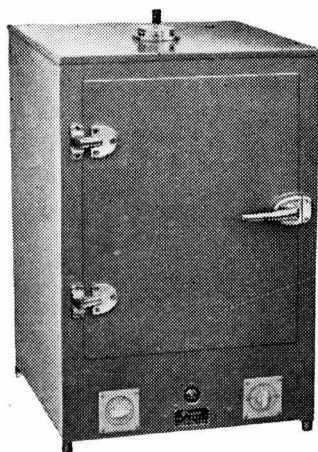
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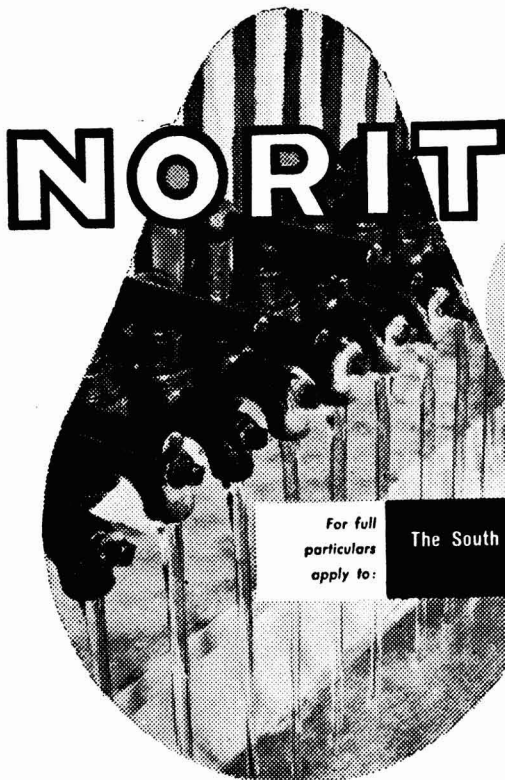
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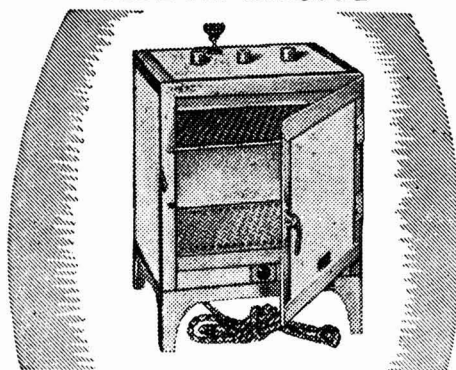


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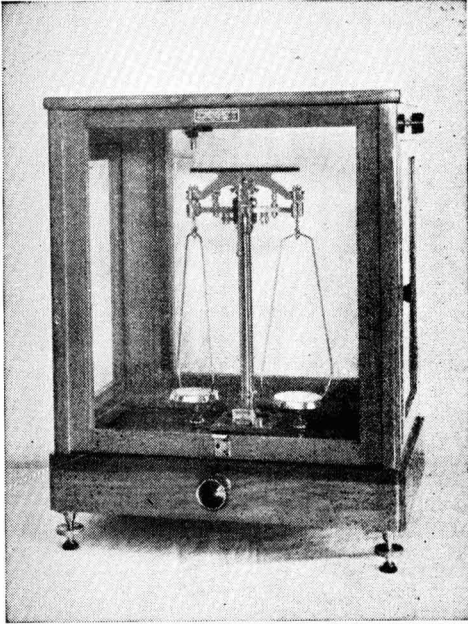
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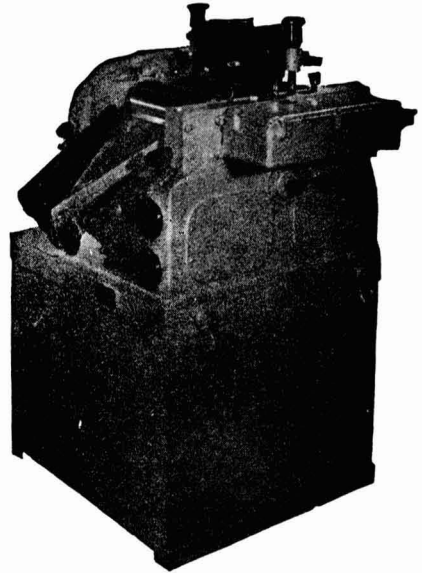


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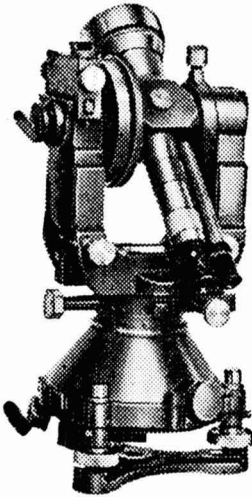
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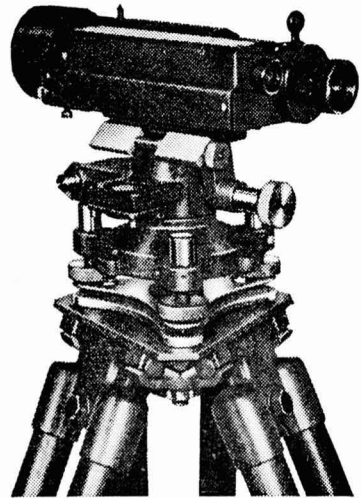
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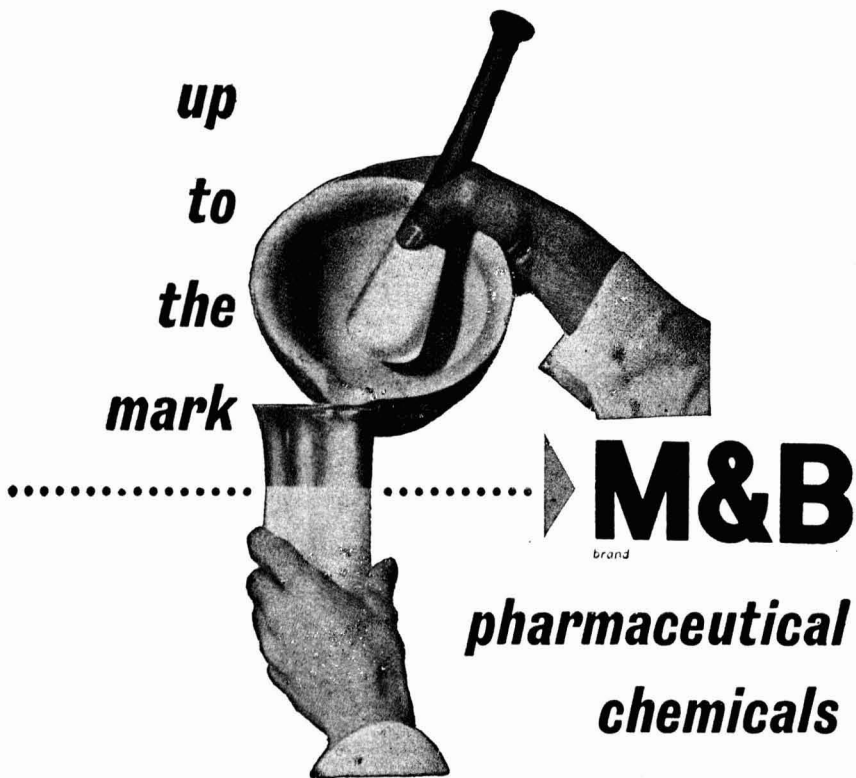
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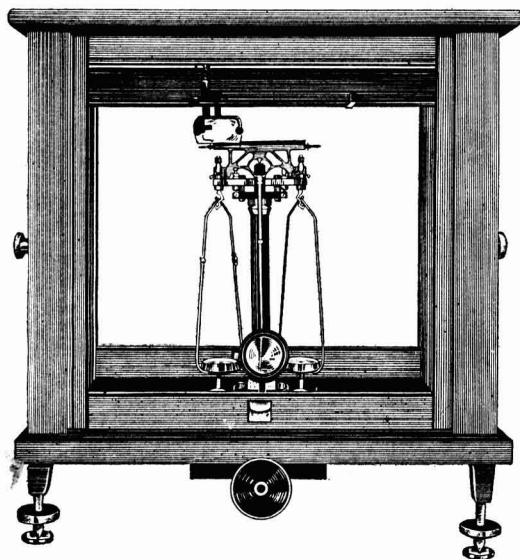
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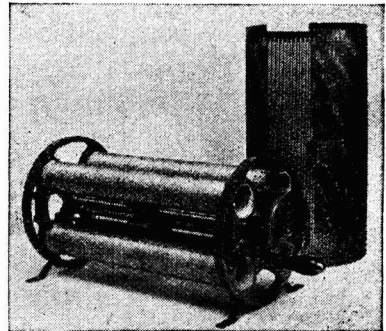
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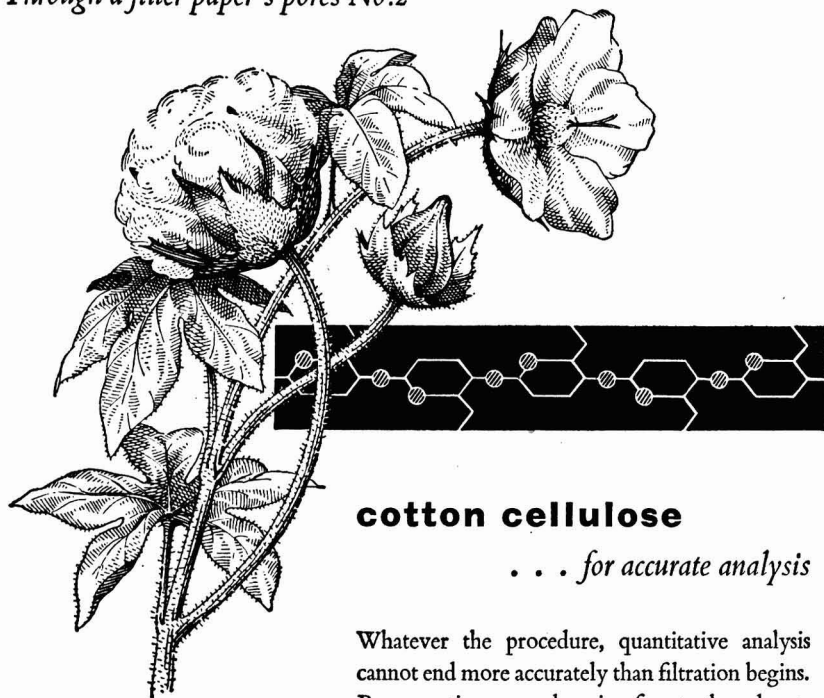
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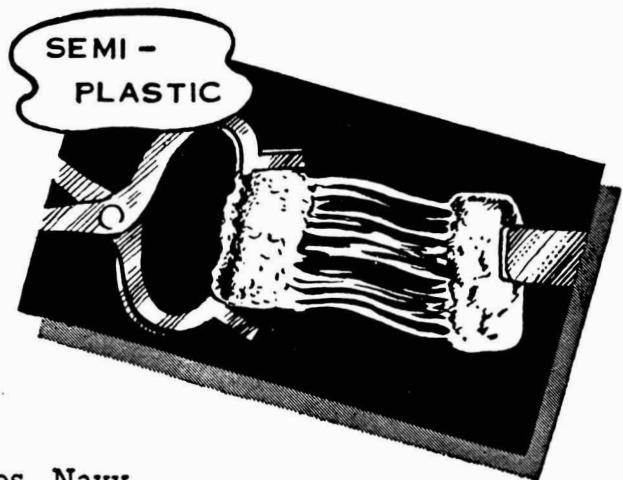
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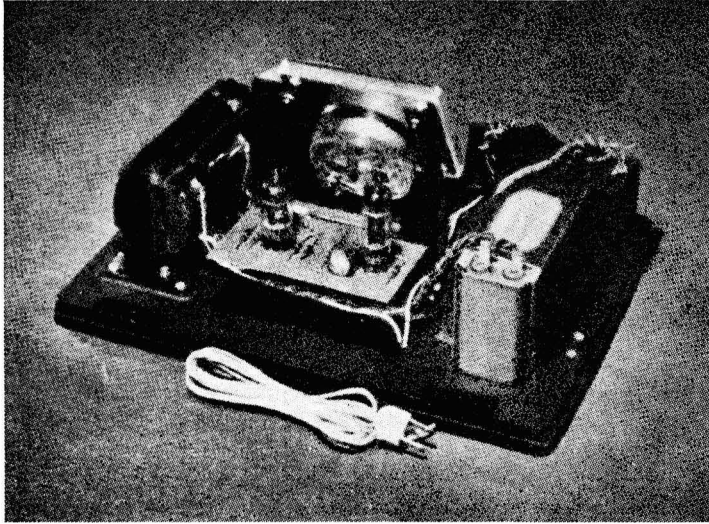
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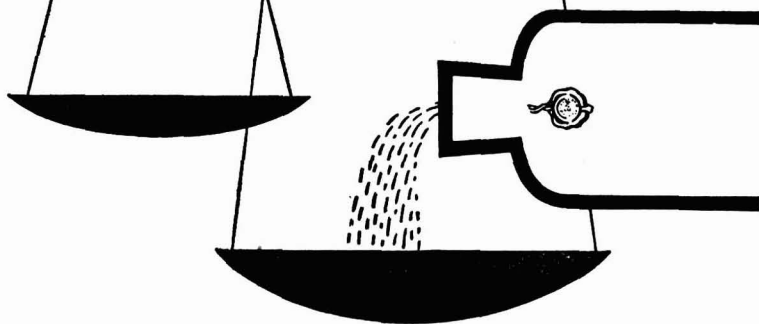
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The International Geophysical Year: 1957-58 — World Programme

A. P. MITRA

Secretary, Indian National Committee for the IGY, National Physical Laboratory, New Delhi

THE International Geophysical Year, which began on 1 July 1957, and will last till 31 December 1958, was conceived at an informal gathering of geophysicists in U.S.A. during April 1950, when the American physicist Dr. L. V. Berkner suggested a repetition of the polar years. The proposal was placed before the session of the Mixed Commission on the Ionosphere (CMI) at Brussels in 1950, which recommended that the Third International Polar Year should be organized in 1957/58. The recommendation of the CMI was approved successively by the International Council of Radio Union (URSI) and the International Astronomical Union (IAU) in 1950; by the International Union of Geodesy and Geophysics (IUGG) and the World Meteorological Organization (WMO) in 1951; by the International Geographical Union (IGU) in 1952; by the International Union of Pure and Applied Physics (IUPAP) in 1953; and by the International Union of Biological Sciences (IUBS) in 1954. In 1952, ICSU appointed a special committee of the International Geophysical Year (CSAGI) to plan the programme of this enterprise. The CSAGI's first task was to invite the national bodies affiliated to ICSU to form national IGY committees. It held its first formal meeting at Brussels in July 1953 when 21 national committees (which included India) presented reports and proposals for the IGY. Since then considerable planning has been made regarding the international programme in which 64 countries have now joined.

Purposes of the IGY

The essential aim of the IGY is to have a fuller understanding of the earth from its interior to the fringe of its atmosphere.

The programmes of the IGY were selected to solve specific planetary problems of the earth. To achieve such solutions, it was decided to supplement the existing facilities of the world by additional observations suitably distributed in space and time.

Problems requiring special attention were selected according to the following criteria:

(a) Problems requiring concurrent synoptic observations at many points involving cooperative observations by many stations; (b) problems whose solution will be aided by the availability of synoptic or other concentrated work in many branches of geophysics during the IGY; (c) observations of all major geophysical phenomena in relatively inaccessible regions of the earth that can be occupied during the IGY because of the extraordinary effect during that interval, to augment basic knowledge of the earth and the solar and other influences acting upon it; and (d) epochal observations of slowly varying terrestrial phenomena, to establish basic information for subsequent comparison during later epochs.

The twelve distinct fields in which the programme has been divided by the CSAGI can be broadly classified as follows:

(i) The interior and surface of the earth, involving fields of geomagnetism, latitudes and longitudes, glaciology, oceanography, seismology and gravimetry;

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World Meteorological Interval

JANUARY 1958

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①

Regular world day

⑫

Day of total eclipse

APRIL 1958

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⑩
Regular world day at new moon

JULY 1958

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⑬
Regular world day with unusual meteoric activity

OCTOBER 1958

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DECEMBER 1958

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⑧
Unusual meteoric activity (but not world day)

(ii) the atmosphere of the earth from the ground to the exosphere, involving fields such as meteorology, aurora and airglow and ionosphere; and

(iii) extraterrestrial sources that affect the earth and its atmosphere (e.g. solar radiation, cosmic rays).

Station distribution

It was realized that an adequate description of the earth and its atmosphere could only be achieved if the observation stations are carefully distributed. As in the First and Second Polar Years, special emphasis has been laid on the Arctic and Antarctic regions. There will be 159 stations in the Arctic and 40 stations in the Antarctic. There is also emphasis on the equatorial belt since in that area observational coverage has been insufficient in the past. Special meridians have been selected along which station distribution will be particularly numerous. These are the meridians 70°-80°W. (from the North Pole through Canada, along the eastern U.S. coast, the west coast of Latin America to the South Pole), 10°E. (Scandinavia, middle Europe, Africa, and part of the Atlantic Ocean), and 140°E. (through Alaska and the Pacific Ocean).

Many of the geophysical phenomena, such as geomagnetism, aurora and airglow, ionosphere and cosmic rays, depend on the geomagnetic co-ordinates of the station. The earth has, therefore, been divided into a number of zones, as follows:

		<i>No of stations</i>
1. Arctic Region	$\phi > 60^{\circ}\text{N.}$	169
2. Northern Subauroral Belt	$\phi > 45^{\circ}\text{N.} < 60^{\circ}\text{N.}$	323
3. Northern Minauroral Belt	$\phi > 20^{\circ}\text{N.} < 45^{\circ}\text{N.}$	322
4. Equatorial Belt	$\phi \leq \pm 20^{\circ}$	224
5. Southern Minauroral Belt	$\phi > 20^{\circ}\text{S.} < 45^{\circ}\text{S.}$	109
6. Southern Subauroral Belt	$\phi > 45^{\circ}\text{S.} < 60^{\circ}\text{S.}$	35
7. Antarctic Region	$\phi > 60^{\circ}\text{S.}$	40

The total number of stations is more than 1000. In addition, there are 2000 or more permanent meteorological stations spread over the entire globe. Station distribution in the different disciplines is: Geomagnetism, 278; aurora, 225; airglow, 50; ionosphere, 294; solar activity: (a) optical observations, 88; (b) solar noise observation,

49; cosmic rays, 129; latitudes and longitudes, 75; glaciology, 84; oceanography, 250; rockets, 43; seismology, 335; and gravimetry, 184.

World Days and alerts

While it is important that stations should be as widely distributed as possible, it is equally important that observations should be simultaneous and sufficiently frequent on special days. During the IGY the observations will be intensified on the following special days: (1) Regular World Days (RWD), (2) World Meteorological Intervals (WMI) and (3) Sudden World Intervals (SWI).

The first two have been selected in advance. The RWD's have been chosen so that each month two of them would fall at new moon, and the others at times of unusual meteor showers or near one of the lunar quarter phases. These will also include the day of each solar eclipse and also adjacent days for control observations.

The WMI's are series of ten consecutive days at the solstices and the equinoxes. Special programmes in meteorology will be undertaken during this period.

The SWI's, however, cannot be determined in advance. They are to be selected on the basis of certain unusual phenomena, such as enhanced solar activity, magnetic storms, etc., which will occur. SWI will be preceded by an 'alert' to warn observers of the likelihood of the unusual outbreak of magnetic, auroral and ionospheric disturbances, as judged from observations on solar activity. The messages will be distributed throughout the world through these agencies and the WMO telecommunication networks. The time stations such as WWV, WWVH, JJY, etc., are also co-operating in this distribution. Distribution of the messages inside the country is the responsibility of the participating country. Since the success of the SWI's depends to a large extent on reception of these messages in time by all the IGY stations, the Warning Service was initiated and tested to satisfaction as early as January 1957.

Interior and surface of the earth

A major portion of the IGY programme concerns the study of the physical structure of the earth, covering subjects such as geomagnetism, latitudes and longitudes, oceanography, seismology and gravity.

Geomagnetism — The main objective of the IGY programme on geomagnetism is to study magnetic storms, magnetic pulsations and the daily magnetic variations.

The overhead electric current systems in high latitudes, especially along the auroral zones and across the enclosed polar caps, are rather complex and variable. This makes it difficult to plot the overhead currents unless magnetic data are available from many stations in these regions. During the IGY a close network will be achieved by operating auxiliary stations, whose purpose is to determine the space gradients of the magnetic field at the existing stations. Such measurements will be made at high latitudes and also near the magnetic equator. The latter would be valuable in the investigation of the 'electrojet'. These measurements would be supplemented by rocket exploration of the earth's magnetic field. While the rocket method has the drawback of the brevity of the record, it is of great value in the study of the S_q -current system and will be used in recording the field changes along the auroral electrojet.

The rapid pulsations of the earth's field, which sometimes affect only a limited region of the earth and are at other times simultaneous and worldwide, will be especially studied during the IGY.

The regular daily variations of the geomagnetic field, caused by the sun and the moon, is well understood, but our knowledge of the associated electric current systems in the ionosphere needs to be improved.

Latitudes and longitudes — The basic objectives of this programme are: (i) improvement of the determination of terrestrial time; (ii) more precise determination of irregularities of the earth's rotation; and (iii) an improvement of the star catalogue.

A network of about 40 stations [including 21 permanent observatories associated with the Bureau International de l'Heure (BIH)] will attempt to determine very precisely the astronomical co-ordinates of the observatories and their variations. The BIH will continue its normal service of giving the definitive time, in terms of Universal Time (U.T.), from the collective results of the various time services.

There will be a new lunar observation programme with equipment consisting of dual-rate cameras which hold the moon fixed relative to the stars during a simultaneous

time exposure by means of a central dark filter which can be tilted. Twenty stations will participate in this lunar campaign, and it is expected that, with this campaign, the uncertainties in the distance between continents will be reduced to about 90 ft. The new technique adds greatly to the precision with which changes in the speed of rotation of the earth can be measured, and will shed new light on the inner constitution of the earth.

Glaciology—Glaciological bases established in about 45 places will study the extent of glaciers and snow cover on earth, and of their effects upon the general weather pattern. Glacier studies indicate that if the present cycle of warming continues for 25 to 50 years, most of the ice of the Arctic Ocean will melt making it navigable and increasing the sea level appreciably. The importance of glaciology may be realized from the fact that the estimated volume of the ice of the earth is 21,740,000 cu. km. equivalent to a sheet of water 54 m. thick. Considerable emphasis will be placed on the study of glaciers in the polar regions, particularly of the Antarctic. In the Antarctic observations are planned on all geophysical aspects of the ice sheet and shelf ice and the various practical aspects which determine the relative efficiency of operations on its glacial terrain. On selected glaciers in many parts of the world, particular note would be made of ablation, accumulation, movement, change of mass, and radiation effect. In addition, where detailed work cannot be carried out, reconnaissance observations of glacier variations would be made on as many glaciers as possible.

Oceanography — The oceans, which form two-thirds of the earth's surface, play a critical part in the life on the earth. During the IGY an intensive study of the oceans has been planned. The principal aims are to improve the present understanding of the short and long period changes in sea level and of the general circulation of water in the oceans. Sea-level recorders will continue to measure storms and seismic surges, tides and seasonal changes of sea level. The chief value of these measurements will be more effective knowledge of normal and abnormal changes which affect harbours and shipping and cause floods and other damage. Many of the tidal observations are being made in islands near the middle of ocean basins and are now also planned at new places round

the margins. Studies of oceanic circulation include temperature measurements, water sampling and current measurements at all depths along critical ocean traverses. Special attention is being paid to the water and energy exchanges across the equator and between the temperate and Arctic regions.

Seismology — Advantage would be taken during the IGY of the occupation of stations in the Antarctic to study the geological structure and the seismicity of the Antarctic continent: seismicity along the whole length of Victoria Land on the west coast of the Ross Sea has been observed. Seismological stations, already existing, will continue their observations, and artificial earth tremors would be produced by dynamite charges. There are also projects on long phase waves and long period seismic waves.

Atmosphere

Although meteorology is mostly concerned with the lower few kilometers of the atmosphere, scientists have found in recent years subjects of considerable interest in its higher regions. During the IGY, the atmosphere will be studied from the ground to the exosphere by conventional and modern methods and subjects of study will be meteorology, aurora and airglow and ionosphere.

Meteorology — More than a thousand observing stations located in the low country, on the mountains, along the coasts, on weather ships and on whalers, are taking meteorological observations on the ground and in upper air up to heights of 25-30 km. The main objective in this field is to obtain a fuller understanding of the large-scale physical, dynamic and thermodynamic processes of general circulation.

In meteorology, as in other geophysical disciplines, our knowledge of the equatorial phenomena is much less extensive than that of arctic phenomena. Tropical meteorology is important in many ways, influencing, as it does, the flow patterns in the troposphere and in the stratosphere the subtropical jet-stream and anticyclones in relation to atmospheric ozone, and effecting exchange of dynamic and energy properties across the equator and across subtropical latitudes. For the IGY the tropical network has been improved between the parallels 30°N. and S.

Synoptic and dynamic meteorology — The synoptic network, which has been divided

into a number of convenient zonal sections, has programmes of both surface and upper-air observations.

Surface observations include synoptic observations daily at 00.00, 06.00, 12.00 and 18.00 G.M.T. and precipitation observations twice daily every twelve hours. In order to determine the thermal influence of the earth's surface on meteorological phenomena, measurements are being made of the soil temperatures at various depths, of the temperature of the snow surface and of the water surface. Accurate estimations of the cloudiness will be made at a large number of stations for general planetary analysis of radiation data. Daily measurements will be continued of the evaporation in free water surfaces.

Upper-air soundings comprise of two radio soundings (pressure, temperature and humidity) and four radio-wind observations daily. It has been recommended that the soundings should be made to attain occasionally the 10 mb. level, especially in tropical latitudes. These observations will help in the traffic of long-range jet aircrafts which in near future will be flying at altitudes close to the 50 mb. level, and will help to solve the question whether or not solar influences, acting through the ozone layer, affect the development of the weather situation in the adjoining layers.

Physical meteorology — The programme on physical meteorology includes the study of radiation balance, atmospheric ozone, atmospheric electricity, radio meteorology, nuclear radiation in the atmosphere and chemical composition of the air and precipitation.

Radiation measurements include continuous recording of the total incoming radiation from the sun and the sky and where possible, from the sky alone, both on a horizontal surface; measurement of the radiation balance and its various short and long-wave components or of the effective radiation for all wavelengths of a black surface; measurement of the effective long-wave outgoing radiation; measurement of the direct solar radiation, both for selected spectral regions and for the whole spectrum; measurement of the ultraviolet radiation of sun and sky; and recording of sunshine duration.

The ozonosphere (shown in Fig. 1) is believed to transmit solar influences to the lower levels. During the IGY vertical distribution of ozone will be studied by a

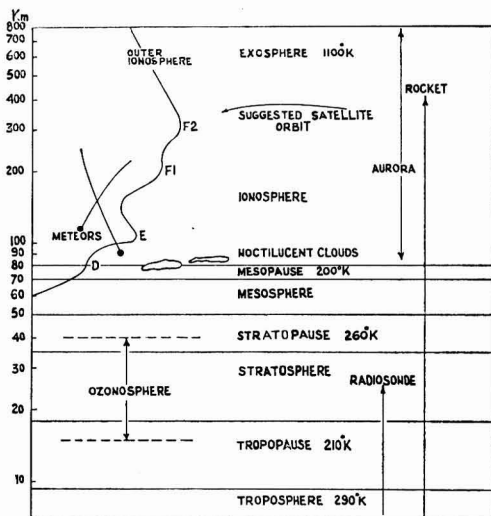


FIG. 1 — ATMOSPHERE OF THE EARTH

network of about 70 stations, particularly to the east and west of subtropical anticyclones between latitudes 15° and 40°N., and on both sides of the subtropical jet-stream.

In the field of atmospheric electricity, studies will be continued on the relations between the electric, thermic and dynamic phenomena of the atmosphere. In addition, the distribution of thunderstorms over the surface of the earth, a knowledge of which will be obtained by radio-meteorological techniques, will provide information on the control of the electric balance of the atmosphere and on the maintenance of the earth's charge.

In recent years it has been possible to locate and track thunderstorm sources from distances of a thousand kilometer and more, by a three-station network, possessing radio-direction finders and receiving atmospheric electricity emitted by the thunderstorm source. This method, known as the sferics method, is being widely adopted during the IGY. Such measurements are being supplemented by observations by radar and meteorological reconnaissance aircrafts. Meteorological factors in the path of microwaves propagation through the troposphere will be actively examined, since the influence of such factors on this propagation appears to be appreciable.

Another interesting programme is the use of radioactive elements as tracers for the study of atmospheric and oceanic movements.

The chemical composition of air and precipitation will also be carefully studied. A wide network of stations, especially on the ocean and coastal regions, will measure CO₂ content of the air and of the oceans. The chemical composition of precipitation and the acidity (pH) and conductivity of precipitation will be studied. Such studies are useful for synoptic meteorology and agriculture as well as for the physics of clouds and hydrometeors, and for geochemistry in general.

Aurora and airglow — The auroral programme, as in the last two polar years, is very extensive and covers more than 200 stations. The aurora, generally visible in polar latitudes at altitudes between 60 and 1000 km., is caused by atomic particles which originate from the active centres of the sun. The airglow is a faint luminosity of the upper atmosphere, emitted all over the world. Particular emphasis has been given to the study of 'Aurora Australis' with thirty-three stations in the Antarctic alone. The main objective of the auroral programme is to study the morphology of the aurora. While naturally the programme will be mostly concentrated in the polar region, the importance of observing tropical auroras has been emphasized. Due to their extreme rarity they are of outstanding scientific interest. A large number of tropical and subtropical stations (including nine in India) is watching for these auroras. In the auroral study in the polar regions, the most modern tools like the recently developed all-sky camera will be employed besides the established radio methods.

The airglow programme includes observations of the day, twilight and night airglow. A network of 50 stations distributed the world over will study the geographical and seasonal variation of its intensity. The airglow stations are distributed along the following special chains: Europe-Africa chain (approximately 10°E.); India-Kashmir chain; Far East chain (approximately 140°E.); and American chain (approximately 80°W.).

Rockets will give a new dimension to airglow research, since day and twilight airglow can only be recorded by them. Artificial sodium airglow will be produced by some rockets by injection into the atmosphere of a small quantity of sodium.

Ionosphere — The ionosphere programme for the IGY consists mainly of: vertical incidence soundings at 176 stations, absorp-

tion measurements at 64 stations, measurements of ionospheric wind at 46 stations, and special observations including radar and visual meteor study, sferics, whistlers, radio auroral studies, ionospheric tides and scatter observations over a wide network. A special feature of the vertical incidence observations is the increased density in the Arctic, the Antarctic and the Equatorial belt. To improve interpretation of records, particularly in the high and low latitude stations, new scaling procedures and new forms of presentation of data (such as f-plots) have been introduced. In most stations the frequency of soundings is four times an hour, to be increased during World Days and SWI's. For problems involving special measurements, 'key stations' have been nominated.

To study ionospheric absorption, pulses will be sent up from ground-based transmitters (terrestrial method) and radio waves from galaxy will be received (extraterrestrial method). The latter method will also be used for the study of auroral absorption and of solar flares. The primary objectives in both methods are to examine the solar control of normal absorption, to study the morphology of winter anomaly and to relate the observations with other geophysical phenomena.

In the high atmosphere drifts have been discovered having horizontal velocities of the order of 80 m/s. in the E region and 100 m/s. in the F region, the F region value sometimes increasing to as much as 300 m/s. during times of magnetic storms. The physical significance of such drifts is still uncertain. While such motions may have been caused by a movement of the surrounding neutral air set in motion by normal meteorological processes, the possibility that the apparent motion may have been produced by a wave motion in the distribution of electrons remains. During the IGY this and other associated topics will be examined by four different methods.

Scatter experiments, which are particularly valuable for inaccessible locations, will be undertaken by a network of 42 stations, of which eleven are in the Arctic region. Both forward and back scatter experiments will be undertaken.

There will also be observations on atmospheric and terrestrial radio noise. The IGY programme will include: measurements of noise at high, medium and low latitudes;

study of solar flares by enhancement of atmospherics, particularly at 27 kc/s.; location of storm centres by the sferic technique; and observations of whistling atmospherics.

Exosphere — While estimates differ as to the region where exosphere begins, it seems possible, from extrapolation of recent rocket results, that this region is not much beyond 500 km. Methods used for studying this region are of recent origin; these include (a) the method of whistling atmospherics, and (b) the method of radioastronomy (e.g. ionospheric absorption of cosmic radio noise; refraction of radio noise from discrete sources). To these will be added during the IGY the artificial satellites.

Both whistlers and radioastronomy methods have indicated larger concentration of electron density in the exosphere than was believed possible. It seems that even at a height of 12,000 km., electron density is as large as 50/ml. During the IGY a wide network of stations will intensify observations on the outer ionosphere using both these methods. The radioastronomical programme will mostly involve measurement of ionospheric absorption using cosmic radio noise but will also include the new technique developed at Manchester based on the long period fading of radio echoes reflected from the moon.

The whistlers will be studied by a network of 27 stations in the northern hemisphere and 16 stations in the southern hemisphere. Several of these are at the extremities of magnetic lines of force and are intended to examine whether or not these atmospherics are propagated along the terrestrial magnetic lines of force.

The most effective method will, however, be provided by the artificial satellites, proposed to be launched by the U.S.A. and the U.S.S.R.

Extraterrestrial sources influencing the earth

Sun — A network of 88 solar and 49 radio observatories will watch the sun during the IGY — when the activity of the sun will reach an unusually large peak, with consequent increase in the number of flares and active sunspot groups. In fact, the beginning of the IGY coincided with an intense magnetic storm and a very large solar flare.

The solar programme is twofold. The first part concerns observations of disturbances in the sun, such as chromospheric

eruptions, calcium plagues, and in the radio frequency region, of solar bursts accompanying flares, for helping the issue of alerts. The second part concerns observations which will be examined or analysed at a later date. Some of the observations serve, of course, both the purposes.

Observations on sunspots on an international basis, which have been going on for a long time, will be continued with a greater density of stations. Fine structures of the spots will be studied for the first time. A special recording of the characteristic calcium plague structures will be undertaken. Stations already studying solar magnetic fields will intensify their work in this field. Flare patrols are being kept with Lyot filters, spectrohelioscopes, spectroheliographs and spectrographs, and by radio methods involving the observations of sudden enhancement of atmospheric and cosmic noise absorption. The Meudon Observatory will continue (and intensify) publication of synoptic maps of the sun with form and development of filaments, extension and intensity of faculae. Photometric measurements of flare and plague indices, still largely unexplored, will be undertaken. Surges, which sometimes accompany solar flares and sometimes occur in the absence of flares, and the active region prominences such as active loops, down-flowing streamers, sprays, eruptives, etc., which often appear above sunspot groups, will be studied. Daily maps will be prepared of the fine structure of the chromosphere as it appears in the wider surroundings of centres of activity. Coronal isophotes will be prepared.

There is, in addition, an extensive network for the observation of solar radio noise over a wide range of frequencies up to 10,000 Mc/s. In this programme both large telescopes and interferometers will be used. At some of the stations (Australia, U.S.A., Japan) sweep frequency observations of the sun will be undertaken.

Cosmic rays—The total number of stations participating in the cosmic ray programme is 129, most of which are now operating. Two types of instruments will be used: Counter telescopes which register the high energy particles of the cosmic rays and ionization chambers which identify particles of lower energy. Balloons will be launched to record cosmic ray intensity at higher altitudes; and several high altitude stations have been estab-

lished. A sequence of stations extending from above 60°N. magnetic latitude to beyond 60°S. is studying the latitude effect of cosmic ray intensity. For problems involving symmetry between the northern and the southern hemispheres, three special longitude bands have been selected. For the detection of particles associated with solar flares and for the study of 24 hr. variations a wide distribution of stations in longitude has been established at many latitudes. The remarkable discovery made recently by the French scientists which showed that cosmic ray intensity varies with sidereal time will receive special scrutiny during the IGY.

Meteors—The meteor programme comes under the purview of the first five disciplines of the IGY, namely World Days, Meteorology, Geomagnetism, Aurora and Airglow, and Ionosphere.

It has already been mentioned that on the IGY calendar certain World Days have been adjusted to coincide with the major meteor showers and with days of unusual meteoric activity. Observations in many fields of geophysical discipline will be intensified on these days.

Meteors, it is believed, play a prominent role in certain ionospheric phenomena. There is considerable evidence that the night time E region is maintained by meteoric ionization and that certain intense meteor showers contribute appreciably to the general ionization of the E layer. It is also believed that, at least on occasions, the irregular clouds of ionization that maintain long distance VHF propagation are of meteoric origin. The Jodrell Bank experimental station in Great Britain has been a pioneer in this field. During the IGY this station will continue to obtain a systematic record of meteoric phenomena and, in particular, to determine (a) wind speeds at E-region heights from measurement of the shift of the ionized meteor trail by a doppler method, and (b) scale heights and densities in the 100 km. region of the atmosphere. While Jodrell Bank has the most extensive programme for the study of meteors, other countries, including the U.S.A., Canada and Australia, are also contributing to this programme.

Rockets and satellites

Rockets—Since World War II, rockets, such as the V₂, Viking, Aerobee and Deacons,

have been shot up into the high atmosphere, some even reaching to heights of 400 km. The results of these launchings have given a new dimension to the study of the upper atmosphere. More than 100 rockets have gone up in the past and a substantial part of our present knowledge of the stratosphere and ionosphere is based on these explorations.

All rocket observations made in the past will be repeated during the IGY, and on a much larger scale, and in more countries. Some 200 rockets will be sent up. On 4 July, an Aerobee was sent up from Fort Churchill, U.S.A., to mark the inauguration of this programme. The U.S.A. will send up 36 Aerobees and about 100 rockoons (rockets borne by balloons to altitudes of several kilometers before ascending under their own power). France will launch 12 Veroniques from the Sahara Desert. The U.K. will launch several Skylarks. There will also be rocket launchings by Japan. These rockets will measure the atmospheric pressure, temperature and composition at E region heights and above. Some will be especially launched at the time of solar flares to study the L_{α} radiation during a flare. Magnetometers carried by rockets will study the location and distribution of the S_q -current system. Sodium particles will be injected into the atmosphere to produce artificial airglow.

Satellites — The most exciting programme, and the most revolutionary, concerns the artificial satellites. Both U.S.A. and U.S.S.R. are expected to launch these satellites. The first satellite will probably be launched by the end of this year.

The U.S. satellite, details of which are available, will be a sphere, 20 in. in diameter and weighing approximately 21.5 lb. Of this weight, about half will be required for the structure itself, leaving half for various instrumentation, including the telemetering system. The satellite will be launched from the east coast of Florida at Cap Canaveral, using a three-stage rocket assembly. The satellite will revolve about the earth once every hour and a half.

The U.S. satellite will have an orbit shifting within a band between 40° N. and 40° S. This will make the satellite observable from many parts of the United States, Central and South America, Asia, Africa, Southern Europe and possibly some regions in mid-northern latitudes. The satellite will be

observable only during the twilight period and for only a few minutes*.

Acquisition of the satellite — Once placed in its orbit the satellite will become a celestial body, and as such, the first problem becomes its acquisition. Acquisition and subsequent tracking of the satellite will be done by both optical and radio methods.

Optical observations will be of two kinds: the 'moon watch' programme, involving teams of observers, and the precision optical tracking system. In the 'moon watch' programme, trained teams of observers using binoculars, placed on fixed mounts, will give an initial acquisition of the satellite.

Once the satellite has thus been acquired, the precision equipment will be rapidly brought into play. This equipment consists of improved Schmidt cameras and crystal clocks. This system will track the satellite with an accuracy of about 2 sec. of arc in a direction transverse to the path. However, the path must be initially known to a precision of 3 degrees before the precision system can be used.

There is, in addition, a radio tracking system at 108 Mc/s., known as 'Minitrack'. The estimated precision is about three minutes of arc with improvement to a precision of 20 seconds of arc for observation at small zenith angles. The radio tracking system is distributed principally in a north-south chain over the Americas. The primary network will be supported by a simplified system (Mark II Minitrack) which would be more widely distributed.

Scientific uses of the satellites — The scientific programme planned for the satellites involves both ground measurements and measurements inside the satellite.

The number of equipment that can be fitted up within the satellites is governed by the payload limitations. At present the plans call for measurement of temperature, pressure, meteoritic influx, solar ultraviolet and X-radiation and cosmic rays. The L_{α} radiation in the extreme ultraviolet will be particularly watched. Primary cosmic rays, which are normally masked by the atmosphere, will be studied.

*Recent report from the U.S.S.R. committee indicates that the Russian satellite will be launched from the U.S.S.R. at a small angle to the meridian, and will consequently be observed in its orbit from all parts of the earth except the central areas of the Arctic and Antarctic.

These experiments will be supplemented by an elaborate programme from the ground in which both optical and radio observations will be involved. From the geometry and path of the satellite, calculations can be made of the air density of the exosphere, much of which is still uncertain. Variations of the orbit from the predicted one will permit revision of our concept on the mass distribution of the earth, and will improve our knowledge on the shape of the earth.

Another programme of unusual interest would be the comparison of the simultaneous position determination by the optical and the radio systems. While for the optical system there will be little refraction, the radio system will suffer appreciable refraction by the ionosphere, and a comparison of the two values will give information about the total electron content of the ionosphere.

Antarctica

Unlike the Arctic, which is an ocean of ice, the Antarctica is a huge continent of 1.32×10^7 sq. miles with an average altitude of 2000 metres. It is the most inaccessible part of the world, and the least known.

The Antarctica programme is one of the most outstanding features of the whole enterprise, and exceeds that of the entire First Polar Year. For it alone, the IGY would have been justified. The most modern machines are being used for this programme: aircrafts, helicopters, huge ice breakers, electric snow-ploughs, etc.

Eleven countries have or will have bases in the Antarctica. These are: Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, U.S.S.R., U.K. and U.S.A. At the South Pole itself two permanent bases will be established, one by the Americans, another by the Russians. Advance expeditions have been under way for some time by some of these countries and have already provided important geographical advances. All-sky photographs that

have been obtained of 'Aurora Australis' at $75^{\circ}31'S.$, $26^{\circ}36'W.$ by the Royal Society Advance Party are considered among the finest auroral pictures ever taken.

The Antarctica programme covers most of the geophysical disciplines included under the IGY. In addition to the basic environmental studies that will have to be made incidental to the occupation and maintenance of the stations, intensive programmes have been and will be undertaken in the fields of meteorology, geomagnetism, aurora and airglow, ionosphere, glaciology and seismology.

World Data Centres

A vital principle of the IGY is that all the IGY data shall be made universally available. For this reason, World Data Centres (WDC) have been established in all the disciplines and all countries participating in the IGY are under obligation to supply their data to at least one of the centres. The CSAGI appointed Vice-Admiral Sir A. Day as co-ordinator for helping to arrange the collection and interchange of IGY data.

In each field there are at least three WDC's. Each centre will keep a central catalogue and index of all the material in its charge. *Investigators anywhere will be able to buy any data from these centres at no more cost than the cost of copying and transmission.*

The World Data Centres consist of:

Centre A — All disciplines. U.S.A.

Centre B — All disciplines. U.S.S.R.

Centre C — There are a number of such centres, different for different disciplines, and distributed in many countries.

Acknowledgement

In the preparation of this article, use has been made of the various publications of CSAGI, URSI, WMO and UGGI, and the reports of the national committees participating in the IGY.

Activation Analysis

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ACTIVATION analysis is a new and useful analytical tool for the research worker. For employing activation analysis, a knowledge of the nuclear characteristics of the radioactive isotopes of elements is a necessary prerequisite. Nuclear particles such as neutrons, protons and deuterons are used to produce radioactive isotopes by activation of the nuclei of the sample elements which are then detected and measured by their characteristic radiations. The method is specific since each induced radionuclide has its own particular decay constant and type of radiation. In activation analysis, external contamination during analysis, most commonly experienced in the conventional methods of analyses, is negligible because the contaminants must be present before irradiation in order to undergo nuclear reaction. Activation analysis can be applied for the determination of trace elements in various types of materials; solid as well as liquid samples can be used for analysis. A few milligrams of material are sufficient for precise work.

Analysis by radioactivation was introduced by Hevesey and Levy¹ in 1936 when they used neutrons from a 300 mc. radon-beryllium source to activate certain rare-earth elements. It was not until the advent of nuclear reactors that sources of sufficiently high neutron flux became available to give high sensitivity to this method.

The general equation governing activation by irradiation is:

$$W = \frac{\text{Activity} \times \text{Atomic weight}}{6.02 \times 10^{23} \times f \times \sigma A t \times (1 - e^{-0.693T/t_{1/2}})} \dots (1)$$

where W is the weight of the element (g.), f , flux of the bombarding particles (neutrons/sq. cm./sec.), $\sigma A t$, atomic activation cross-section (sq. cm./target atom), i.e. isotopic cross-section for the reaction \times percentage abundance of the isotope, T , duration of bombardment, and $t_{1/2}$, half-life of the radio-isotope produced in same unit as T . Activity represents disintegrations per second.

From equation (1) it is clear that (i) the activity for a given amount of material is directly proportional to the neutron flux, and (ii) the weight of the material that gives a specified activity is inversely proportional to the flux. Hence the higher the neutron flux, the greater the sensitivity for detection of a given isotope.

In actual practice the results are usually compared with standards in order to eliminate corrections for neutron flux, counting geometry, efficiency, etc. A sample of known weight (standard) and the unknown sample are irradiated and counted under identical conditions and from the relation

$$\frac{\text{Weight of element in unknown}}{\text{Weight of element in standard}} = \frac{\text{Activity in unknown}}{\text{Activity in standard}} \dots (2)$$

the concentration of the element in unknown sample is calculated.

Apparatus—Equipment necessary for activation analysis are: (i) a neutron activation source, and (ii) a radioactivity detection equipment.

The following activation sources are commonly used:

ACTIVATION SOURCE	USABLE FLUX n/sq. cm./sec.
Ra-Be, 25 mg.	$10^2 \cdot 10^3$
Sb-Be, 1 curie	$10^3 \cdot 10^4$
Van de Graaf	$10^7 \cdot 5 \times 10^9$
Cyclotron	$10^8 \cdot 10^9$
Oak Ridge reactor X-10	5×10^{11}
Oak Ridge reactor LITR	1×10^{13}
Brookhaven reactor BNL	2×10^{13}
Idaho reactor MTR	2×10^{14}

The cyclotron or Van de Graaf generator is a secondary neutron source. Low level neutron sources like radium-beryllium and antimony-beryllium can be used for analysis whenever lower sensitivities can serve the purpose.

Cost—The reactors, cyclotrons and neutron generators are generally costly for analytical purposes. A 25-milligram radium-beryllium source costs about Rs. 3000 giving

a constant neutron flux. A 1-curie antimony-beryllium source costs about Rs. 200 with an additional irradiation cost of about Rs. 150 per month. Since antimony-124 decays with a half-life of 60 days, the source needs reactivation from time to time. A polonium-beryllium source can also be used as a low level neutron source. Thermal activation with low level neutron sources like antimony-beryllium and radium-beryllium has a major advantage over activation with larger sources like the accelerator or the reactor, namely that only isotopes with a high activation cross-section and short half-life are detected after short irradiation. Moreover, the various neutron-induced activities in an accelerator or reactor are eliminated.

The detection equipment includes: (i) β -gas counter, (ii) 4π -counter, (iii) scintillation well counter, and (iv) scintillation spectrometer.

Sensitivity — Elements with high cross-section, e.g. europium, dysprosium, samarium, holmium, lutecium and rhodium, give extremely high sensitivities by activation with a strong neutron source². Thus with the Oak Ridge LITR reactor, europium and dysprosium provide sensitivities of 10^{-12} g. or even less. Compared to this spectrographic analysis gives a sensitivity value of 10^{-8} g. for europium and 10^{-7} g. for dysprosium. Samarium, holmium and lutecium, after activation in the LITR reactor, give sensitivities of the order of 10^{-10} g. Thus, in some cases analysis by radioactivation surpasses other methods like arc and spark spectroscopy, flame spectrometry, colorimetry and amperometry. It is possible to detect traces of the above rare-earth elements after activation even with low level neutron sources. This high sensitivity inherent in activation analysis of certain elements is an outstanding merit of the method.

Detection of impurities — Several methods have been developed for detecting impurities by activation analysis. Using scintillation spectrometry, impurities present in silicon, meant for use in transistors, can be determined³. Neutron activation analysis has been applied to potassium mineral dating — the argon-40 content of potassium minerals is measured by activation to radioactive argon-41⁴. Microgram and sub-microgram quantities of uranium have been determined in synthetic samples, ores, soils and sea water⁵. Szekeley⁶ developed a method for the analysis of traces of copper in germanium. James and Rich-

ards⁷ analysed arsenic in silicon, Foster and Gaitman⁸ determined phosphorus in aluminium and alumina, while Jenkins⁹ analysed small quantities of thorium using activation analysis. A rapid method¹⁰ has been developed for the analysis of milligram quantities of fluorine and microgram quantities of other halogens. In this method the neutron source is the nuclear reaction $\text{Be}(d, n)\text{B}$ using deuterons accelerated at 2 m.e.v. by a Van de Graaf accelerator. Procedures have been worked out for determining trace impurities in liquid metal coolants¹¹. Other schemes comprise the determination of trace elements in sea water, reactor cooling material and biological material². In all these cases high level neutron sources were employed either from a reactor or from an accelerator.

A polonium-beryllium source was used as a low level neutron source by Mayr *et al.*¹² for the detection of boron in tissues. Meinke and Anderson¹³ used a 25 mg. radium-beryllium neutron source (low level neutron source) for the estimation of rhodium, silver or indium in the presence of several other elements and for the estimation of several rare-earths for which spectrophotometric determinations are difficult. Meinke and De¹⁴ explored the possibilities of using an antimony-beryllium neutron source for activation analysis by means of scintillation well counter in conjunction with scintillation spectrometry for the measurement of radiations.

In general, the activities of the samples are measured, compared with standards under identical conditions, and their decay followed down to background to identify the elements being counted. In a mixture of two elements, the decay curves are resolved into the two half-life components and the activity of each component compared with the respective standard. In the case of gamma-emitting isotopes a scintillation spectrometer is used to obtain the characteristic spectra as well as quantitative measurements. A spectrogrammeometer automatically records the spectra and also the activity due to a certain radioisotope.

For precise work, care has to be taken against errors in activity measurement, incomplete chemical separation, radioactivity contamination in carrier, errors in activation due to competing transmutation, flux inhomogeneities and self-absorption.

The major application of activation analysis is in solving specific and difficult

analytical problems. The analysis of minute amounts of hafnium in zirconium, detection of sub-microgram amounts of arsenic and estimation of certain rare-earths are some typical examples.

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Indian Standards Convention

THE INDIAN STANDARDS INSTITUTION WILL hold the third Indian Standards Convention in Madras from 22 to 29 December 1957. The subjects to be discussed are: testing and certification for quality, implementation of Indian standards, problems of changeover to metric system, modern physico-chemical methods of test and ana-

lysis, modernization of farming practices, storage and conservation of agricultural and food products, agricultural products as raw materials for industry, and food quality. The technical papers meant for the Convention should reach the Organizing Secretary of the Convention by 15 September 1957.

REVIEWS

SYNTHETIC POLYPEPTIDES: PREPARATION, STRUCTURE AND PROPERTIES by C. H. Bamford, A. Elliott & W. E. Hanby (Academic Press Inc., New York), 1956. Pp. xiii + 445

The subject of synthetic polypeptides is one of current interest and has been intensively studied during the post-war years. The book under review has been written by three authors belonging to the well-known British research laboratory of Courtaulds Ltd. and hence it is a welcome entrant into the literature of chemistry. The interest in these polypeptides is twofold: (i) They are closely related to natural proteins, many of which are extremely important and play a vital part in physiology and industry, and (ii) the polypeptides constitute a class of high polymers with unique characteristics and having definite relationship between properties and molecular structure. The methods of study are multi-sided involving chemical as well as physical methods of different types. As a result of concerted attack using a number of techniques, useful information has been obtained.

The book contains twelve chapters and starts with a small introduction (Chapter I) in which the nature of the monomers and the scope of the book are discussed. The synthesis of polypeptides is described in detail in Chapter II. It not only contains a good account of the development of modern methods but also gives the experimental details of the methods of preparation of monomers and subsequent polymerization. It includes a discussion of the quantitative determination of N-carboxy- α -amino acid anhydrides and a table consolidating the data on the preparation of these anhydrides. The mechanism of polypeptide synthesis from N-carboxy- α -amino acid anhydrides (NCAs) is discussed under several headings in Chapter III. The interesting subject of chain configurations is presented in Chapter IV dealing in detail with different types of helical structures. The following five chapters describe the methods of infrared spectroscopy and X-ray diffraction, and their application to the study of the molecular structure of the polypeptides. Each of these techniques is introduced at a fairly ordinary

level and then developed. The discussion will be helpful for even those who have not specialized in these techniques.

Chapter X gives a full account of the properties of synthetic polypeptides under a large number of heads such as molecular weights by chemical and physical methods, α - β transformations, effect of groups, solubility, dyeing properties, optical rotation and molecular orientation. The biological properties of synthetic polypeptides have not been much investigated and what is known in this respect is contained in a small chapter (XI) of five pages. The last chapter deals with fibrous proteins and their relation to synthetic polypeptides. The composition and structure of silks are discussed first, followed by an account of the keratins of wool and hair.

The printing, paper and get-up fully maintain the standard of the publishers. The volume is sure to be welcomed as a clear and handy account of a growing subject of great importance.

T. R. SESHADRI

REPORTS ON THE PROGRESS OF APPLIED CHEMISTRY, Vol. XL (Society of Chemical Industry, London), 1954. Pp. 1000

Researchers in applied chemistry look forward to the *Reports on the Progress of Applied Chemistry*, which, though not so extensive as many other annual reports on certain individual subjects, do give excellent summaries of the recent scientific, technical, patent and trade literature on a large number of subjects. The present volume contains the usual eight sections, the subject matter, including the references, covering up 815 pages. There are in addition 79 pages of name index, and 106 pages of subject index. Under the revised policy, which has been in operation for the last few years, some of the subjects are dealt with only once in 2-3 years.

The first section deals with inorganic chemistry. In addition to the usual chapters on acids, alkalies and salts, glass, ceramics and refractories, road and building materials, there is a chapter on industrial gases. The permanent gases, oxygen, nitrogen, hydrogen

and the rare gases and some of the hydrocarbons, viz. acetylene, methane, propane and butane, are dealt with, but not the oxides of carbon or synthesis gas. The usual chapter on physical metallurgy has been omitted in the section on metals. A new chapter on cosmetic and toilet preparations is included in the section of organic chemistry, instead of the usual chapter on explosives. There are special chapters on the reactivity of cellulose and industrial uses of isotopes, but both adhesives and enzymes have been omitted.

It is not possible for a single reviewer to make critical comments on each and every chapter of these reports; the overall impression that one forms on going through the different sections is that though on the whole the reports admirably serve the useful purpose for which they are meant, there is scope for considerable improvement in some sections, an example of this being the section on Chemical Engineering. Similarly the regular reader of the Reviews of Current Literature relating to the paint, colour, varnish and allied industries, published by the Research Association of British Paint, Colour and Varnish Manufacturers, Paint Research Station, Teddington, will find the chapter on resins, drying oils, etc., poor. The basis of including the chapter on rubber under the section of biological products is also questionable, when greater part of the information is about synthetic rubbers. In fact, just as the Society of Chemical Industry has a separate Plastics and Polymer Group, so also a separate section devoted to polymers — adhesives, fibres, plastics, rubber and organic coatings — will be very appropriate.

Half a dozen printing mistakes have been given in the *errata* on page 1000, to which the following two may be added: page 92, lines 3-4, "for t can . . ."(?); page 530, reference 192 (*see* also p. 849), "Joslin" should read "Joshi".

The printing and layout are of the usual high standard. The Reports should find a prominent place in all scientific and technical libraries as reference manuals.

N.R.K.

THEORY OF MACHINES THROUGH WORKED EXAMPLES by G. H. Ryder (Cleaver-Hume Press Ltd., London), Second Edition, 1956. Pp. viii+255. Price 20s.

The aim of this book is to provide adequate practice to students in working out problems

of Theory of Machines. This has been achieved through solution of a large number of problems on the basis of summary of principles, formulae and methods of solution included in each chapter. There are some 280 practical problems out of which 170 have been worked out in detail. The remaining problems, accompanying answers and hints on solution, are intended for practice. The graphical method of solving problems has been frequently used in many chapters. In some examples both graphical and analytical solutions have been provided to familiarize the students with both methods.

The first 6 chapters deal comprehensively with the analysis of motion in linkages, gears and cams. The problems involving clutches, bearings, belts, brakes and inertia forces have been presented in the next 4 chapters. Chapter 12 covers the important applications of balancing, such as balancing of rotors, in-line engines, locomotives and radial engines. The scope of this chapter could have been profitably enlarged by including a few more practical problems on balancing of locomotives and Vee engines. The chapter on gyroscopes is short but informative. The last three chapters deal with vibration of systems with one and two degrees of freedom. The author has tried to include many important aspects of vibration in these short chapters. However, it would have been easier for the student to master the principles of vibration if the subject were dealt with in more detail. There is no definite limit to the scope of many of the chapters and some problems which cannot be classified have been grouped in the chapter on general dynamic problems.

In general the problems presented in the book cover the requirements of students entering for university degree examinations and examinations of professional institutions. The author's endeavour to write a book of this nature will be highly appreciated by students and teachers alike.

S. P. SEN

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NOTES & NEWS

Synthesis of penicillin V

THE ABILITY OF ALIPHATIC CARBODIIMIDES to form amide bonds in aqueous solution directly from the amine and carboxyl components under very mild conditions has been made use of by J. C. Sheehan and K. R. Henery-Logan of the Massachusetts Institute of Technology for the first rational synthesis of penicillin V (phenoxy-methylpenicillin) in good yield.

D-Penicillamine was condensed with *t*-butyl phthalimidomalonaldehyde to give *t*-butyl D- α -4-carboxy-5, 5-dimethyl- α -phthalimido-2-thiazolidineacetate, which on hydrazinolysis followed by acidification with hydrochloric acid gave *t*-butyl D- α -4-carboxy-5, 5-dimethyl- α -amino-2-thiazolidine acetate hydrochloride. The latter was reacted with phenoxyacetyl chloride and triethylamine to yield α -*t*-butyl D- α -phenoxy-methylpenicilloate. Cleavage of the *t*-butyl ester with dry hydrogen chloride, followed by crystallization from acetone-water containing an equivalent of pyridine, led to 75 per cent of D- α -phenoxy-methylpenicilloic acid hydrate. The latter, on treatment with N, N'-dicyclohexylcarbodiimide in dioxane-water (20 min. at 25°C.) cyclized as the monopotassium salt in 10-12 per cent yield. By partition between methyl isobutyl ketone and phosphate buffer of pH 5.5 (two funnels) the totally synthetic crystalline potassium salt of penicillin V was isolated. The entire reaction sequence starting with penicillamine was conducted at or below room temperature [*J. Amer. chem. Soc.*, **79** (1957), 1262].

Energy of α -particles from U²³⁴, U²³⁸ and Th²³²

THE α -PARTICLE ENERGIES OF U²³⁴, U²³⁸ and Th²³² have been measured with a grid ionization chamber. The electronic equipment was designed to provide low noise, high resolution and good long-term stability. Ra²²⁶, Em²²², Po²¹⁸, Po²¹⁴ and Po²¹⁰ were used as energy standards. An investigation was made of the corrections to the measurements due to

variation in pulse rise-time, source thickness and imperfect shielding of the collector by the grid. The experimentally observed resolution was satisfactorily accounted for by the combination of these factors and the noise and ionization straggling.

α -Particle pulse heights were measured in terms of the output of a precision pulse generator and the corrected pulse heights related to the energies of the standard sources by a two-parameter least squares calculation; the standard deviation was less than 5 keV. On extrapolating to zero ionization the line so obtained intercepted the energy axis at 83 keV. The α -particle energies deduced using this line were: U²³⁴, 4.768 \pm 0.003; U²³⁸, 4.195 \pm 0.005; Th²³², 4.007 \pm 0.005 Mev. [*Canad. J. Phys.*, **35** (1957), 258].

Zirconium as a reactor material

ZIRCONIUM, ON ACCOUNT OF ITS low cross-section for neutron capture, its resistance to heat, radiation, oxidation, corrosion and good mechanical performance, is replacing aluminium as the core material in reactors. Zirconium alloys free from hafnium can be employed in reactors in which low thermal-neutron capture cross-section is required. Zirconium can be continuously used for thousands of hours in contact with water at 400°C. without appreciable corrosion and temperatures up to 450° should be attainable. It resists the action of air up to 480°C. and of some molten metals up to 600°C. There is, however, a little loss of strength at elevated temperatures. The addition of 0.5-5 per cent of tin to zirconium reduces sensitivity to corrosion and decreases the deleterious effects of impurities. Smaller additions of tin, molybdenum, niobium, titanium or aluminium increase performance at high temperatures [*Atomics*, **8** (1957), 121].

Radiological units and measurements

THE INTERNATIONAL COMMISSION on Radiological Units and Mea-

surements (ICRU), in co-operation with the staff of the National Bureau of Standards (NBS), has recently (April 1957) issued the 'Handbook 62' detailing the latest recommended radiological units and measurements superseding an earlier publication. The report was prepared to explain the units and measurements agreed upon at the Commission's meeting at Geneva in April 1956. In addition to the new recommendations on radiological measurements, an extensive description of the physical background and the factors which concern the problems of the measurement of absorbed dose of all kinds of radiation are contained in the report. The handbook also includes reports of two subcommittees of ICRU, viz. Subcommittee on X-ray Standards and Subcommittee on Standards of Radioactivity. A number of tables and charts useful in the above measurements, some appendices like Treatment summary form, Survey of primary X-ray standards, Radioactivity standards available from U.S.A. and U.K., etc., and an extensive bibliography are given at the end.

Mode and origin of radio scintillations

THE SCINTILLATION OF A RADIO star is believed to be caused by irregularities in the density of ionization at a height of *c.* 400 km. These irregularities move with a windlike motion past the observer's line of sight. The nature and origin of this ionization have been studied at the Department of Physics, Queen's University, Ontario.

At Ottawa, during 1954, the radio signal from the strong source in Cassiopeia was recorded continuously at a frequency of 50 Mc/s. An analysis of the records revealed that the sun is not primarily responsible for the observed variation in scintillations; instead the interstellar particles captured by the sun's gravitational field can explain the scintillation measurements. The sun moving through a cloud of particles deflects them, forming, with the help of many inter-particle collisions, a relatively dense accumulation of particles behind itself. From this so-called collision region, particles fall towards the sun.

If such particles striking the earth's atmosphere contribute to

the ionization responsible for scintillations, the solar hour of the day of maximum occurrence of scintillations corresponds to a most nearly perpendicular incidence of the infalling particles. It is possible, therefore, to proceed from solar hour of maximum scintillation, through a correction for the earth's orbital velocity, to direction of the component of the velocity of infalling particles in the earth's equatorial plane. Their speed has been calculated (making use of the earth's known orbital velocity) to be 3.3×10^4 m./s., and the collision region 200 million miles from the sun.

In the observations made there were three periods during the year when the scintillation record reached a maximum near 1200 hr., suggesting the arrival of particles from the sun. On two of these occasions (February and October-November) particle speeds of about 2×10^5 m./s. were calculated and these two periods coincided with the two broad maxima which were displayed by the planetary K index during 1954. On the third occasion (August-September) the speed of the particles was very much higher, which may be related to the fact that the only solar flares of 1954 occurred during that period. There was no other evidence in the scintillation measurements of effects directly attributable to sun.

The kind of particles involved must depend on the kind of interstellar matter available. On that basis, only hydrogen atoms and interstellar dust need be considered. Two arguments strongly favour hydrogen. Firstly, meteor studies suggest that dust particles produce ionization only at altitudes lower than 400 km.; and further, they show no correlation between meteor activity and radio star scintillations. Secondly, the sun's radiation pressure would remove small dust particles from its vicinity while allowing hydrogen atoms to fall inward.

Combining information about solar times of maximum occurrence of scintillations with the observed annual variation, the celestial radiant of the infalling hydrogen is estimated to lie within the limits: right ascension 16 hr. 40 min. to 17 hr. and declination -20° to -40° . In addition, the components of the velocity of the particles with respect to the galactic plane has been estimated to be: tangential, 28×10^4 m./s. (the par-

ticles are judged to be overtaking the sun from behind), radially outward 2×10^4 m./s., and transverse 0.2×10^4 m./s. [*Nature, Lond.*, **179** (1957), 608].

Atmosphere of mars

AN ACCOUNT OF THE OBSERVATIONS made to date on the atmosphere of Mars is given in an article in *Trans. N.Y. Acad. Sci.*, **19** (1957), 352.

Like the earth, Mars rotates on its axis with a period of 24 hr. 37 min. and 22.6 sec. and its equator is inclined with respect to the plane of its orbit around the sun by $25^\circ 12'$, which is close to the terrestrial value of $23^\circ 27'$. Similar Coriolis and seasonal effects on Mars are, therefore, expected as on the earth. Mars's period of revolution about the sun is 1.88 of earth's year; thus the seasons will be nearly twice as long. The radius of the planet is 0.53 of the earth and the acceleration of gravity is only 380 cm./sec./sec. Thus, the adiabatic lapse rate (in a nitrogen atmosphere) is only $3.7^\circ\text{C. km.}^{-1}$ (cf. terrestrial value of $9.8^\circ\text{C. km.}^{-1}$).

Visual and photographic observations indicate a complex system of dark markings and areas against a reddish orange background on the planetary surface. Some of these markings show seasonal variation; during winter they are small and not very dark and as summer approaches they grow in size and darken. This behaviour has long been interpreted as signifying the existence of plant life on Mars. In addition, there are distinct white polar caps that wax and wane with the seasons.

Spectroscopic studies on composition of the atmosphere of Mars have established the presence of carbon dioxide, nitrogen, argon and water vapour. The content of carbon dioxide is estimated to be c. 13 times its mass per unit area in the earth's atmosphere. Water vapour must be present because the polar ice caps are composed of frozen water. As the surface frost points are near -90°C. , it is presumed that the atmosphere is far more arid than at any place on the surface of the earth. Oxygen is absent in the atmosphere of Mars which is considerably thinner than that of the earth (c. 125-50 g. cm.⁻² of air, cf. c. 1000 g. cm.⁻² on the earth). The estimates of argon and carbon dioxide account for only 10 per cent of the mass, the

rest being probably composed mostly of nitrogen.

Radiometric studies to calculate the surface temperature of the sunlit parts of the Mars indicate that the surface temperature may rise to 30°C. or more near the thermal equator, but a strong latitudinal temperature gradient exists, especially in the winter hemisphere. Near the equator the temperature rises well above 0°C. about 1 hr. after the local noon. The minimum temperatures at night cannot be observed for purely geometric reasons, but observations close to the morning limb indicate equatorial temperature near -40°C. ; it may even fall to -80° or -90°C.

The atmosphere of Mars exhibits a variety of clouds of various types. The clouds occur commonly near the limbs of the planet. These visible clouds occur also near the centre of the disk, but far less frequently than near the edges. They may be either dust or convective H₂O clouds. The other type of cloud, known as 'blue haze', composed of very small particles, is normally present in Mars. This scatters blue light more effectively than yellow or red light, hence the name. The polarization of the scattered blue light suggests that the mean particle radius is in the vicinity of 0.2μ . The terminal velocity of spheres on Mars with a radius of 0.2μ is so slow that any sizable cloud would require a very long time to dissipate. However, clearing can occur in a few days. Calculations indicate that a CO₂ ice cloud would be far too opaque, but that an H₂O ice cloud could have proper optical and geometric thicknesses provided the surface frost point is near -90°C. Thus, the haze appears to be composed of tiny ice crystals.

The general circulation of Mars is simpler and steadier than that of earth as there are no oceans on arid Mars and the interplay of continents and oceans apparent in our atmosphere is absent. A study on drifts of the clouds on Mars gives evidence of subtropical high pressure cells, middle latitude westerlies, and sharp cyclonic shears that may be due to frontal systems.

Semiconducting oxide catalysts

THE ACTIVITY OF A SEMICONDUCTING catalyst is influenced by its

electronic state. In an attempt to investigate the form of the relation between the two values the electrical conductivities of several semiconducting oxide catalysts were studied during the course of catalytic dehydrogenation of ethanol using *n*-semiconductors (ZnO, Fe₂O₃) and *p*-semiconductors (Cr₂O₃, MgO, NiO) and their mixtures.

An appreciable change in the conductivity of the catalyst was noted after the vapours of the water-alcohol mixture had been introduced into the apparatus. The change of the logarithm of the conductivity $|\Delta \log \sigma|$ was of the order of several units. The conductivity of the catalysts consisting of the *n*-conducting oxides (ZnO, Fe₂O₃) or their mixtures increased during 5-10 min. up to a constant level (catalyst ZnO, temperature 400°C.). When the current of flowing vapour was replaced by air, the conductivity dropped to its initial value. With the *p*-conducting catalysts NiO, Cr₂O₃ (up to 450°C.) or with MgO-Cr₂O₃ mixtures, the conductivity decreased to a constant value (catalyst Cr₂O₃, temperature 350°C.).

The conductivity of chromium oxide above 450°C. at first decreased and then increased with time to a value higher than the initial. Such a behaviour can be explained by assuming the transition of *p*-type conductivity of Cr₂O₃ to *n*-type due to the shifting of the Fermi level after the exposure of the catalyst to reacting vapours.

In the case of mixtures of *n*- and *p*-type conducting oxides, both types of $\log \sigma$ changes were found, depending on which of the two oxides was predominant in the composition.

The influence of temperature on the change of $\log \sigma$ (value of $|\Delta \log \sigma|$ in the course of the catalytic reaction on the surface of the ZnO+Fe₂O₃ catalyst, as well as the influence of temperature on the catalytic reaction yield r (after the conductivity reached its constant value) are taken as a measure of the reaction. The parallelism of both values suggests a close relation between the r and $|\Delta \log \sigma|$ values.

The factor A in the equation $r = A |\Delta \log \sigma| + B$ expressing the linear relationship of r and $|\Delta \log \sigma|$ was in all cases positive except in the case of Cr₂O₃, or Cr₂O₃-rich MgO-Cr₂O₃ and

ZnO-Cr₂O₃ catalysts, and some inactive industrial catalysts which gave negative A values.

The linear relationship of r and $|\Delta \log \sigma|$ is independent of temperature, since the catalytic reaction yield, as well as the number of electrons which were transferred to or taken out of the catalyst, are functions only of the number of molecules chemisorbed by the catalyst [*Nature, Lond.*, **179** (1957), 668].

Electron image recording by xerography

THE ELECTROPHOTOGRAPHIC process of xerography for recording optical images depends on photoconductivity produced in a film of a black vitreous form of selenium by the incident radiation. Induced conductivity in a thin film of amorphous selenium observed during electron bombardment has suggested the possible application of xerography to the recording of electron images similar to those produced in electron microscopes and electron diffraction cameras.

In the process the vitreous selenium plate is charged before loading into the apparatus and is required to retain the charge for *c.* 10 min. while evacuation is taking place. The plate is then exposed to the pattern in the normal manner, and after removal from the camera, developed with a powder cloud. The plate which was initially negatively charged gets discharged due to the electrons contributing to the diffraction maxima and later the background is developed with a positively charged powder cloud. The diffraction maxima are thus characterized by the absence of powder in the resulting image.

Experiments using 50 kV. electrons have shown that the particular selenium plates employed require an exposure similar to plates with Ilford N. 50 photographic emulsions. A diffraction pattern just visible on the fluorescent screen requires an exposure time of *c.* 5 sec. From the measurement of the ring diameters of a gold transmission pattern, there is no evidence of electron refraction in the electric field associated with the initial charge on the surface of the plate. The d_{hkl} values calculated from the measured ring diameters on a xerograph are in agreement with those calculated from a conven-

tional photograph to better than ± 0.05 per cent.

The main advantages offered by xerography in recording electron images are: (1) The vitreous selenium plates are free from out-gassing effects at room temperature. (2) Xerographic plates of the type developed for radiography can be used for recording electron images produced in electron optical instruments using beam accelerating voltages between 45 and 55 kV. (the range investigated so far). (3) Such plates require an exposure similar to that used with the high-contrast photographic emulsions commonly employed in electron microscopy and electron diffraction. (4) The use of suitable liquid developing techniques makes possible image resolution beyond the limits attainable with conventional photographic materials, without sacrificing the plate sensitivity. (5) The high image contrast and wide latitude of exposure with xero-radiography could be advantageous in the recording of electron microscope images, which frequently exhibit low relative contrast [*Nature, Lond.*, **179** (1957), 773].

Properties of neptunium

PROPERTIES OF NEPTUNIUM prepared by a bomb reduction process have been studied. Metallographic examination of the prepared sample indicated that inclusions were present to the extent of about 3 per cent by volume and at least two types were recognized. The larger inclusions had segregated to a narrow band at one surface while the remainder, in the main body of the material, appeared to outline a dendritic structure. Porosity was mainly confined to a single cavity, probably produced by contraction during solidification, and was estimated at less than 0.1 per cent of the specimen as a whole. The difference between the observed density (20.2 g./ml. at 20°C.) and the theoretical (20.45 g./ml.) is probably due to the presence of impurities in the sample. Reasonably good grain contrast was obtained under examination in polarized light after the specimen, in the mechanically polished condition, had been allowed to oxidize for some hours in air. There appears to be a close relationship between these grains and the original dendritic

structure. The grains, which had a mean diameter of about 0.3 mm., were irregular in size and shape and to a little extent similar to those in cast uranium. Deformation twins observed near hardness impressions were long, thin and parallel-sided, and were frequently restricted to a single system in a given grain.

From Meyer hardness analysis the Meyer index is found to be 2.19 and the ultimate ball number 458. Diamond pyramid indentations with loads greater than 10 kg. gave a Vickers hardness figure of 355. The metal thus appears to be considerably harder than uranium in a similar condition. The ultimate tensile strength of neptunium is of the order of 80-90 tons/sq. in. [*Nature, Lond.*, **179** (1957), 910].

New nuclear particles

IN AN ATTEMPT TO EXPLAIN nuclear forces and the complicated characteristics of the hitherto known particles, Dr. Edward Teller of California University has predicted two new nuclear particles yet unnamed and undiscovered. The particles, only theoretical conceptions based on indirect evidences, may be close to the simplest form of radiation having so short lives that their detection may not be possible by existing methods. They would be neutral in charge and have only the properties of energy and momentum. They would not have the usual particle properties of charge and spin. The masses of the particles are undetermined, but they probably would be somewhat heavier than pi mesons and lighter than K mesons [*Sci. Newslett., Wash.*, **71** (1957), 195].

Atomic structure of actinide series

RECENT STUDIES OF THE EMISSION spectra of actinium at the National Bureau of Standards, U.S.A., have helped in elucidating the atomic structure of elements in the actinide series. The results confirm that *f*-type electrons are characteristic of this series.

The spectrograms of actinium supplied by Argonne were measured and interpreted for this purpose. It was found that a spectrogram of Ac II, like La II, is more complex than either Sc II or Y II, the homologues in Periods

IV and V; to explain the extra lines it is concluded that, in excited states, electrons of type *f* as well as type *p* are present, though less tightly bound. These results show that actinium introduces in the seventh period, another group of 14 'rare earths' in which the *f*-type electrons are incorporated into the outer structure of the heavier elements.

f-Type electrons appear only in highly excited states of Th I, and the unexcited thorium atoms have two *d* and two *s* electrons, whereas *f* electrons are found in the normal configuration of proto actinium atoms [*Chem. Engng. News*, **35** (1957), 32].

Determination of hydrogen in mines

AN APPARATUS FOR THE DETERMINATION of hydrogen in the mine air has been developed by the National Coal Board, England.

In the apparatus, separation of hydrogen from the other components in a given sample is effected by means of a column of active carbon, 7 ft. long, contained in an annealed copper tube of $\frac{3}{16}$ in. bore. An identical column through which only reference gas is passed serves to compensate for slight changes of inlet pressure. A twin-cell platinum-wire katharometer and its associated bridge circuit are used as the detecting device, each cell receiving gas from one of the columns.

Oxygen-free nitrogen is normally used as the carrier and reference gas. If a particularly high sensitivity is required, argon is preferable on account of its lower thermal conductivity. The pressure drop across the columns is maintained at 14 cm. of mercury, equivalent to a flow rate of about 50 ml./min. through each column. A 10 ml. sample is taken for each analysis, hydrogen being eluted from the separating column after 40 sec. For gases which are eluted from the column very rapidly, it is permissible to assume that the peak height is proportional to the amount of the component present, over a wide range of concentrations; thus the recorder can be calibrated directly in terms of hydrogen. Determinations can be carried out with an accuracy better than ± 0.005 per cent of hydrogen. Hydrogen present in 0.005 per cent concentration can be detected.

The instrument can also be used for the determination of methane. The sensitivity of the instrument to methane is lower than with hydrogen due to lower thermal conductivity of methane [*Nature, Lond.*, **179** (1957), 911].

Hydraulic pressure cleaning

A COMPACT HIGH-PRESSURE hydraulic cleaning unit with some unique features is being constructed by Joseph Evans & Sons (Wolverhampton) Ltd. Originally designed for use in paper mills the unit is now used in many other industries such as oil refineries, chemical works, dairy plant and locomotive cleaning.

At the centre of the installation is a 1½ in. by 4 in. stroke totally enclosed horizontal treble ram pump, capable of delivering 16.5 gal./min. against a pressure of up to 1000 lb./sq. in. For jet cleaning a gun is supplied which has a venturi aperture and entrains air, delivering high-pressure water and air from the nozzle. The air intake can be connected to a dry sand supply so that a wet sand blasting effect is produced, which is particularly advantageous when carrying out difficult operations such as the cleaning of heat exchanger tubes in oil refineries or the removal of paint. Similarly detergents can also be inducted into the water supply. An adjustable spray nozzle can be fitted to the gun and the high-pressure jet can be easily changed to a fine spray.

Pipe cleaning can be carried out by this unit. By means of self-propelled pipe-cleaning nozzles the hose is automatically driven either forwards or backwards along the pipes by the force of the water. Bends in pipelines can be successfully negotiated.

A unique feature of the unit is an unloading valve which automatically bypasses full pump output back to suction when the nozzles are closed and also handles any excess capacity over and above that required at the delivery pressure. The complete unit is mobile, being mounted on a fabricated steel frame trolley with rubber tyred wheels and axles [*Chem. Age*, **77** (1957), 611].

Porosity detection in plated coatings

A NON-DESTRUCTIVE PROCEDURE for ascertaining both the size and

position of pores in electrodeposited surface has been developed at the National Bureau of Standards, U.S.A. The method involves photographing an electroplated specimen exposed to radiation. In determining the location and size of pores, the specimen, a flat sheet of plated metal a few thousandths of an inch thick, is placed on a photographic film with the coating against the film emulsion. The assembly is held in a cardboard cassette, and the basis-metal side of the specimen is exposed to X-rays or radiation from a radioactive material. To insure good contrast, the X-radiation used must be soft. This requirement of low-energy X-rays limits the thickness of the basis material. Radioactive iron, nickel or cobalt held against the plated specimen in a cassette are also adequate sources of radiation.

After a suitable exposure time the film is removed and developed. Satisfactory radiographs result from a 3 or 4 min. exposure to an X-ray machine, and from a 24 hr. exposure to 1 μ c. of radioactivity. Wherever a pore exists in the coating, a black spot appears on the developed film. A fine-grain industrial X-ray film gives the most readable radiograph.

The radiographic method detects pits, voids and inclusions in the coating of the order of 0.001 in. in diameter. Discontinuities in the basis metal may also be determined by radiographing the metal before plating [*Tech. News Bull., U.S. Bur. Stand.*, **41** (1957), 44].

Stains on silverwares

SILVERWARES OFTEN DEVELOP stains which are not easily removed by normal cleaning methods. These stains vary in colour from almost black to a pale straw. This phenomenon has been attributed to faulty electroplating and the use of detergents for washing up. Recent investigations undertaken to pinpoint the cause of this stain formation show that detergents containing halides, which would give insoluble silver halides, are responsible for the stain formation. From practical point of view stains may be formed by salt or detergent particles falling through washing-up water on to the silver. The essential requirement for stain production is a local concentration of the halide at the silver

surface; this promotes the formation of half-cells of different potential from that existing elsewhere on the surface of the article. Electrochemical action then proceeds and a stain is formed.

When a piece of silver sheet is immersed in a solution containing a high concentration of sodium chloride, a complex of sodium silver chloride is formed and a stream of electrons starts flowing through the silver from the area adjacent to the strong solution to that adjacent to the weak solution. The first area serves as anode to the cell and the second as cathode. The loss of electrons from the anode permits the passage into solution of more silver ions which may then react as follows:



thus producing the visible stain. This electrochemical reaction proceeds faster in solutions having a higher conductivity and also in solutions containing ions readily reduced at the cathode. Most chlorides, bromides and iodides react similarly in the formation of stains. Fluorides, however, do not cause stain on account of the very high solubility of sodium fluoride.

It is, hence, inferred that if a reagent forms a relatively insoluble compound of silver which is soluble in excess of the reagent to give a complex, a local concentration of that reagent will cause anodic corrosion and staining at the metal surface. The mechanism of this anodic stain formation also applies to copper in the presence of cyanides, chlorides and iodides, to lead in the presence of iodides and to cadmium and zinc in the presence of cyanides.

To prevent the formation of stains during washing up it is necessary to preclude the possibility of local halide concentrations at the metal surface. If solid detergents must be used, these should be dissolved completely before immersing the silver.

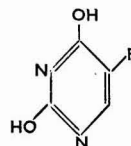
Although no quick and easy method of stain removal has been found, it is possible to effect removal of stain by immersing the article in a hot strong salt solution. Chemical solution of the stain then proceeds, but electrochemical action also sets in. At the metal surface in the area of the stain a relatively high concentration of the NaAgCl_2 complex is formed resulting in a lower

sodium chloride concentration and, therefore, a higher silver ion concentration compared with the rest of the surface. Consequently, this area becomes cathodic and deposition of silver occurs, while in the surrounding anodic areas silver passes into solution. The stain becomes lighter in colour and is then more easily polished to match the surroundings [*Nature, Lond.*, **179** (1957), 557].

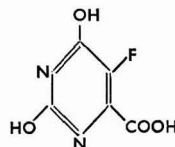
Tumour inhibitory compounds

THE TUMOUR INHIBITORY ACTION of 6-azauracil and the profound biological effects obtained when fluorine is substituted for hydrogen have led to the synthesis of a number of hitherto unknown 5-fluoropyrimidines and their 2-thio derivatives. 5-Fluorouracil (I, Ro 2-9757) and 5-fluoro-orotic acid (II, Ro 2-9945) exert considerable antitumour activity against transplanted tumours in rats and mice, whereas 5-fluorocytosine (III, Ro 2-9915) and various 2-thio derivatives are inactive.

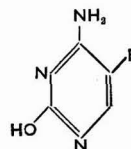
Compounds I and II also exhibit bacteriostatic effect *in vitro* against Gram-negative bacteria. 5-Fluorouracil exhibits more than 5000 times the activity of 5-bromouracil, 5 times the activity of 5-fluorocytosine, and 25 times the activity of 5-fluoro-orotic acid. These compounds act as antimeta-



I



II



III

bolites either by entering into the pathways of metabolism of organisms which might result in non-functional nucleic acid, or by blocking the incorporation of various normal precursors into nucleic acid pyrimidines or co-enzymes. These compounds show promise for treating human cancer [Nature, Lond., 179 (1957), 663].

Determination of the C¹⁴-distribution in labelled sugars

A PROCEDURE HAS BEEN DEVELOPED for determining the activity of the individual carbon atoms in D-fructose labelled with C¹⁴. D-Fructose is degraded by lead tetra-acetate oxidation and the product hydrolysed to glycolic acid, formic acid and D-glyceraldehyde. Glycolic acid is oxidized to formaldehyde (carbon-1) and carbon dioxide (carbon-2), and formic acid to carbon dioxide (carbon-3). D-Glyceraldehyde is degraded to carbon dioxide (carbons-4 and -5, combined) and formaldehyde (carbon-6); after reduction of a second portion of the D-glyceraldehyde to glycerol, the degradation products obtained are carbon dioxide (carbon-5) and formaldehyde (carbons-4 and -6, combined). The activity of carbon-1, -2, -3, -5 or -6 is thus determined directly and of carbon-4 by difference in two ways. The procedure should also be applicable to C¹⁴-labelled L-sorbose. Lead tetra-acetate oxidation of sedoheptulose followed by hydrolysis yields glycolic acid, formic acid and D-erythrose. These three fragments are degraded in turn to afford a method for partial determination of the C¹⁴-distribution in samples of sedoheptulose. The process is applicable for quantities as little as 1 millimole of the sugar [Canad. J. Biochem. & Physiol., 35 (1957), 7].

Estimation of cellulose

SCHRAMM AND HESTRIN'S MICRO-METHOD used hitherto for the estimation of bacterial cellulose is rather tedious and the neutralization step is critical. A micro-method developed at the National Research Laboratories, Ottawa [Nature, Lond., 179 (1957), 579], halves the time taken for analysis by eliminating acetolysis, hydrolysis and neutralization.

Samples of bacterial cellulose are prepared by treatment with 4 per cent (w/v) sodium hydroxide to remove cells, washed and centrifuged. Talc is added to weight the cellulose fibres in the centrifuge tubes. Each dried sample is suspended in a definite volume of water in a large test tube to bring the concentration of cellulose within the correct range of 0-150 µg./ml. Three times this volume of 96 per cent (w/v) sulphuric acid is added dropwise, the tube heated for exactly 6.5 min. in a boiling water bath and cooled under running water. The pink solution is centrifuged to remove any suspended talc, and its optical density is measured at 520 mµ in a 'Coleman Junior' spectrophotometer. The standard curve uses glucose as reference substance.

The method also works well for filter paper and possibly also for other suitably purified forms of cellulose.

Estimation of blood protein

A QUICK AND SIMPLE WAY to determine the kind and quantity of proteins in human blood has been developed by the Detroit Institute for Cancer Research and the Henry Ford Hospital, Detroit. The technique has been used to measure the quantities of nine distinct proteins and to detect the presence of many others. It may well act as an important new diagnostic tool for many diseases.

Each specific human plasma protein is injected into chickens for producing antibodies against it. The antibody-loaded serum is extracted ten days later and used to test small samples of human plasma. The chicken antiserum precipitates out of the sample the same protein against which the chicken developed the antibodies. By measuring the amount of precipitation, the quantity of the protein present in the sample can be determined.

The new technique is faster and more sensitive than the standard electrophoretic method, in which plasma proteins are identified by the speed with which they travel across electrified paper [Sci. News Let., Wash., 71 (1957), 184].

Assay of vitamin B₁₂

A METHOD FOR MICROBIOLOGICAL assay of vitamin B₁₂ in presence of growth factors such as methionine and its derivatives has been

developed at the Bengal Immunity Research Institute, Calcutta.

Deacidite F.F. (a highly basic resin based upon cross-linked polystyrene containing quaternary ammonium groups) was used in the hydroxide form to adsorb the acidic methionine or acetyl methionine, folic acid, etc., leaving the cyanocobalamin in the percolate which was then assayed microbiologically using *Escherichia coli* mutant 301.

The adsorbed methionine or acetyl methionine could be eluted with dilute sodium hydroxide solution and estimated, the recovery being 98-99 per cent. With standard solution of vitamin B₁₂ also, the recovery was found to be 99 per cent.

The results show that this method of separating vitamin B₁₂ from methionine or methionine-like bodies is quite satisfactory and that the amount of vitamin B₁₂ in the resin percolate can be easily estimated microbiologically. In all the above experiments microbiological assay and spectrophotometric estimation indicated similar results [Indian J. Pharm., 19 (1957), 96].

Antibiotics for plant diseases

USES OF ANTIBIOTICS AGAINST plant diseases have been recently discussed in a symposium held by the Association of Applied Biologists, U.K. The antibiotics streptomycin produced by *Streptomyces* spp. and griseofulvin produced by *Penicillium* spp. have been used against plant diseases. These antibiotics are absorbed from culture solutions by roots of uninfected plants, and the amount of griseofulvin taken up is related to the amount of water transpired and the concentration in the solution. Within the plants their fates vary from species to species.

Griseofulvin affects the development of a wide range of fungal and allied diseases caused by *Plasmidiophora brassicae*, *Fusarium* spp., *Erysiphe* spp. and *Botrytis* spp.

Griseofulvin added to mixtures of unsterilized soil and sand inoculated with resting spores of *P. brassicae* decreases the number of root-hair infections on cabbages, the percentage of plants clubbed and size of the clubbed roots. It is most effective against low concentrations of inoculum. When the retarding effect of the antibiotic has disappeared, bigger clubs associated with greater

weight of foliage are produced than on the untreated plants. Griseofulvin given to the soil three weeks after inoculation acts against *P. brassicae*. Spraying of roots with water suspension of a formulation of griseofulvin controlled chrysanthemum powdery mildew, a leaf disease caused by *Oidium chrysanthemi*, the incidence of *Botrytis cinerea* on lettuce and *B. tulipae* on tulips.

The effect of streptomycin on bacterial canker of cherry caused by *Pseudomonas mors-prunorum* varies with the stage of the hosts development at application. Spraying trees with streptomycin hydrochloride (220 p.p.m.) during the spring blossom period has a large immediate effect of reducing the severity of the necrotic leaf-spotting phase of the disease, but has little persistent effect on the supply of inoculum available for infection of branches in the autumn, as measured by the numbers of bacteria present on the leaf surfaces. Autumn sprays of streptomycin reduce the amount of leaf-surface inoculum, but less effectively than 'low' strength Bordeaux mixtures. The seed-borne organism causing silverying disease of beat, *Corynebacterium betae*, was as effectively controlled by soaking seeds in streptomycin solutions at 200 p.p.m. for 24 hr. as by dusting them with mercury fungicides.

It was concluded that the antibiotics were capable of reducing the severity of a range of plant diseases as effectively as the chemicals in general use. However, if used indiscriminately in high doses, they were harmful both to the plants and to the consuming human [*Nature, Lond.*, 178 (1957), 1330].

International Congress of Entomology

THE TENTH TRIENNIAL SESSION OF the International Congress of Entomology was held at Montreal from 17 to 25 August, 1956. The Congress, after the inauguration, divided itself into different sections, namely systematics; morphology and anatomy; physiology and toxicology; behaviour including social insects; ecology; geographical distribution; genetics, cytology and biometrics; palaeontology; arachnida and other land arthropods; agricultural entomology; forest entomology; medical and veterinary entomology;

stored products entomology; biological control and agriculture. Some of the important subjects discussed at the technical sections were: Systematic studies in relation to evolution and phylogeny; Mechanism of insect nutrition and feeding; Physiological responses of insects to insecticides and of resistance to DDT; Mechanism of virus transmission by insects with special reference to its entomological aspects; Eradication of insects and pests by gamma radiation and various aspects of breeding, genetics, cytogenetics; Geographical distribution, etc. In all, over five hundred papers were presented.

Dr. Chester Bradley (U.S.A.) gave an account of the 'Evolution of Hymenoptera' tracing their origin from a common stem with the holometabolous orders *Lepidoptera* and *Trichoptera*, in the Jurassic period. He pointed out that the larval food habits and provision made for the larvae by the adults have been significant features of their evolution. He described in detail how the evolutionary process would have taken place. Prof. M. S. Ghilarov (U.S.S.R.), referring to the significance of soil in the origin and evolution of insects, observed that the establishing of environmental conditions in which the given direction of evolution was feasible was of great value in solving the problems of animal phylogeny.

Mr. J. D. Bletchly (England), describing some laboratory investigations on the eradication of wood-boring insects by gamma radiation, observed that larvae could live up to 5 weeks even after treatment at 150,000 γ , and it seemed that very high dosages would be needed to produce larval mortality. Adults could, however, be sterilized and development of larvae inhibited at much lower dosages.

Dr. A. P. Kapur (India) read a paper on the 'High altitude insects of the Himalayas' giving an account of the insects collected from the Kulu, Lahaul and Spiti valleys including a large number of them from above the snowline. He supported the phenomenon of the migration of moths and also described certain hitherto unrecorded structural characters in the Noctuid moths *Cteipolia acrophila* that were collected alive from above the snowline.

Dr. M. L. Roonwal (India) communicated a paper on 'Recent

advances in forest entomology in India'.

The next session of the Congress is scheduled to be held in Austria.

High purity metals

SEVERAL PURIFICATION TECHNIQUES have been developed at the General Electric Company Laboratories, U.K., for a number of metals ranging from copper and aluminium to molybdenum and tantalum.

The zone-refining process, which has been used successfully for semiconductors, is also of considerable value for the purification of metals. To apply the zone-refining process to metals of high melting point an apparatus has been developed for passing a molten zone along a vertical metal bar which is supported only at the ends, the zone being held in position by surface tension forces. The molten zone is produced by a water-cooled copper coil connected to a high frequency generator, and the metal rod is moved slowly through the coil. The advantages of this 'floating zone' technique are that the molten metal does not come into contact with any crucible material and that metals with very high melting points can be zone-refined.

Another purification technique applicable to high melting metals consists of volatilizing the impurities in an electric arc under reduced pressure of argon or in a vacuum. This technique is carried out in a specially developed arc furnace in which a vacuum of 10^{-6} mm. Hg can be maintained. The furnace chamber is of glass and includes a gettering system so that, when an argon atmosphere is used, the gas can be continuously purified.

The removal of impurities by volatilization can also be carried out on metals in the solid state. An apparatus has been designed for treating bars 8 in. long and up to $\frac{1}{2}$ in. square in a vacuum of 10^{-5} mm. Hg. Bars of such metals as tungsten or tantalum can be maintained at a temperature just below their melting point, using direct resistance heating. A sensitive guide to the residual oxygen content of tantalum is its hardness, and the apparatus developed has enabled tantalum to be prepared with a lower hardness value than previously reported [*G.E.C.J.*, 24 (1957), 74].

Announcements

■ *A Symposium on Standardization of Plastics*—The American group for ISO/TC 61 Plastics is planning a Symposium on Standardization and Testing of Plastics to be held in Philadelphia on 30 and 31 October 1958. A panel discussion of 5 or 6 participants on the standardization body and its *modus operandi* of the participant's country will form the subject matter of one of the four sessions to be held. The other three sessions are proposed to discuss (i) methods for molecular characterization of plastics, (ii) properties of plastics in molten state (rheology), and (iii) methods of test for engineering properties of plastics.

■ *Lady Tata Scholarships*—The Trustees of the Lady Tata Memorial Trust have announced the award of the following scholarships for the year 1957-58.

International scholarships (totalling £4990) for research in diseases of the blood with special reference to Leucaemias are made to Dr. J. F. Kieler (Denmark), Dr. G. Marinone (Italy), Dr. M. Simensen (Denmark), Dr. B. G. Thorell (Sweden), Dr. A. J. Therkelson (Denmark), Dr. M. Seligmann (France), Dr. G. Klein (Sweden), Dr. G. V. Seaman (England), and Dr. M. Bessis (France).

Indian scholarships of Rs. 250 per month each for one year for investigations having a bearing on the alleviation of human suffering from disease have been awarded to Mr. U.W. Kenkare (Bombay), Dr. (Miss) Satwant Kaur Sokhi (Madras), Dr. (Mrs.) Avalokita Bhadrakumh Desai (Bombay), Dr. Goodwin Benjamin Newton (Lucknow), Dr. Bimalendu Das (Patna), and Dr. (Miss) Habib Bano (Lucknow).

■ *Scholarships to Foreign Students*—The Government of India have announced the award of 140 scholarships of Rs. 200 per month to non-Indian students and students of Indian origin permanently domiciled in 50 foreign countries for higher studies during 1958-59. The scholarships will be awarded for studies in Arts and Humanities, Science, Agriculture, Medicine, Technology, Education, Law, Commerce, Forestry, Veterinary Science, Engineering, etc. Preference will be given for post-

graduate studies. Applications should be addressed to the Indian Embassies in respective countries.

■ *Award of Doctorate Degrees*—Sri Ishverlal Narottamadas Solanky and Sri Krishnaji Gopal Divekar have been awarded the Ph.D. degree by the Poona University for their theses *Embryological studies on family Chenopodiaceae* and *Spectrophotometric studies of ferric-phenol complexes* respectively. Sri Shanmuganathan has been awarded the Ph.D. degree in Chemistry by the Annamalai University for his thesis *A physico-chemical study of sulphur-oxygen bond and conjugation in sulphones*.

INSTRUMENTS AND APPLIANCES

TEMPERATURE CONTROLLER

A self-contained instrument which indicates and controls temperature to a close accuracy over a wide range in accordance with pre-determined time programme is being constructed by Ether Ltd., Birmingham.

Known as the Transitrol Programme Temperature Controller, Type 994, it can also control any process where the signal can be converted into direct current or voltage. It is used mainly for controlling the heating and cooling cycle of a furnace-load and its operation is such that the load is automatically heated at a pre-determined rate, held at the soaking temperature for a given time, and then cooled as required.

The instrument combines an indicating temperature-control unit with a time/temperature programme unit. Both units are housed together in a robust welded-steel case, fully sealed against dust and moisture, and is suitable for wall or panel mounting. The indicating unit is situated above the programme unit to enable the operator to maintain a visual check on the indicator while the programme is being set. Electrical connections to control relay, thermocouple and mains supply are evenly distributed inside the case.

The unit operates on a transistor, thus eliminating the need for thermionic valves, magnetic amplifiers and oscillator circuits. It incorporates a conventional galvanometer, used as the measuring system, and an indicating-pointer which operates a simple photo-

electric system and controls the heating medium [*Chem. Age*, **77** (1957), 251].

RECORDING RATEMETER

A recording ratemeter designed to indicate and record the regular or random rate of pulses arriving at the input and furnish signals, for giving warning or process control, is being produced by Labgear (Cambridge) Ltd., Cambridge.

Four ranges of count-rate, up to a maximum of 600,000/min. to an accuracy of better than 1 per cent, are claimed. This degree of accuracy is obtained by the use of a diode-pump type of circuit embodying automatic compensation for counts lost in a random distribution of pulse input, as compared with regularly spaced pulses.

The instrument is designed to operate from pulses originating from all types of detectors and is equally applicable to nuclear and industrial installations [*Chem. Age*, **77** (1957), 249].

ULTRASONIC CLEANING PLANT

A high frequency ultrasonic cleaning plant is being produced by Kerry's Ltd., London. In the plant, the articles to be cleaned are loaded into containers which pass into a pre-wash tank. They then travel to the ultrasonic section and stop directly over a multiple transducer array of rectangular barium titanate plates. The dwell period can be varied by a calibrated dial between two seconds and two minutes.

The ultrasonic tank is supplied with clean filtered solvent at 400 gallons per hour. Multiple filters are included in the pumping circuit and remove particles down to one micron. The solvent is constantly replaced by redistilled fluid so that the finer particles below one micron are removed together with oil dissolved from the cleaned articles. The containers then pass to a vapour still where the temperature of the articles is raised and as they emerge through the cool zone of the still the solvent evaporates and the containers are automatically off-loaded from the conveyer with the contents clean and dry [*Chem. Age*, **77** (1957), 251].

ABSORPTION CELL FOR MICROWAVE SPECTROSCOPY

A new type of microwave absorption cell (of Pyrex glass tubing),

free of metals, has been developed by the Physics Department, National Research Council, Ottawa. In use, the microwave energy is fed into one end of the tubing by means of a microwave horn and polystyrene lens and is taken from the tubing at the other end by a similar lens and horn. The undesirable loss of power in the absorption cell is negligible and does not affect the spectrometer sensibility. In addition to forming part of the microwave optical system, the lenses serve very conveniently as the vacuum windows. The attenuation at 8.5 mm. wavelength is 3.4 db. for a 250 cm. cell. Since there are no metal surfaces, this type of cell is very suitable for the investigation of reactive molecules. It can also be used in a high temperature microwave spectrometer for the investigation of corrosive substances with low vapour pressures, or in a Zeeman modulation spectrometer for the study of free radicals [*Canad. J. Phys.*, **35** (1957), 241].

FERRO-ELECTRIC CERAMICS

A range of ferro-electric ceramics has been developed by General Electric Co. of England comprising solid solutions of sodium niobate with either cadmium or lead niobate, in which pairs of sodium atoms are replaced by a cadmium or lead atom. The properties change progressively with composition up to a limit of *c.* 25 per cent replacement. The saturation polarization is about 18 $\mu\text{c./sq. cm.}$ for the cadmium material and 10 $\mu\text{c./sq. cm.}$ for the lead material, with coercivities of 10 kV./cm. and 15 kV./cm. respectively.

After polarization, both materials show an electro-mechanical activity comparable with that of barium titanate with the advantage of an appreciably higher maximum permissible operating temperature. The new materials are, therefore, likely to be used in the manufacture of transducers which require a piezoelectric material, particularly in applications where it is necessary to extend the operating temperature above 100°C., the upper limit for barium titanate.

In the niobates, the structural changes which occur at Curie temperature are complex; some of them are linked with the Curie temperature and are directly

associated with the electrical properties and with the ferroelectric or antiferroelectric nature of the material. For the three solid solutions formed by sodium niobate with potassium, cadmium and lead niobates the Curie temperature does not depend on the size of the replacement atom [*G.E.C.J.*, **24** (1957), 72].

BROADBAND BOLOMETER AND THERMISTOR

Two new broadband disc bolometers for coaxial detectors, models N603 and N603-4.5, covering the frequency range 500-10,000 m/c., and a new broadband disc thermistor, model N335, covering the same frequency range, have been developed by the Narda Corporation, New York.

The new bolometers, consisting of two 100-ohm Wollaston wire bolometer elements mounted on a mica disc, are for attenuation measurements and relative power measurements. Square law response error is less than 1 per cent for power levels of 0.2 mW. with 8.75 ma. bolometers or 0.1 mW. with 4.5 ma. bolometers. Microwave power levels of 0.01 mW. to 10 mW. can be measured with 8.75 ma. bolometers and power levels of 0.01 to 3 mW. with 4.5 ma. bolometers.

The new thermistor is particularly suited for measurement of pulsed signals.

ORE MINERAL IDENTIFICATION

An electric cell photometer has been used successfully in conjunction with a micro-indentation hardness tester for the rapid identification of ore minerals in polished sections. The hardness tester is a bench type instrument, manufactured by Hall Telephone Accessories Ltd.

In the technique employed both the photometer and hardness tester are fitted to the same standard ore microscope. The reflectivity of the unknown mineral is measured relative to a known standard using tungsten filament illumination of specified colour temperature. This measurement can be made on mineral grains down to about 30 μ in diameter with a precision of 1 per cent. The hardness of the same unknown mineral can be determined immediately after the reflectivity measurement, by rotating the dia-

mond pyramid of the hardness tester into the position of the objective, making the indentation, returning the objective to its original position and measuring the size of the indentation. The positioning of the indentation can be made with a precision of less than 5 μ . A Vickers 136° pyramid is used for making the indentation and the hardness is expressed in terms of Vickers hardness numbers.

Each measurement normally takes less than one minute to complete and when the values obtained are used in conjunction with other easily observed properties such as colour, anisotropy and reflection pleochroism, most ore samples can be satisfactorily identified [*Nature, Lond.*, **179** (1957), 628].

RADIATION THICKNESS GAUGE

The radiation thickness gauge, type 170, developed by Isotope Developments Ltd., Berks, in collaboration with Davy & United Engineering Co. Ltd., has been designed specifically for use in the metals industry to provide an instrument giving accurate thickness indication with a very fast response time (0.05 sec.) and making no contact with the material under inspection. The mechanical construction of the gauge is such that it withstands the conditions normally encountered on cold metal processing lines.

Standard thickness range of measurement is 0.005 to 0.025 in. of steel. Special arrangements, however, extend the range down to 0.002 in. or up to 0.040 in. Variations as small as $\frac{1}{4}$ per cent of sheet thickness give a clear indication on the instrument and may be used to actuate the reject mechanism. Two controls are provided to select the positive and negative values of 'off-gauge' at which the reject signal is actuated. These controls may be graduated in thickness or weight units or in percentages [*Chem. Age*, **77** (1957), 610].

ELECTRONIC POTENTIOMETER RECORDERS

Electronic continuous balance potentiometer recorders, developed by Honeywell-Brown Ltd., Middlesex, form standard components of vapour phase partition chromatography equipment.

In vapour phase partition chromatography the components of the vaporized sample (in one method of detection) affect the electrical resistance of a hot wire as they emerge from a chromatographic column. The changes in electrical voltage thus produced are measured by, and are automatically recorded on, the moving chart of a recorder. The changes in electrical resistance of the hot wire are measured by the instrument's 'continuous balance' potentiometer circuit. The measurements are recorded as a series of peaks on the recorder chart. The position of the peaks on the trace affords the qualitative evidence for analysis. The height or area of the peaks provides the quantitative information required [*Chem. Age*, **77** (1957), 610].

MICROWAVE VALVES

An experimental form of magnetron for low-power pulsed operation at 10,000 Mc/s. has been produced by General Electric Co., U.K. The magnetron has an anode system of the 'rising sun' form within a glass envelope. Coupling to the waveguide is by direct radiation from the anode system through a specially shaped waveguide transformer. A pulse power of about 1.5 kW. may be obtained with a voltage of 2.5 kV. and pulses as short as 0.1 μ s. may be generated without jitter at the pulse start.

A more robust higher power magnetron for operation at 10,000 Mc/s. has also been produced. Giving a power of 80 kW. at a pulse length of 1 μ s., it is capable of operating with a rate of rise in voltage of 25 kV./ μ s. [*G.E.C.J.*, **24** (1957), 56].

SILICON TRANSISTOR

An experimental silicon power transistor, capable of providing an output of 5 watts at 10 megacycles either as an oscillator or an amplifier, has been developed at Bell Telephone Laboratories. Unilateral gain is in excess of 20 db., and a collector efficiency of better than 40 per cent has been achieved.

The unit is a p-n-i-p diffused emitter and base transistor, in which a near-intrinsic or 'neutral' layer of silicon separates the collector from the other elements. Alpha cut-off by the transistor is

about 100 megacycles per second, and some laboratory samples have provided as much as one watt output as an oscillator at 100 megacycles per second. Input and output impedances are of the order of 20 and 300 ohms respectively.

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Erratum

In the article entitled "The Assessment of Solar Heat Stress on the Human Body", **16C** (1957), 61, authors' names should be read in the order N. C. Mehra and K. V. Mani.

Progress Reports

INDIAN CENTRAL TOBACCO COMMITTEE

A BRIEF ACCOUNT OF THE RESEARCH ACTIVITIES OF the Committee during 1955-56 is given below.

During the period under review, the Central Tobacco Research Institute, Rajahmundry, evolved an improved strain S-27 of cheroot tobacco, which gives *c.* 49 per cent higher yield than the local variety. Another improved strain K. 20 of *bidi* tobacco evolved at the Institute of Agriculture, Anand, gives *c.* 15 per cent higher yield than the control strain K. 49. Improved strains of *hookah* tobacco No. 337 and No. 238 have been evolved at Tobacco Research Substation, Ferozpur.

Agronomy — Application of 80 lb. nitrogen as groundnut cake or 1 in. layer of farmyard manure gave about 50 per cent more transplants than otherwise. Positive linear response to residual effect of doses of nitrogen (20 and 40 lb./acre) in plots manured for 3 successive years was significant to the doses in all the three years.

Pedology and chemistry — The inorganic nitrogenous fertilizers, ammonium sulphate, ammonium sulphate-nitrate, Chilean nitrate and urea have not shown any difference in their effect on the crop. Similar is the position with the organic nitrogenous manures, viz. blood meal, hornhoof meal and stera meal. Nitrogen, in general and hornhoof meal in particular, produced slightly heavier leaves. Application of N, P, K either singly or in combinations increased the nicotine content of the leaf. A survey of flue-cured tobacco soils from the East Godavari and Guntur districts showed that they contained 0.035-0.05 per cent total nitrogen. Flue-cured tobacco samples from Andhra contained less K_2O , S and Cl and more CaO than those in the American tobacco samples. The P_2O_5 , MgO and nicotine contents of both tobaccos were of the same order.

Physiology — Germination of seed treated to low temperatures (50° or 64°F.) for 5-15 days was 50-200 per cent higher than that of untreated seed. The number of transplants obtained with treated seeds was also higher by *c.* 50-70 per cent.

Entomology — D.D.T. spray (50 per cent W.P.) at a concentration of 2 lb./100 gal. of water sprayed at the rate of 7 gallons per 100 sq. yd. controlled the infestation of cutworms and caterpillars in the nursery to a large extent. In a laboratory experiment a dosage of 14.8 mg. < Dieldrin (50 per cent W.P.) per g. weight of the body of the beetle killed 88 per cent of beetles in 72 hr. In the field, the mortality increased with increased concentration up to 5 lb. per 100 gal. which was the highest concentration tried. Dieldrin and Chlorodane 10 per cent dust and 25 per cent W.P. killed comparatively large number of beetles. A prophylactic treatment either with endrine 1 per cent dust at 2 lb. per acre or nicotine sulphate 40 per cent spray at 8-16 oz. per acre reduced the incidence of aphids on Lanka tobacco to less than 40 per cent. Aphids on flue-cured tobacco were effectively killed by the spray of endrine (19.5 per cent) and Basudin (20 per cent) at 10 oz. per acre.

Breeding — In the varietal trial conducted, Virginia Gold maintained its superiority over both Harrison Special and Chatham under untopped conditions. A new variety, Super Gold I, imported from U.S.A., was found to be as good as Chatham and superior to Harrison Special both under topped and untopped conditions. Among the synthetic cultures, Nos. 11, 18 and 31 of culture 40 and Nos. 26 and 27 of culture 53 were found to be superior to both Harrison Special and Chatham.

RADIO RESEARCH IN BRITAIN

SOME OF THE IMPORTANT RESEARCH ACTIVITIES OF the Radio Research Board, U.K., for the year 1955-56 are summarized below.

Propagation of low-frequency ground waves — Investigations on the change of phase with distance of 127.5 kc/s. ground waves transmitted from stations of the Decca Navigator System, over all-land and land-sea paths with particular attention to the effects of geological boundaries have indicated that the measured phase changes were in close agreement with those derived theoretically from the existing theories of propagation over homogeneous ground and boundaries using conductivity data.

Surface waves — Observations on the field distributions and the launching efficiencies of radial surface waves at 10,000 c/s. from a single vertical dipole radiator, placed at different heights above the surface, propagated over a flat metal plate inductively loaded either by coating it with a thin layer of dielectric or by corrugating it in concentric circles revealed good agreement, with theoretical work based on an extension of Cullen's analysis for a plane surface wave.

Forecasting of radio transmission conditions — To ensure accurate predictions of the transmission conditions a machine has been developed which displays a set of charts drawn for constant Local Mean Time (L.M.T.) in such a way that a Universal Time (U.T.) for any place can be obtained. The machine is also valuable for indicating the occurrence of maxima and minima at places where there are no ionospheric observatories.

A bulletin of predictions for sunspot maximum condition in the F_2 layer has been prepared for the equinoxes and solstices using the 'standard epoch' method which considers all available ionospheric data as part of a closed cycle of variation extending from sunspot minimum to sunspot maximum.

Characteristics of the ionosphere — Improvement has been effected in the customary representation of the lower layers D, E and F_1 by simplified models (i.e. neglecting electron movement and the rate of change of ionization). Detailed analysis of the E-layer data accumulated at the Swansea station revealed, on diurnal, seasonal and latitude variation in the normal critical frequency (fE), for stations near the latitude 35° north and south of the equator, a striking latitude variation in the index M in the equation $(fE) = A \cos x$ where A and M are constants and x, the zenith angle of

the sun. It is suggested that these anomalies are associated with the foci of the current systems due to radiation from the sun which cause the variations of the earth's magnetic field on undisturbed days, and are on the average located near these latitudes.

From a study of the variation of the maximum electron density in the F_2 layer during a solar cycle, it has been shown that the critical frequency f_oF_2 is sensitive to both changes in photon emission measured, roughly by a Wolf sunspot number R' , and to corpuscular radiation measured by the associated magnetic activity C .

Remarkable similarities were found between the perturbations at Ibadan for a partial eclipse in a year of low solar activity and those on a previous occasion at Bocayuva, Brazil, whose magnetic latitude is very similar to those of Ibadan during a total eclipse in a year of great solar activity. It is concluded that the perturbations were mainly due to abnormal electron drifts generated during the eclipse, these movements being similar at the two stations, most probably due to the closely similar location as far as the magnetic effects are concerned. The form of the eclipse movement is largely determined by the angle of dip of the earth's magnetic field.

A provisional monthly mean index (IF_2) has been constructed for the period 1938-1955.

Propagation of HF and UHF radio waves — Development of a special apparatus comprising a high powered (peak power, 150 kW.) pulsed transmitter in the frequency 5-25 Mc/s. set up at distances of a thousand miles or more from the receiving site, which operates for short, controlled periods (100 μ sec.) at a succession of frequencies and a synchronized receiver installed at the Slough station to display the pattern of pulses has been undertaken and regular measurements on the azimuthal and zenithal angles of arrival and their spread, of signals received from Bombay (on 18.42 Mc/s.), Japan (14.435 Mc/s.) and Australia, have been made.

A receiver having narrow effective band width providing a means of measuring field strengths up to 0.03 μ V./m. (median level, 0.01 V.) at 53.25 Mc/s. has been constructed with which the signals on 53.25 Mc/s. from the Kirk O' Shotts television station of the BBC, 530 miles from Slough, have been received.

Field strength measurements of the television transmitters in band I (41-68 Mc/s.) have been supplemented by a programme of observations in bands III and IV (174-216 Mc/s. and 470-585 Mc/s.).

Field strength observations on metre-waves propagated with varying height above ground over 60-475 km. path lengths have shown that the farther the receiving point beyond the horizon, the smaller is the gain in signal strength over a given height interval.

Scattering of radio waves at the ground and ionosphere — Experimental measurements on the skip distances and the maximum usable frequencies, using the back-scatter method, and theoretical studies on the different aspects of the mechanism of back-scatter propagation have been undertaken and attempts have been made to apply the technique to improve the efficiency of operation of a particular long-range fixed and mobile h.f. communication services.

It has been found that the frequency band from about 25 to 60 Mc/s. affords a means of regular communication, particularly by telegraphy, for distances up to about 2000 km. Telephony on a 24 hr. basis seems impracticable, however, except with extremely high transmitting powers which would be uneconomical if attainable at all.

HF and UHF direction finding — Work has been carried out on the directional errors introduced by lateral deviation of the rays in the ionosphere and on the reduction of these errors in practice by paying attention to the observational technique of direction finding and to improvement in the instrumental design. Analysis of directional measurements made at Slough on a pulsed transmitter located at Malta shows that the actual deviation of a ray may be very small in some circumstances.

Analysis of directional measurements made on pulsed and continuous wave transmitters located at distances over 2100 km. and using the precision, wide-aperture, spaced-loop direction finder showed that the actual deviation (0.8° about the overall ground mean) of a ray may be very small under some conditions.

To overcome the difficulties arising from the effect of re-radiation, theoretical consideration has been given to the idealized problems of a direction finding system with non-interacting aerials situated on a uniform plane earth with no pick-up of horizontally polarized radiation. An arrangement of aerials in a ring was considered and the method of fitting constant-phase lines to such an arrangement by the least squares process was applied, incorporating amplitude weighting. Such a system was shown to be a close approximation to the German Wullenwever system.

Semiconductor research — Various aspects of the behaviour of germanium in commercial components (diodes and transistors) and in rectangular monocrystalline filaments have been studied. Experimental measurement at 65°C. of the spectral density of the mean square noise current generated in a current carrying germanium filament over a wide frequency range (0.04 c/s. to 8 Mc/s.) showed a dependence of the spectral density on frequency of the form b^{-n} where 'n' was equal to one at the lowest frequencies, gradually increasing to about 1.24 above 100 c/s. to 2.0 above 1 Mc/s. This inverse square dependence on frequency at a few Mc/s. for this type of noise has not been observed previously in either filament, point-contact or junction diodes, perhaps being obscured by the apparent uniformity of the spectral density in other cases to much higher frequencies.

Magnetic and dielectric materials — Research on preparation and properties of ferromagnetic materials carried out at the Imperial College of Science and Technology has resulted in the development of a method of general application to ferrite materials where 1 mm. crystals are sufficiently large for measurements to be made for preparing single crystals of ferromagnetic ferrites. The general method used was to dissolve the constituent oxide of the ferrite in a molten 'flux', usually anhydrous borax, by heating for a few hours at 1300°-1400°C. and then cooling the melt at a carefully controlled rate (a few degrees per hr.). Alternatively it is possible to evaporate the flux at a constant temperature (1300°-1400°C.) until crystals are deposited from the solution.

Effect of Temperature on the Efficiency of Monomolecular Films in Suppressing Evaporation

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(Manuscript received 2 June 1957)

The evaporation from a water surface covered with a film of cetyl alcohol has been shown to be a function of temperature. The efficiency of the film is less when it is in liquid or gaseous form at higher temperatures than when it is in a less compressible form as at lower temperatures.

THE fact that monomolecular films of certain organic compounds, spread on a clean water surface, have the effect of reducing the rate of evaporation of water was noticed by Rideal¹ and Langmuir². Langmuir showed that cetyl alcohol possesses this property to a remarkable degree. Ramdas³ suggested in 1927 that if the oceanic surfaces were to get covered by monomolecular films as a result of wreckage of oil-bearing ships, the actual rainfall might be affected because of the diminished evaporation.

More recently, Mansfield^{4,5} in Australia has carried out experiments in the laboratory as well as in the open which show that reduction in evaporation of the order of 50 per cent may be achieved by spreading monomolecular films of cetyl alcohol (hexa-decanol) on water surfaces. One of these field trials has been in progress for some time at the Stephens Creek Reservoir, Broken Hill, N.S.W.

This important application of surface physics to the control of evaporation from reservoirs and lakes is naturally attracting worldwide attention⁶, and large-scale experiments with cetyl alcohol and similar substances have been planned at some of the irrigation project sites in India.

In this connection, it seemed worth while to undertake laboratory experiments on the effect of temperature on the evaporation-inhibiting efficiency of monomolecular films of long straight-chain alcohols with high

melting points. This aspect of the problem is important. The question is, how far the efficiency observed in the low-temperature zones of the earth can be achieved in warmer areas, e.g. in the various zones of India? The present note discusses the results of our preliminary experiments in the laboratory when using cetyl alcohol.

Experimental procedure

Pure cetyl alcohol dissolved in normal hexane was used. Preliminary tests on clean water surfaces dusted with lycopodium indicated the minimum quantity of the solution to be applied to the water surface so as to form stable monomolecular films. As soon as the solution spreads, the solvent evaporates leaving behind the cetyl alcohol film. Any slight excess of cetyl alcohol will, as is well known, remain in small lumps floating on water, but in equilibrium with the monomolecular film. The vigorous movements that camphor or antipyrin particles show while floating on a clean water surface come to a dead stop when the water surface is covered with the monomolecular film of cetyl alcohol.

Two identical glass petri dishes, 8.5 cm. in diameter, containing similar amounts of water up to a depth of 2 cm. were used. The free water surfaces were tested for purity and one of them was covered with cetyl alcohol film while the other was kept pure as the control. These dishes were kept in separate circular vessels of 20 cm. diameter which contained 5 cm. depth of water at the same temperature, the test vessels being suitably adjusted on platforms at the centre of the bigger vessels so as to have all the water surfaces at the same level. The annular surfaces of the water surrounding the test vessels served not only to minimize edge effects, but

also to maintain the same temperature of the water in both the test vessels so as to minimize differential evaporative cooling due to the presence of the cetyl alcohol film on one of them. The test vessels were exposed to a steady horizontal wind of 2 miles per hour from a fan for definite time intervals, their positions being interchanged at half the intervals to equalize any slight differences of exposure. The loss of weight by evaporation was measured by weighing before and after. Except during the interval of evaporation, the vessels were kept covered with air tight lids.

Results and discussion

The results have shown that the film-covered water surface always gives a lower rate of evaporation than the clean water surface at the same temperature. This decrease of evaporation is best expressed as a percentage of the evaporation from the clean water surface. The results obtained at different temperatures ranging from 20° to 60°C. are shown in Fig. 1, where the percentage reduction in evaporation is plotted against the temperature of the evaporating water. There is a conspicuous fall in the reduction of evaporation with the rise of water temperature, from about 60 per cent at 20°C. to about 13 per cent at 60°C. It is obvious that the resistance offered by a film of cetyl alcohol to the movement of water molecules from the liquid to the vapour phase (evaporation) is a function of temperature. The efficiency of the film is less when it is in liquid or gaseous form at the higher temperatures than when it is in a less compressible form as at lower temperatures.

Further experiments on structure and compressibilities of films in relation to evaporation through them and on the temperature dependence are under way. The

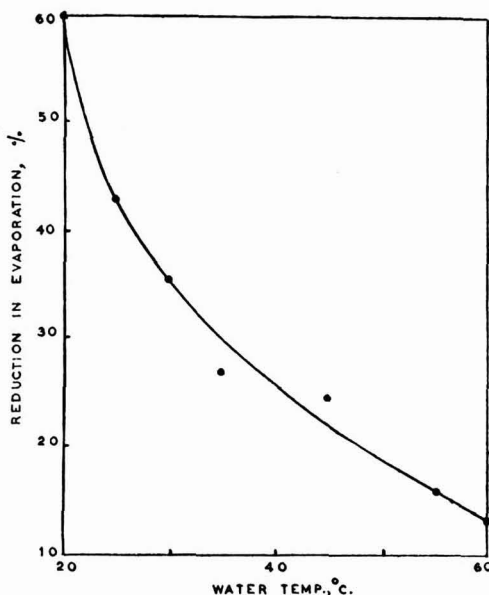


FIG. 1 — EFFECT OF MONOMOLECULAR FILM OF CETYL ALCOHOL ON THE EVAPORATION OF WATER

use of cetyl alcohol and other spreading substances capable of inhibiting evaporation is being examined. It is realized, however, that the conditions in large open reservoirs, exposed to wind and sun, are not identical with those of laboratory tests, but laboratory observations and results are the pointers for field tests.

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Briquetting of Indian Coals: Part V—Briquetting Performance of Coals of Different Rank

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(Manuscript received 14 January 1957)

The strength of briquettes obtained from coals of different ranks has been found to be influenced by the degree of comminution, briquetting pressure and moisture content. The extent to which these variables influence the strength depends on the rank of coal. Maximum strength is obtained when briquetting is carried out at a moisture corresponding to the air-dried moisture content (at 60 per cent relative humidity and 40°C.). The order of variation of strength under optimum briquetting conditions, however, is: medium rank < high rank < low rank coals. Strong briquettes can be obtained from all ranks of coal (–72 mesh B.S.S.) on compressing at suitable pressures. For coals containing less than 76 and more than 88 per cent carbon, the minimum briquetting pressure is 5 tons/sq. in. For coals having carbon between 76 and 88 per cent it is above 12 tons/sq. in.

ALTHOUGH several theories¹⁻³ have been advanced to explain the mechanism of briquetting of coals and several methods developed⁴⁻⁶ for evaluating briquetting performance of coal based on elastic and plastic behaviour of briquetted compacts and on index of plasticity, no systematic work on the performance of coals of different rank seems to have been carried

out so far. For a quantitative evaluation of the effects of moisture, pressure, size and rank it is often convenient to compare the mechanical strength of self-bonded briquettes for a range of coals prepared under identical conditions. In the present paper are presented the results of study on the briquetting performance of coals of different rank.

Experimental procedure

The procedure adopted for briquetting and testing of coals was the same as described earlier⁷. The analyses of coals used in the present investigations are presented in Table 1. Throughout these experiments, unless otherwise stated, samples passing through –72 mesh B.S.S. were used.

Results

The influence of factors like degree of comminution, briquetting pressures and moisture content on the briquette strength for coals of different ranks was studied. The influence of degree of comminution was studied for a low rank and a high rank coal.

TABLE 1—ANALYSIS OF COAL

COAL SAMPLE	PROXIMATE ANALYSIS (AIR-DRIED BASIS)				ULTIMATE ANALYSIS (D.M.M.F. BASIS)				
	Moisture* %	Ash %	V.M. %	F.C. %	C %	H %	N %	S %	O (by diff.) %
CAJ/116 + 117/B Madhuband colliery	1.0	27.10	20.20	51.70	91.70	4.85	1.89	0.78	0.78
Ekra Khas coal dust	1.4	21.60	20.50	56.50	89.80	4.72	2.10	0.71	2.67
CAJ/127 R.O.M. Bhutgoria coal	1.0	21.50	27.70	49.80	87.38	5.17	2.23	0.68	4.52
Chanah coal	1.7	17.00	27.80	52.50	85.82	5.09	2.27	0.53	6.29
CAC/252/56 Argada coal	3.3	17.55	32.17	46.98	84.26	5.32	1.76	0.67	7.99
Chapui Khas coal dust	6.4	14.54	34.24	44.82	81.19	5.42	1.91	0.52	10.96
Assam coal† (Laitryngew)	3.3	13.20	30.60	43.90	80.04	5.61	0.84	3.60	9.91
Palana lignite†	15.8	8.00	43.37	32.83	72.18	4.92	—	1.03	21.87
South Arcot lignite	17.0	8.70	40.46	33.84	70.89	4.89	—	—	—

*At 60% R.H. and 40°C.

†M.M. = 1.08 + 0.55S.

Degree of comminution — Using coal of different sizes the compression strengths were determined at different briquetting pressures for South Arcot lignite and Ekra Khas coal (a high rank coal) at their optimum moisture contents (Figs. 1 and 2). In general, with decrease in particle size there is an increase in the briquette strength at all briquetting pressures.

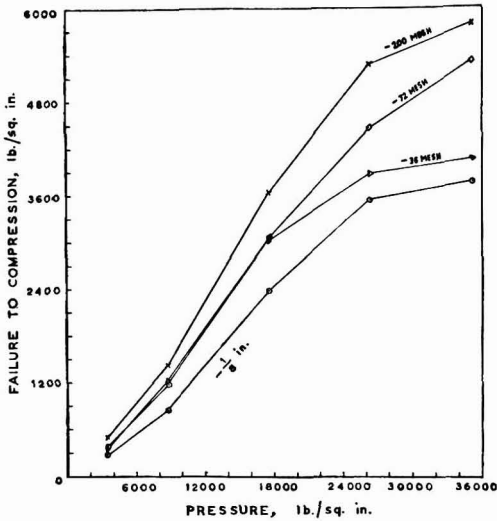


FIG. 1 — INFLUENCE OF DEGREE OF COMMINUTION AND PRESSURE ON THE BRIQUETTING OF SOUTH ARCOT LIGNITE

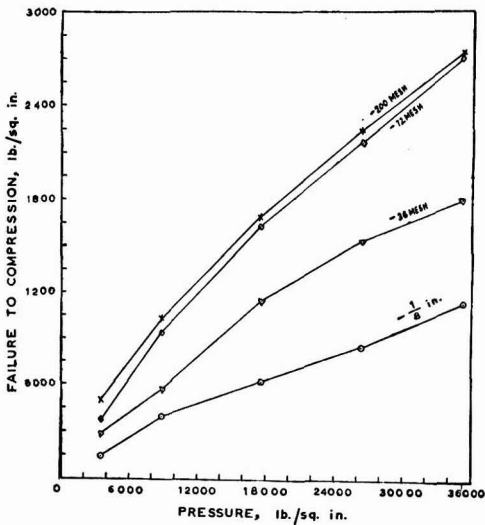


FIG. 2 — INFLUENCE OF DEGREE OF COMMINUTION AND PRESSURE ON THE BRIQUETTING OF EKRA KHAS COAL

While in the case of Ekra Khas coal, further decrease in the particle size below 72 mesh B.S.S. does not markedly improve the strength, there is an appreciable increase in the case of South Arcot lignite which is a low rank coal.

Influence of moisture — The influence of variation in moisture content on compression strength of briquettes prepared at different

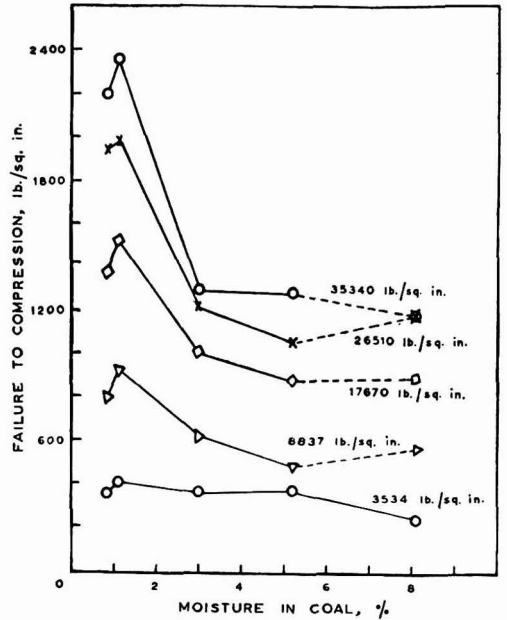


FIG. 3 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF MADHUBAND COAL

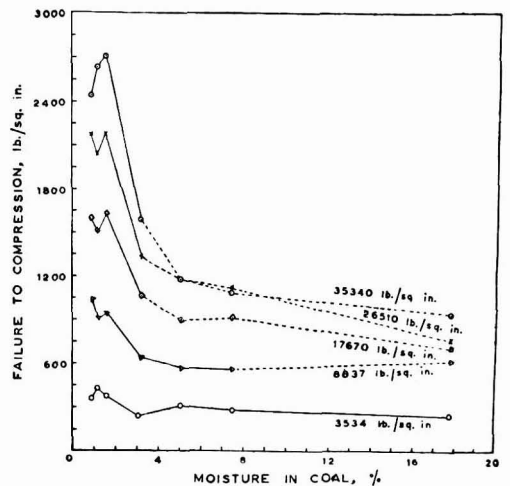


FIG. 4 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF EKRA KHAS COAL DUST

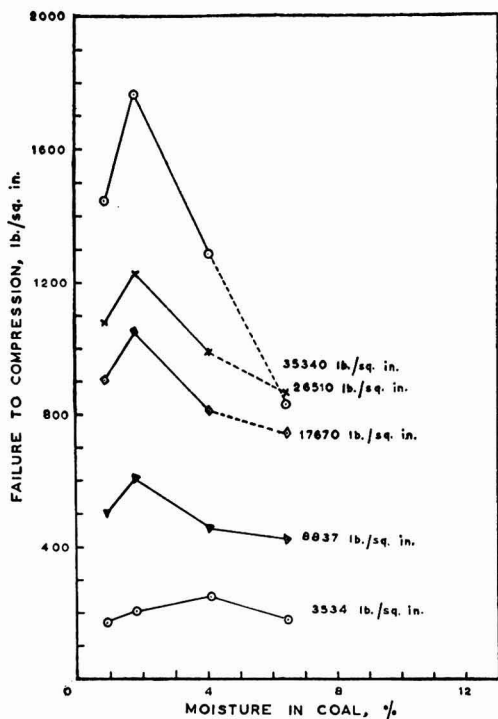


FIG. 5 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF BHUTGORIA COAL

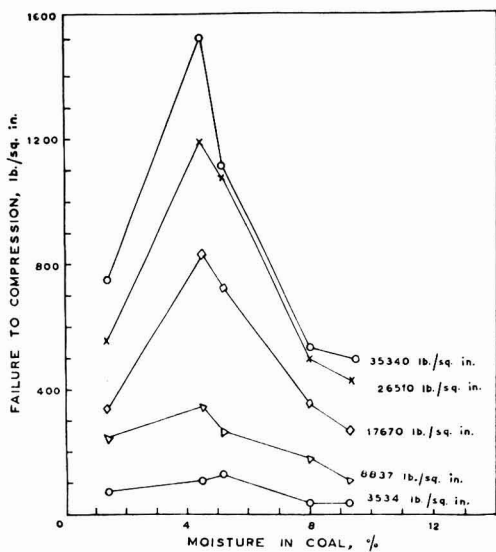


FIG. 6 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF ARGADA COAL

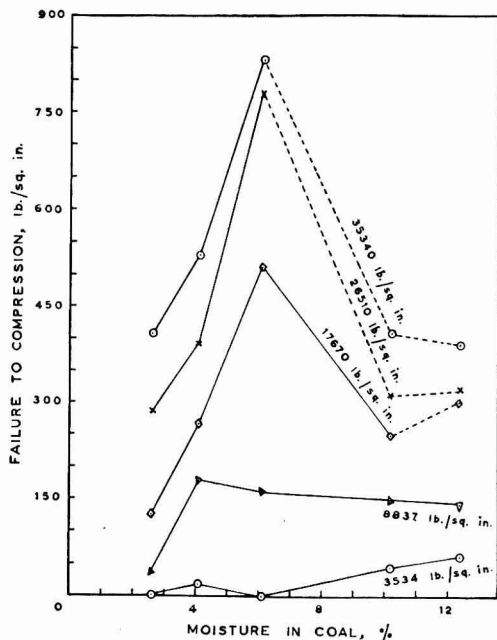


FIG. 7 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF CHAPUI KHAS COAL

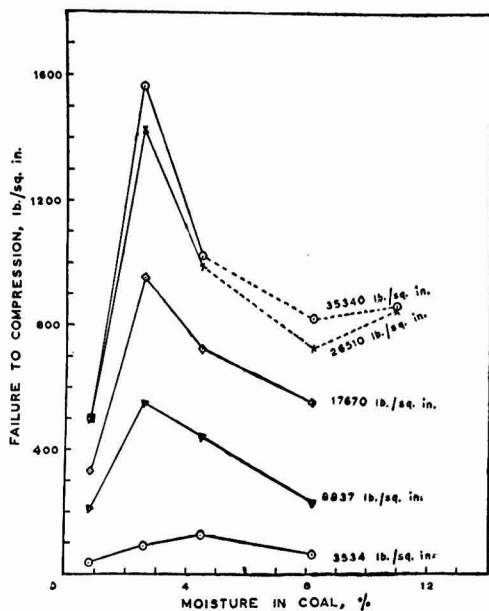


FIG. 8 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF ASSAM (LAITRYNGEW) COAL

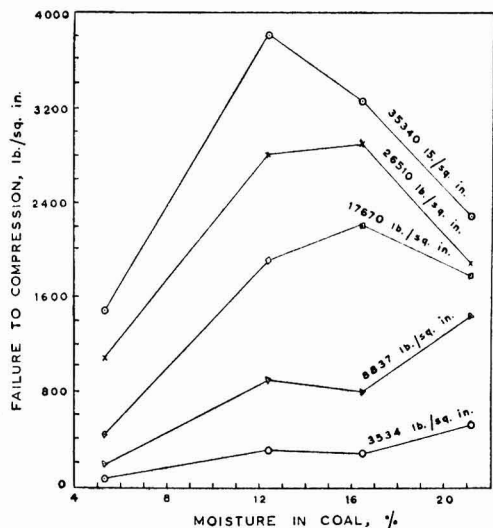


FIG. 9 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF PALANA LIGNITE

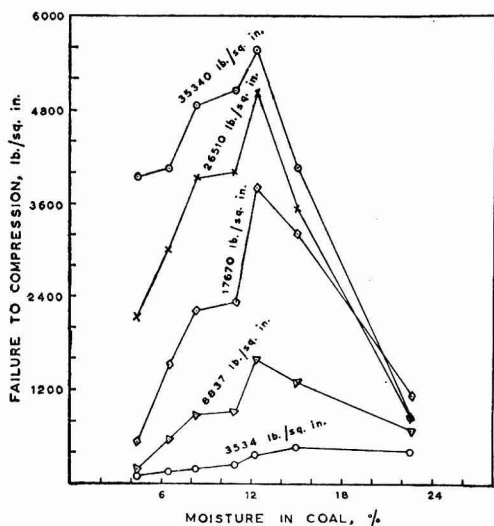


FIG. 10 — INFLUENCE OF MOISTURE AND PRESSURE ON THE BRIQUETTING OF SOUTH ARCOT LIGNITE

pressures is shown in Figs. 3-10. In general, briquettes possessing maximum strength are obtained at all pressures, except in the case of lignites, at an optimum moisture content, which is characteristic of the coal. This characteristic moisture content corresponds to the air-dried moisture content of the coal (as determined at 60 per cent relative humidity and 40°C.).

Influence of briquetting pressure — Compression strengths were determined for different coals after subjecting them to different briquetting pressures. The results obtained are presented in Figs. 3-10. The compression strength for coals of different ranks prepared at their optimum moisture contents and at different briquetting pressures is shown in Fig. 11. In general, there is an increase in briquette strength with increase in the briquetting pressure.

The influence of pressure on the compressibility of coals of different rank was also studied. Beyond a particular pressure the change in volume was negligible (Fig. 12). This relationship can be represented as

$$Y = A + \frac{B}{X} + \frac{C}{X^2}$$

where X is the pressure applied, Y is the height of the briquette in inches and A , B and C are constants⁸. This equation is not valid for pressures below 0.394 ton/sq. in. It gives an upward bias at pressures of 19 tons/sq. in. and above.

Discussion

The results obtained show that the strength of the briquettes at room temperature is largely influenced by the briquetting pressure (which in turn depends on the elastic

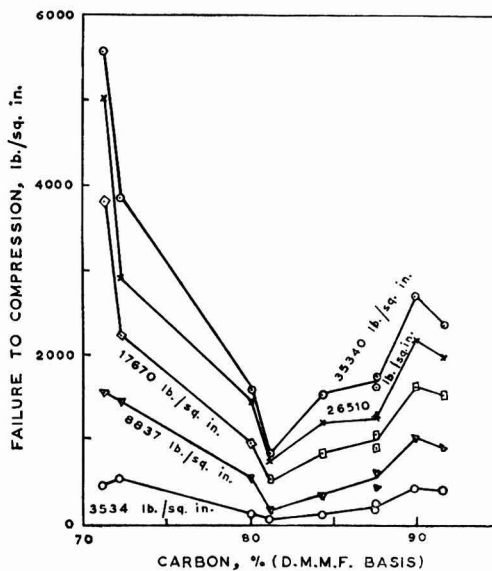


FIG. 11 — INFLUENCE OF PRESSURE ON THE COMPRESSION STRENGTH OF COAL

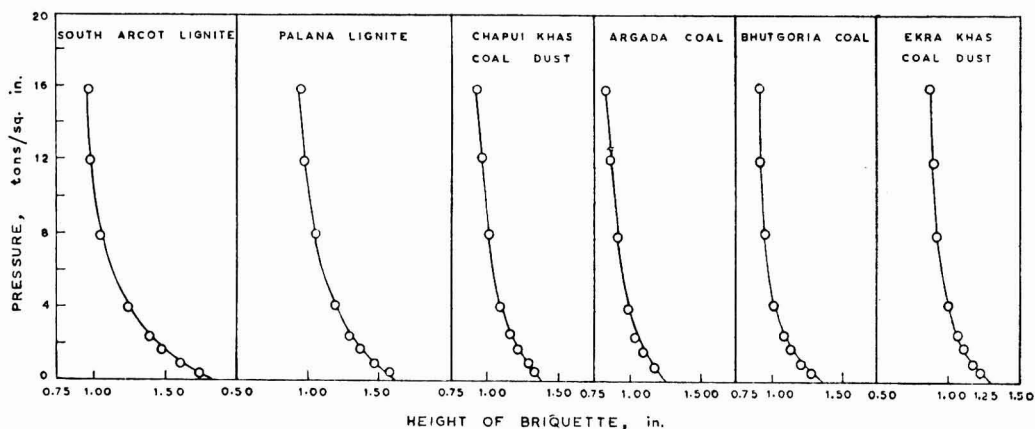


FIG. 12 — INFLUENCE OF PRESSURE ON THE COMPRESSIBILITY OF COAL

constant of the material being briquetted), degree of comminution, and moisture content. While the degree to which these factors influence the strength of the briquette depends largely on the rank of coal, the influence of moisture is most important. The influence of moisture on the strength of the briquette is strikingly similar for all coals irrespective of rank (Figs. 3-10) and in general it is same as in the case of lignite, the strength of the briquette being maximum at an optimum moisture content which in the case of coals corresponds to their air-dried moisture content (at 60 per cent relative humidity and 40°C.)*.

When the compression strength of coals briquetted at their air-dried moisture content and different pressures are plotted against their carbon content (Fig. 11), the plot exhibits a minimum at about 81-82 per cent carbon. Above and below this carbon content there is an increase in strength, the increase being more in the case of low rank coal than high rank coal. This characteristic is also reflected in the index of plasticity, compressibility and bulk modulus⁷. It is interesting to note that the minimum of the curve coincides with the disappearance of the COOH groups in coal. It was shown elsewhere¹⁰ that in lignites the briquettes are

*As shown elsewhere⁹ and from results from this laboratory, the reactive groups present in coal hold a certain amount of water in a hydrogen bonded state and, strictly speaking, it is this moisture which gives the optimum strength to the briquettes. This moisture approximately corresponds to the air-dried moisture of the coal (at 60 per cent relative humidity and 40°C.).

largely sustained by a hydrogen bonding mechanism involving the simultaneous participation of the OH and COOH groups. The results of the present investigation indicate that this mechanism holds true for coals having less than 80-81 per cent carbon. In coals containing more than 80 per cent carbon other type of cohesive forces in addition to the hydrogen bonding type also come into play, the contribution of the former increasing with increase in carbon content. The contribution of the hydrogen bonding forces is, however, still considerable (40-50 per cent) even at 90 per cent carbon as is indicated by water immersion tests (Table 2). Where the briquettes are sustained mainly by hydrogen bonding mechanism as in lignite, they completely disintegrate on immersion in water due to weakening of the bonds by 'solvation effect'. The medium rank coals (80-82 per cent carbon) decrease in strength by nearly 75 per cent and high rank coal (90 per cent carbon) by about 50 per cent on immersion in water. This con-

TABLE 2 — INFLUENCE OF IMMERSION IN WATER ON THE STRENGTH OF BRIQUETTES

(Briquettes were made at 15.8 tons/sq. in. pressure, immersed in water for 28 hr. and then tested for crushing strength)

COAL	ORIGINAL STRENGTH lb./sq. in.	STRENGTH AFTER IMMERSION IN WATER FOR 28 HR. lb./sq. in.	REDUCTION IN STRENGTH %
Ekra Khas coal dust	2402	1218	49.30
Bhutgoria coal	1783	883	50.50
Chanck coal	1625	795	51.17
Chapui Khas coal dust	874	106	87.99

TABLE 3 — CRUSHING STRENGTH OF BRIQUETTES OBTAINED AT ZERO MOISTURE (EXTRAPOLATED VALUE) AND AIR-DRIED MOISTURE

COAL SAMPLE	CRUSHING STRENGTH OF BRIQUETTES PREPARED AT 3534 LB./SQ. IN.			CRUSHING STRENGTH OF BRIQUETTES PREPARED AT 3887 LB./SQ. IN.			CRUSHING STRENGTH OF BRIQUETTES PREPARED AT 17670 LB./SQ. IN.			CRUSHING STRENGTH OF BRIQUETTES PREPARED AT 26510 LB./SQ. IN.			CRUSHING STRENGTH OF BRIQUETTES PREPARED AT 35340 LB./SQ. IN.		
	Air-dried moisture lb./sq. in.	Zero moisture lb./sq. in.	Diff. %	Air-dried moisture lb./sq. in.	Zero moisture lb./sq. in.	Diff. %	Air-dried moisture lb./sq. in.	Zero moisture lb./sq. in.	Diff. %	Air-dried moisture lb./sq. in.	Zero moisture lb./sq. in.	Diff. %	Air-dried moisture lb./sq. in.	Zero moisture lb./sq. in.	Diff. %
Madhuband coal	406	220	46	918	480	48	1519	1040	32	1978	1860	6	2349	1760	25
Ekra Khas coal dust	424	{ 150 345 }	{ 65 19 }	1024	810	21	1625	1110	32	2172	1560	28	2702	{ 8445 1830 }	32
Bhutgoria coal	247	140	43	619	400	35	1051	770	27	1227	940	23	1766	1120	37
Argada coal	106	60	43	344	210	39	830	130	84	1192	280	77	1519	420	72
Chapui Khas coal dust	62	0	100	177	0	100	512	0	100	777	105	87	880	185	78
Assam coal	124	20	84	548	0	100	954	50	95	1481	50	97	1571	0	100
Palana lignite	530	0	100	1448	0	100	2225	0	100	2914	0	100	3815	0	100
South Arcot lignite	459	0	100	1590	0	100	3796	0	100	5016	0	100	5563	0	100

clusion is further supported by the difference in the behaviour of the low, medium and high rank coals on briquetting in a completely dry condition (Table 3). The lignites do not form briquettes in a completely dry state even at high briquetting pressures; medium rank coals yield only weak briquettes, but the high rank coals form strong briquettes, though the strength is much less than that of briquettes obtained from air-dried samples.

Conclusion

The briquetting pressure, degree of comminution and moisture content considerably influence the strength of the briquettes, the extent of the influence depending on the rank of coal.

In general, the order of strength of the briquettes obtained at optimum moisture and at identical briquetting pressure from different rank coals is as follows: medium rank < high rank < low rank.

Briquettes of crushing strength 1000 lb./sq. in. and above* can be obtained from coals of less than 75 per cent and more than 88 per cent carbon content (-72 mesh B.S.S.) by briquetting them at their respective air-dried moisture contents at a minimum pressure of about 5 tons/sq. in. Coals whose carbon content lies between 76 and 88 per cent have to be briquetted at their respective air-dried moisture contents at pressures of the order of 12 tons/sq. in. to give similar results.

Acknowledgement

Thanks are due to Dr. A. Lahiri, Director, Central Fuel Research Institute, for his keen interest in these investigations and for permission to publish the results. Thanks are also due to the Principal, Bihar Institute of Technology and to Dr. Choudhury, Professor of Mechanical Engineering, B.I.T., for providing facilities for carrying out various tests at their Institute.

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*While no standard specification is available for the strength of commercial briquettes, 500-700 lb./sq. in. is normally expected as the minimum^{11,12}.

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The Curing of Freshly Harvested Paddy: Part I—Principles of Curing

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(Revised manuscript received 29 May 1957)

(Original manuscript received 24 March 1956)

Suitable 'wet heat' treatment of freshly harvested paddy or an incipient parboiling of the rice just prior to cooking reduces the pastiness, on cooking, of rice. Such heat treatment can be used for curing paddy or rice to enable its use immediately after harvest.

The viscosity of the gruel obtained by cooking under standard conditions or the content of alcohol precipitable solids in the gruel can be used for comparing the cooking quality of rice samples.

RICE from freshly harvested paddy cooks to a pasty consistency. It has also poor swelling capacity during cooking and is reported to cause digestive disorders. The cooking properties are, however, improved after storage for 4-6 months. The pastiness on cooking of fresh rice has been attributed to its high amylase content¹. The improved cooking properties on storage were explained by Sanjiva Rao² in terms of a colloidal 'sol-gel' transformation. It has been shown that changes occur in the physico-chemical properties of the amylose fraction during storage³.

Pastiness has been shown to be due to disintegration of the fresh rice leading to a dispersion of the starch granules in the cooking water and formation of a viscous sticky gruel³. If the grain could be so hardened as to minimize the loss of rice solids into the gruel, pastiness can be eliminated. Addition to the cooking water of hardening agents or

chemicals used for improving the baking quality of wheat flour did not prevent pastiness. Addition of fatty acids to the cooking water improved the cooking quality; but it imparted bitterness and was, therefore, impracticable. Application of dry heat was unsuitable as it caused cracking of the grain. Beneficial effects were indicated when paddy or rice was 'wet heat' treated. This method was studied in greater detail in order to arrive at optimum conditions of processing. The practice of 'hay stacking' which consists in heaping the ears and the straw of the paddy plant after harvesting for 15-30 days before threshing is generally believed to cure fresh paddy very quickly. Hay stacking represents a storage condition of high humidity and moderate heat. The steaming treatment maintains much higher temperatures and hence the curing period is shorter.

The 'parboiling' of rice has been generally known to harden the rice grain and prevent its tendency to become pasty on cooking. It has long been practised as a method of improving the milling and cooking quality of rice, especially the soft varieties. But the methods adopted result in complete gelatinization of the starch and usually the fully parboiled rice has an yellowish colour. If prepared by commercial methods as adopted in India, it has an associated off-flavour also.

These characteristics of fully parboiled rice are not desired by the consumers of raw rice. The curing treatment should, therefore, bring about only a partial gelatinization of the starch so that the treated product resembles raw rice in appearance. Such partial gelatinization does not confer any appreciable improvement in the milling properties of the rice^{4,5}, but the method could be applied to hard varieties which are normally used by consumers of raw rice. For commercial exploitation, paddy itself can be heat-treated, while for home scale operations, a treatment of rice would be more convenient. The results of experiments carried out in this connection are reported in the present communication.

Experimental procedure

Paddy—Samples were steamed for 15 min. in a cooker at various temperatures between 100° and 115°C. and then dried in the sun. The rice obtained after milling was tested for its cooking quality. One sample of paddy was soaked for half an hour in water and then steamed for 15 min.

Rice—With rice, it was necessary to evolve a simple additional treatment to be given just prior to cooking, as heat-treated rice was found to crack on standing. The most convenient method adopted was to wet the rice with one-fifth of its own weight of water and heat it in a covered vessel (to minimize loss of steam) for 5-10 min. (simulating conditions of incipient parboiling), heat being controlled to prevent charring. Thereafter, boiling water was added and the cooking continued in the usual way.

Cooking trials—Samples of rice (50 g.) were cooked in 300 ml. water by direct heating over fire and the gruel strained by decantation and filtering over a wire gauze. The cooked rice was rinsed with water to remove adhering gruel and the combined gruel and rinsings made up to volume. When steam cooking was employed for comparison, 50 g. samples soaked in 125 ml. water were steamed in a cooker for 45 min., the cooked samples being rinsed with water and made up to volume as before.

As a measure of the comparative index of pastiness in the cooked rice, the viscosity of the gruel, its total solids content and the amount of solids precipitable by alcohol (70 per cent, v/v) were determined in various samples of rice. The conventional

method of gauging the cooking quality by determining the swelling number⁶, although suitable for old rice, was not found sensitive for comparing the cooking quality of freshly harvested rice which cooks to a pasty mass. The cooked rice holds a lot of gruel. Hence the method of using the consistency of the gruel as an index of cooking quality has been used in these trials. A 50 ml. aliquot of the gruel was used for the determination of total solids. A similar aliquot was treated with alcohol (final concentration 70 per cent v/v) and the starch and dextrin precipitate filtered, washed, dried and weighed. The viscosity of the strained gruel was determined in a specially prepared viscometer with a wide capillary.

Results and discussion

The data on the pastiness of the rice samples are presented in Tables 1 and 2.

It is clear from Table 1 that steaming of paddy reduces the pastiness of rice. Steaming at 110°C. gives a satisfactory opaque product that cooks without any pastiness. Heating at 115°C. further strengthens the grain, but gives a definite 'parboiled' appearance to the rice. The rice also cooks hard unlike raw rice. From the commercial point of view, however, mere steaming of dry paddy is not likely to be of value in view of the high degree of breakage observed during milling. Previous soaking of the paddy in water for half an hour before steaming gives a product satisfactory in both milling and cooking properties. The grains were slightly yellow although the core was white. The treatment represented a stage of partial parboiling.

The data presented in Table 2 show that a preliminary parboiling of rice in the cooking vessel and then cooking it in hot water is a simple and effective method of preventing the pastiness of freshly harvested rice. Putting raw rice straight in boiling water reduces pastiness only slightly. If rice is cooked in steam with just as much water as it would absorb, the gruel loss and the pastiness are considerably reduced. By cooking in an open vessel with excess water, the grains break by collision, resulting in a thick, sticky gruel.

The total solids content of the gruel obtained by cooking the rice samples under comparable conditions, the amount of starch and dextrin precipitated from the gruel by

TABLE 1—EFFECT OF STEAMING PADDY ON THE COOKING QUALITY OF RICE

(*Halubbulu, a commercial variety of paddy, was used*)

STEAMING TEMP. °C.	LOSS OF TOTAL SOLIDS IN GRUEL %	LOSS OF ALCOHOL PRECIPITABLE SOLIDS IN GRUEL %	VISCOSITY OF GRUEL AT 24°C. (FLOW TIME) sec.	PASTINESS OF COOKED RICE	DEGREE OF BREAKAGE DURING MILLING OF TREATED PADDY	APPEARANCE OF RICE
Control	20.0	19.1	173	Very pasty	—	Opaque
100	18.7	17.9	155	Pasty	+++	do
105	16.2	15.4	100	Slightly pasty	+++	do
110	10.1	9.2	41	Not pasty	++	do
115	9.0	8.1	34	Hard like parboiled rice	+	Yellowish opaque
Soaked for 30 min. and then steamed	12.0	10.9	52	Not pasty	—	Slightly yellowish grains with a white centre

TABLE 2—EFFECT OF INCIPIENT PARBOILING OF RICE ON ITS PASTINESS

TREATMENT	LOSS OF TOTAL SOLIDS IN GRUEL		LOSS OF ALCOHOL PRECIPITABLE SOLIDS IN GRUEL		VISCOSITY (FLOW TIME*) AT 24°C.		PASTINESS OF RICE
	Direct heat cooking %	Steam cooking %	Direct heat cooking %	Steam cooking %	Direct heat cooking sec.	Steam cooking sec.	
Control (cold water added to rice and then cooked)	18.4	7.1	17.6	6.2	143	27.2	Very pasty
Boiling water added to rice and then cooked	12.4	6.5	11.6	5.7	84	24.9	Pasty
Moistened rice heated in a covered vessel for 10 min. and then cooked in hot water	6.2	3.4	5.1	2.6	31	21.7	Not pasty

*The corresponding flow time for distilled water was 19.5 sec. As the gruel was only a suspension and not a solution, the data have not been presented in terms of specific viscosity.

70 per cent alcohol and the viscosity of the gruel are good indices of the relative cooking quality of different samples of rice. The gruel loss varies with the method of cooking and the method can, therefore, be used only for comparative purposes. No specific relation exists between changes in viscosity and the solids content of the gruel, indicating that only a particular fraction of the total solids in the gruel contributes to viscosity. The starch in the gruel is in the form of a suspension and not in true solution and this may account for the abnormal change in viscosity.

Conclusion

Wet heating is able to give the desired cooking characteristics to freshly harvested

rice. Changes similar to those that occur during prolonged storage at atmospheric temperatures can be brought about by treatment with moist heat for a short period. A definite correlation exists between the degree of gelatinization and the cooking quality of rice.

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The Curing of Freshly Harvested Paddy: Part II—Applications

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(Manuscript received 29 May 1957)

By steaming fresh paddy for 15-30 min. and heaping the hot paddy for 1-2 hr. before drying it by aeration in the shade, a rice which possesses the appearance and cooking qualities of old raw rice and the nutritional properties of parboiled rice is obtained.

A simple type of rice cooker which can be used to cook freshly harvested rice has been constructed for use in the household. As the rice is steamed preliminary to cooking, pastiness during cooking is avoided.

The method of treatment has been applied successfully in rice mills.

THE factors responsible for the improvement in the cooking quality, on storage, of rice from freshly harvested paddy have been investigated by different workers¹⁻³. From studies on the possibility of accelerating these storage changes, the suitability of a mild form of 'wet heat' treatment on a laboratory scale was indicated⁴. In the present communication the practical application of the method for commercial and domestic curing of rice is described.

Commercial curing—The method of heating the paddy for 15 min. at 110°C., as suggested on the basis of laboratory trials⁴, was not found suitable for commercial practice as it involved steaming under pressure. The principle of steaming the paddy for 15 min. and then keeping it hot for 1-2 hr. before drying was tried and found to be suitable. The high breakage observed in laboratory trials was found to be due to uneven drying of the paddy in severe sunshine resulting in cracks. To avoid the breakage, the paddy was dried by exposure to atmosphere in the shade in these experiments.

After preliminary trials the following method was found to give a satisfactory product resembling old raw rice in its cooking characteristics.

Fresh paddy (1 or 2 ton batches) is placed in a cylindrical kettle provided with steam coils (available with rice parboiling

mills) and steam is passed for 15-30 min., depending on steam pressure and size of the kettle, until all the paddy in the kettle is heated and excess steam emerges both from the top and bottom of the kettle. The steam is cut off and the paddy kept in the hot condition in the kettle for about 1 hr. Alternatively, the paddy can be drawn out from the kettle, heaped and covered with gunny bags to minimize atmospheric cooling. The paddy absorbs about 5 per cent extra moisture during the steaming process and it is necessary to dry it by aeration either in the shade or in mild sun with occasional raking. The fine and hard varieties of rice that are conventionally milled for raw rice lend themselves to this treatment, while the coarse and soft varieties undergo high breakage and have to be parboiled in the conventional way to prevent breakage.

In the case of mills which do not have a boiler and use a pan-kettle for raising steam, a longer steaming time is necessary.

Cooking quality and nutritive value of the steamed fresh paddy and its consumer acceptability—The rice obtained from paddy as treated above resembles old rice in appearance and cooking qualities. The pastiness on cooking and the high viscosity of the gruel obtained with fresh rice are both eliminated (Table 1). The iodine colour value of the gruel after centrifuging is also low for the treated rice sample (Table 1) indicating the superior cooking quality of the treated rice. For determining the iodine colour value of the gruel, it was centrifuged and the centrifugate filtered to remove floating impurities. To 0.5 ml. of the filtrate were added 400 ml. water, 5 ml. 2N sulphuric acid and 0.5 ml. N/10 iodine and the contents made to 500 ml. The iodine blue colour was read in a Klett Summerson photoelectric colorimeter using red filter No. 66⁵.

For determining the effect of steaming treatment on the swelling quality of the

TABLE 1—COOKING QUALITY OF FRESH AND STEAM-TREATED FRESH RICE

	CONTROL FRESH RICE	FRESH RICE TREATED BY	
		Commercial steaming	Home cooker
Total solids in gruel, g.	2.9	0.9	1.3
Viscosity in terms of flow time in viscometer*, sec.	14.2	8.4	8.8
Iodine blue colour reading in K.S. units	69.0	34.0	34.0

*Flow time for distilled water was 8.1 sec.

resulting rice, 20 g. each of treated and untreated rice of different varieties were taken in a 100 ml. graduated Pyrex boiling tube, 40 ml. water added and the rice cooked in a steam cooker for 45 min. The volume of cooked rice was finally noted. The volume for treated samples was: *Halubbulu* rice, 80 ml.; *C. sanna*, 82 ml.; and *Bangar sanna*, 82 ml. The corresponding values for the untreated samples were 67, 65 and 70 ml. respectively. It is clear from these results that the steaming treatment improves the swelling quality of rice during cooking.

The steaming of fresh paddy also induces vitamin penetration in the rice grain⁶. Thus, the milled rice from steamed paddy possesses the nutritional properties of parboiled rice also, although in appearance and cooking quality it resembles raw rice. Thiamine content of different varieties was determined by the thiochrome method before and after steam treatment. The values obtained for the treated rice were: *Halubbulu* rice, 1.1; *C. sanna*, 1.5; *Alur sanna*, 1.5; and *Bangar sanna*, 2.2 γ /g. The corresponding values for the untreated control samples were 0.7, 0.8, 0.9 and 1.2 γ /g. respectively. It can, therefore, be concluded that the steaming treatment helps in supplying higher amounts of thiamine to the consumer. Consumer acceptability studies with the treated rice have shown that it is readily accepted by consumers of both raw and parboiled rice.

Cost of treatment — The cost of the steaming treatment is not more than 6-8 annas/100 lb. rice. As old rice costs Rs. 5-10/100 lb. more than new rice, the cost of the steaming treatment can be considered to be very small.

Treatment of fresh rice in the house before cooking — Heating of moistened rice in a closed vessel prior to cooking has been found to re-

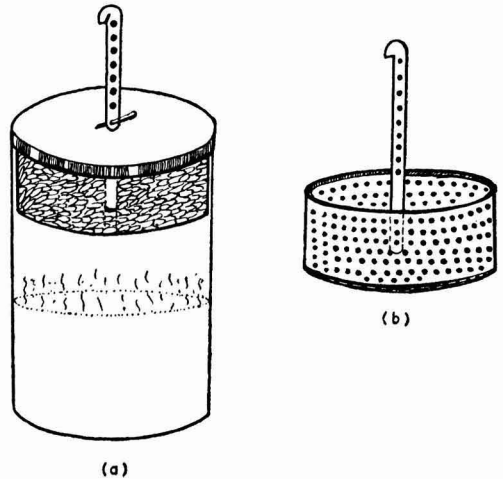


FIG. 1 — (a) RICE COOKER FOR COOKING FRESH RICE; (b) PERFORATED BASKET FOR HOLDING THE RICE WHILE STEAMING

duce its pastiness during cooking⁴. Instead of merely moistening, the soaking of the fresh rice in water for 2-3 hr. in cold water or for half an hour in hot water at 60°C. and allowing it to imbibe water, has been found to result in good gelatinization during the subsequent steaming. The rice obtained by cooking the gelatinized grain consists of discrete and individual grains without any pastiness. As the rice is cooked immediately after steaming, there is no yellowing of the rice in spite of almost complete gelatinization of the starch. In order to facilitate cooking by using this method a type of cooker which can be used both for the preliminary steaming and the subsequent cooking has been constructed (Fig. 1). Rice, previously soaked in water, is placed in the perforated basket which is slipped through the lid of the cooker and is suspended inside the cooker so that it is above the level of the water. It is steamed for 10-15 min. and the rod that holds the basket in position is removed so that the basket is submerged in the boiling water to complete the cooking.

As the rice is already partially cooked during the steaming period, subsequent cooking takes *c.* 10 min. so that the total cooking time is under half an hour. If water taken for cooking is only as much as will be absorbed by the rice (2-2½ vol.), there is no need to drain the gruel. The resulting

cooked rice by this procedure is not pasty and consists of integral and individual grains. The total solids content of gruel, its viscosity and iodine colour are given in Table 1.

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Effect of Condiments on the Control of *Aspergillus niger* in Mango Pickle

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(Manuscript received 20 April 1957)

The effect of different condiments on the growth of *Aspergillus niger* in mango pickle has been investigated. Most of the spices, except cinnamon and cloves, had little or no inhibitory effect on this mould. Common salt, although not effective itself, supplements the preservative effect of cinnamon and cloves.

DIFFERENT condiments and spices are added during the preparation of pickles and their use is regulated on the basis of the type of pickle to be prepared. They not only add to the odour and taste of the pickles, but are also believed to possess definite preservative effects. The empirical standards for the type and quantity of condiments to be added, evolved through experience, do not always lead to successful preservation of the pickles and their spoilage due to various micro-organisms is often observed. Once spoilage organisms establish themselves on pickles, they bring about certain physico-chemical changes like disintegration of fruits, etc., which are due to pectolytic activity of certain fungi. This is often followed by fermentation and putrefaction. These changes make the pickle unwholesome and unfit for consumption.

The strongly acidic nature of pickles restricts their early contamination by moulds and yeasts^{1,2}. Among moulds, *Aspergillus*

niger species were found to grow well in pickles containing 10-20 per cent salt and requisite proportions of spices.

The effect of some of the spices and condiments in controlling spoilage in mango pickles was first investigated by Prasad and Joshi². Making inherent microbial population in fresh fruit as a target for control, they assigned preservative role to cloves at 2 per cent level when used by themselves for pickling. Cloves, cinnamon and cayenne pepper were also reported to be more effective if the pickles are steamed for $\frac{1}{2}$ hr. after their addition. The addition of 20 per cent salt to pickles was reported to completely suppress the growth of spoilage organisms². Ground spices like cinnamon, cloves and mustard and their oils have been shown to inhibit the growth of certain species of yeast and bacteria on different media²⁻¹⁰. Walker *et al.*¹¹ found that mustard oil has a marked toxic effect on moulds, with *Aspergillus niger* showing the least sensitivity among the fungi studied. Bitting¹² described the mechanism of the action of mustard on the prevention of mould growth. Walton *et al.*¹³ showed that fresh garlic possesses bactericidal properties. Ginger in 5 per cent concentration was shown to have bactericidal effect¹⁴. The present investigation was undertaken to determine the efficacy of some of the condi-

ments used in mango pickle in suppressing mould growth.

Experimental procedure

Preparation of substrate — Raw mangoes of seedling variety, commonly used in pickles, were dipped in 50 parts per million of free chlorine for 20 min., washed thoroughly in running water, drained and sliced with stainless steel knives, rejecting the stony kernels. The slices were made into fine pulp in an electric mincer. The pulp was filled into polythene bags in 1 lb. packs. The bags were sealed, frozen and stored at -15°C . At the time of use the pulp was thawed and removed from the bag. The pulp analysed (wet basis) to: moisture, 81.9 per cent; acidity (as citric acid), 2.95 per cent; reducing sugars, 0.82 per cent; vitamin C, 45 mg./100 g.; tannins and colouring matter, 0.046 per cent. Its pH (at 24°C .) was 2.92.

Preparation of mould spores — A strain of *Aspergillus niger* isolated from a pickle sample was used. The spores were cultivated on acid dextrose agar (prepared by the addition of 5 ml. sterile 5 per cent tartaric acid to 100 ml. melted dextrose agar) containing 8 per cent common salt in Kolle's culture flasks. The flasks were incubated at 30°C . for 7 days and the growth of spores removed with sterile glass beads using glass-distilled water. The suspension was passed through sterile gauze to remove lumps of agar, etc., and washed 3 times with glass-distilled water in a centrifuge. The final suspension containing 10^8 spores per ml. (measured by haemocytometer) was stored in a refrigerator at 2°C . The viability of a suitable dilution of the above suspension was checked by inoculating on acid dextrose agar slants each time before use.

Condiments and spices — Different condiments were cleaned and ground to 20 mesh fineness. Small pieces of asafoetida (L. G. Brand) were fried in gingili oil and crushed. Asafoetida oil was extracted with petroleum ether and used as an emulsion stabilized with 1 per cent gum acacia. Mustard oil was expressed from powdered seeds in a hydraulic press. Garlic bulbs were segmented into cloves, peeled and crushed in a pestle and mortar. Green ginger was likewise peeled and crushed. Powdered marine salt having 97.0 per cent (dry basis) sodium chloride was used.

Experimental technique — The pulp was thawed and removed from the bags. Requisite proportions of salt, spices and other constituents were added to weighed portions of pulp and the entire mass mixed up thoroughly. Ten g. portions of treated pulp were taken in previously cleaned and sterilized 2 oz. wide mouthed bottles. As far as possible, aseptic precautions were observed in the handling of pulp. Each bottle was inoculated with a loopful of conidia suspension and thoroughly mixed giving an average 10,000 spores/g. of pulp. The stoppered bottles were stored at 26° - 28°C . in a dark place. The growth was confirmed by the formation of white matted tufts on the surface of the pulp followed by the formation of dark coloured fruiting heads. The spores germinated within 4 weeks in the absence of condiments. Control lots were run for each treatment to verify any extraneous contamination.

Results and discussion

It is evident from Table 1 that *Aspergillus niger* can grow in mango pulp containing up to 26 g. salt/100 g. pulp. The resistance of mould to high concentration of salt indicates that preservation of pickles free from *A. niger* attack required additional inhibitory substances. It is also clear from Table 1 that *A. niger* grows more slowly in light than in darkness, the lag in time being greater in pulp with higher salt concentration. Earlier, Levine and Fellers¹⁵ had also observed that *A. niger* grows faster in darkness than in light.

The inhibitory effect of different spices on the growth of *A. niger* was studied in salted pulp containing 15 g. salt/100 g. pulp. This level of salt concentration was preferred because the average content of salt in a large number of pickle samples was found to be of this order. The results are given in Table 2.

TABLE 1 — EFFECT OF LIGHT ON THE GROWTH OF *ASPERGILLUS NIGER* IN SALTED MANGO PULP

AMOUNT OF SALT g./100 g. pulp	NO. OF DAYS AFTER WHICH GROWTH WAS OBSERVED	
	In dark	In light
14	5	5
16	5	6
18	6	9
20	8	11
22	8	12
24	8	13
26	10	14

TABLE 2—EFFECT OF DIFFERENT PROPORTIONS OF CONDIMENTS TO INHIBIT THE GROWTH OF ASPERGILLUS NIGER IN SALTED* MANGO PULP

CONDIMENT	CONVENTIONAL PROPORTIONS IN PICKLE RECIPES g./100 g. mango slices	INHIBITORY LEVELS FOR MOULD SPORES g./100 g. pulp
Aniseed	0.5-3.0	>10.00
Asafoetida (<i>hing</i>)	0.1-0.2	>0.50
Asafoetida oil	Not used	0.04
Black pepper	0.0-3.0	>10.00
Caraway (<i>zeera</i>)	0.0-1.5	4.00
Chillies	1.5-10.0	>10.00
Cinnamon	Not used	0.30
Cloves	do	0.20
Fenugreek (<i>methi</i>)	0.2-10.0	>10.00
Garlic	Not used	>0.50
Ginger (fresh)	0.0-10.0	>15.00
Ginger (dry)	Not used	>2.00
<i>Kalaunji</i> (onion seeds)	0.0-3.0	>10.00
Mustard powder	0.0-4.0	>10.00
Mustard oil	Covered with thin layer. Growth positive in covered pulp	
Salt	5.0-25.0	>26.00
Turmeric	0.3-3.0	>6.00

*Mango pulp containing 15 g. salt/100 g. pulp.

TABLE 3—EFFECT OF DIFFERENT CONCENTRATIONS OF CINNAMON AND CLOVES ON THE CONTROL OF ASPERGILLUS NIGER IN MANGO PULP

AMOUNT OF SPICE g./100 g. pulp	GROWTH OF SPORES IN THE PRESENCE OF SALT g./100 g. pulp				
	0	4	8	12	16
Cinnamon					
0.0	+	+	+	+	+
0.3	+	+	+	+	—
0.6	+	+	+	—	—
0.9	+	—	—	—	—
1.6	+	—	—	—	—
3.0	—	—	—	—	—
Cloves					
0.0	+	+	+	+	+
0.2	+	+	+	+	—
0.3	+	+	—	—	—
0.4	+	—	—	—	—
0.6	—	—	—	—	—

+, growth positive; —, no growth.

The condiments like aniseed, asafoetida, black pepper, caraway, chillies, fenugreek, garlic, fresh ginger, *kalaunji*, mustard and turmeric do not inhibit the mould growth even when added in sufficiently large proportions and much above the conventional limits. Mustard was ineffective in checking mould growth even at 10 per cent level although it has been reported to delay fermentation in apple cider for 24 days in 0.5 per cent concentration¹⁰. The addition of these spices in mango pickle recipes seems to have other functions like adding to the odour, taste and colour of the pickles. Asafoetida oil was found to be inhibitory towards mould at 0.04 per cent level whereas

asafoetida itself was not effective even when added at 0.5 per cent level against the conventional level of 0.1-0.2 per cent. Larger proportions of asafoetida may not be desirable as it may spoil the odour and taste of pickles. A thin layer of mustard oil on the pulp did not protect it from subsequent growth of *A. niger*. Cloves and cinnamon were found to be effective in small doses and did not permit the germination of mould spores. This confirmed the findings of the earlier workers^{2,4,8} that cloves and cinnamon are effective in inhibiting the growth of bacteria and yeast.

To find out the relative effectiveness of cloves and cinnamon in inhibiting the germination of mould spores at other salt concentrations in pulp, further studies were conducted using different amounts of these spices. The results are given in Table 3. Whereas 0.3 per cent cinnamon was sufficient to inhibit mould germination in a lot containing 16 g. salt/100 g. pulp, 3 per cent cinnamon was required to have a similar effect in pulp without salt. A progressively higher dose of cinnamon was needed to prevent the mould germination in pulp containing relatively lower proportions of salt. In the case of cloves relatively lower concentrations of spice were needed as compared to cinnamon to effectively control the germination of mould spores. Whereas 0.6 per cent cloves had a preservative effect in unsalted pulp only 0.2 per cent of the spice was needed to have a similar effect in the lot containing 16 g. salt/100 g. pulp. The effect of cloves as a preservative, like cinnamon, varied with the concentration of salt in the pulp. These results indicate that the inclusion of cloves and cinnamon in small proportions in pickle recipes may aid in preventing spoilage in pickles due to *Aspergillus niger*. The effect of the essential oils of these spices as controlling agents for spoilage in mango pickle may be of interest and further work on these lines is in progress.

Acknowledgement

The authors are grateful to Dr. V. Subrahmanyam for his kind interest in the work.

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Letters to the Editor

BENEFICIATION OF A LATERITIC IRON ORE FROM RAJHARA PAHAR, MADHYA PRADESH

IRON ORES OF INDIA FALL UNDER THREE major groups: (1) banded ferruginous formations of precambrian age which account for the major portion of the high grade deposits now being exploited, (2) sedimentary iron ores of sideritic composition and (3) lateritic ores.

Laterite caps are fairly widespread in India and overlie good iron ore belonging to group (1). They are, however, of low grade (25-35 per cent iron) and are unsuitable for the production of iron under normal conditions. At the request of the Bhilai Steel Project authorities a sample of lateritic iron ore from Rajhara Pahar, Madhya Pradesh, was investigated in this laboratory for amenability to beneficiation. Several ore-dressing methods were tried to reduce its alumina and silica contents with a view to obtaining a material suitable for blast furnace smelting.

The sample had high silica and alumina contents and analysed: iron, 34.14; silica, 19.24; alumina, 18.02; phosphorus, 0.13; and loss on ignition, 12.36 per cent. Microscopic examination indicated that the sample consisted essentially of hydrated oxides of iron and aluminous material, present in a very intimate mixture of varying composition representing various stages of lateritization, pure iron oxide being present only in minor quantity. In polished section, the sample showed pisolitic structure with layers of ferruginous and aluminous material of varying composition. At some places the more

aluminous material was seen to enclose minute grains of ferruginous material even smaller than 5μ in size. Quartz, goethite, coarse grains of haematite and magnetite were also present in very small quantities.

The sample contained minor amounts of high iron minerals like haematite or goethite and was made up mostly of (i) a reddish material, (ii) a yellowish material and (iii) an intimate mixture of (i) and (ii) in varying proportions. The bulk of the sample was made up of (iii). The yellow and the reddish materials, which were carefully scooped out from a few specimens, assayed iron, 29.77; alumina, 23.75; and silica, 20.81 per cent and iron, 45.33; alumina, 12.63; and silica, 12.4 per cent respectively.

These preliminary examinations and the experiments carried out, involving washing, tabling, magnetic separation, reduction roast followed by magnetic separation and flotation, indicated that the lateritic iron ore was not amenable to beneficiation. The maximum grade of concentrate that could be obtained assayed about 43 per cent iron with a very low iron recovery.

This lateritic ore can, however, be combined with ores of other types — massive and laminated — in making up sinter charges for its better utilization.

S. B. DAS GUPTA
G. V. SUBRAMANYA
P. I. A. NARAYANAN

National Metallurgical Laboratory
Jamshedpur
24 September 1956

RECOVERY OF SULPHUR & GOLD FROM THE TAILINGS OF NUNDYDROOG MINES, KOLAR GOLD FIELDS

THE GOLD TAILINGS FROM NUNDYDROOG Mines, Kolar Gold Fields, obtained after cyanidation and dumped as waste, contain sulphide minerals like arsenopyrite, pyrrhotite, pyrite and traces of galena and chalcopryrite. This mine treats about 21,000 tons of gold ore per month and hence a study of the possibilities of recovering sulphur from the tailings is of interest to India in view of the acute shortage of sulphur-bearing minerals in the country.

A sample of tailing obtained from the mines assayed: total S, 1.58; sulphate S, 0.47; Fe, 10.69; Al_2O_3 , 7.97; SiO_2 , 58.93; CaO, 7.13; MgO, 5.47; and As, 0.46 per cent with traces of Cu and 0.5 dwt. of gold per ton. The sample consisted mostly of quartz and chlorite. The sulphide minerals were mostly arsenopyrite and pyrrhotite with minor amounts of pyrite, marcasite and a few grains of chalcopryrite indicating that the grade of sulphide concentrate that can be obtained by flotation must necessarily be low due to the low sulphur content (19.7 per cent) of arsenopyrite and also that the presence of arsenopyrite in appreciable amounts in the concentrate will restrict its use for sulphuric acid manufacture. The sample was received in moist condition and got highly oxidized during storage.

Flotation tests using different combinations of sulphuric acid, copper sulphate, sodium carbonate, potassium ethyl and amyl xanthates and pine oil yielded concentrates assaying only 15-17 per cent sulphur with recoveries from 24 to 32 per cent. The arsenic content of the flotation concentrate was high (2.31 per cent). With fresh sample more sulphide is likely to float resulting in higher recovery, but due to the low grade of the concentrate and its high arsenic content, it is of limited use for sulphuric acid manufacture.

Study on the possibility of recovering gold from the tailings showed that best results are obtained by using potassium ethyl xanthate and pine oil which recovered 45.1 per cent of gold from the sample in a concentrate of grade 4.8 dwt. per ton. Cyanidation of this flotation concentrate after roasting extracted 95.9 per cent of gold which was equivalent to a recovery of 43.3 per cent

of the gold present in the original sample. The consumptions of potassium cyanide and lime were 2.0 and 19.0 lb. respectively per ton of flotation concentrate (0.09 and 0.9 lb. respectively per ton of original sample). Almost similar recoveries of gold and sulphur in the flotation concentrates indicated that gold was associated with the sulphide minerals and hence it could not be extracted by the cyanidation process employed at Kolar. With fresh sample of tailing from Kolar better recovery of gold could be possible and a larger proportion of the gold rejected with the cyanide tailing may be recovered.

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29 April 1957

SILAGE MAKING : PANEVAR (*CASSIA TORA* LINN.) & PADDY STRAW SILAGE AS LIVESTOCK FEED

THE IMPORTANCE OF FODDER CONSERVATION in the economy of livestock feeding is well recognized. The conservation of monsoon fodders by ensilage was one of the means advocated by Kehar¹ to meet the acute shortage of succulent feed in dry months. *Panevar* (*Cassia tora* Linn.) is a leguminous plant that grows ubiquitous, during monsoon, from sea level to a height of *c.* 5000 ft. Ordinarily, it is not relished by animals in green condition. But its silage is highly relished². In an earlier investigation (Kehar N. D., unpublished work) effort was made to improve the palatability of cereal straws by ensiling them with some leguminous fodder. An attempt was, therefore, made to find out if *panevar* and paddy straw could also be ensiled to make a nutritious and palatable fodder.

The silage was prepared by ensiling 40 md. green *panevar* plant and 12 md. paddy straw. The silage pit was opened after about 6 months for evaluating the nutritive value. It was found to possess a pleasant odour with brownish appearance. The pH of the material was 4.5. The percentage chemical composition of the silage (on dry basis) was as follows: crude protein, 8.56; ether extract, 1.38; total carbohydrates, 72.05;

total ash, 18.01; calcium, 1.38; and phosphorus, 0.26 g.

The silage was highly relished by cattle. The feeding of the silage was further extended to a batch of buffaloes to observe any species difference in the palatability of the silage. The buffaloes also relished it immensely. They had, however, loose faeces in the initial stages, which was corrected by supplementing the silage with wheat *bhoosa* (straw). Silage alone was found to meet the nutritional requirements of Kumaoni cattle, but for buffaloes it had to be supplemented with about 3 lb. wheat *bhoosa* to meet the dry matter requirement. The daily consumption was found to be 3.3 lb. and 3.8 lb. in the case of buffaloes and Kumaoni cattle respectively per 100 lb. of body weight.

After a preliminary feeding for about 20 days, a metabolic trial was conducted on Kumaoni cattle and buffaloes to evaluate the nutritional value of the *panevar*-paddy straw silage.

The average intake and retention of nitrogen, calcium and phosphorus, the digestibility coefficients for crude protein, ether extract and total carbohydrates for Kumaoni cattle and buffaloes are shown in Table 1.

It is evident from the results given in Table 1 that both the buffaloes and Kumaoni cattle were in positive equilibrium with respect to nitrogen, calcium and phosphorus, and maintained their body weight and general health. The differences in the coefficients of digestion of the proximate principles are, however, insignificant between cattle and buffaloes and as such the average of the two species have been used in calculating the

digestible nutrients in *panevar*-paddy straw silage and is shown below:

	%
Digestible crude protein	3.06
Digestible ether extract	0.85
Digestible total carbohydrates	41.64
Total digestible nutrients	46.61

From the above results it is clear that *panevar*-paddy straw silage can form a maintenance ration for Kumaoni cattle, but for buffaloes it needs to be supplemented with a small quantity of dry roughage, like wheat *bhoosa*, to meet the dry matter requirements.

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6 February 1957

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THE MAKING OF ROUNDED CRYSTALS

IN PARA 23 OF MY RECENT NOTE [*J. sci. industr. Res.*, 15A (1956), 539] on the making of a free-flowing salt I had stated that 'crystals of the desired size and approximately spherical in shape can be obtained by evaporation of the purified brine in open or vacuum pan crystallizers'. For reasons of patent priority I did not then disclose how to arrive at this desirable result. These details can now be given.

Some years ago Stranski had explored the concentration gradients about a crystal growing in a static supersaturated solution. His results suggested that, at least in the case of crystals of cubic symmetry, spherical crystals would be obtained if the concentration gradients surrounding the crystal seeds could be eliminated during crystal growth.

In technical practice, crystallization is effected in a steam-jacketed open or vacuum pan, generally fitted with an axially disposed stirrer. The movement of the pan contents is then largely one of mass motion, the crystals for the most part remaining

TABLE 1 — DAILY NITROGEN AND MINERAL BALANCES AND THE DIGESTIBILITY COEFFICIENTS

PARTICULARS	KUMAONI CATTLE	BUFFALO
Nitrogen intake, g.	33.25 ± 0.27*	71.98 ± 0.30*
Nitrogen retention, g.	0.45 ± 0.17	0.63 ± 0.23
Nitrogen retention, %	1.35	0.87
Calcium intake, g.	33.47 ± 0.27	69.15 ± 0.28
Calcium retention, g.	1.76 ± 1.91	6.15 ± 2.22
Calcium retention, %	8.89	5.26
Phosphorus intake, g.	6.89 ± 0.05	14.41 ± 0.06
Phosphorus retention, g.	0.15 ± 0.21	0.45 ± 0.32
Phosphorus retention, %	2.18	3.12
<i>Digestibility coefficients</i>		
Crude protein	38.00 ± 1.78	33.70 ± 2.86
Ether extract	61.90 ± 1.17	58.70 ± 2.88
Total carbohydrates	59.80 ± 0.88	56.00 ± 1.07

*Mean with standard error.

stationary with respect to the mother liquor. Thus the Stranski concentration gradients are established and maintained during crystallization.

As early as 1922, Jeffery derived expressions for the rotational and translational motions executed by particles suspended in a fluid subjected to a velocity gradient. Such gradients exist in a fluid in which laminar shear is produced. From Jeffery's equations, later confirmed experimentally by Trevelyan and Mason, and from solute diffusion data, it is realized that the introduction of a relatively small degree of asymmetry in the crystallizing pan assembly should result in sufficient laminar shear to cause the growing crystals to gyrate so fast as to secure a virtually uniform concentration in the mother liquor surrounding each growing crystal.

A simple way of achieving the desired reduction in symmetry of the crystallizer is by fixing one or more deflector blades to the side of the pan with the flat surfaces in line with the pan and stirrer axes. Offsetting or inclining the stirrer axis from that of the pan has a similar effect. Laminar shear is produced in the stirred liquor. The growing seeds, cubic to begin with, rotate rapidly within the liquid and grow into spheres. Occasionally two cubical seeds grow together through coalescence of vicinal faces; the final

crystal is then ellipsoidal in shape. A degree of turbulence extravagant in power consumption is quite unnecessary.

The control of crystal size range is simple. If the degree of supersaturation during crystallization is low, the rate of seed formation is also low and the crystal size will be relatively large and the size range narrow. On the other hand, if the supersaturation is high, 'flash' formation of nuclei will result in small crystals, but the crystal size range will be relatively wide owing to parasitism by the larger grains. The desired degree of supersaturation lies between these extremes and is easily found by experiment.

The crystal size range can be further narrowed down by partially counteracting the effect of size on the rate of fall of the crystals in the mother liquor. This can be done by curving the deflector blade or blades such that the larger crystals, while still tending to concentrate towards, do not settle out on, the pan bottom, where the degree of supersaturation is, on the average, lower than at the surface of the evaporating liquor.

G. I. FINCH

*National Chemical Laboratory
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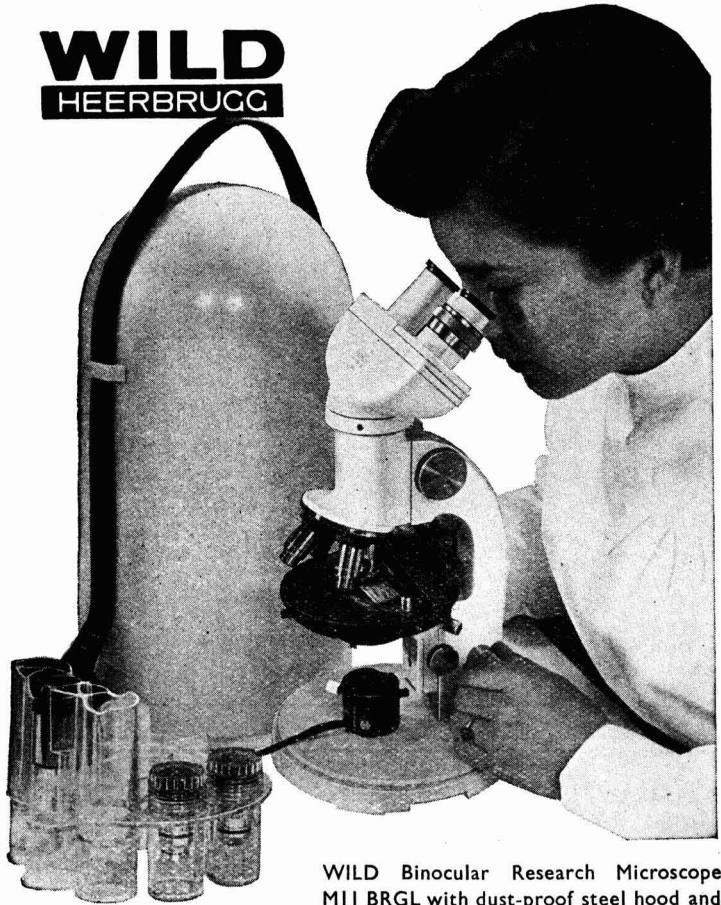
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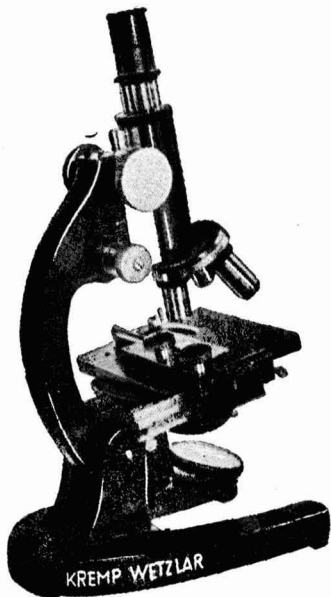
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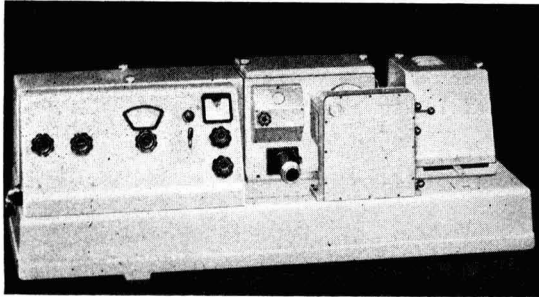
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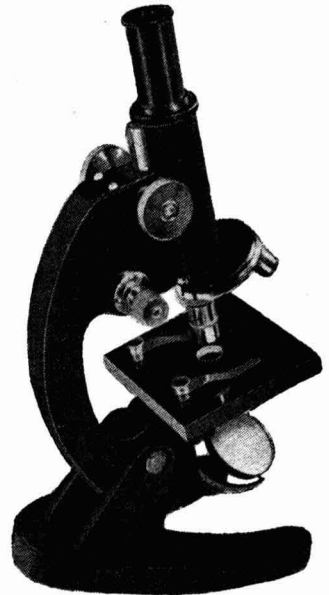
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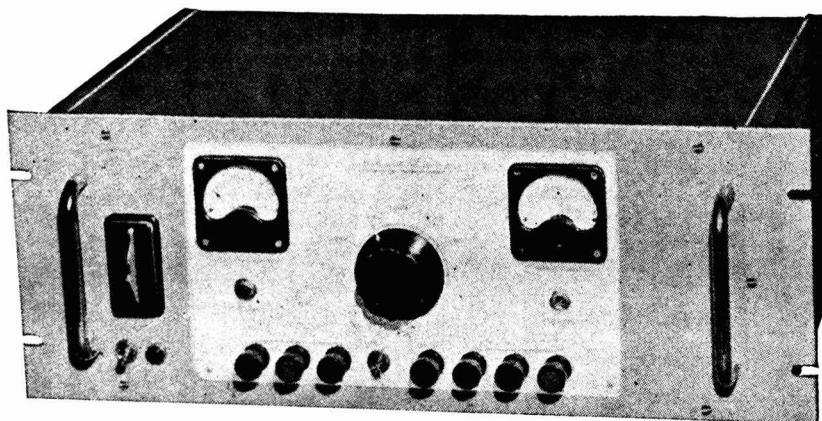
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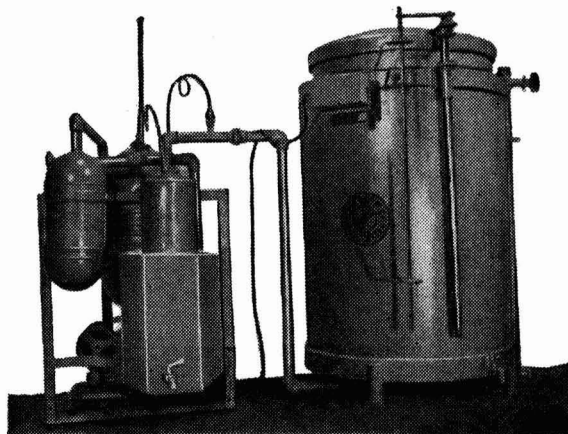
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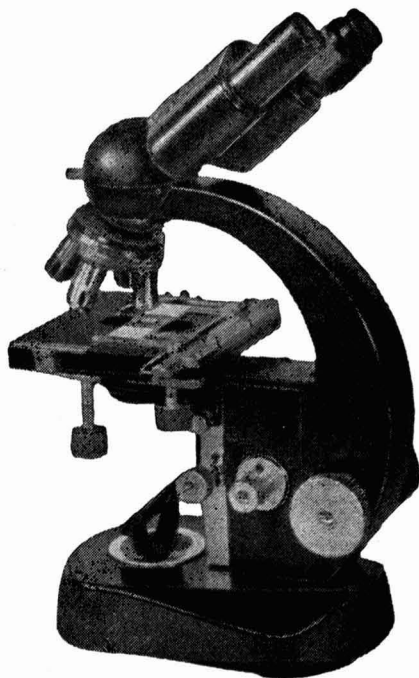
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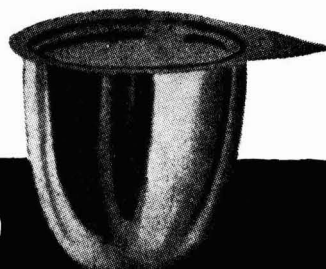
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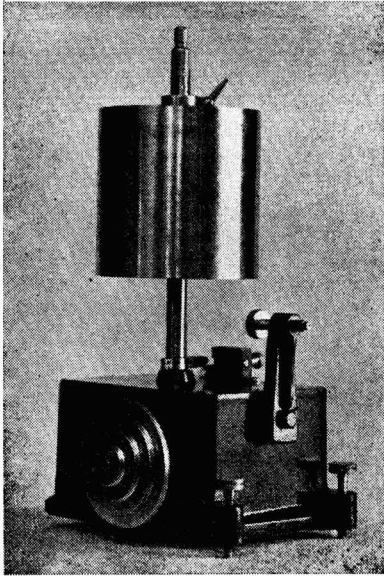
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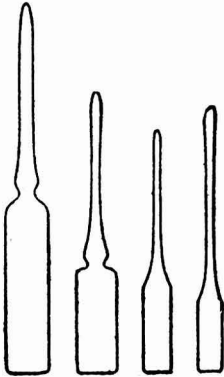
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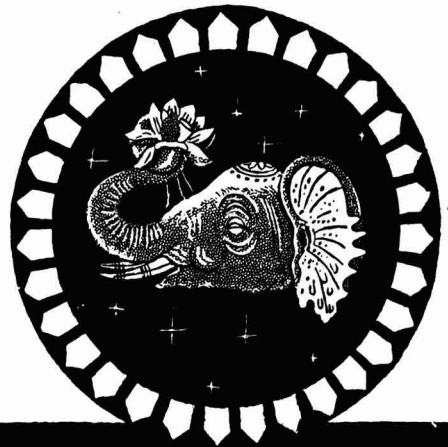
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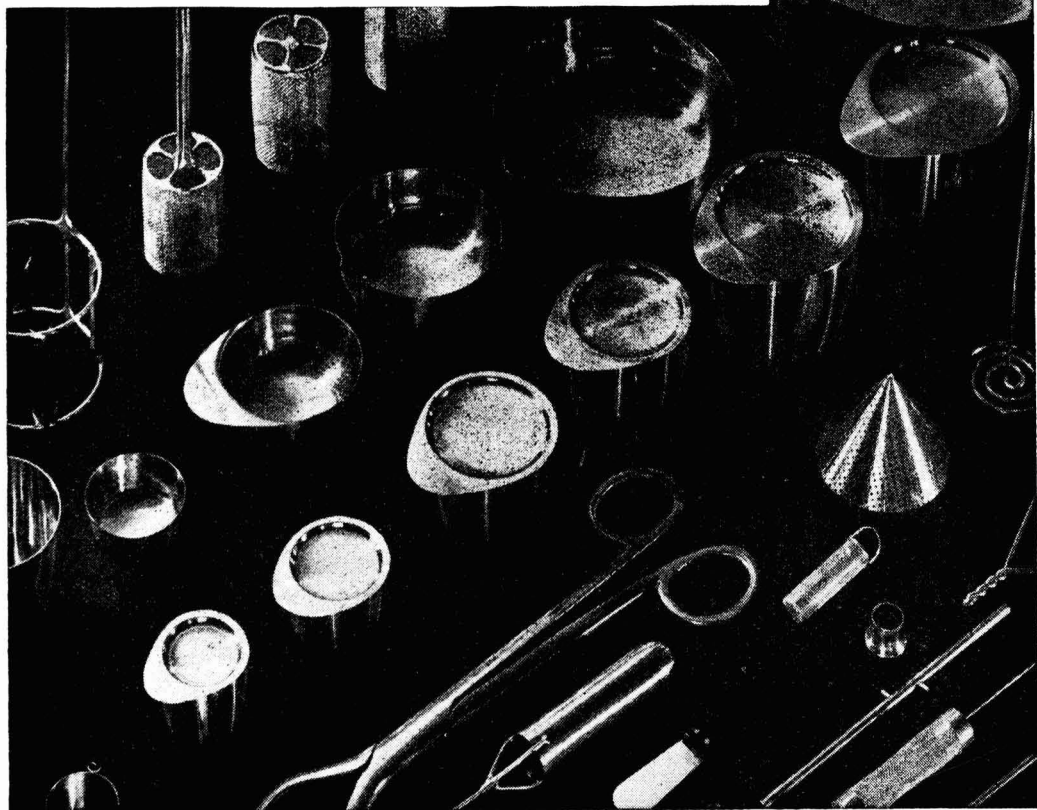
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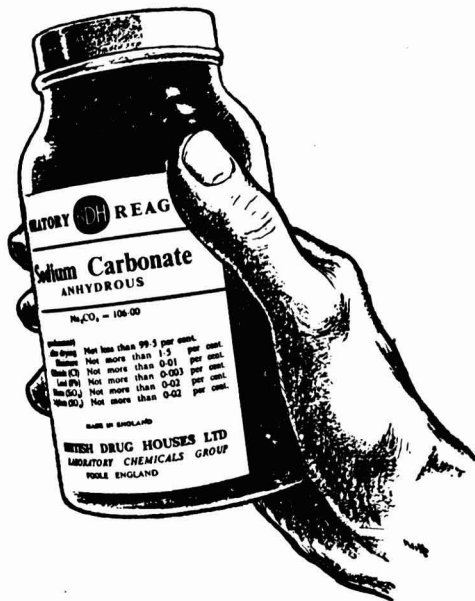
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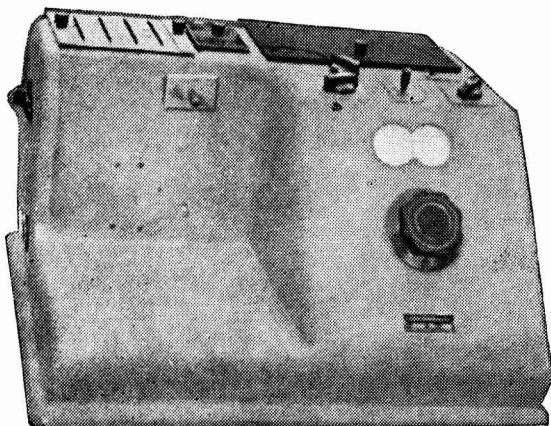
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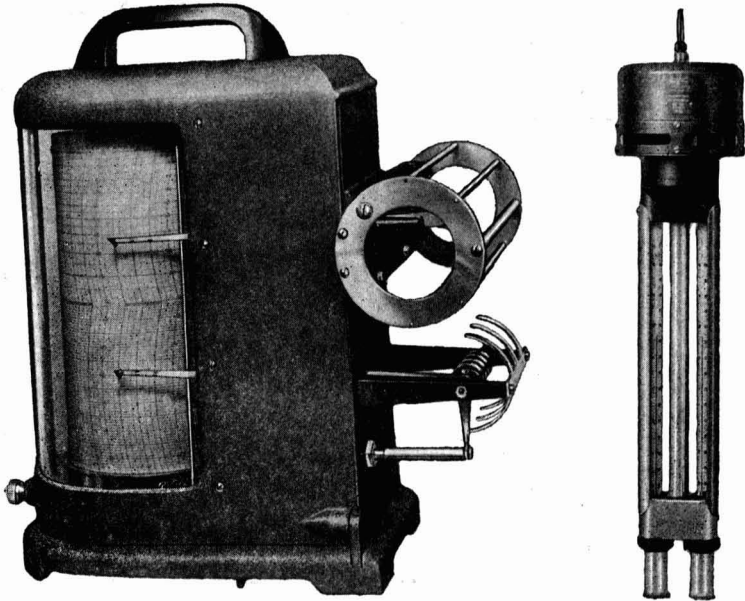
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Printed by H. JACQUEMOTTE, S.J., at the Catholic Press, Ranchi, India
Published by the Council of Scientific & Industrial Research, India. Editor: B. N. SASTRI, M.Sc.

Regd. No. P-842