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## THIS ISSUE

### GENERAL

Production of multicavity  
metrons

Hydrolyzation of edible fats  
and waxes

Comparative study of  
Indian and foreign silica  
products

### PHYSICAL SCIENCES

Structure of silver electro-  
deposited from complex  
cyanide iodide bath

Measurement of temperature  
fluctuations in jets

The structure of sterculic  
acid

### BIOLOGICAL SCIENCES

Studies on the metabolism  
of the snake, *Asperis*

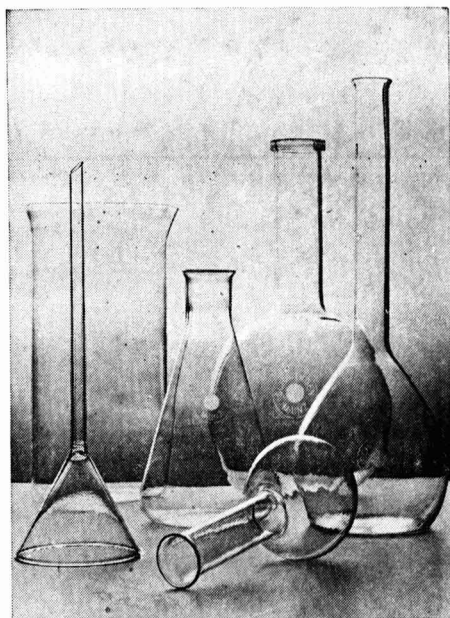
Serology of trachoma



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J. sci. industr. Res., Vol. 16A, No. 4, Pp. 143-186

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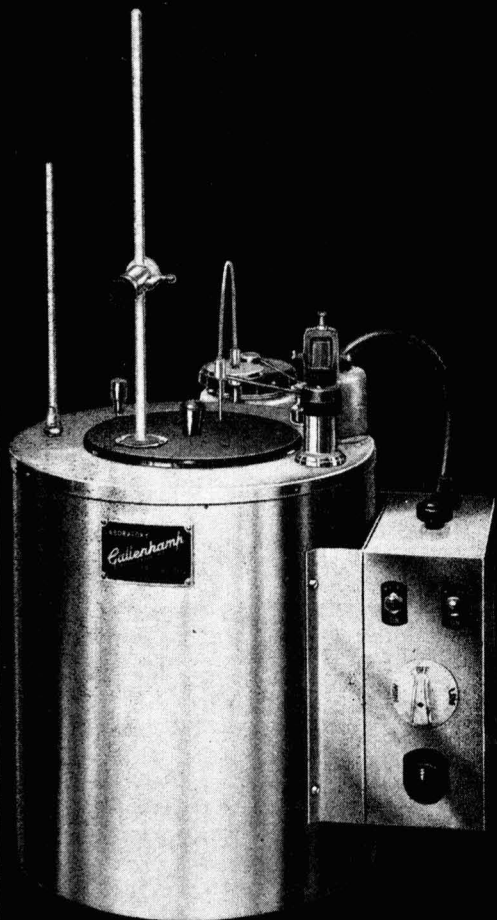
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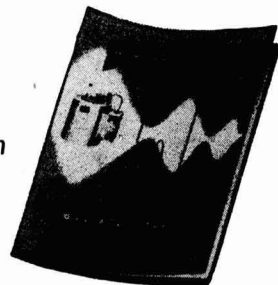
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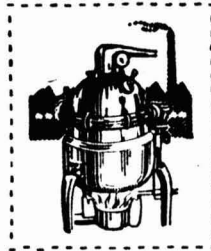
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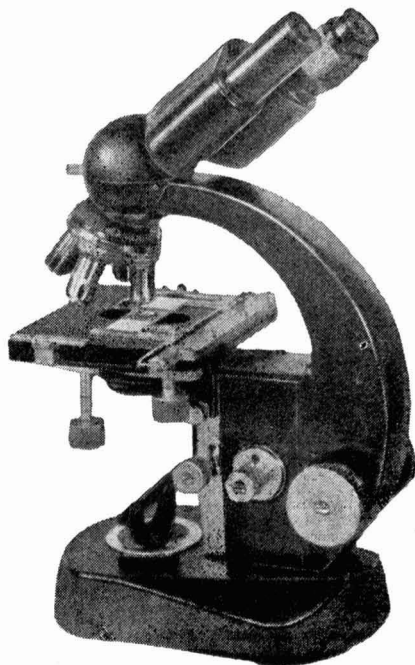
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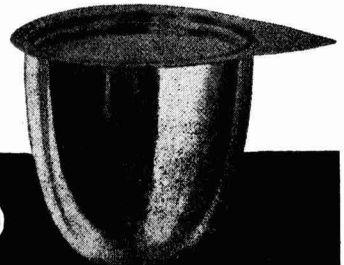
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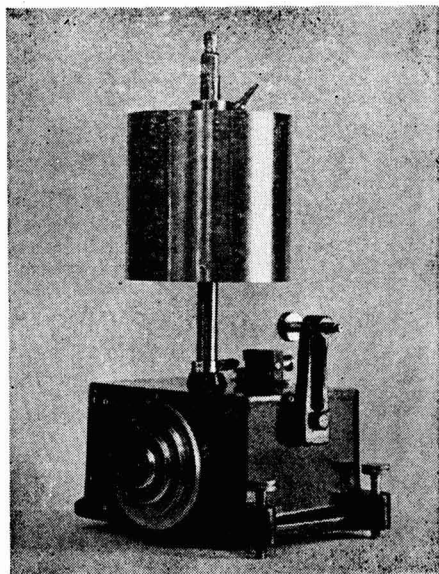
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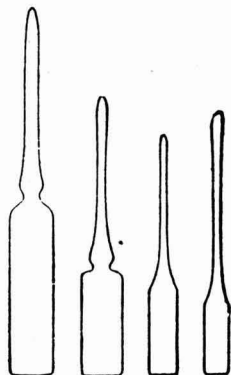
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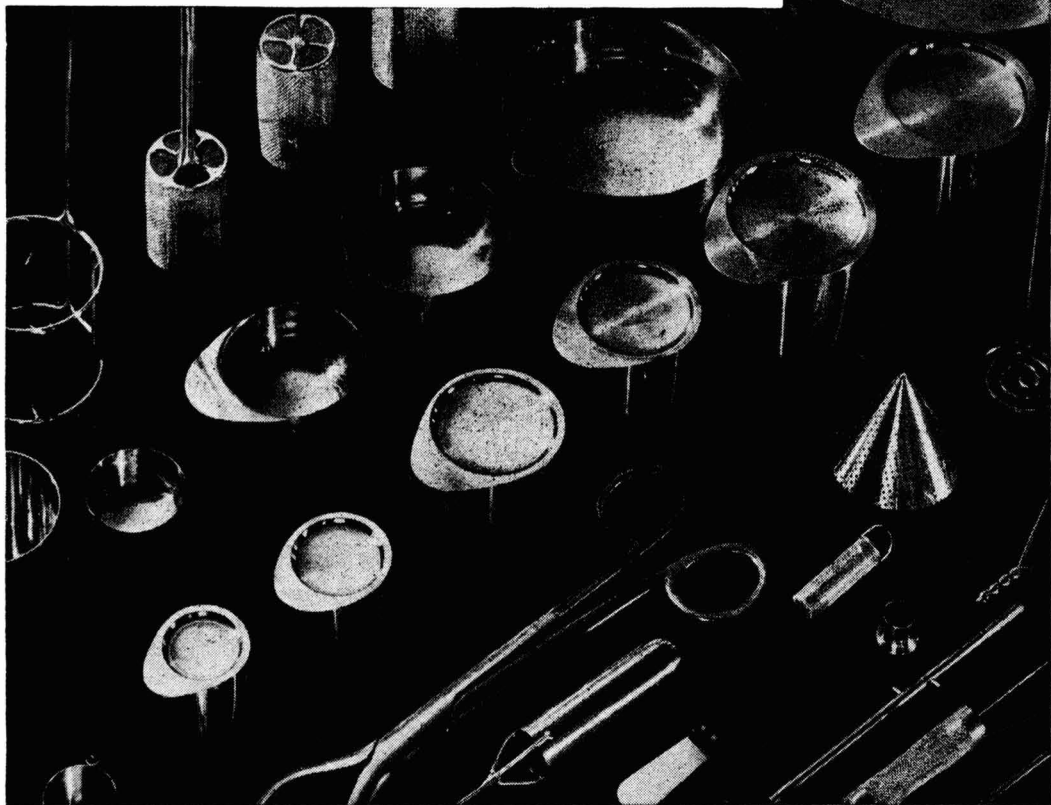
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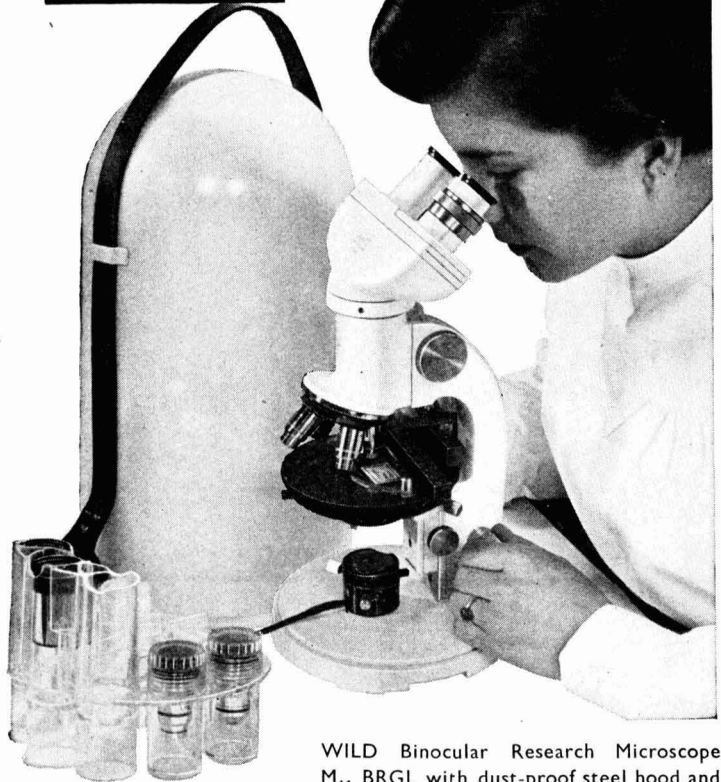
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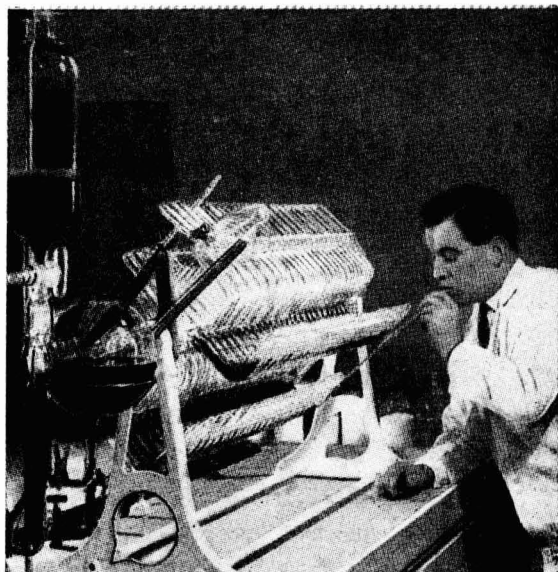
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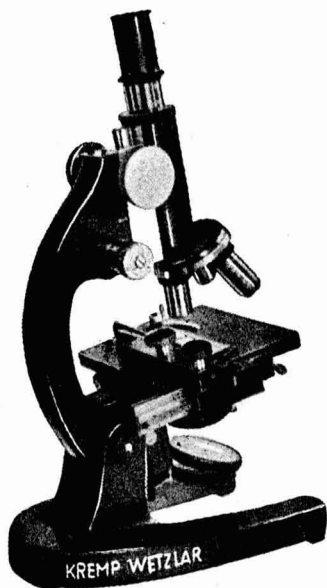
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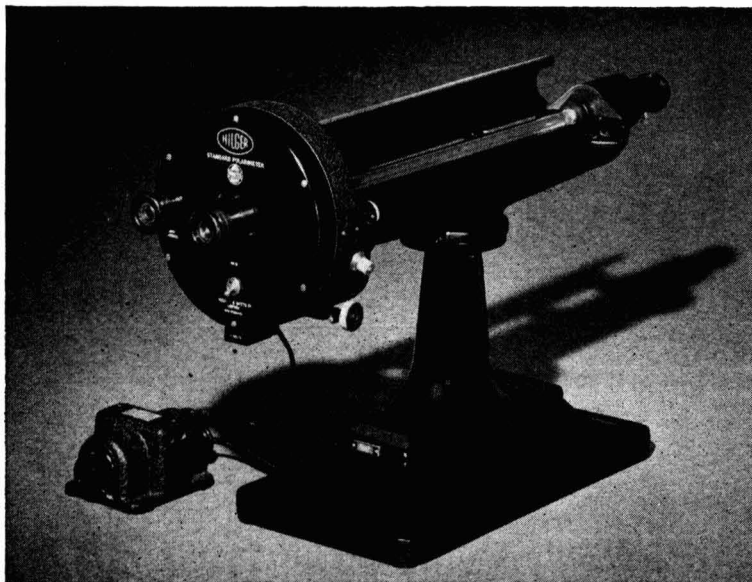
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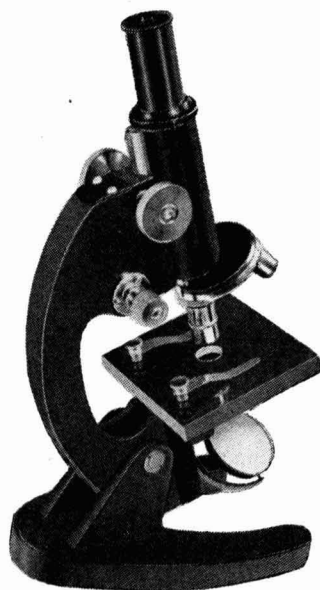
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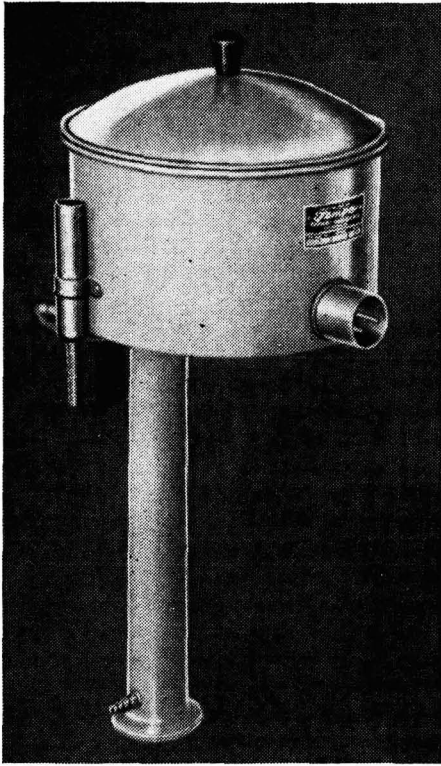
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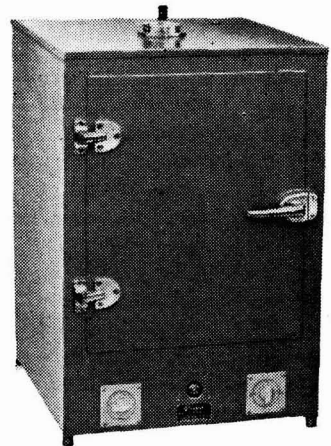
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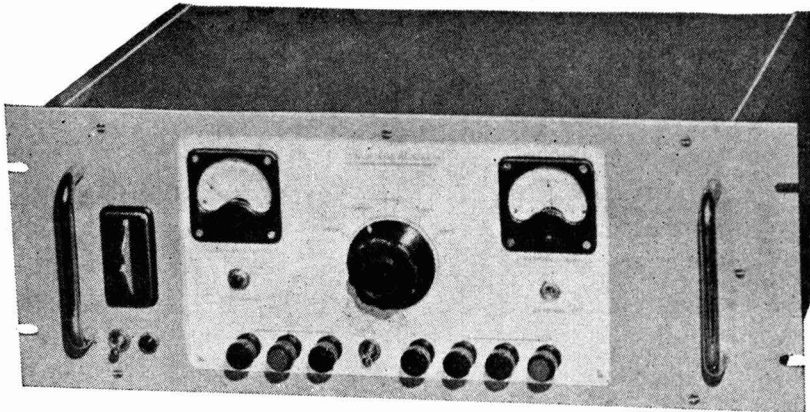
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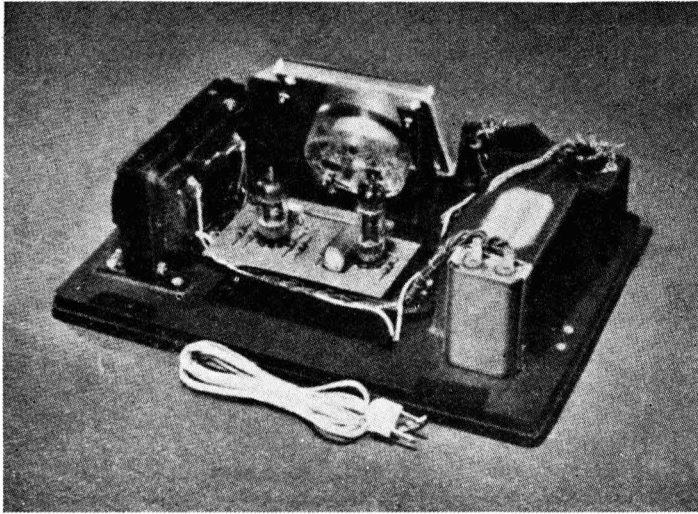
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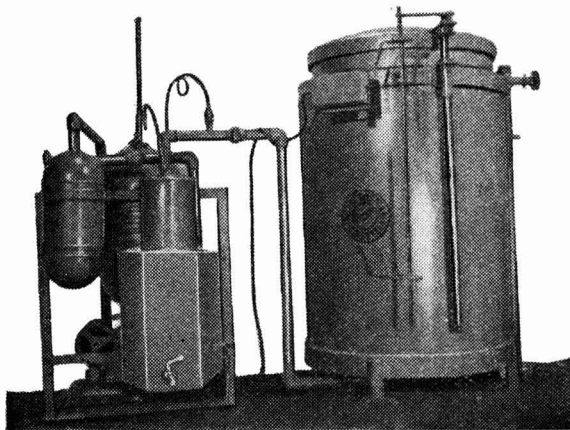


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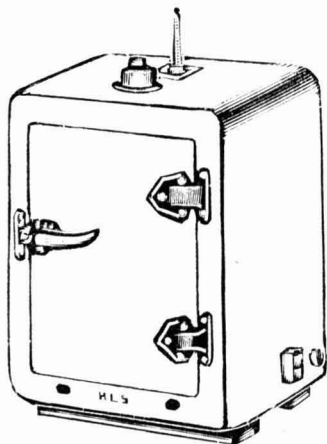
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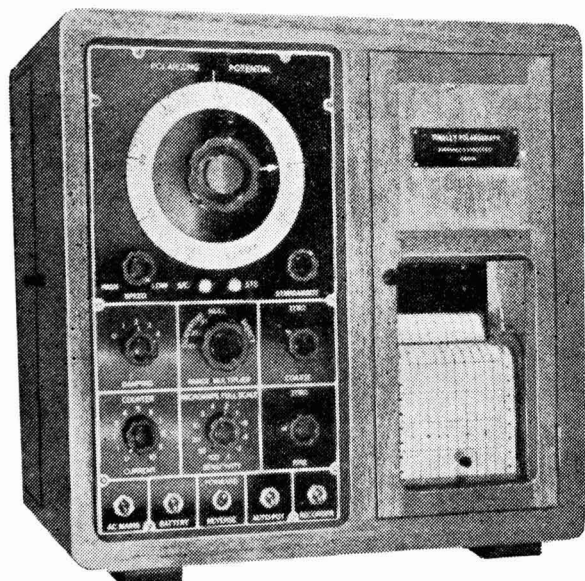
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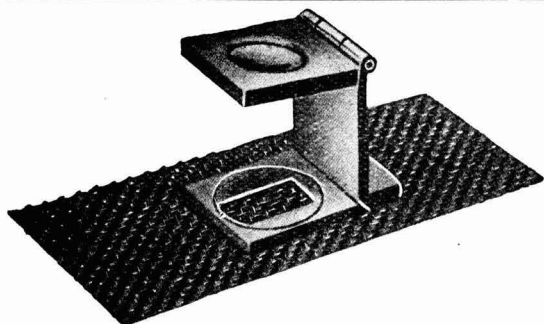
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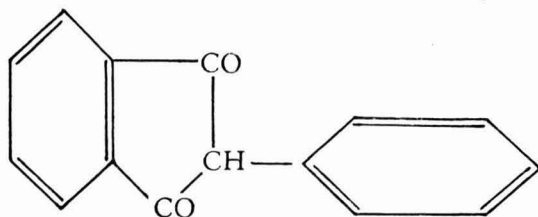
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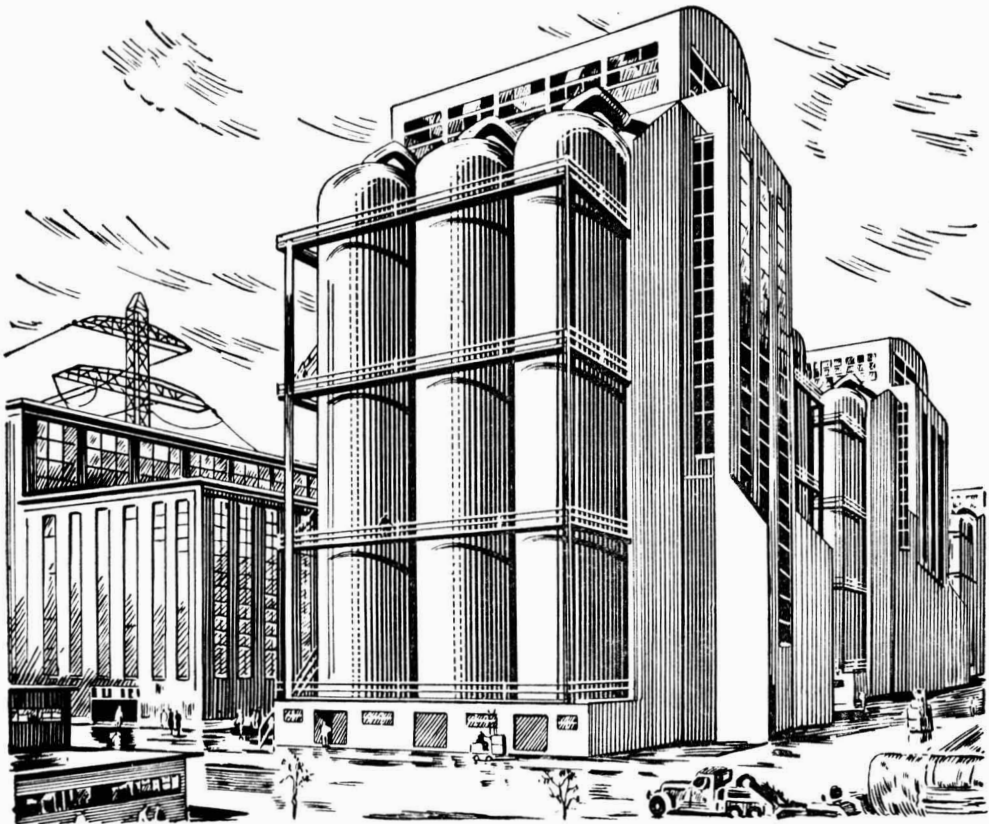
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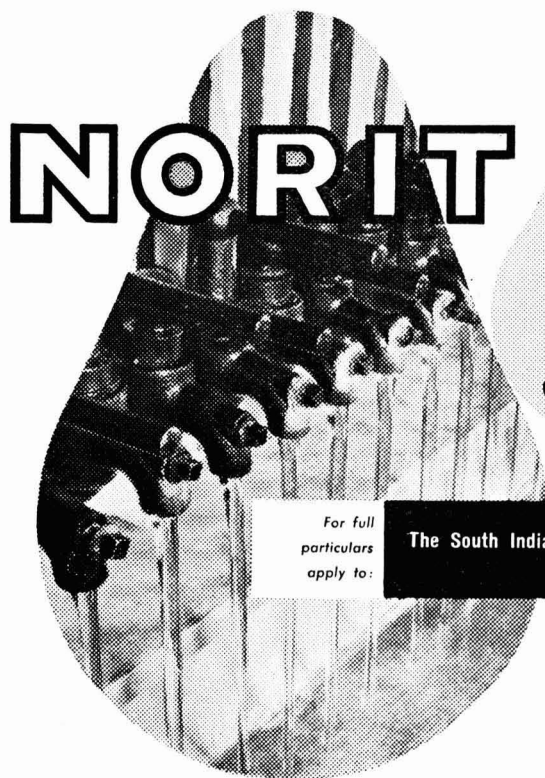
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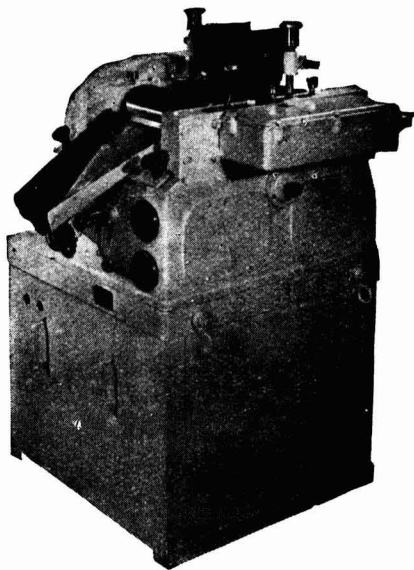
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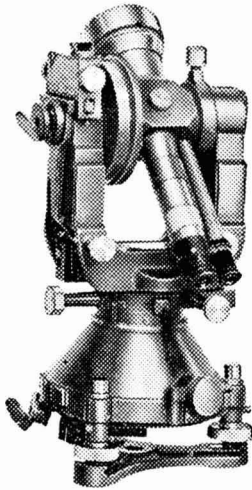
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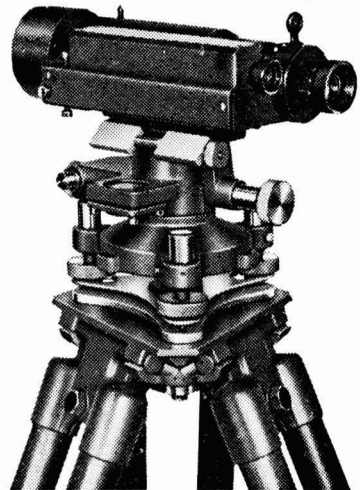
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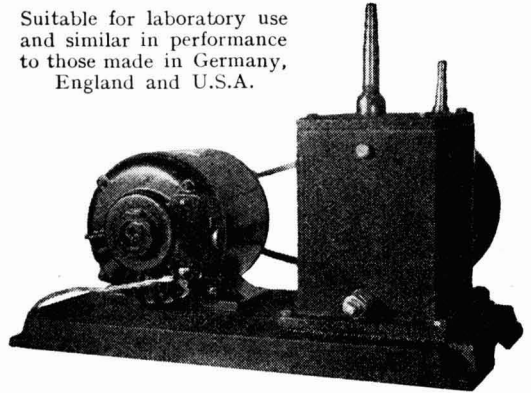
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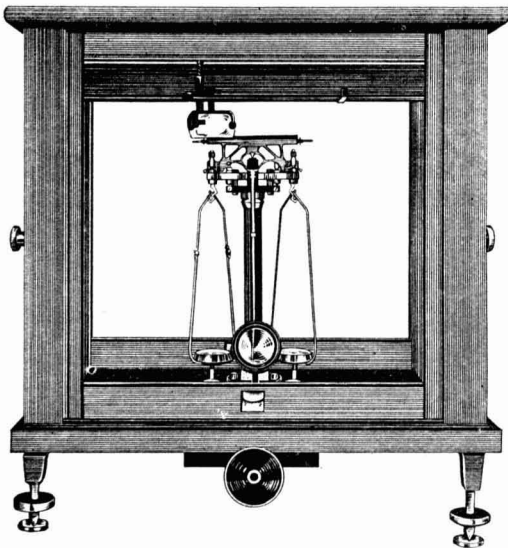
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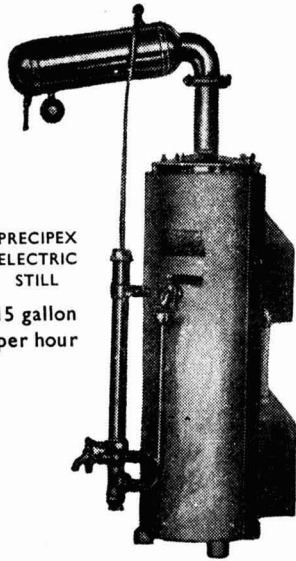
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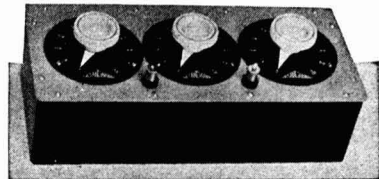
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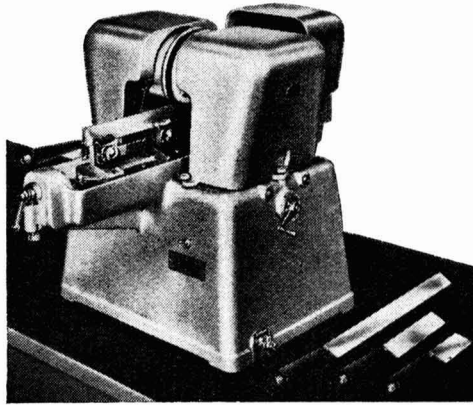
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# The National Calendar of India

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S. BASU

India Meteorological Department, New Delhi

*"It is always difficult to change a calendar to which people are used, because it affects social practices. But the attempt has to be made even though it may not be as complete as desired. In any event, the present confusion in our own calendars in India ought to be removed. I hope our scientists will give a lead in this matter."*—JAWAHARLAL NEHRU (in his message to the Calendar Reform Committee)

ON 22 March 1957, the day following this year's spring equinox, India adopted for civil, social and other purposes a reformed national calendar recommended by the Calendar Reform Committee set up by the Council of Scientific & Industrial Research in November 1952 under the Chairmanship of the late Professor Meghnad Saha. This reform can be regarded as one of the steps, like the decimalization of the coinage and the introduction of metric weights and measures in India, which would lead to greater uniformity of practices in the daily life of the citizen of independent India. Coming as it did just about 10 days ahead of the decimalization of coinage—the introduction of the Naya Paisa—the adoption of the new national calendar was a comparatively quiet event, the more so as the Government has allowed a certain degree of freedom, to those who want it, to continue to follow the existing indigenous calendars for purposes of their religious observances. Nevertheless, the step taken is one which is of quite a far-reaching importance inasmuch as a calendar is to a great extent the natural result of a people's political and cultural history and affects their social practices. Therefore, if by this reform, based on a scientific approach to the problem, a measure of uniformity is eventually brought about in the multiplicity of calendars and date reckoning practices in India, the Government would not have taken this step in vain.

## Time reckoning

The flux of Time, of which all are conscious, is apparently without beginning or end; but it is marked by (1) the ever-recurring alternation of day and night, (2) the recurrence of the moon's phases and (3) the recurrence of the seasons. It is these recurring phenomena which provide the basis for the measurement of time. The day being the smallest *natural* unit is taken as the fundamental unit of time, and the lengths of months and the year are expressed in terms of the day.

When mankind started organized social life, several millennia before Christ, in the valleys of the Indus, the Ganga, the Nile, the Tigris and the Euphrates, and the Hoang Ho, the three astronomical phenomena mentioned above acquired new importance. For, the early societies were based on agriculture, and agricultural practices depend on seasonal weather conditions. With these practices, therefore, grew national and religious festivals necessary for the growth of social life. People wanted to know in advance when to expect the new moon or the full moon, the onset of the winter or of the rains. Calendars are designed, so to say, to predict these events and calendaric astronomy has a long history behind which we need not go into in detail here.

The length of the day, whether measured from sunrise to sunrise or midnight to midnight, was found to be variable, however

accurate the measurements may be. It will take too long to explain the astronomical reasons for this; but this fact has resulted in the formulation of the *solar* day as the fundamental unit of time. The mean solar day is the average interval between two successive passages of the sun over the meridian of a place as derived from a very large number of observations of such meridian transits.

In addition to the solar day, astronomers also define a *sidereal* day, which is the time period between two successive transits of a fixed star; in other words, it measures the time of rotation of the earth round its axis. It should be realized at this stage that the solar day is larger than the sidereal day. This is roughly because, in the time in which the earth completes a rotation round its axis, the sun apparently slips nearly a degree to the east due to the motion of the earth along its orbit round the sun, and, therefore, it takes a little more time for the sun to come back to the meridian of the place. The relationship is:  $365\frac{1}{4}$  mean solar days =  $366\frac{1}{4}$  sidereal days.

The month is essentially a lunar phenomenon and was intended to be the time period between two new moons. But the length of the month so defined varies roughly between 29.2 and 29.8 days owing to the eccentricity of the moon's orbit and other causes. Besides, it is now well known that the motion of the moon is very irregular and complex and, therefore, the moon is a very inconvenient time-marker.

Then we come to the year, which is the period taken by the seasonal characteristics to recur. The year was taken by the very early people to consist of 360 days, made up of 12 months of 30 days each. It was the Egyptians who, from observations of the recurrence of the Nile floods, found very early that the year had a length of 365 days. Later, they also found that the true length was  $365\frac{1}{4}$  days!

The ancient Babylonians, or Chaldeans as they were called from about 600 B.C., appear to have been the earliest people who tried to obtain correct measures of the month, the year and the seasons in terms of the day. Their determinations were transmitted to the Greeks who considerably refined the notions as well as the measurements. The ancient Egyptian solar calendar is the basis from which the present Gregorian calendar has sprung.

### Early Indian calendars

In India there have been about 30 calendars in use. According to the late S. B. Dixit of Poona, three periods can be distinguished in the history of the Indian calendar: (1) the Vedic period up to about 1350 B.C., (2) the *Vedanga Jyotish* period from 1350 B.C. to about A.D. 400 and (3) the *Siddhanta Jyotish* period from A.D. 400 to modern times. Without entering into the detailed historical development of the calendar in India period by period, it is enough for our purpose to take a brief note of the main features. Before the advent of the Moslem rule, the different states of India used a variety of calendars for civil as well as religious purposes. The inscriptions of Indian kings from the first century A.D. to mediaeval times are dated according to these calendars. During the period of Moslem supremacy, A.D. 1200-1757, the lunar *Hejira* calendar had been used both for administrative and Moslem religious purposes except for a short period (A.D. 1556-1630) when on the authority of the Emperor Akbar its use was prohibited and a form of Iranian solar calendar, the *Jelali* calendar, was introduced under the name *Tarikh-i-Ilahi*. Since the coming of British power in India in A.D. 1757 the country has been using the Gregorian calendar for official purposes.

### Need for reform

As the Gregorian calendar, on account of historic reasons, has attained the status of a world calendar it is important enough for us to use it for governmental and many other public purposes. But the people of India have not given up the use of some of the indigenous calendars. These are still used for fixing dates for business purposes and moments of religious festivals and observances, following different schools of Hinduism and other religions having their origin in India such as Buddhism and Jainism. They use different eras, different year-beginnings, and sometimes different methods of calculations based on the three *siddhantas*, or scientific astronomical treatises, namely the *Surya Siddhanta*, the *Arya Siddhanta* and the *Brahma Siddhanta*—all dating from ancient and mediaeval times. The different practices have often produced a bewildering confusion in fixing dates and moments of observance of festivals. The Calendar Reform Committee was set up for studying the

various Hindu calendars and it recommended to the Government a unified National Calendar for the whole of India.\*

### The Indian calendaric system

From the earliest times, the Hindu calendars have followed two fundamental rules, namely: (1) that the religious observances must take place in the right seasons, and (2) that within the proper seasons, the dates should be fixed by the moon's phases. The Hindu religious calendar is, therefore, *lunisolar* in which the seasons are fixed by the solar calendar, while the dates and moments are fixed according to the lunar calendar pegged on to it.

The calendar depends upon the science of astronomy which has evolved methods of correctly predicting the positions of the sun, the moon and the planets — the *Ephemerides*. So, the astronomical part of the calculations should be based upon sound astronomical principles and accurate computations no matter what calendar is evolved for use anywhere. But this is not all. The calendars in use in practice depend a great deal upon conventions also, which vary widely from country to country and even from state to state within the country.

The scientific basis and the conventions which go in the making of the solar calendars are:

- (1) The year should be properly defined, and the length of the year should be astronomically correct.
- (2) The seasons should be properly defined and should start on proper dates.
- (3) The day should start from midnight.

It is seen from the *Surya Siddhanta* that Aryabhatta, the author of that famous treatise (having its origin in about A.D. 400), accepted these principles and had laid down the following rules:

- (1) The year should start from the instant when the sun crosses the spring equinoxial point and the length of the year should be the tropical year (*Sayana*).
- (2) The seasons should consist of two solar months, each defined by the time taken by the sun to traverse 30° of the sun's path (*ecliptic*).

- (3) The day should be reckoned to start from midnight (*ardharatrika* system) for purposes of astronomical calculations.

For civil purposes, it is necessary that both the year and the month should be made up of a whole number of days, and the civil day, according to Hindu practices, should start from sunrise (*Savana*). To achieve these, different conventions have been followed in different regions which account partly for the calendar confusion in this country.

But the most serious defect has been in the length of the year adopted in the *Surya Siddhanta*, the standard astronomical compilation. The length of the year had been taken to be 365·25676 days which is presumably the sidereal year; but even then the length of the year is in excess by 0·0024 day. Actually it is laid down in the *Surya Siddhanta* that the length of the year should be the *tropical year*, which according to the modern measurements consists of approximately 365·2422 days.

The errors in the fixing of the lengths of the years and months are common in all ancient astronomical treatises, whether Indian or occidental. In the West, however, the correct values as obtained later by accurate observations were adopted for calendaric calculations by the edicts of dictators like Julius Caesar or Pope Gregory XIII on the advice of astronomers. In India, on the other hand, astronomical observations ceased to be made from about A.D.1200, after the advent of the Turkish invaders, when the Indian observatories were either destroyed or abandoned by the astronomers and calendar-making fell into the hands of astrologers with the older treatises as their only guide.

In their failure to grasp the full implications of the phenomenon of *precession of the equinoxes*, the Indian astronomers were not alone; for, the false notions about this phenomenon were not given up even in Europe until Newton's time (1687). Anyhow, the Indian year is longer than the *tropical year* by 0·01656 days, and this error has been accumulating for nearly 1400 years. Hence, the solar year now starts nearly 23-24 days later than the day following the spring equinox (21 March) on which it started in the time of Varahamihira. In this way, the festivals as given by the Indian almanac makers quite often fall in the wrong season. For example, in 1955 *Sarad Purnima* was

\*A summary of the Committee's recommendations was reported in the *Journal of Scientific & Industrial Research*, 15A (1956), 187.



celebrated in the *Hemanta* season. It is obvious that this is neither the scriptures nor science.

### The Unified National (Solar) Calendar of India

*The year* — The new National Calendar has tried to rectify this fundamental error by recommending what the *Surya Siddhanta* laid down, namely that the year should begin on 22 March (the day after the spring equinox) which has been made to correspond to first of *Chaitra*, and that the length of the year should be the *tropical year (Sayana)*. The year will consist of 365 days normally and 366 days in leap years, once in 4 years, as in the Gregorian calendar.

*The months* — The Hindu solar months vary from 29 to 32 days as the time of passing  $30^\circ$  of the ecliptic varies according to the older data used in the *Surya Siddhanta* from 29-32 days to 31-64 days. Such varying lengths can fully be explained on the basis of Kepler's laws and by the application of Newton's law of universal gravitation, which were unknown to astronomers in the time of the *Surya Siddhanta* (A.D. 400). The lengths of months are different according to the *siddhantas* because they were calculated according to three different formulae. Kepler's laws and the shift of the equinoctial lines not being known, the ancient astronomers probably assumed that the times of passage through  $30^\circ$  as calculated by their formulae would remain valid for all times. But it is now known that this assumption is incorrect and we cannot, therefore, stick to the lengths of the months as prescribed in the *siddhantas* which differ among themselves. According to the new National Calendar, the months *Chaitra* and *Aswin* to *Falgun* will have 30 days each and *Vaisakha* to *Bhadra* (and *Chaitra* in leap years) will have 31 days each. It thus not only fixes the number of days in each month as in the Gregorian calendar, but also the starting dates of each of its months will have a permanent correspondence with fixed dates of the Gregorian calendar. The first days of *Chaitra*, *Jaistha*, *Ashard*, *Agrahayan* and *Poush* will correspond to 22nd of March, May, June, November and December respectively; first of *Vaisakha*, *Magh* and *Chaitra* in leap year to 21 April, January and March; first of *Sravan* to *Kartik* to 23 July to October; and the first of *Falgun* to 20 February.

*The era* — For systematic date reckoning a continuously running era is required to be mentioned besides the month and the date according to the prevailing calendar. This enables an event to be placed correctly on the time scale. In international practice the Christian era is used. This is supposed to have started from the year of birth of Jesus Christ. But actually it is an extrapolated era which came to be used about 500 years after that event, and even so its starting day may be quite different from the actual birthday of Christ.

In India nearly 30 different eras were or are used which are either of foreign origin, purely Indian origin or hybrid ones. It will take far too long to give a history of these which is not, therefore, attempted. It is clear from historical records that date reckoning by using an era started in India from the time of the Kusana emperors and Saka satraps of Ujjain. The introduction of the era is connected with the development of sense of 'History' which came rather late in the time scale of civilization. In any case, it has little to do with any fundamental principles of astronomy, and the adoption of one or the other era is rather a matter of choice.

The National Indian Calendar has adopted the Saka era after a critical examination of the points in favour of the various eras used in the Indian calendaric systems. The Saka era is certainly the era *par excellence*, since it is used by all Indian astronomers, and had been used, and is still used, for calendaric calculations all over India since the days of the Ujjain astronomers in the first century A.D. It is the era used in all Indian scientific treatises including the post-siddhantic treatises. It is, therefore, but appropriate that the National Indian Calendar should have adopted the year 1879 of the Saka era which is the era current in March 1957.

*The leap year* — To find the leap years according to the national calendar, all that need be done is to observe this rule: Add 78 to the Saka era year, and if the sum is divisible by 4 then the year is a leap year. Thus, 1878 S.E. was a leap year (corresponding to A.D. 1956) and 1882 S.E. and every 4th year thereafter will be leap years. When, however, after adding 78 to the Saka year, the sum is a multiple of 100, that year will be a leap year only if the sum is divisible by 400 — otherwise it will be a common year. This is as in the corresponding rule

in the case of the century years in the Gregorian calendar, the reasons for which are well known.

It will be seen, therefore, that the new solar calendar is scientific, uniformly applicable to all parts of India, follows the *Surya Siddhanta* in all essential points and is absolutely sound in its astronomical basis. The conventions have been revised with the sole object of having a uniform system for the whole country.

#### The Religious (Lunar) Calendar of India

The Hindu religious calendar is mainly lunisolar, i.e. the seasons are fixed by the solar calendar, while the dates and moments are fixed according to the lunar calendar pegged on to it. The lunar calendar depends on the correct calculation of the moments of conjunction (*Amavasya*), opposition (*Purnamasi*) and of the *tithis* (the moments when the moon gains  $12^\circ$  or its integral multiples on the sun). For calculating these the Indian calendar-makers use the formulae for lunar motions given in the *siddhantas*. As these are known to be in error, some corrections known as *bija* have been introduced in them by later Indian astronomers. But, for the calculation of the moon's positions according to the correct astronomical concepts of the present times, formulae are used which run up to twenty printed pages and contain about 1500 terms in all! These formulae and the terms involved have been worked out from more accurate and elaborate astronomical measurements which have now become available with the progress of astronomy but which were not known to astronomers of older times.

Now the orthodox Indian calendar-makers still use the older formulae dating from A.D. 400 and so their calculations of the ending moments of *tithis* do not agree with those given in the Nautical Almanacs based on the modern formulae and verified by actual observations. The errors sometimes amount to as much as  $5\frac{1}{2}$  hours or more! Many of the Indian calendar-makers are aware of these discrepancies, and some of them have taken to incorporating the ending moments of *tithis* from the Nautical Almanac; but all do not do so. However, when it comes to giving the moments of the beginning and ending of the eclipses, lunar or solar, they all take the times from the Nautical Almanacs. The reason for this is clear. As the times of the

eclipses, calculated according to the *siddhantas*, may be grossly inaccurate, the mistakes in the case of the eclipses will at once catch public attention and lower the prestige of the concerned almanac!

The calculations of *tithis* used for the National Calendar are to follow the Nautical Almanac and are based on correct positions of the moon and the sun.

Another radical departure has been made. According to the conventions, a religious festival is observed in a locality when the prescribed *tithi* is current at a particular hour of the civil day of the locality. But on the same day and hour, the *tithi* may vary from locality to locality; and this, taken with the mistakes in calculating *tithis* according to ancient methods, may produce a full day's difference in some cases in fixing the dates of religious festivals. In the National Calendar the ending moments of *tithis* have been given according to modern calculations (following the Nautical Almanacs) and the *tithi* current for the Central Station (a hypothetical station at  $23^\circ 11' N$ . lat. and  $82^\circ 30' E$ . long.) has been taken to be the *tithi* for the whole of India. This view is a very justifiable one. If, on the other hand, one were to truly follow the *siddhantic* conventions to the letter, then even with the calculations made correctly every station should have its own *tithi* and consequently have its own almanac! Obviously, this is neither possible nor sensible. Therefore, in laying down that the country should follow the *tithi* calculated for a central location there is no more violation of the *siddhantic* conventions than they are already violated.

As a result of all the reforms and adjustments described above the National Calendar would ensure that the religious festivals and observances, determined by the sun alone, would follow astronomically correct seasons, while those determined by the lunar calendar would continue to be observed at the times conforming to the present practice. But even in their case also, the corrections now introduced in the length of the year will prevent their further shift in relation to the seasons. It has been explained earlier that the dates of the festivals have already shifted by 23 days from the times at which they were observed about 1400 years ago as a result of ignoring the precession of the equinoxes. Although it may seem desirable that this shift also should have been adjusted at this

time, it has been considered expedient to maintain this shift of 23 days as a constant difference, so that for the present there would be no deviation from the prevailing custom in this observance.

#### Other recommendations

While fixing the dates of the various local festivals in the Reformed Calendar it was observed that in some cases different conventions are followed in the different states for fixing the same festival. In their present fixation of the dates of the festivals statewide, the Committee has followed, as far as practicable, all these local conventions. But they have expressed the opinion that in this matter also a uniform convention should be followed throughout India, and that it is desirable for the Government to take the necessary steps in order to explore the possibilities of such a unification. Reform of an existing calendaric system is not a new thing, such reforms having taken place quite a few times in the past in other parts of the world at various stages of man's civilization. Changes have inevitably been accepted, though tardily sometimes and often reluctantly in the sphere of religious observances. It is in consideration of this reluctance that the Committee has not proposed the necessary correction in respect of the dates of the religious observances, a compromise which the Government too have perhaps rightly accepted. But every right-thinking person should realize that even the religious practices ought to be guided by a calendar which is based on a more scientific system of time reckoning and on astronomically accurate ephemerides.

Before concluding, two further recommendations of the Calendar Reform Committee are worth noting. One is that the Government of India should take steps to compile annually an "Indian Ephemeris and Nautical Almanac" showing in advance the positions of the sun, the moon, the planets and other heavenly bodies; and that the Indian Calendar, both civil and religious, should be included in that publication every year. The Government lost no time in implementing this very important recommendation and the Council of Scientific & Industrial Research took very early steps to fulfil this need by appointing an Indian Ephemeris Unit to work under the late Dr. Meghnad Saha for compiling the Indian

Ephemeris and Nautical Almanac. This unit was subsequently transferred as a permanent measure under the India Meteorological Department which, it is gratifying to see, have just published the Indian Ephemeris and Nautical Almanac for 1958.\* It is the first Indian publication of its kind and marks a very significant step in the plans for the development of astronomical work in India.

Finally, the Calendar Reform Committee has recommended that steps should be taken to establish, at a suitable place, a National Astronomical Observatory provided with modern equipment and apparatus and time-service. It is the earnest hope of every one that the Government, having already acted on the other main recommendations of the Committee with commendable expedition, will give their serious and early consideration to this very important recommendation also — a step that will undoubtedly help a great deal to bring India back to the place of eminence she once occupied in the past in the field of astronomical studies.

#### Conclusion

The Prime Minister in his message to the Calendar Reform Committee had expressed the hope that the scientists will give a lead in the matter of removing the calendar confusion in India. The scientists have fulfilled his hope by evolving a scientific and astronomically sound uniform National Calendar; and the Government have acted with zeal and praiseworthy vision by adopting it. It is now for the people of the nation to lend the National Calendar their unstinted support by its quick universal adoption for all their civil and even religious purposes. By so doing they will have shown that they can rise above the tenets and practices derived merely from usage and custom most of which are not in themselves sacrosanct, but very often based on man-made rules and dogmas.

#### Acknowledgement

In preparing this article, I have drawn extensively from the material set forth in the *Report of the Calendar Reform Committee* published by the C.S.I.R. and from the writings of the late Prof. Meghnad Saha, F.R.S.

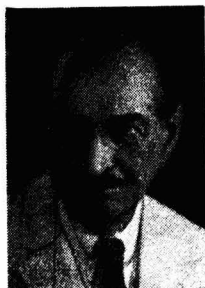
\**The Indian Ephemeris and Nautical Almanac for the year 1958* — published under the authority of the Director General of Observatories by the Government of India Press, Calcutta.

## Dr. D. N. Wadia, F.R.S.

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**T**HE election of Dr. D. N. Wadia, Geological Adviser to the Department of Atomic Energy, as a *Fellow of the Royal Society* "for researches into the geological structure of the Himalayas" has been announced.

Born in 1883, Dr. Wadia received his early education at the Baroda College, Bombay University. He began his career as Professor of Geology, Prince of Wales College, Jammu and Kashmir State, in 1907. His contact with the Himalayas thus began at an early period in his life and his interest in the biggest mountain range of the world continued to dominate his geological studies in subsequent years. He joined the Geological Survey of India in 1921 and carried out several important explorations, among them the survey of Pirpanjal range, the Kashmir Himalayas, Hazara and parts of N.W. India, and Waziristan. On his retirement from the Geological Survey of India in 1938, he was appointed Mineral Adviser to the Ceylon Government and later, Director, Bureau of Mines, Govt. of India. Since 1949, he has been Geological Adviser to the Department of Atomic Energy and has been directing the survey for uranium and other atomic minerals which has yielded promising results.



DR. D. N. WADIA

His well-known book *Geology of India* and many other scientific publications, including *Syntaxis of N.W. Himalayas* and *Structure of Himalayas*, won for him a name in the geological world. He has been elected Fellow of many geological societies and awarded several medals; he has participated in several

International Conferences as representative of India. He was President, Indian Science Congress, in 1942. He was recently invited by the Egyptian Government to advise the Government on the organization of a survey for atomic and other economic minerals.

Dr. Wadia is intimately connected with the activities of the Council of Scientific & Industrial Research in different capacities. He is a member of the Board of Scientific & Industrial Research; Chairman, Mineralogical and Geological Research Committee; and member, Editorial Board, *Journal of Scientific & Industrial Research*.

## "Atoms for Peace" Award

PROF. NIELS BOHR, DISTINGUISHED DANISH physicist and winner of the Nobel Prize in 1922, is the recipient of the first "Atoms for Peace" Award, established in 1955 through a \$1 million grant by the Ford Motor Company of America. Prof. Bohr (71) is one of the founders of the modern atomic theory. His earliest contribution to the

unfolding of the structure of the atom was made in 1913 when he devised an atomic model which could explain the spectra of elements and their position in the Periodic Table. Later, he developed the theory known after his name, which has provided the basis for all subsequent work on atomic structure.

# Cellulose Research — A Symposium

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**A** THREE-DAY symposium on Cellulose Research was organized under the auspices of the Cellulose Research Committee of the Council of Scientific & Industrial Research at Ahmedabad during 4-6 February 1957. The symposium was inaugurated by Dr. K. R. Ramanathan, Director of the Physical Research Laboratory, Ahmedabad, and Dr. V. A. Sarabhai, Chairman of the Cellulose Research Committee, delivered the introductory address.

Nineteen papers were presented and discussed in five sessions covering the following subjects: Chemistry of cellulose; Structure and mechanical properties of cellulose; Reactions of cellulose with cross-linking agents; Cellulose for the rayon industry; and Research in other cellulosic industries.

Reviewing the progress of cellulose research in India, Dr. B. K. Vaidya pointed out that the study of raw materials for the paper industry formed the main interest of cellulose research in the years preceding the establishment of the Cotton Technological Laboratory in Bombay in 1924. Valuable work on the mechanical, chemical and technological aspects of cotton cellulose was undertaken in this laboratory, and the progress achieved provided the inspiration for initiating similar studies on jute cellulose in the Jute Technological Laboratory at Calcutta, which was started in 1937. In the recent past, a number of institutes have been set up in the country and various aspects of cellulose research are now receiving attention.

The Cellulose Research Committee was one of the earliest committees organized by the Board of Scientific & Industrial Research when it was established in 1940. Among the research projects supported by this Committee, mention may be made of investigations on cellulosic raw materials for the rayon industry, manufacture of chemical pulp, preparation of cellulose derivatives and anatomical examination of bamboos. The Committee has drawn up a comprehensive scheme of research on cellulose to be carried out during the Second Plan period, 1956-61.

## Cellulose fibres — chemistry and properties

Cellulose is a linear polymer exhibiting properties akin to poly-alcohol compounds. The characteristic alignment of chain molecules into closely and orderly packed 'crystalline regions' and disorderly packed 'amorphous regions' is responsible for many of the textile properties, such as tensile strength, elasticity, dye receptivity, moisture regain, etc. Various modifications can be effected in the structure, and one or more of the textile properties can be improved upon.

The mechanical properties of cellulosic fibres are related both to external (or macroscopic) form and internal (or sub-microscopic) structure. In the former category are: cross-sectional size and shape, crimp or kinkiness, and surface features, such as cracks and wrinkles. The more important characteristics of the internal structure to be considered for understanding the mechanical properties of the fibre are, length distribution of chains, mass-order distributions and orientation-order distributions, radial inhomogeneities (skin-core differences) and organizational imperfections or fracture surfaces within the fibre. These properties vary considerably for the major native and regenerated cellulosic fibres and generally account for the differences observed in strength and extensional properties.

Studies on light scattering of cellulose solutions in concentrated acids reveal the formation and growth of a polymer of 5-hydroxymethyl furfural, a dehydrated product of glucose. Studies on this polymer formed the subject of a paper by Dr. P. K. Choudhury.

Investigations on the fluidity of cellulose solutions have been undertaken in the Sri Ram Institute for Industrial Research, Delhi, by Dr. H. R. Chipalkatti and co-workers. It has been shown that phosphoric acid as a solvent for cellulose has certain advantages over cuprammonium solution; viscosities can be measured from the very early stages of cellulose dissolution.

In a paper entitled 'Some studies on X-ray diffraction by cotton', Dr. T. Radhakrishnan discussed the applications of X-ray diffraction techniques for measuring molecular orientation produced by stretching and washing alkali-swollen cellulose. The data obtained

have been correlated with the physical properties of mercerized cotton. An inexpensive X-ray diffractometer has been devised for measuring fibre orientation.

#### Cellulose and cross-linking agents

The effect of treatment with formaldehyde, urea-formaldehyde and melamine-formaldehyde condensates, and isocyanates on the properties of the fibre, yarn and fabric was reviewed in a paper presented by Dr. P. C. Mehta. In another paper, Shri K. Mannivannan and Dr. V. B. Chipalkatti discussed the methods for overcoming the major defects normally encountered in viscose rayon fabrics.

Exposure of cellulose to the mercury arc results in the formation of two types of alkali-sensitive glycosidic linkages, viz. those that break down in the post-irradiation stage and those that are stable.

Results of investigations carried out in the laboratories of Technical Development Establishment, Kanpur, to prevent or slow down the pace of degradation by light and by microbial attack were discussed; it was pointed out that copper, in binary combination with nickel or manganese, is effective against both actini and microbial attacks.

#### Cellulose for rayon

India imports 50 tons/day of 'cellulose pulp' or 'dissolving pulp', a specially purified form of pulp for the manufacture of rayon. For meeting the requirements of the expanding rayon industry, the requirement of pulp in

1961 has been estimated to be 150 tons/day valued at Rs. 5.5 crores per year. India has ample resources for the production of pulps required by the rayon industry. Extensive research on indigenous cellulosic raw materials, like bamboo, bagasse and *sabai* grass, and developmental work should be undertaken as an urgent measure.

Some aspects of the composition and evaluation of viscose grade pulps, and chemical analysis of cellular components, like fibres, parenchyma cells, epidermal and nodal tissues from untreated bamboo (*Dandrocaltham strictus*) were discussed in two papers by Shri G. M. Vyas.

#### Other cellulosic industries

Attention was drawn to several fundamental problems on jute cellulose requiring investigation, e.g. significance of individual fibre constituents and reactive groups of the cellulose molecule and their role in the treatment employed for modifying fibre properties. It was reported that jute  $\alpha$ -cellulose, irrespective of the method of its isolation, is always associated with xylan.

Anatomical structure of some indigenous hardwoods has been exhaustively investigated with special reference to their suitability for pulp and paper. Studies designed to determine the optimum conditions for producing strong pulps from bamboo have shown that the best yield is obtained when bamboo chips are digested by the 'impregnation method' with liquor containing 8 per cent active chemicals at 153° for 1½ hr.

## Decimal Coinage

THE INTRODUCTION OF DECIMAL COINAGE IN India from 1 April 1957 is the first step in the phased programme of switching over to the decimal system of currency, weights and measures.

The decision to change over to the decimal system was prompted by the rapid pace of industrialization in the country and the need for a rational mode of computations and measurements. The prevailing system of coinage, weights and measures, though hallowed by time, is cumbersome and computations based on it are wasteful of time and energy.

Writing on the decimalization of coinage in India, the *New York Times* said that India was embarking on "an experiment that is courageous, imaginative and significant. It is obvious that with a decimal currency, India will have moved more closely into touch with the whole modern world. It will be easier to speak one branch of the international language. If India is successful in this experiment — and we are confident she will be — there will be a valuable object lesson for all those who seek better and more accurate media of worldwide communication."

# A New Theory of Olfactory Stimulation

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**A**TTEMPTS to correlate odour with other molecular properties and to suggest a trigger mechanism for the olfactory process have been made in the past. But chemical correlation with physical properties, other than low-frequency molecular vibrations, has been unsuccessful and most of the proposed triggering mechanisms are unsatisfactory. Because of the lack of any distinct chemical correlation, it is now generally agreed that odour is a 'whole-molecule' effect, not an effect due to specific chemical groups. It is plausible that the low frequency molecular vibrations form the physical basis of odour, as such vibrations are due to the 'whole-molecule' effect, in contrast to the higher frequency vibrations characteristic of chemical bonds.

A complete theory of the olfactory process must account not only for the exceptional odour sensitivity at very low thresholds but also the ability to discriminate a wide variety of odours and identify them. Hainer and co-workers have recently proposed a theory in which the nature of olfaction has been considered in terms of subjective olfactory experience, the neuro-physiology of the olfactory system, and the requirements for the storage and the transmission of information [Hainer, R. M. *et al.*, *Ann. N.Y. Acad. Sci.*, **58** (1954), 158]. This theory answers many complex olfactory phenomena, e.g. fatigue, adaptation and classification of odours and has accounted for the well-known Weber-Fechner law. It does not attempt to explain the mechanism by which the rather small quanta associated with vibrations in the far infrared region are able to trigger the much larger discharges of energy necessary for the initiation of a nervous impulse. Such a mechanism, which is consistent with the hitherto known facts of olfaction as well as with the accepted physico-chemical principles and the neuro-physiology of the olfactory system, has now been suggested by R. H. Wright and his associates of the University of British Columbia [*Chem. Ind.*, No. 37 (1956), 973].

## Current knowledge

The relevant facts known about olfaction are: (1) the olfactory end organ is an elongated bipolar neural cell, which terminates at its outward end in an enlargement, called the olfactory vesicle. The neural cells extend through the cribriform plate from the olfactory bulb of the brain into the nasal passage. The vesicle carries 6-12 protoplasmic filaments or hairs (diameter,  $0.1 \mu$ ; length,  $1-2 \mu$ ) which are integral parts of the cell. Olfaction involves direct interaction between the neuron and the source of stimulation. (2) In man, there are about 50 million primary neurons. These carry the olfactory hairs at their distal ends, and proximally they lead into the olfactory bulb. About 45,000 nerve fibres lead out of the olfactory bulb to the brain. They are grouped in bundles of 24 which are connected to some 1900 glomeruli located in the olfactory bulb. According to Hainer *et al.* there are 24 types of primary neurons responding to different stimuli and feeding 24 secondary or cerebral neurons which emerge from each glomerulus. This provides a very large number of possible digital patterns (over 16 million) and constitutes the 'informational' basis of the surprising selectivity of the nose in discriminating various odours. (3) The existence of olfactory end organs capable of selective response to different stimuli has been experimentally demonstrated by electrophysiological methods. (4) Nerve cell walls in their normal state are the site of an electrical double layer. The initial event in nervous stimulation appears to be a localized breakdown or discharge of the layer which is accompanied by an alteration in the permeability of the cell wall. The discharge is propagated along the nerve as a pulse of about 1 millisecond duration. The magnitude of the pulse, however, does not reflect the odour intensity. (5) To induce an olfactory sensation, the air in the nasal passage must be moving. (6) To produce perceptible odour, molecules of the odorous substance should make a close approach to the olfactory end organ. (7) The odour may

be connected with the low frequency molecular vibrations. (8) The olfactory epithelium is coloured by the presence of an 'olfactory pigment', the constitution and the precise location of which are not yet definitely known.

#### Olfactory pigment and nervous stimulation

A pigmented molecule is one whose structure involves 'chromophoric' groups resulting in the presence of weakly bound electrons. The electrons may be excited by small quanta of light in the visible region, and it is this absorption which provides the characteristic colour of the pigment. Wright *et al.* proposed that, normally, molecules of the olfactory pigment located in the end organ can be similarly (electronically) excited by chemical means, metabolic processes supplying the necessary energy and the coloured molecules acting as energy acceptors. They further suggested that the de-excitation of these molecules, possibly by an odorous molecule, may provide the redistribution of charges necessary to effect the breakdown of the membrane potential, which in turn may initiate a nervous impulse. In the extremely minute olfactory hairs, the discharge of a relatively small number of such molecular dipoles might be sufficient to outweigh the effect of metabolic reactivation.

#### Triggering mechanism

The return of the excited molecule to the ground state may take place quite early by radiation or only after some delay. The transition of the former type is known as 'allowed' transition, that of the latter type, 'forbidden' transition. The probability of occurrence of the latter type of transition is far lower than that of the former. The electronic transition postulated in the theory of Wright *et al.* is of the 'forbidden' type arising from the symmetry of the system. A probable mechanism for the triggering may be based on the fact that resonance between the vibrations of the odorous molecule and the receptor pigment may result in a change of population in the vibrational levels of the electronically excited state. If the shift were into a vibrational level from which the transition to the ground state is more 'allowed', then a local discharge of the cell membrane might result.

#### Similarity to Fermi resonance

Wright *et al.* postulated that the increased overlap and the transition probability of the electronically excited pigment molecules are brought about by a perturbation process similar to Fermi resonance between the odorous and the receptor molecules. The effect is closely similar to the case of two mechanically coupled oscillators in which the two identical vibrational frequencies are split into one slightly higher and one slightly lower than the original value. Overlap and transitional probability are maximum when the peaks of the wave functions representing the upper and lower states are in phase with each other. For odorous molecules which are generally polarizable, surface adsorption compounds provide the required degree of intimate contact between the odorous molecule and the receptor.

#### Common observations explained

Available experimental evidence indicates that the strength of the olfactory sensation is weakened when the humidity is high and the air temperature is close to that of the body temperature. Wright *et al.* interpreted the effect of increased temperature and high humidity as due to the interposition of an adsorbed film of water between the odorous molecule and the pigment in the cell membrane. Due to the specific adsorption required for the Fermi resonance to be effective, the adsorbed molecules would remain on the end organ and produce a more or less persistent sensation. Wright *et al.* pointed out that this does not happen. The odorous molecules are expelled violently and thrown out by a distance of several free paths from the surface by the very electronic process which they trigger in the cell membrane. The air close to the surface becomes rapidly denuded of the odorous molecules by a process of preferential adsorption followed by violent ejection. Air movement is required to bring the odorous molecules back to the surface. If fresh, non-odorous air is inhaled it will instantly sweep away the odorous molecules. This explains the evanescence of the olfactory sensation.

#### Probable nature of the pigment

The theory assigns a central role to the olfactory pigment and requires that the cell walls and, particularly, the olfactory hairs



shall contain the pigment or other molecules having low vibrational frequencies associated with that part of the molecule which has a low-lying electronic level. The pigment should consist of several chemical species, probably of a single basic type but tuned to different vibrational frequencies by substituents of varying mass or position (somewhat akin to the 24 primary neuron types suggested by Hainer *et al.*). The observed brown colour of the olfactory region is more consistent with absorption by an array of coloured molecules than by a single molecular species. The physical behaviour of the pigment can be best met by a molecule with a conjugated, but loosely bound, 'flapping' type of structure, well satisfied

by the vitamin A type of molecule. In *in vitro* systems, molecules such as terphenyl and the cyanine dyes with a structure close to that of vitamin A, act as typical energy traps. In fact, it has been observed that rats suffering from a severe vitamin A deficiency lose the ability to discriminate between eucalyptol and benzaldehyde. The process of colour vision is known to involve several pigments and has an obvious parallel with the suggested mechanism of odour perception. From the close physical association of the organs of sight and smell and their possible evolution from a common sensitive area, it is most likely that olfactory pigments will turn out to be closely related to visual pigments of the rhodopsin type.

## "Endeavour" Prizes, 1957

THE IMPERIAL CHEMICAL INDUSTRIES LTD., publishers of *Endeavour*, have offered a sum of 100 guineas to be awarded as prizes for essays submitted on one of the six scientific subjects listed below. The primary purpose of these awards is to stimulate younger scientists to take an interest in the work of the British Association for the Advancement of Science and to raise the literary standard of scientific writing. The competition is restricted to those whose twenty-fifth birthday falls on or after 1 June 1957.

The five prizes to be awarded are: First, Second and Third Prizes, 50, 25 and 15 guineas respectively; two Special Prizes of

5 guineas each, exclusively for competitors below 18 years.

The subjects for the essay competition are as follows: (1) The International Geophysical Year, (2) Science Fiction, (3) Irish Contributions to Science, (4) Atmospheric Pollution, (5) Chemistry and the Conquest of Disease, and (6) Particles in Plant and Animal Cells.

All entries should be addressed to: The Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London W. 1. The last date for the receipt of entries is 1 June 1957. The First Prize-winning essay will be published in the *Advancement of Science*.

# REVIEWS

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CRYSTALLOGRAPHIC DATA FOR THE CALCIUM SILICATES by L. Heller & H. F. W. Taylor (H.M. Stationery Office, London), 1956. Pp. v + 79. Price 10s. 6d.

During World War II Prof. Bernal had much to do with the design and construction of air-raid shelters. Perhaps it was this experience which aroused his interest in cement. Be that as it may, the present book summarizes admirably and in handy form our present knowledge of the calcium silicates and their hydrated products, to which the authors have themselves made many notable contributions while working in Bernal's laboratory.

There was a time when the manufacture of cement was controlled largely by chemical analysis amplified by crushing and tensile tests of the hydrated product. Those days are past, for the choice of raw materials is more restricted and the demands to be met by the finished product are increasing in severity. Today no cement factory can be regarded efficient unless its laboratory is equipped, not only for chemical control, but also with X-rays (Cu-K $\alpha$ ) for structure analysis, a mineralogical microscope, and for differential thermal analysis.

The data so well set out in this book have for the most part been published in journals not normally available to the work's chemist or the physical chemist. Thus, by bringing together the relevant crystallographic, optical and chemical data in such a systematic and compact form the authors have rendered a real service to the cement industry and cement users.

Three appendices following the main text add to its usefulness. The first deals with thermal dehydration aspects and the second, in outlining the skeletal structural types, affords a critical review of a field in which there has been much speculation. Here, infrared absorption spectroscopy would have helped in the characterization of the silicon-oxygen groups. The table, in Appendix III, of the 'd' values of the three principal lines for the various silicates affords a ready means of quick identification.

This is a book which should be in every chemical library; it is of immense value to

the scientist in the cement, ceramics and building industries.

It is to be hoped that before long the state of our present knowledge of the calcium aluminates will, in its turn, be equally well brought together in such handy form.

G. I. FINCH

PRACTICAL SOLUTION OF TORSIONAL VIBRATION PROBLEMS WITH EXAMPLES FROM MARINE, ELECTRICAL, AERONAUTICAL AND AUTOMOBILE ENGINEERING PRACTICE by W. Kern Wilson (Chapman & Hall Ltd., London), Third Revised Edition, 1956. Pp. xxxii + 704. Price 5 guineas

In the preface the author has mentioned that during the last decade or two the study of vibration has gained considerable improvements of instrumentation and experimental procedures which have resulted in a better understanding of some of the more complex aspects of the subject. Hence in the third revised edition of the book the author has endeavoured to bring his book up to date by including the developments that have taken place in the field of vibration engineering.

The study of vibrations in engineering dates back to the beginning of this century. Tremendous progress was made in this branch during the period preceding World War II and in the post-war period due to the development of high speed engines, especially those required for propulsion in modern aeroplanes. This led to the manifold developments in the field of instrumentation during the years 1935-45. In aeronautical engineering, the problems of vibration opened the way to systematic studies in flight; considerable progress was made in analytical studies during this period. Application of improved experimental procedures in work on engines and aircraft vibration indicated that in a number of cases the experimental results did not agree with theoretical predictions. This led to a series of approximations and paved the way for practical approach to the problem.

The trend of engineering development towards higher operating speeds and increased

economy of material has emphasized more and more the importance of vibratory phenomena in determining the safety and durability of engineering structures. Though in some cases the problems are comparatively straightforward requiring no more than the determination of the fundamental frequencies of the systems, in many cases, for working solutions a threefold approach is generally necessary, namely (a) theoretical analysis to guide experimental work and assist interpretation of experimental work; (b) the experimental investigation to verify theoretical predictions, provide data for numerical solutions and indicate refinements or extensions of basic theory; and (c) fatigue testing, preferably with full-size components, to determine safety margins.

The author has endeavoured to make all these approaches to the solution of complicated problems and has very successfully tackled and brought them within the comprehension of all those engaged in vibration study and analysis. Based on years of experience, both in the research and development of internal combustion engines of all ranges, the author has successfully compiled all his experiences in a very comprehensive volume. While the book itself contains 12 chapters covering various aspects of torsional vibrations, the bibliography at the end of the book is very exhaustive wherein all modern work on vibration engineering is referred to. The book is indispensable not only for advanced class-room study but also for reasearch workers.

V. CADAMBE

FRUIT AND VEGETABLE PRESERVATION INDUSTRY IN INDIA (Central Food Technological Research Institute, Mysore), 1956.

Pp. xiv + 485. Price Rs. 6; 15s.; \$ 2.50  
The Central Food Technological Research Institute, Mysore, has brought out the proceedings of the symposium on problems of the fruit and vegetable preservation industry in India, held under its auspices in October 1954. This was the fourth symposium organized by the Institute with a view to bringing together scientists, technologists, industrialists, government officials and public men working in the field of horticulture, biochemistry, microbiology, food technology and production and marketing of fruit and vegetable products. The publication includes sixty-four papers on various aspects

of the industry presented and discussed at the symposium, arranged in the following eleven sections: (1) Raw materials (including minor fruits and vegetables), their survey, quality, etc.; (2) Advancement in scientific and technical knowledge (of the Indian fruit and vegetable preservation industry); (3) Quality control of manufacturing processes; (4) Sanitation and microbiological problems in relation to the quality and shelf-life of processed fruit and vegetable products; (5) Additives and preservatives; (6) Nutritive values of preserved products; (7) Applications of refrigerated storage of fruits and vegetables for the benefit of the preservation industry; (8) Containers (tin, glass, plastics, paper, etc.) for fruit and vegetable products; (9) Plant and equipment in the processing of fruits and vegetables; (10) Technical information service and publicity for the Indian fruit and vegetable preservation industry; and (11) General — some other aspects of the industry. Besides these 64 papers, the publication includes introductory speeches, resolutions and concluding remarks.

The importance of fruits and vegetables as protective foods essential for providing adequate nutrition to the predominantly grain-eating population of India need hardly be stressed. It is also well known that the *per capita* production of fruits and vegetables is very low in India and that a considerable part of the production goes waste, especially in the peak season, owing to defective transport, delays in marketing, lack of cold storage facilities, etc. The reasons for the slow and inadequate development of the fruit and vegetable preservation and canning industry on a commercial scale in India are also well known, namely insufficient markets for canned products, high cost of manufacture (due to high cost of sugar, containers, etc.), transport difficulties, horticultural development not being oriented to the requirements of the canning industry, etc. The resolution passed at the symposium takes account of these usual difficulties and makes recommendations for removing them.

It is unfortunate that even though the Central Food Technological Research Institute has done so much useful work on home and cottage-scale preservation and canning, the symposium was primarily oriented towards the problems of the commercial development of this industry. Leaving aside the modern methods of chemical preservation,

sterilization and refrigeration, the art and science of preservation by other methods, e.g. drying and dehydration, pickling and fermentation, concentration of spices, salt or sugar, etc., have been employed in Indian homes for ages. In fact, the extent of the fruit and vegetable preservation industry in India would be considerable if the home and cottage-scale industry is also taken into account and calculations are not based merely on commercial units licensed under the Fruit Products (Control) Order, 1953. The commercial industry could and should no doubt be developed for catering to urban markets, the Defence Services and the export markets. But no real improvement in the utilization of fruits and vegetables as a whole can come about until and unless the development is oriented towards the larger segment of the industry represented by home-canning and cottage-canning in the thousands of villages and the millions of homes in India.

Some of the participants in the symposium were no doubt aware of these problems. For example, the Agricultural Marketing Adviser, Dr. M. B. Ghatge, made the following remarks in his opening address: "The method of preparation of fruit products on a cottage-scale varies from place to place and from season to season. It has, therefore, been possible for these manufacturers to produce a wide range of products which are suited to the tastes of local clients. It is for the technologists and the manufacturers to consider whether suitable recipes and processing techniques cannot be evolved so as to produce a similar range of products by the more recently organized industry which could be made available for sale to different classes of consumers in different parts of the country. . . It is necessary also that the technologists, while keeping abreast of the modern advancements in this field, should not lose sight of the indigenous methods of production with their standardized conditions by the trade or the unique aspects in the traditional methods of preservation of fruits and vegetables in Indian homes. It would not be out of place to say that the method of preservation used in the Indian homes for centuries has certain subtleties about them which result in exceedingly good products and which it has not yet been possible for the large-scale manufacturers to reproduce in their factory-scale production. I would

wish that the technologists will study and guide the industrialists to capture the elusive taste of the products of the small-scale manufacturers." The late Dr. S. S. Bhatnagar also dwelt on this aspect of the problem, by referring to the use of spices. "The influence of spices on the preservation of foods is a subject of considerable interest. For example, cloves, ajwain, etc., are good preservatives and it is possible, by the Indian way of cooking, for manufacturers to put food products on the market with advantage without the addition of any other antioxidant or preservative which changes the taste of the food."

The deliberations of the symposium in 1954 led to the appointment by the Planning Commission in 1955 of the Panel on the Fruit and Vegetable Preservation Industry, and consequent on the recommendations of the Panel, a sum of Rs. 1.75 crores has been provided in the Second Five-Year Plan for the development of the fruit and vegetable preservation industry and the setting up of cold-storage plants. It is to be hoped that the funds will be utilized towards development of this industry on a small-scale basis and towards improving the techniques of home and cottage-scale preservation and canning. Special attention should be paid to the development of this industry in the Community Development and National Extension Blocks. The fruit and vegetable preservation and canning industry can be developed as a small-scale industry *par excellence*, suited to the conditions and requirements of Indian life. Indian scientists and industrialists should take note of the rapid technological developments in the field of food preservation which are taking place in foreign countries, especially U.S.A. B.V.N.

ANALYSIS OF BISTABLE MULTIVIBRATOR OPERATION (THE ECCLES-JORDAN FLIP FLOP CIRCUIT) by P. A. Neeteson [Philips' Technical Library, Eindhoven, Holland; *Distributors in India*: Philips Electrical Co. (India) Private Ltd., Calcutta], 1956. Pp. 82. Price Rs. 8/12

This book gives a detailed analysis of the dynamic behaviour of the bistable multivibrator. It is written basically as a thesis on the subject and forms Vol. X of the series on Electronic Valves, published by the Philips Technical Library.

The bistable multivibrator, though conceived by Eccles and Jordan as early as 1919, has only recently started playing an important role in the electronic pulse techniques applied to counters, computers, etc. Because of the recent development of the circuits there is not much literature available on the subject. In the design of such a circuit it is usual to consider only the stability of the static condition when the circuit is at rest. In such cases, one has to deal with the d.c. conditions only. In the dynamic switching over periods, it is rather difficult to derive a formula for the phenomenon because of the influence of the tube characteristics and circuit components. Prompted by practical problems, the author has investigated on the dynamic behaviour in detail and has dealt with the various conditions systematically in 12 chapters. The results have enabled the development of special tubes for the purpose and other similar circuits in the field of pulse technique.

A general introduction on the bistable multivibrator with a summary of the articles dealt on the subject by different authors earlier have been presented concisely in the first three chapters. With a brief outline on the switching mechanism of an electronic network, the static and the dynamic conditions of a bistable multivibrator circuit have been discussed in the next three chapters. Later the author has analysed the triggering sensitivity and speed as well as the waveforms in detail, taking into account the design consideration from the tube characteristics and the capacitive anode loads. The network behaviour of the whole circuit during the various phases of dynamic operation is further theoretically analysed in the appendices. The numerical examples are also given wherever necessary.

The book will be appreciated principally by those who feel that in the long run it is not satisfactory to apply certain circuits on the basis of technical feeling or practical experience but a thorough insight into the nature of the phenomena is necessary in order to realize the full potentialities. It is very useful for the radio engineers working on the electronic switching systems used in com-

puter mechanisms. The mathematical discussions on the various conditions of the subject are given in such detail that the book may not be useful to be prescribed as a textbook for the ordinary student. All the same, it is a valuable addition to any electronics library.

C. S. RANGAN

FROM MICROPHONE TO EAR — MODERN SOUND RECORDING AND REPRODUCTION TECHNIQUE (Philips' Technical Library; Cleaver-Hume Press Ltd., London), 1956. Pp. vii + 169. Price Rs. 9/8

In this book the author has attempted to compress, in about 165 pages, relevant information on the modern techniques of recording and reproduction of sound. It is impossible to compress in such a short space every aspect of electro-acoustics technology. Nevertheless, the author has attempted to cover a fair amount of ground in non-mathematical language. It is mainly intended for non-technical readers and many problems posed by the users of electro-acoustic devices have been answered in simple and unambiguous language.

The book is divided into 12 chapters, first three of which are devoted to the earlier mechanical methods of recording and reproduction of sound, describing processes ranging from wax-recording to the actual processing of the ordinary disc records. The next four chapters describe the modern electric pick-up units, their principles and characteristics. Hints have been given on the maintenance of these units. There is also a useful chapter on record players and record changers. Chapters VIII and IX are devoted to amplifiers and loudspeakers, their operation and characteristics. Chapter X is devoted to acoustic problems of enclosures. Magnetic tape recorders, their principles and practice form the subject matter of Chapter XI. A small appendix giving the response characteristics of various pick-up units is given at the end of the book.

Any one wishing to have an elementary knowledge of modern electro-acoustic techniques would find the book informative. It is well printed and illustrated.

N. B. BHATT

# NOTES & NEWS

## Recent research and developments in glass

THE RECENT RESEARCHES AND developments in glass technology were discussed at the meeting of the Chemistry Section of the British Association held at Sheffield on 4 September 1956.

The fundamental aspect in all glass manufacturing processes is the variation of viscosity of glass with temperature. The high viscosity of glass is associated with the nature of inter-atomic binding forces, like directed bonds between silicon and oxygen. Silica melts at 1713°, but the liquid formed flows with great difficulty because of the directed forces. The liquid can be cooled easily through its freezing point without solidifying. Cooling further, a second stage of thermodynamic instability is reached. The distribution function of a liquid has a particular value for each temperature, but the difficulty of the atoms moving in respect to one another increases rapidly as the temperature falls, until the time taken for the distribution function to reach the value appropriate to the lower temperature becomes long compared with the time taken to make an experimental measurement. The properties of glass then appear to vary with time towards equilibrium values corresponding to the temperature of the experiment. This occurs when the temperature falls below a value at which the viscosity is about  $10^{13}$  poises. When cooled by another 100° the rate of approach to equilibrium configuration is so slow that the distribution function remains practically constant. Thus, at room temperature, glass is a special type of solid, having the macroscopic mechanical properties of a solid, but the atoms are arranged with all the disorder of the atoms of a liquid in which thermal motion of translation has ceased.

A large number of new and special glasses have been prepared in recent years to meet the demands of scientific research and industrial development. For example, the addition of some oxides to silica has conferred a greater

ease of fabrication. New high refractive index optical glasses containing appreciable quantities of lanthanum is another development. Extremely high transparency optical glasses have been produced on a commercial scale by using very pure materials and melting the glass batch in platinum vessels. Infrared radiation absorbing glass developed recently is useful in projectors in preventing overheating of slides. Infrared transmitting glasses have also been prepared by eliminating completely even the traces of water present in ordinary glasses, which otherwise impart to the glass marked absorption in the infrared region. Glasses based on silica are not suitable for work beyond 5  $\mu$ ; selenium and sulphide (arsenic sulphide) glasses can be used up to 15  $\mu$ .

Glasses containing 80 per cent lead oxide find application in nuclear technology for absorbing radiations. A glass block,  $3 \times 2 \times 2$  ft. (the unusually large thickness is required for providing sufficient absorbing power), weighing 4000 lb., has been made to serve as a protective window. A similar but pure and transparent glass has been employed as  $\gamma$ -ray detector by using the Cerenkov radiation. Certain glasses, different from the usual soda-lime-silica glass and containing potassium, barium, and aluminium phosphates with up to 7 per cent silver, develop a colour or the ability to fluoresce when exposed to harmful radiation. These are suitable as radiation 'dosimeters'. X-ray absorbing glasses contain large proportions of tantalum, boron, phosphorus and germanium. The glass used for the inner tube of street lighting mercury lamps now contains no alkali, which was formerly considered useful and necessary. A silica-free glass has been fabricated for making sodium discharge tubes, which can still resist sodium vapour attack. The presence of silica was deemed necessary, till recently, for resisting corrosion caused by sodium vapour.

Glass fibres drawn as single continuous fibres are obtained by

the glass wool process in which a stream of glass issuing from a platinum orifice is subjected to an intense blast of superheated steam. Earlier, it was considered that the steam shattered the glass into droplets which were drawn into fibres. But calculation from theoretical considerations showed that this explanation is not probable. Investigation using high-speed cine-photography visually demonstrated that the stream of glass was shattered into very fine fibres of glass [*Nature*, **178** (1956), 831].

## Electron microscope observations on dislocations

THE MOTIONS OF INDIVIDUAL planes of molecules constituting crystal dislocations have profound influence on the mechanical properties and growth of crystals. These dislocations have been directly observed for the first time using an electron microscope which can utilize useful magnifications up to 2,000,000, at the Tube Investments Research Laboratories, Minxton Hall, England. The line of disturbance or strain produced by dislocations has a cross-sectional dimension of  $c. 10^{-7}$  cm. which is far beyond the resolution of the light microscope. Up till now, for observing dislocations, indirect methods were used such as making visible the dislocations by the preferential growth of 'decorating' silver particles along the dislocation lines or observing the motion of visible surface markings which can be associated with internal dislocations. But these methods are unsatisfactory as these techniques permit observations of a static nature only, while the importance of dislocations lies in their movement and interactions under stress or as a result of heating.

In the preparation of specimens for direct examination, the replica technique is unsuitable because with larger molecules, the self structure of the replica does not interfere with the faithful reproduction of the surface contour of the crystal while with small molecules the undulations of the replica are submerged in the microstructure of the replica material. Hence resort was made to a direct study of the crystal itself in the electron microscope. The crystal must be sufficiently thin to transmit the electron beam and to be able to withstand the

intense electron bombardment. The lattice spacing must be high and it is preferable that the molecules contain heavy atoms to enhance contrast. The crystal should be oriented in the electron beam so that the edge-on view of the crystal planes can be seen to avoid overlapping of planes which may cause confusion.

After due consideration, the phthalocyanines have been selected for study. These compounds are of medium molecular weight and consist of a complex organic ring structure composed of carbon, hydrogen and nitrogen surrounding a metal atom. Crystals of platinum phthalocyanine can be grown in the form of thin ribbons, with a lattice spacing of  $12 \times 10^{-8}$  cm. perpendicular to the ribbon surface and traversing the length of the ribbon.

Electron microscope pictures enlarged up to 1,500,000 times showing regular parallel lines corresponding to edge-on views of the planes of the molecules in the lattice have been obtained in the case of platinum phthalocyanine, sodium faujasite (crystal plane spacing:  $14.5 \times 10^{-8}$  cm., two sets of planes intersecting at an angle of  $70^\circ$ ) and molybdenum trioxide (crystal spacing:  $6.8 \times 10^{-8}$  cm.). The clarity of the electron micrographs indicates that the resolvable limit can be lowered still further so that the method can be extended to study some metal crystals also. It has been possible also to observe the edge type dislocations enabling the exact position of the incomplete planes of molecules in the crystal. Experience till now indicates that ultimately the dislocation movements can be studied in action [*Times Sci. Rev.*, No. 22, 1956].

### Mutation in virus

MUTATION IN THE CHEMICAL structures of viruses has been accomplished for the first time at the University of California. The rate of mutation induced is the highest ever achieved by any means and the mutants produce mutant offspring. Mutations have been induced by altering the fundamental structure of ribonucleic acid of a virus. Sulphanilamide introduced into the virus culture blocks the formation of thymine, normally an essential part of the nucleic acid of the viruses. The new virus formed accepted 5-

bromouracil, added earlier, in the absence of thymine. About 10 per cent of the offspring were mutants containing this chemical. This is a rate of mutation about 1000 times larger than that occurring normally.

These findings suggest the possibility of producing non-infectious viruses from infectious ones with the help of chemicals. Viruses are now almost immune to attack by antibiotics and other chemicals. These results are also likely to have an important bearing on the studies of the genetic change among living forms [*Sci. News Lett.*, 70 (1956), 402].

### Radio-farming

A RADIO-ISOTOPE FARM HAS RECENTLY been opened at the Medical College of Virginia, U.S.A., for growing medicinal and other plants in a radioactive environment. So far this kind of cropping is largely a greenhouse venture, and the source of radioactivity is carbon dioxide made from carbon-14. The drugs and chemicals obtained from these plants are naturally radioactive, though only a few atoms of  $C^{14}$  appear among the millions of ordinary carbon atoms constituting the chemicals. This small proportion is, however, enough for using the chemicals as tracers and as a source of mild radiation.

This method of producing radioactive drugs and chemicals is easier than synthesizing them from materials containing radioactive elements.

Lucerne, soyabean, buck wheat, tobacco, poppies and other plants have been grown in this way for the production of useful radio-labelled chemicals, such as digitoxin, morphine, nicotine, sugars, certain amino acids and proteins and vitamins [*Chem. Age*, 76 (1956), 63].

### Deminerlization of sea water

THE RECENTLY DEVELOPED ELECTRIC membrane process for deminerlization of sea water operates by the use of selective cationic and anionic barrier membranes. The plastic cation membrane, operating under a d.c. potential, permits the passage of positively charged ions, while fixed negative groups, distributed evenly within the insoluble matrix of the membrane, prevent the passage of anions

through the membrane. The anion membrane is constructed similarly but is selective for anions.

An individual cell consists of an anion membrane and a cation membrane separated by spacers to permit the flow of saline water between them. Multi-cell systems have cation and anion membranes arranged alternately and connected in series between a single set of electrodes. When d.c. voltage is passed across the terminal electrodes, the ions migrate so that the salt content increases in one half of the flow passages and decreases in the other half. The basic multi-cell system can separate a multitude of highly ionized constituents from non-ionized or slightly ionized constituents.

The selectivity of the membrane is high, particularly in the brackish water range. The following approximate relationship correlates the energy, throughput and membrane area:

$$(N_i - N_o) \log_{10} (N_i/N_o) + \frac{(N_i - N_o)^2}{10^4} = 6AU/F$$

where,  $N_i$  and  $N_o$  are p.p.m. of total dissolved solids in the feed water and product water respectively;  $A$  is the plant membrane pair area in sq. ft.;  $U$  is the d.c. energy per unit of water produced in kWh./1000 gal.; and  $F$  is the production rate of deminerlized water in thousands of gal./hr.  $U/(N_i - N_o)_{max.} = 2.5 \times 10^{-3}$  kWh. per 1000 gal./p.p.m. and  $(N_i)_{max.} = 6000$  p.p.m. [*Industr. Chem.*, 32 (1956), 554].

### Atomic inks

DRAWING INKS INCORPORATING radioactive isotopes developed at the Louisiana State University, U.S.A., have introduced considerable improvements in the art of lithography. The inks transmit radiations strong enough to expose photographic print paper placed over drawings made with such inks. The resulting print is a perfect image of the original drawing. The reproducible detail achieved by this means is almost impossible to obtain by any conventional lithographic work. Another advantage is that thousands of copies can be made from the same original without loss of detail. The inks are expected to be useful in broadening the range of textures and shades in the reproduction of art works [*Atomics*, 7(11) (1956), 388].

## Liquid metal fuelled reactor

STUDIES ON THE USE OF LIQUID metals as reactor fuels, carried out at Brookhaven in U.S.A. and Harwell in Britain, have shown the feasibility of constructing an experimental liquid metal fuelled reactor.

A liquid fuel element has several advantages over a solid fuel; irradiation damage does not alter the mechanical or metallurgical properties of the fuel, thus avoiding frequent replacement of the fuel elements; continuous chemical processing may be effected to remove neutron-absorbing fission products; and, the fuel may act as its own heat transfer fluid by being circulated continuously between the core and the heat exchanger. If highly enriched  $U^{235}$  or pure  $P^{233}$  is dissolved in bismuth (1 per cent by wt. at  $550^\circ$ ) the liquid has nuclear properties similar to those of natural uranium containing 0.7 per cent  $U^{235}$  and can be used to replace solid uranium fuel elements in a reactor. Besides, bismuth, unlike mercury, has a low neutron absorption cross-section and does not react with graphite so that it can be pumped directly through channels in the graphite moderator and no canning material is required.

Test loops constructed out of steels containing 1.2 per cent chromium and molybdenum have been found to be most suitable for circulating bismuth between zones at temperatures corresponding to the temperature of the core ( $550^\circ$ ) and the heat exchanger region ( $400^\circ$ ) of the reactor. Due to a high temperature coefficient of solubility of iron in bismuth (from 30 p.p.m. at  $550^\circ$  to 3 p.p.m. at  $400^\circ$ ), a plug of crystallized iron is formed on the walls of the circuit at the coldest point which blocks the circulation. To prevent oxidation of the highly reactive dissolved uranium, a deoxidant such as magnesium is added to the solution and consequently there is no protective oxide coating between the pipe wall and bismuth and the mass transfer continues rapidly until the circuit is blocked. Chromium molybdenum steels were most resistant. Investigation carried out to study the mechanism of the protection indicated that zirconium, with magnesium as a deoxidant, inhibits mass transfer in the uranium-bismuth system similar to that empirically observed in mercury systems

to which zirconium or titanium is added. It is probable that a protective coating of zirconium nitride is formed on the deoxidized steel surface due to reaction between zirconium and traces of nitrogen present in the steel. This coating not only retards the rate of solution of iron from the hot region but also inhibits the crystallization of iron at the cold region. The zirconium present also forms a layer of zirconium carbide on graphite preventing reaction between uranium and graphite to form uranium carbide. The technology of producing protective coatings of other metals like tantalum, niobium, molybdenum or beryllia is complex.

Another type of liquid metal fuelled reactor suggested uses a suspension of very fine particles of  $U^{235}$  in liquid sodium, seeking to avoid the corrosion problems associated with bismuth. In this case also the protection of graphite from attack by sodium, the complexity of chemically processing a fine suspension and the engineering difficulties of pumping a liquid metal slurry are problems which have to be tackled before the projected reactor can be built [*Discovery*, 17(11) (1956), 469].

## Commercial phosphor markers and signals

THE UNITED STATES RADIUM Corporation, Morristown, New Jersey, have announced the first commercial high-brightness, safety signals and markers, specially useful in installations where power and maintenance are limited. Treated phosphor crystals excited to luminescence by the radioactive gas Krypton<sup>85</sup> are used. These devices, available in a number of colours—blue, green, yellow, pale orange and orange-red—are readily visible at distances of over 500 yd. The sources are enclosed in hermetically sealed, transparent capsules which are weather and tamper-proof. They can be adapted to a wide range of signal, directional and marking systems. Circuit installation, replacement of transformers and bulbs or refuelling or cleaning of oil lamps inherent in the existing systems are eliminated. The units are available in a variety of shapes, sizes and brightness and are suited for use in mining, transportation, marine and heavy industrial fields

[*News from United States Radium Corpn.*].

## Cleaning of radio-contaminated metals

IRRADIATED METALS FROM REACTORS can be decontaminated by electro-cleaning in a hot electrolyte containing sodium hydroxide, 4; sodium carbonate, 2; and trisodium phosphate, 2 oz./gal. water. The radio-contaminated metal, suspended by an insulated link into a stainless steel kettle containing the electrolyte, is connected to the anode of a high amperage source of direct current and the kettle to the cathode. High current densities are used to ensure vigorous evolution of oxygen.

After 1-3 min., the material is removed and rinsed in water. Wire brushing with alkaline solution may be necessary at this stage to remove paints, etc. It is then dipped in 2N sulphuric acid and may be made anodic at a low current density. Smut, carrying radioactive particles, appears on the surface at this stage, but most of it may be removed by wire-brushing the acid-wet surface. The material is again rinsed with water and dried with rag or tissue. The process has been mostly applied in decontamination of stainless and carbon steels [*Nickel Bull.*, 29 (1956), 156].

## Estimation of gallium

GALLIUM CAN BE ESTIMATED IN the presence of uranium after separating the metal from an ethereal solution of uranium-gallium chloride mixture as gallium camphorate and igniting the precipitate at  $1200^\circ\text{C}$ . to form gallium oxide. To effect complete precipitation and elimination of the sodium salt, a pH of 3.3 was maintained, using sodium formate-formic acid buffer. Interference from ferric iron was removed by a preliminary reduction with hydroxylamine hydrochloride.

Gallium can also be estimated volumetrically after separating the metal by ether extraction, then titrating against ethylenediaminetetraacetic acid (EDTA), in the pH range 2.5-3.0. A coloured lake produced by gallium with galloxyanine is used to determine the end point. This method is suitable at all concentrations of gallium, from 0.25 to 50 mg.



Microgram amount of gallium can be determined absorptiometrically using a fluorimeter. This method is based on the reddish violet complex formed by gallium in hydrochloric acid solutions with rhodamine B, which is extracted with benzene [*Chem. Age*, **75** (1956), 215].

### Deoxygenation of boiler water

HYDRAZINE IS FOUND TO BE USEFUL for deoxygenating boiler water without affecting the dissolved solids in the water and producing any acidic substances. Hydrazine is almost as volatile as water and so travels round the whole system. The result is lesser blow-down, purer water and cleaner internal surfaces. Corrosion from oxygen is controlled throughout the system [*Overseas Engr.*, **30** (1956), 178].

### Sigmamycin

SIGMAMYCIN, A NEW ANTIBIOTIC announced by the Pfizer Ltd., New York, is a combination of two antibiotics, tetracycline and oleandomycine. It demonstrates the phenomenon of synergistic activity, that is the action of each antibiotic is greater in combination than when used singly. The new antibiotic is claimed to be the answer to one of medicine's great and growing problems today, viz. the patient's toleration to antibiotic treatment and the emergence of microbial-resistant strains [*Chem. Age*, **76** (1956), 171].

### Chlorofluorocarbons as lubricants

STUDIES CARRIED OUT AT THE Battelle Institute, London, have indicated the possibility of using chlorofluorocarbons as lubricants. These chemicals exhibit great thermal stability, good load-carrying capacity and stability in oxygen by virtue of which they can be used in bearings operating under high loads, as lubricants and sealants, for bearings and pistons operating under severe oxidizing conditions and as additives to increase the load-carrying capacity and lubricating ability of natural and synthetic lubricants without diminishing the stability of the latter [*Chem. Age*, **76** (1956), 329].

### Protectants for pyrethrum potency

THE TOXICITY OF INSECTICIDES containing pyrethrum drops considerably during the first three or four weeks of storage. The addition of the antioxidants BHA (butylated hydroxyanisole) and 4-methoxy-2-propyl-phenol in 0.2 per cent concentration protects pyrethrum dust for eight weeks or more [*Indian Soap J.*, **22** (1956), 118].

### Ultra-pure silicon

COMMERCIALY AVAILABLE SILICON, even of the highest purity, contains significant amounts of impurities which must be removed if the material is to be used for fabricating semiconductor devices. Of these impurities, the most difficult to remove is boron.

A new method based on the reaction of molten silicon with water vapour for reducing its boron content to a very insignificant amount (one part in ten thousand millions) has been developed at the Bell Telephone Laboratories. This method, when used together with the zone refining technique [*J. sci. industr. Res.*, **15A** (1956), 381] developed earlier by the same laboratories, makes possible the production of ultra-pure silicon having resistivity greater than 3000 ohm-cm. [*J. Franklin Inst.*, **262** (1956), 298].

### 'Honeycomb' information storage unit

A NEW INFORMATION STORAGE tube which can store, for several minutes, nearly a million bits of information has been developed at the General Electric Research Laboratory, U.S.A. It is the first practical storage tube working on the 'mosaic' principle and having sufficient ruggedness and resolution necessary for many practical applications. At the heart of the tube is a thin sheet of glass, about one inch square, in which close, small, etched holes have been filled with metal, forming a honeycomb structure. Information is written onto one side of the honeycomb by an electron-beam scanning method and is picked up from the opposite side by a 'reading gun'. The spacing between consecutive holes in the honeycomb is about  $\frac{1}{800}$  in. so that a square inch

contains 250,000 individual cells. Each cell can recognize at least 10 different levels of intensity from the 'writing guns', thus increasing the number of information bits that can be stored at any one time to more than 800,000 (250,000 times  $\log_2 10$ ). Each cell 'remembers' by building up charge in the capacitance formed between the recessed metal plugs and the conducting layers deposited on both surfaces of the glass. The glass itself acts as an insulator between the plugs and surface layers and between the plugs. This design overcomes the 'leaking' and 'smearing' trouble inherent in closely placed storage cells. Registration has been eliminated because the surface layers and recessed metal plugs are inherently lined-up. The rigidity and ruggedness of the spacing of the elements eliminate problems of microphonics. Two methods of reading information are available. In the first method the electronic beam erases the screen as it picks off stored information and in the other the information can be kept for re-reading or to be altered or added to by the writing beam. The new device is expected to make possible smaller electronic brains with bigger memories. It is also useful in television cameras and 'scan converters' in which scanned information is collected and later displayed on an ordinary television screen [*J. Franklin Inst.*, **262** (1956), -323].

### Advisory Committee on Marine Sciences

THE FIRST SESSION OF THE INTERNATIONAL Advisory Committee on Marine Sciences was held during 22-24 October 1956 at Lima, Peru, under the chairmanship of Dr. G. E. R. Deacon. Eighteen leading marine scientists took part in the meeting; Dr. D. V. Bal represented India. The chief aim of the Committee is to encourage and develop marine sciences, especially in regions where it has received little attention.

The Committee recommended assistance for the following projects: joint oceanographic investigation of China and Java Seas; physical oceanography of the Indian Ocean; study of water circulation of the South-west Pacific Ocean and Tasman Sea; wave studies on the coast of Pakistan; evaluation and use in

the North Atlantic Ocean of new methods of measuring deep currents; study of variations in flow of water from the Arctic basin to the North Atlantic Ocean; use of radium distribution as a measure of oceanic circulation; study of seiches and long waves in the Baltic Sea; and physical oceanography of the Mediterranean Sea. Some of the proposals under active consideration of the Committee are: unification of methods in biological studies; organization of biological work of laboratories taking part in the oceanography programme of the International Geophysical Year; publication of regional plankton keys; translations of specialized papers on marine research; central laboratory for making standard carbon-14 ampoules; co-ordinated study of the fertility of the seas round South America; marine science exhibition; and building of an international research ship.

The next meeting of the Committee will be held at Bangkok on 15, 16 and 18 November 1957.

#### International agency for fissionable material

THE SETTING UP OF AN INTERNATIONAL agency under the United Nations for the promotion of the peaceful uses of atomic energy has been voted upon by 82 nations. According to the terms of the agreement reached the so-called 'non-atomic' powers may receive through this agency fissionable material, technical assistance and possibly assistance in financing construction of power reactors. The new agency will not only be a clearing house for information, but will also act as a research centre especially concerned with peaceful utilization of fissionable material. U.S.A., to start with, has made available 11,000 pounds of uranium-235 to the agency [*Chem. Engng. News*, 34 (1956), 5499].

#### Literature coverage in Russia

RUSSIA HAS RECENTLY STARTED an 'express information service' to speed up the circulation of foreign (mostly U.S. and European) scientific literature to Soviet scientists. Russia's new literature coverage scheme is aimed at the fastest possible circulation of western scientific information. Long summaries of articles from foreign journals are prepared subjectwise. These are then re-

produced and despatched from the Soviet Academy of Sciences to all working scientists in Russia. Chemical engineering, mining and metallurgical reports receive particular attention in this coverage. Later the 'express' articles, along with other articles from foreign journals, are abstracted for Russia's eleven abstracting journals which are fairly comprehensive and fair-sized volumes [*Chem. Engng. News*, 34 (1956), 5588].

#### Award of Doctorate Degrees

THE FOLLOWING HAVE BEEN RECENTLY awarded the Ph.D. degree by the University of Delhi: Virendranath Gupta [*Studies of (a) special chemical components of heartwoods and (b) some reactions involving active methylene groups*]; Surya Narain Dixit (*Morphological and embryological studies in the Loranthaceae loranthoideae*); (Miss) Anant K. Nanda (*Psychological needs of adolescent girls and their bearing on individual adjustment*) and (Miss) Kamla Devi Singh (*Differential geometry of subspaces*).

M. Suryanarayana has been awarded the D.Sc. degree by the Andhra University (*Studies in analytical chemistry of molybdenum*).

#### Announcement

■ *The Institution of Chemical Engineers, London*—Application forms for entrance to the 1957 examination, returnable not later than 1 June 1957, may be obtained from the General Secretary, The Institution of Chemical Engineers, 16 Belgrave Square, London S.W.1.

#### INSTRUMENTS AND APPLIANCES

##### AUTOMATIC REVERBERATION TIME RECORDER

An equipment which enables quick and automatic plotting of the frequency-reverberation time curve of a test enclosure, thereby eliminating the tediousness inherent in the conventional tracing of the decay curves, has been designed and constructed in the Research Department, All India Radio, Government of India, New Delhi. With this apparatus, room resonances and other undesirable acoustical characteristics can be detected and can subsequently

be investigated in detail by conventional methods.

The apparatus incorporates several modifications in a circuit originally developed in Netherlands (cf. *Tijdschrift Van Let Nederland Radio Genoot*, 1951, Chap. 16, p. 49) including the provision of a direct recording RT meter.

A variable frequency generator feeds sound energy to a loudspeaker through a relay ( $R_1$ ) which is periodically switched 'on' and 'off' by a suitable switching circuit. A microphone located in the enclosure picks up the sound energy radiated. The microphone output after amplification is connected through another relay ( $R_2$ ) to a circuit which indicates the instant at which the level in the chamber has decayed by 40 db. from the instant of switching 'off' of the loudspeaker. The time interval between the instant of tripping of the relay  $R_1$  and that of the relay  $R_2$  is the time taken for 40 db. decay which is measured and taken as two-thirds the value of reverberation time assuming an exponential decay of sound energy. The value of reverberation time thus obtained is indicated on a direct-reading panel meter. It is also recorded on a waxed paper as a straight line whose length is proportional to the value of the reverberation time. A number of such lines is obtained automatically at close intervals each line representing the value of reverberation time at a frequency slightly higher than the one corresponding to the previous line. Since all the lines have the same zero axis, the curve joining the other ends of these lines gives the reverberation time vs. frequency curve.

The measurements with this equipment do not hold good if the sound decay consists of double slopes, flutter or delayed echo. It is also essential to establish an initial sound level higher than 40 db. above the noise level, at the microphone pick-up point, necessitating the feeding of several high wattage amplifiers and loudspeakers in phase to efficiently diffuse the sound in the enclosure.

Typical studio measurements showed that approximately the same characteristics could be obtained with this equipment in only 15 min. as against 3 hr. required for measuring them by the conventional method. The recorder is particularly useful in the

low frequency region where prominent modes and other resonant frequencies can be easily located [*J. Instn. Telecomm. Engrs.*, **3**(1) (1956), 12].

#### TWINKLE TELESCOPE

A new instrument, the 'twinkle telescope', developed at the Perkins Observatory, Delaware, Ohio, U.S.A., makes possible the measurement, from the ground, of the speed and direction of high-altitude winds. Its further development is likely to result in its becoming a standard equipment for the meteorologist in gauging the upper atmosphere winds by replacing the present radiosonde balloon tracking methods.

The turbulences in the upper atmosphere are responsible for the observed twinkling of stars and in a telescope image they give rise to shadow bands which being very transient cannot be recorded by ordinary photography.

In the new device two telescopes are pointed at the same star, and the starlight is recorded electronically. A comparison of the intensity records obtained from the two telescopes gives an estimate of the motion of the shadow bands. Observations on this new instrument showed that the shadow bands movement agrees both in direction and magnitude with that of the winds at an altitude of about 40,000 ft. Since this is the altitude at which jets usually fly, twinkle telescopes installed at airports may assist pilots in locating favourable wind zones and avoiding areas of severe turbulence [*Sci. News Lett., Wash.*, **70**(16) (1956), 246].

#### HIGH SPEED ELECTRONIC POWER SWITCHING

A method is reported for the periodic and quick reversal (at 50 c/s.) of a few amperes of current, not satisfactorily achieved with normal electro-mechanical contactors. The method finds ready application in modern electroplating technique. The circuit used consists of a square wave oscillator synchronous with the mains supply and is arranged to give a negative bias for independently controllable intervals between 0.02 and 2 sec. to the grids of two opposed pairs of heavy-duty thyratrons. The technique enables the circuit to deliver rectified current up to 10 amp., in either direc-

tion, to the plating bath [*Indian east. Engr.*, **119** (1956), 379].

#### ELECTRONIC 'H' METER

An electronic H meter which can rapidly measure the 'H' values of permanent magnets has been developed. The device consists of an a.c. bridge with two identical inductive arms, comprising several hundred of turns of wire wound on thin Mumetal rods, serving as the probes. The bridge is supplied with power at a stabilized frequency of 2.7 kc/s. and is first balanced with the probes remote from any appreciable magnetic field. Later, when one of the probes is placed in a magnetic field, the partial saturation of the Mumetal core produces an out-of-balance current, which is rectified and read on a microammeter. The instrument can be operated by an unskilled person by incorporating a relay in the indicator circuit to give pass or reject signals at predetermined magnetic limits [*Indian east. Engr.*, **119** (1956), 379].

#### PERISCOPES FOR NUCLEAR OBSERVATIONS

P. W. Allen & Co. have designed periscopes which can be used for observation and inspection, at a distance, of objects and phenomena which are not observable directly because of their position or attendant danger. They consist of a tube 1.2 in. in diameter with an objective at one end to form an image of the scene to be viewed. An optical system and a focussing eyepiece transmit the picture to the eye. Prisms can be introduced in the path of the rays to deviate the beam by 90°, if required, and permit the operator to be out-of-direct line of the object under examination. The maximum length of the 1.2 in. diameter periscope tube, without loss of efficiency, can be up to 23 ft. A magnification of 8 is possible with a 6° field of view. The normal angle of view with reduced magnification can be 45°. The field of view is increased by attaching to the instrument a scanning prism which turns within the objective tube or which can move towards or away from the objective. The objective head can be made water or airtight. Special materials including cerium-stabilized radiation resistant glass lenses are available for use when the remote end of the periscope

has to reach radioactive areas. The precise optical specifications of the system permit the use of a photographic recording attachment [*Atomics*, **7** (1956), 420].

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# Progress Reports

## INDIAN STANDARDS INSTITUTION

THE NINTH ANNUAL REPORT OF THE INSTITUTION for the year 1955-56 records considerable expansion in its activities. The Agricultural and Food Products Division Council was created during the year and it was decided to set up two more Divisions, viz. the Electrochemical Division and the Structural and Metals Division. In addition, a Branch Office of the Institution was opened at Bombay. The number of subscribing members of the Institution rose from 1032 during the previous year to 1181 and the financial contribution from the members increased from Rs. 2.69 lakhs to Rs. 3.02 lakhs.

One hundred and forty-four Indian Standards including two revisions were published during the year and another 27 were under print, bringing the total number of Indian Standards published and in the press since the inception of the Institution to 760; 77 per cent of these have been adopted by one or more of the purchasing departments of the Government. In all, 234 proposals were received for formulating standards during the year and of these 187 were accepted.

Under the ISI Certification Marks Scheme, 66 applications for grant of licences to use Standard Marks were received during the year; licences were granted in respect of 8 of these while 27 more were still under consideration.

A comprehensive programme involving an expenditure of Rs. 1 crore has been drawn for the Second Five-Year Plan period. The programme envisages an increase in the output of standards from about 140 to 200 per year against an estimated demand of about 300 standards per year. About 300 licences to use Standard Marks will be issued under the Certification Marks Scheme. The plan also aims at the opening of 3 branch offices at Calcutta, Madras (or Bangalore) and Kanpur.

An account of the activities of the various Divisions is given below.

**Engineering Division** — Among the 41 Standards published were those on dry battery operated and a.c. mains operated radio receivers; community radio receivers; a.c. whole current electricity meters; PVC insulated cables and flexible cords; varnished cambric insulated cables for electricity supply; bicycle components, such as rims, frames, handle bars, chains, hub assemblies, etc.; copper bars and rods for electrical purposes, electrical steel sheets; and aluminium and aluminium alloys, sheet and strip. Another important publication brought out was the Code of Practice for General Engineering Drawings.

The Committee of the Division set up 6 new Sectional Committees to deal with sewing machines, optical and mathematical instruments, cargo marking, ball and roller bearings and boilers.

The 76 new subjects accepted for the formulation of standard specifications include radio and auto-

mobile lamps, air circulators, transformers, standard community radio receivers, preferred sizes of firebricks, coal dust and raw sands for foundry purposes, optical and mathematical instruments and a number of internal combustion engine and automotive vehicle components.

Investigations conducted under the auspices of the Refractories Sectional Committee have revealed that moderate heat-duty firebricks can replace high heat-duty firebricks in several applications.

**Building Division** — The Council of the Division accepted 75 new subjects for formulation of standards which include water fittings, methods of test for natural building stones, items of hardware, wood products, gypsum tiles, boards and plaster finishes, fire-fighting equipment and soil engineering. Two new Sectional Committees were set up to deal with the last two subjects.

Fifteen new standards were published during the year which included those on Indian Standard sand, unreinforced corrugated asbestos cement sheets, salt glazed stoneware pipes and fittings, sheet linoleum, wire products, such as mild steel wire nails and mild steel and brass cup, rubber and square hooks and screw eyes, refrigeration and air-conditioning, such as safety codes for mechanical refrigeration, construction and safe operation of cold storages, metal air ducts and air-conditioning wood separators, for plywood and blown type bitumen.

**Textile Division** — During the year, 3 new Sectional Committees were set up to deal with the following: Jute bags for packing sugar, cotton weaving machinery components, and cotton spinning machinery components. Among the 45 new standards published, 24 related to handloom fabrics and 12 to colour fastness tests. Two important standards were published for the National Flag of India, one for silk khadi and the other for wool khadi.

**Chemical Division** — The Council of the Division accepted 42 new subjects including bleaching earths, phenolic urea, polystyrene and cellulose acetate moulding powders, phosphatic fertilizers and rubber gloves. The 46 new standards published included those on rectified spirit, orthophosphoric acid, soda ash, caustic soda, superphosphate, common salt, rubber products, essential oils, drawing inks, transparent toilet soap, etc.

**Agricultural and Food Products Division** — Fifteen new standards were formulated during the year. These included *bukhari*, *kolhar* and *morai* types of rural foodgrain storage structures, foodgrain structures suitable for trade and government purposes for the eastern, southern and coastal regions and improvement of existing structures used for the storage of foodgrains.

One hundred and twenty-five research projects sponsored by the Institution were being investigated at various research institutes, university laboratories and national laboratories.

## SCIENTIFIC &amp; INDUSTRIAL RESEARCH IN AUSTRALIA

THE EIGHTH ANNUAL REPORT OF THE COMMONWEALTH Scientific & Industrial Research Organization, Australia, for the year ending 30 June 1956, records the research activities of its 17 Divisions and the results of researches undertaken on a co-operative basis with industry and other establishments. A number of conferences were organized during the period under review, the most important among them being the International Wool Textile Research Conference, the first of its kind ever held. The Division of Soils and the Division of Plants were expanded during the year with the establishment of a Soil Mechanics Section in the former and a Biophysics and Biochemistry Section in the latter.

The following is an account of the important research activities of some of the Divisions of the organization.

**Soils**—On the basis of the results of the chemical study of the interrelationships of terra rossa and rendzina soil of South Australia, it has been suggested that all profiles having shallow to moderately shallow solum with no marked textural differentiation throughout, and overlying calcareous material, should be designated *terra-cal*.

Spectrochemical investigations on the distribution and variation of the elements between soil profiles showed that on the basis of decreasing mobility, the six elements which have so far been studied can be arranged in the order: cobalt, copper, gallium, vanadium, molybdenum, manganese. The techniques for spectrochemical analysis of soils and plant ash have been perfected. A method for the determination of extremely small amounts of phosphate has been developed. Geochemical work on soil profiles of the alpine humus group has revealed interesting differences in ultimate weathering of feldspathic minerals proceeding from higher to lower levels of the landscape following a progression to podzolic soil types.

**Plants**—In the newly established section of Biochemistry and Biophysics, studies on the nature of pink pigments in root nodules and 'oestrogenic' substances in subterranean clover (*Trifolium subterraneum* L.) have been initiated. The presence of a new amino acid akin to 5-hydroxy-pipecolic acid has been detected in soluble nitrogen fractions of *Leucaena glauca*.

**Animal Health and Nutrition**—The general and chemical pathology of some non-infectious diseases such as those following ingestion of poisonous plants or the grazing of pasture plants under natural conditions have been investigated. Investigations on the use of radioactive sulphate ( $S^{35}$ ) as an inert marker for measuring the rate of passage of small particles through the sheep's rumen, and on the use of radioactive iodine ( $I^{131}$ ) for the study of the pituitary hormones concerned in wool growth have been undertaken.

The role of trace elements in animal nutrition has revealed some interesting results. Soluble sulphides were found to be well tolerated by rats, but if the intake is high the symptoms of copper deficiency appear. *Enzootic ataxia* was apparent at birth in the lambs born to all the copper-deficient groups of ewes, except those that were treated with molybdenum. Zinc deficiency impaired nitrogen metabolism in rats. Similarly, cobalt deficiency

retarded the growth of vitamin  $B_{12}$  producing microflora in sheep.

**Wool**—Inbred flocks of Australian Merinos manifested a slight decline in fibre diameter at levels of inbreeding of 0.25 and above. Detailed comparative studies of the fleeces of 10 mosaic sheep have indicated that, at a given nutritional level, wool production per unit area is the result of the interactions of fibre number, fibre length and fibre diameter, and the interrelationship of length and diameter. From these observations, it is apparent that the relationship of fibre number to unit area wool production varies with nutritional level and that these are density-dependent and density-independent components.

A sensitive apparatus for measuring the gain or loss of water by wool has been designed which records a change of 1 part in 1000 in the weight of a single fibre.

**Food**—Preliminary studies on the effects of freezing on proteins have indicated that there is no change in the viscosity and optical rotation of ovalbumin and  $\alpha$ -casein on freezing and thawing. Loss of soluble protein and skimmed milk is apparently connected with changes in the casein micelle rather than changes at a molecular level. The cause of mortality of some organisms during rehydration of dried micro-organisms has been diagnosed to be due to their susceptibility to variation in the conditions of rehydration, whereas most organisms are unaffected by these variations.

A technique for staining bacteria in very thin sections has been developed. Physico-chemical studies on the drying of vine fruits showed that the heat transfer from the air stream to the grape is an important factor in the drying operation. This heat transfer is required to supply the heat of evaporation of water and to heat the fruit to equilibrium drying temperature. The relative thickness of the cuticle, caused by a contraction of the skin decreases the permeability of water. Permeability increases approximately twofold for a  $10^\circ$  rise in temperature.

**Industrial Chemistry**—A study of methods of separation based on adsorption processes has led to a new chemical engineering development, the 'resin-in-pulp' process, which eliminates a costly filtration step in the recovery of uranium from ore pulps. Pronounced embrittlement in the electrodeposited copper has been found to be due to small amounts of molybdenum in the electrolyte.

A method of separating hafnium and zirconium has been evolved in which aluminium or zirconium is used to reduce the crude mixture containing hafnium and zirconium tetrachlorides. Since the zirconium trichloride formed is involatile the unreduced hafnium chloride is removed by sublimation.

Studies on the intercalation of metals in graphite as chlorides have led to the discovery that certain paraffin-soluble, metal-organic compounds are effective as additives for suppressing the smoking of hydrocarbon fuels.

The development of a novel beneficiation method in which flotation is coupled with hydraulic sizing has enabled 65 per cent of cassiterite to be recovered in a concentrate analysing 50 per cent tin.

A new process using jiggged beds of ion-exchange resins has been devised for direct extraction of uranium from an ore pulp.

# Fabrication of Multicavity Magnetrons

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(Manuscript received 21 January 1957)

**Techniques have been developed for the fabrication of magnetron tubes. Operating magnetrons have been prepared and tested.**

**T**HE study of the techniques for the fabrication of vacuum tubes, particularly of recent types, has been taken up in this laboratory and, as the first step, magnetrons used as transmitter tubes in radar have been constructed.

A magnetron consists of a cylindrical diode with a magnetic field parallel to its axis. The type of magnetron developed for radar has an anode consisting of a number of cavities opening into the central cavity. Various modes of oscillation are possible for this structure. In the one commonly used, adjacent cavities oscillate  $\pi$  radians out of phase. Electrons emitted by the cathode are acted upon by (a) the radial electrostatic field, (b) the axial magnetic field, and (c) the r.f. field which is built up from the noise level, when certain relationships between the various parameters are satisfied. Under these conditions the net effect of the movement of electrons is to take energy from the electrostatic field and give energy to the r.f. field.

A part of the energy stored in the r.f. field is coupled out for use.

Initial difficulties regarding equipment and component parts have been overcome. Techniques have been developed for the fabrication of magnetrons, starting from raw materials. Performance and operating tests have been carried out. These facilities are now being used for the development of a new type of wide tuning-range magnetron.

## Fabrication of parts

The various parts required in a typical multicavity magnetron are shown in Fig. 1.

**Anodes** — The anodes can be fabricated by machining, hobbing or brazing with the help of jigs, etc.<sup>1</sup> Machining, which is suitable for small-scale manufacture and works particularly well for obtaining anodes of hole and slot type, was the method adopted. Furthermore, this method does not require additional facilities beyond those normally available in a workshop.

The material most commonly used for making the anodes is oxygen-free high-conductivity copper (OFHC copper). If the material is not completely free from oxygen,

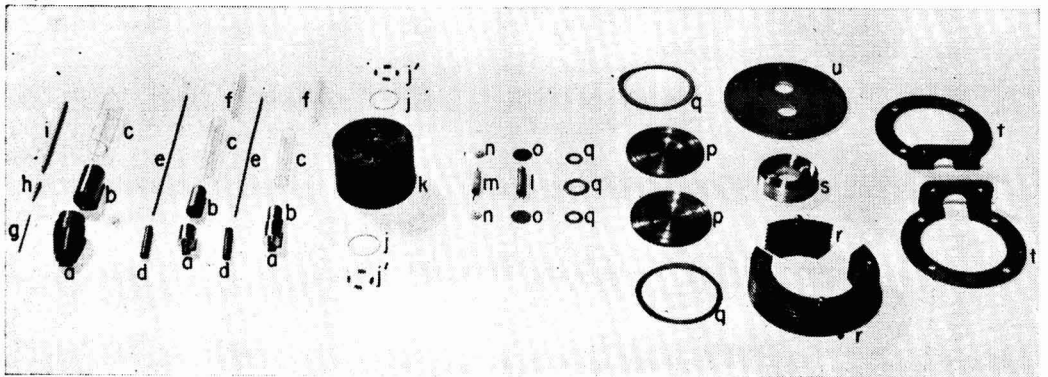


FIG. 1 — MAGNETRON PARTS



the oxide gets reduced during subsequent heating in hydrogen, rendering it porous.

*Cathodes* — Various types of cathodes are used in magnetrons. These include the oxide-coated cathode, thoria cathode, L-type cathode, etc.<sup>1-5</sup>. Where very high powers and frequencies are not involved, an oxide-coated cathode is suitable. In the present study this type of cathode was used.

Pure nickel is commonly used as a core metal for the oxide-coated cathodes. Alloys containing small quantities of reducing agents such as aluminium, magnesium, silicon and titanium are superior to pure nickel as regards ease of activation. However, where long life is the primary consideration, 'passive cores' made of pure nickel or platinum are preferable<sup>6,7</sup>. 'O-nickel' was used for the cathodes fabricated in this laboratory.

Just before the core metal is coated, it should be heated in hydrogen at 1000°C. for *c.* 30 min.

The coating applied to the nickel tube by spraying consists of a suspension of alkaline earth carbonates in organic solvents. During evacuation and processing of the tube, the cathode is heated, resulting in the conversion of carbonates into oxides. There is no uniformity regarding the proportions of barium, strontium and calcium carbonates so far. The mixture\* used in this laboratory contained these carbonates in the following molar proportions: Ba: Sr: Ca:: 47.5: 46: 6.5.

The degree of purity of the carbonates, and the method of preparation exert considerable influence on the results obtained. It is preferable to prepare the carbonates by coprecipitation from a solution of the mixed nitrates, rather than by mixing already precipitated carbonates. The precipitate is obtained by adding sodium or ammonium carbonate to the nitrate solution or bubbling carbon dioxide through it. The temperature, the strength of the solutions, the rate of precipitation and the degree of stirring influence the particle size, and consequently the emission. For preparing the solution of mixed carbonates<sup>8</sup>, solutions of the mixed nitrates and sodium carbonate (10 per cent) were separately prepared in equivalent quantities and maintained at 40°. The nitrate solution was made alkaline by adding a few drops of

aqueous sodium hydroxide. Sodium carbonate solution was then gradually added to the nitrate solution at the rate of 500 ml./min. with constant stirring. The precipitate was filtered, washed repeatedly (*c.* 10 times) with warm distilled water and dried (at 100°).

The suspension is usually prepared in organic solvents. The exact composition of the solvents and binder is not very critical. The composition of the suspension used was: mixed carbonates, 1000 g.; nitrocellulose (Pyroxiline), 25 g.; amyl acetate, 1800 ml.; methyl alcohol, 900 ml.; and diethyl oxalate, 150 ml.<sup>2</sup>.

The suspension was first ball-milled at 100 r.p.m. for *c.* 24 hr. and rolled for *c.* 1 hr. before use. It was then sprayed uniformly on the nickel tube held in a jig and rotated. Care was taken that during application the coating was neither too wet nor too dry. After coating, the cathode was heated in an oven at *c.* 100° for 1 hr. to drive off the organic solvents and make the coating firm.

Between operations, parts should preferably be kept in vacuum desiccators to avoid contamination. This is particularly important for the cathodes. It is also not desirable to keep cathodes for too many days before final assembly.

*Heater for the cathode* — The heaters required for the indirectly heated cathodes are prepared from tungsten wire<sup>1,16</sup>. The wire is wound on a stainless steel mandrel and its ends secured. While still on the mandrel, the coil is annealed by heating in hydrogen at 1000° for *c.* 5 min. When the ends of the coil are released, it unwinds slightly, increasing the diameter slightly, depending upon the exact annealing procedure. Thus the required diameter of the mandrel has to be determined by trial and error.

The prepared coil is cut into suitable lengths, cleaned by boiling in aqueous sodium hydroxide (10 per cent) for 5 min. and coated with an insulating emulsion.

The composition of a suitable insulating emulsion is: alundum (particle size 10-20  $\mu$ ), 1000 g.; amyl acetate, 1800 ml.; methyl alcohol, 1250 ml.; and nitrocellulose, 50 g. The suspension is prepared by ball-milling and is applied uniformly on the heater coils by spraying. The coated heaters are baked at 100° for 1 hr. and later on in hydrogen at 1600° for 5 min. This makes the insulating coating sufficiently hard.

\*Suggested by D. A. Wright, Research Laboratories, General Electric Co., Wembley, England.

*Insulators for the cathode* — The heater coil is supported at its ends by insulators resting in the openings at the two ends of the nickel sleeve. The insulators can be formed by machining a material such as Lavite. Alternatively, they can be pressed out of steatite (soapstone) powder by a suitable die and punch. In either case they are baked in hydrogen at 1000° for 1 hr. when they shrink slightly. The temperature should be raised and lowered gradually, otherwise the insulators are likely to develop cracks.

*Glass to metal seals* — The different techniques of making glass to metal seals have been described in literature<sup>1,6,9-11</sup>. The seals can be divided into two broad categories, namely matched and unmatched seals. In the former case, the metal and the glass are so chosen that the expansion of the two is closely matched up to the softening point of glass. Several combinations are possible<sup>6,9</sup>. Where the degassing of metal parts is to be done by ovening at a uniform temperature, as in the present case, it is desirable to choose a type of glass which can be heated to comparatively high temperatures during ovening. Borosilicate glass is the best for which matching alloys are available. Its safe 'ovening temperature' is 450° as against 350° for lead glass and 300° for soda glass. Glass which seals to tungsten can be ovened at a temperature even higher than 450°. But its use is confined to applications where the metal is in the form of a rod or wire, since tungsten is not easily available in the form of tubes. Among the matched seals with borosilicate type glass, Telcoseal I or Kovar to B.T.H. type C40 or Corning type 7054 have been used successfully. Other combinations found suitable were molybdenum to B.T.H. type C40, or Corning 7052, tungsten to B.T.H. type C9, Vacovit 501 to Schott and Jenaer type 16 III.

In the case of unmatched seals, the metal is usually copper, in the form of a thin sheet, or a tube tapering into a 'feather edge'. It can be sealed to different kinds of glass. The bond between the metal and the glass is not broken by differential expansion or contraction, because copper 'yields' before large stresses build up. However, this type of seal is more liable to leak in the final assembly procedure involving heating in a hydrogen atmosphere, than is the case with matched seals.

*Silver solders* — In making vacuum-tight brazes between various metal components of the vacuum envelope, silver solders with low vapour pressure at the degassing temperature are used. A number of compositions melting at different temperatures are required, so that brazes at later stages of the assembly may be at lower temperatures, leaving the earlier ones undisturbed. A large number of such compositions are already listed in literature<sup>1,6</sup>.

Two compositions which have been used successfully in the present case are: (a) Ag, 72; Cu, 28 (copper silver eutectic, melting and flow point 779°); and (b) Ag, 60; Cu, 25; Zn, 15 per cent (m.p. 682°, flow point 718°).

They were prepared in the laboratory in the hydrogen furnace. The metals were melted in a silica crucible and stirred with a silica rod. The pellet of silver solder thus formed was rolled into a sheet or drawn into a wire.

#### Assembly

The parts to be assembled have to be thoroughly cleaned as unclean parts lead to brazes which are not vacuum tight, and also spoil the vacuum later through vapours. The cleaning methods used have been discussed in literature<sup>1,10,12,16</sup>. Kovar parts have to be annealed in hydrogen at 1000° for 30 min. before brazing them to other parts.

To start with, the side tube sub-assemblies are prepared. The copper tubes (a) are brazed with Kovar tubes (b) and the latter are sealed to glass tubes (c). R.F. decoupling chokes (d) are brazed on the heater-cum-cathode leads (e). The leads (e) are then sealed into the glass tubes (f) which in turn are sealed to glass tubes (c), provision being made for connecting the magnetron to the vacuum pump subsequently. It is also desirable to join a glass side tube (not shown in the figure) containing a getter flag, to one of the tubes (c). This side tube, along with the getter, is sealed off after ageing, and does not form a part of the finished tube. In the case of the output side tube sub-assembly, the inner conductor consists of a copper wire (g) to be formed into the coupling loop, a tapering copper section (h) for matching purposes and a Kovar rod (i) for the glass to metal seal. These three parts are brazed together. The glass to metal seal is made as before. For making the final seal, a jig is used to hold the inner conductor coaxial with the outer conductor.

The straps (j) are brazed on the two sides of the anodes (k) making contact with alternate segments through the strips (j'). The side tubes having the cathode leads are inserted into the anode. The cathode sub-assembly consisting of the coated cathode (l), the coated heater (m) and the insulators (n) is prepared. A tab spot welded to the cathode is also spot welded to one of the heater leads, thus establishing an electrical connection. The cathode is held coaxial with the anode by means of a centring jig. The jig consists of two discs which can be inserted at the two ends of the anode. The discs have holes in the centre for the heater leads, and have certain portions cut away to accommodate the electrodes of the spot welder. Using the jig as reference, necessary adjustments are made in the main leads so as to hold the cathode coaxial with the anode. It is advisable to spot weld two small nickel strips to each main lead, so as to form a Y at the end. The heater lead from the cathode sub-assembly can thus be sandwiched between these two strips; any small adjustments needed can be easily made in these strips.

The cathode sub-assembly is spot welded in position. The end hats (o) are also spot welded on to the main leads. They can be centred in a manner similar to the one described earlier.

The output sub-assembly and the face plates (p) are then inserted into the anode. Silver solder washers are placed at all the five joints at the time of insertion. Brazing is performed in an atmosphere of hydrogen. The tube is then ready for evacuation and final processing.

*Spot welding* — The two metal pieces to be joined are held together between electrodes (usually of copper). Alcohol is applied as a flux, and a heavy current of controlled magnitude and duration is passed through the pieces. The resistance at the contact between the metal pieces is comparatively high. The heat generated there softens one or both of the metals which are thus welded together.

All combinations of metals do not give good spot welds. Different combinations of metals giving good, fair or poor spot welds are reported in literature<sup>13</sup>. In some cases where two metals do not easily spot weld together, good results can be obtained by interposing another metal in between. For

example, tungsten and molybdenum can be spot welded easily by including nickel or platinum in between.

A spot welder of power rating 1-2 kW., with automatic timer, is suitable for this type of work.

*Brazing* — Brazing is usually carried out in a reducing atmosphere of hydrogen, or a mixture of hydrogen and nitrogen. Hydrogen has a cleaning action on metal surfaces. Thus there is no need for any other flux, which would otherwise be necessary for making the silver solder wet the metal surface. Traces of the flux if left in the vacuum envelope are a continuous source of vapours and are thus disastrous for the tube.

Hydrogen gas commercially available in cylinders contains oxygen and water vapour in small quantities. For most applications it is desirable to remove the water vapour and oxygen.

Removal of oxygen is effected by passing the gas either over copper chips heated to about 600° or over palladium black at room temperature. Water vapour is removed either by passing over chemical drying agents, such as phosphorus pentoxide, or by refrigeration.

Dry hydrogen is not, however, used when tungsten wire is heated in an atmosphere of hydrogen. The tenacious layer of graphite on the wire surface has a tendency to form tungsten carbide at high temperatures which makes the wire brittle. This is avoided by using hydrogen saturated with water vapour (by bubbling it through water). The water vapour reacts with carbon at high temperatures to give hydrogen and carbon monoxide, leaving the wire clean and ductile.

For laboratory work, a simple but versatile arrangement for heating in hydrogen has been described in literature<sup>1,10</sup>. A 'hydrogen bottle' set up in this laboratory is shown in Figs. 2 and 3.

For the final assembly operation, two pancake-shaped coils which are in contact with the face plates of the magnetron are used for heating. They are electrically insulated from the magnetron by a coating of alundum, applied in the same way as for cathode heaters. The coils and the tube are held in a jig. Plates of fired steatite are inserted between the coils and the jig to minimize conduction of heat to the jig. The jig is spring loaded, so that when the silver solder washers between the face plates

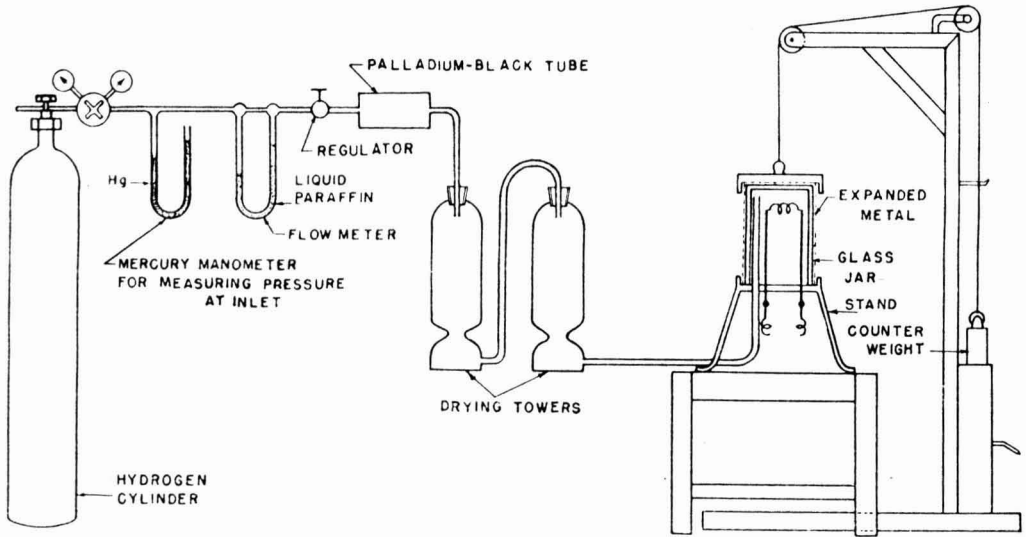


FIG. 2 — EQUIPMENT FOR HEATING IN HYDROGEN ATMOSPHERE

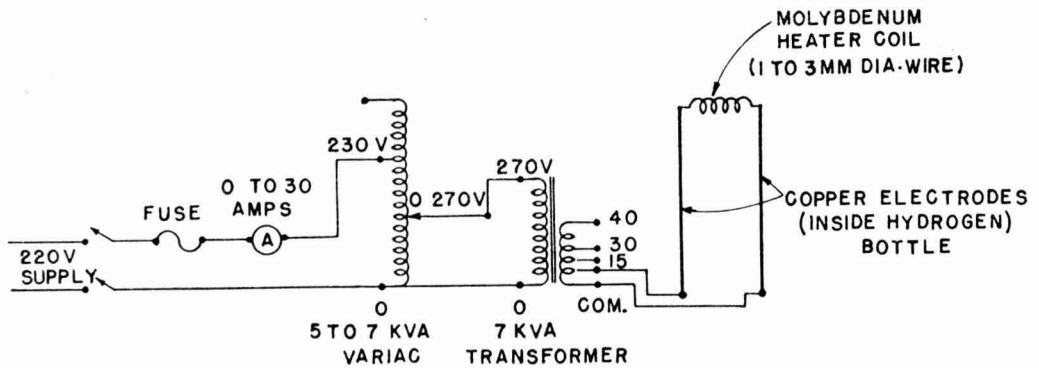


FIG. 3 — ELECTRICAL CIRCUIT FOR 'HYDROGEN BOTTLE' EQUIPMENT

and the anode melt, the face plates are pushed in.

The heat transfer between the coils and the tube is so efficient that the final braze is completed at an input power level of 1100 W. as against 2700 W. needed when the usual method of heating by radiation is employed. Due to this, the glass to metal seals are not subjected to a very high temperature, and the risk of their developing leaks is far less. The risk is eliminated completely by directing the incoming stream of cool hydrogen on the seals and by using a mixture of hydrogen and nitrogen (3:1), instead of pure hydrogen.

The two pancake-shaped coils are operated in parallel and are so designed that the lower

one receives more current. This compensates for the cooling of the lower face by convection and makes the rise in temperature of the tube uniform.

For large-scale work, hydrogen furnaces of continuous operation type are required. These usually consist of a tube of refractory material, through which hydrogen is kept flowing. The central portion of the tube is heated to the required temperature, and the two end regions serve as the loading and unloading chambers respectively. The latter are usually water-cooled.

The equipment for heating in hydrogen atmosphere can be used not only for brazing without additional flux, but also for anneal-

ing and baking. Another advantage of heating the parts in hydrogen is that at the time of evacuation they are degassed comparatively easily.

### Evacuation and final processing

After the tube has been assembled, it is sealed on to the vacuum system. The tube is evacuated and degassed, the cathode is 'broken down' and activated, the getter is flashed and the tube is sealed off<sup>16</sup>. Finally the tube is aged and the getter side tube sealed off.

The different vacuum systems evolved and their components have been described in literature<sup>10,13,14</sup>. The system used by us is shown in Fig. 4. The vacuum 'reservoir' makes it possible to shut off the fore pump for long intervals. It also enables the same pump to be used for lowering the mercury in the McLeod gauge between successive readings. This gauge was included to act as a standard for calibrating the ionization gauge. The latter enables continuous readings to be taken when the pressure is below  $10^{-4}$  mm. of mercury. The Pirani gauge was included to monitor the release of carbon dioxide during the 'cathode breakdown' process, when the pressure rises above  $10^{-4}$  mm. of mercury and the ionization gauge has to be shut off. The latter two gauges were also used for leak detection when necessary. The three-way stopcock No. 1 enables the evacuation of the tube with the fore pump alone in the initial stages, with the diffusion pump in the final stages, and isolation of the tube for leak detection, or when otherwise necessary.

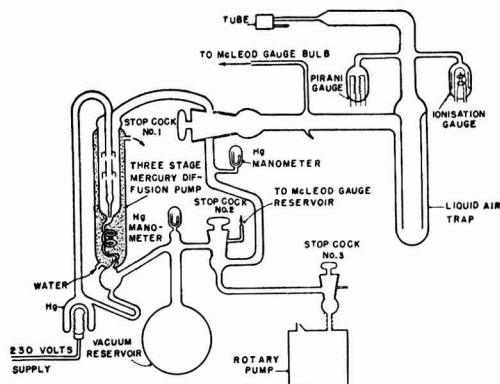


FIG. 4 — VACUUM SYSTEM

After initially evacuating the tube to a pressure below  $10^{-4}$  mm. of mercury, the degassing oven is lowered on it. The temperature is gradually raised, frequently observing the pressure. The highest safe temperature for borosilicate type of glass is  $450^{\circ}$ . The oven is maintained at this temperature for *c.* 3 hr. (the temperature can be conveniently read on a nitrogen-filled mercury thermometer). The rest of the vacuum system is also degassed with a Bunsen burner flame. At the end of this period, the pressure should be below  $10^{-6}$  mm. of mercury.

In the case of tubes having glass envelopes, degassing can best be done by induction heating of the electrodes. The temperature can be raised up to red heat without softening the glass. The same process is applied to the getter in the side tube after completion of the main degassing operation. Alternatively, the getter can be enclosed in a tungsten coil and heated by passing a current through the latter.

The breakdown of the cathode is carried out in the following stages. The cathode temperature is raised gradually to  $900^{\circ}$ . The ionization gauge is then turned off, the temperature raised in one step to  $1100^{\circ}$  and maintained there until the pressure indicated by the Pirani gauge falls below  $10^{-3}$  mm. The temperature is then lowered to  $950^{\circ}$  and maintained at that value until the pressure falls below  $10^{-6}$  mm. It is important that liquid air should not be applied to the vapour trap before the breakdown of the cathode is completed. Otherwise the carbon dioxide released by the cathode solidifies in the vapour trap and the pressure does not fall below  $10^{-6}$  mm., as the vapour pressure of solid carbon dioxide at liquid air temperature is of that order.

During the breakdown process the temperature of the cathode can be measured by a 'disappearing filament pyrometer'. Alternatively a control experiment is performed beforehand to correlate the heater power and the cathode temperature.

After the pressure has fallen below  $10^{-6}$  mm., the cathode is activated by drawing emission current. Anode voltage is gradually raised from zero, in several minutes, making sure after each rise in voltage that the emission does not have a tendency to fall. The emission may fall if the voltage is raised too rapidly, due to the release of residual gas from the anode by electron bombardment.

The residual gas can deactivate the cathode by combining with its free barium, and can also cause damage to the cathode surface through ionic bombardment. Anode voltage is raised until an emission current density of *c.* 25 ma./sq. cm. is obtained.

In the final stages of activation, the getter in the side tube is gradually degassed again. Finally the anode voltage is removed, the cathode temperature brought down to *c.* 600° and the tube sealed off. In this process care has to be taken to heat the thick-walled pinch uniformly and slowly, allowing time for the gases that are released to be pumped away.

After the seal-off the cathode temperature is again raised to 900° and the anode voltage is gradually applied. Emission current is drawn for several hours. This improves the stability of the cathode, and generally increases the emission. At this stage, the cooling fins (r), the coupling flange (s), the mounting brackets (t) and the mounting plate (u) are added.

The final ageing is done under actual operating conditions. Test bench set-ups for magnetrons<sup>1,15</sup> include equipment for applying the magnetic field, the heater power and the anode voltage (pulsed or continuous as the case may be), and for measuring the power output and frequency under various load conditions. Protective circuits are provided for preventing damage to the magnetron or the power supply due to overloading. After the final ageing process, the getter side tube is sealed off.

### Conclusion

Magnetron tubes of the type 2J32 have been fabricated and tested at pulse voltages up to 9 kV., which could be produced by a pulser available in the laboratory. (This is actually a part of radar set AN-TPS-2, modified to give negative pulses of variable pulse height and of duration 2 microseconds.) At this pulse voltage a magnetic field of only 1100 gauss can be used. The power output and efficiency are thus lower than the values for normal operating conditions of the tube (18 kV., 1800 gauss). The values obtained with the tubes fabricated were comparable with published data for similar tubes. For a case taken at random, the operating

conditions were defined by a magnetic field strength of 1050 gauss, peak input voltage of 8.2 kV. and peak input current of 4.55 amp. The observed efficiency and power output were 22.3 per cent and 8.3 kW. as against the published values of 21 per cent and 7.8 kW. respectively at the above-mentioned operating point.

The development of a tunable inverted interdigital magnetron is now in hand.

### Acknowledgement

The authors thankfully acknowledge the encouragement and help given to them by Dr. K. S. Krishnan and Dr. K. N. Mathur. They are also thankful to Mr. Franz Kiss for making the glass to metal seals, and to the workshop staff for help in making the magnetron parts and other equipment.

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switch  $S_2$  is kept open and switches  $S_3$  and  $S_4$  are closed so that only the standard wattmeter is in the circuit when its reading is recorded. Switches  $S_3$  and  $S_4$  are then opened and  $S_2$  closed, and the corresponding reading in the electronic wattmeter is recorded. At the outset preliminary adjustments were made for zero reading of the indicating meter  $M$  (Fig. 1) and the cathode voltage was controlled by  $r$ . During adjustments, switch  $S_5$  is kept open and the load circuit disconnected to compensate for any difference in the characteristics of the two valves. The series resistances  $R_3$  and  $R_4$ , which are of equal value, are so selected that the range of the electronic wattmeter is comparable with that of the standard wattmeter. Various sets of readings are recorded for the range and sensitivity of the instrument with different combinations of series resistances  $R_3$  and  $R_4$  and the cathode biasing resistance (C.B.R.).

The calibration curves with different loads are shown in Figs. 2-4. They have been limited to the range of linearity between the wattage and the readings in the indicating meter. Up to the limit of the range of the instrument, its sensitivity increases as the cathode biasing resistance is decreased (Fig. 2). The sensitivity depends on the magnitude of the difference of the voltages on the grids of the two valves  $V_1$  and  $V_2$  (Fig. 1) produced by a voltage drop across the series resistances  $R_3$  and  $R_4$  in the load circuit, and on the initial voltage applied to the grids of the valves due to the cathode biasing resistance  $r$ . The terminals of the d.c. indicating meter have to be reversed when the cathode biasing resistance is raised too high (above 2950 ohms). This is due to the fact that the voltage drop across  $R_1$  and  $R_2$  is reversed beyond the above limit of cathode biasing resistance, as verified experimentally.

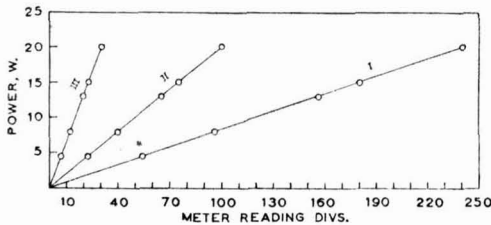


FIG. 2—CALIBRATION CURVES FOR SENSITIVITY [I, series resistance, 20 ohms; cathode bias resistance (C.B.R.), 1000 ohms; II, series resistance, 20 ohms; C.B.R., 2000 ohms; III, series resistance, 20 ohms; C.B.R., 3500 ohms]

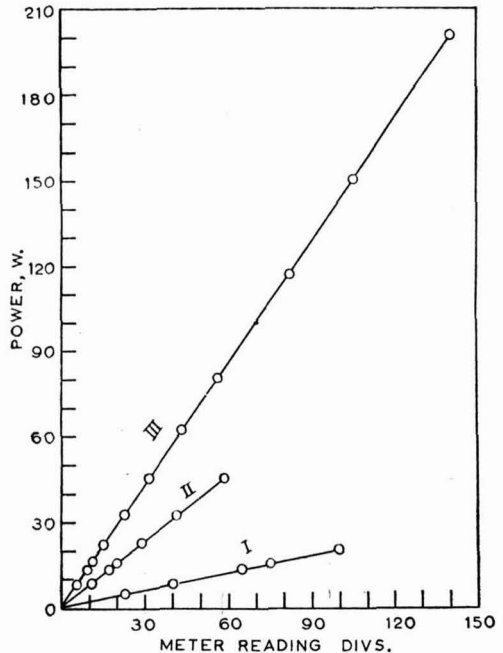


FIG. 3—CALIBRATION CURVES FOR RANGE [I, series resistance, 20 ohms; C.B.R., 2000 ohms; II, series resistance, 4 ohms; C.B.R., 2000 ohms; III, series resistance, 2 ohms; C.B.R., 2000 ohms]

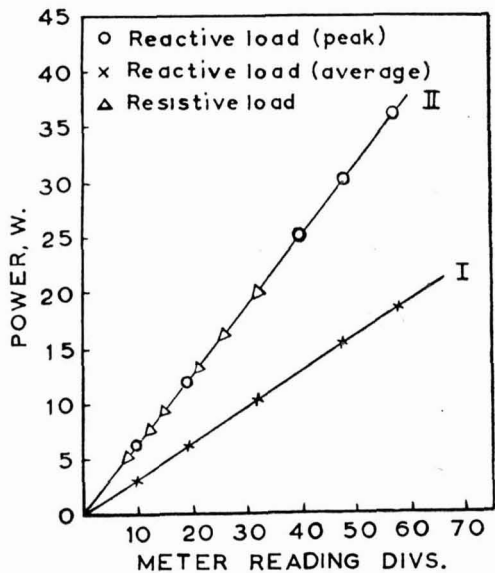


FIG. 4—CALIBRATION CURVES FOR RESISTIVE AND REACTIVE LOADS [I, reactive load (average power), series resistance, 20 ohms; C.B.R., 5000 ohms; II, resistive and reactive loads (peak power), series resistance, 20 ohms; C.B.R., 5000 ohms]



The variation in the range of the wattmeter as the series resistance is changed, keeping the cathode biasing resistance constant, is shown in Fig. 3. The range of the instrument increases when the series resistance is decreased and the sensitivity also decreases simultaneously, provided the cathode biasing resistance is kept constant. Further, for particular values of the series resistances, the range of the instrument is limited, as the voltage on the grids of the two valves reaches the cut-off value of the valves; their proper functioning is thus restricted beyond a certain limit.

The same relationship between the deflection and the power consumed holds good even in the case of reactive loads if the peak power recorded by the instrument is considered. But as calibration is made with the average power consumed, as measured by the electro-dynamometer wattmeter, the calibration curve for reactive load (shown in curve I, Fig. 4) always lies below the peak power calibration curve. The peak power calibration curve for reactive load coincides with that for the resistive load as shown in Fig. 4 (curve II).

#### Summary and conclusion

The variation of the range and sensitivity of the electronic wattmeter of a modified

design has been studied with resistive and reactive loads at power frequency. Suitable combinations of series and cathode biasing resistances have been determined for the above variations. The electronic wattmeter works satisfactorily at medium power up to 200 watts.

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# Hyderabad Earths for Bleaching Vegetable Oils: Part II

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Fullers' earth occurs extensively at Korvi, Chime-idlai, Dastapur and Sulehpeth (Chincholi taluk, Gulbarga district, Mysore State). Earths from these places when activated with hydrochloric and sulphuric acids have adsorption characteristics comparable to those of commercial samples. Korvi and Chime-idlai deposits being fairly free from grit, sand and acid-soluble impurities can be commercially exploited.

THE bleaching properties of diatomaceous earth from Srirangapur and fullers' earth from Gingurti have been reported previously<sup>1</sup>. Of the two, fullers' earth from Gingurti was found to be superior and compared favourably with imported earths. The present communication reports the results of investigations carried out on the preparation of activated earths from Korvi, Dastapur, Chime-idlai and Sulehpeth, situated in Chincholi taluk, Gulbarga district.

The average thickness of the beds of fullers' earth at Korvi (17°23': 77°16') is about 5 ft., under black cotton soil and the product is fairly free from grit and sand. At Chime-idlai (17°26': 77°22½') three deposits occur; the over-burden varies from 0.5 to 10 ft. of solid trap rock underlain by 2-3 ft. of lithomarge. A major portion of the deposit at Dastapur (17°25': 77°22') is interbedded with hard cherts and calcareous clay. A deposit of fullers' earth, greyish in colour, is found near Sulehpeth (17°24': 77°21') under hard 'murrum' to solid trap. The estimated reserves of the fullers' earth in each area are given in Table 1.

The results of analyses of representative samples of fullers' earths from these deposits are given in Table 2<sup>3</sup>.

## Experimental procedure

*Sampling and activation* — Samples of fullers' earth collected from freshly opened pits were mixed thoroughly by the usual sampling technique and powdered in a pot

TABLE 1—ESTIMATED RESERVES OF FULLERS' EARTH<sup>2</sup>

LOCALITY	AREA sq. ft.	AV. THICKNESS ft.	QUANTITY tons
Korvi, No. 1	300600	4.70	59140
Korvi, No. 2	227250	5.51	52430
Chime-idlai, No. 1	39200	4.13	6778
Chime-idlai, No. 2	175000	2.28	16700
Chime-idlai, No. 3	96860	3.12	12660
Dastapur	117540	2.24	11020
Sulehpeth	26770	4.76	5333
		Total	164061

TABLE 2—ANALYSES OF FULLERS' EARTHS

	KORVI	SULEHPETH	DASTAPUR	CHIME- IDLAI
Loss on ignition, %	21.34	20.90	20.01	21.76
SiO <sub>2</sub> , %	53.56	52.00	53.26	51.94
Al <sub>2</sub> O <sub>3</sub> , %	12.98	16.38	11.04	8.05
Fe <sub>2</sub> O <sub>3</sub> , %	8.63	5.65	6.96	7.76
CaO, %	0.91	1.14	0.51	0.13
MgO, %	1.72	2.52	6.46	8.88
Na <sub>2</sub> O + K <sub>2</sub> O, %	0.80	1.50	1.72	1.39

mill to pass through 100 mesh. The samples were activated with hydrochloric acid by the method described previously<sup>1</sup>.

Samples free of grit and sand were activated with sulphuric acid. The procedure followed was more or less the same as for hydrochloric acid except that in this case, the earth (100 g.) was made into a slurry with water (200 ml.) and the acid added slowly.

*Adsorption tests* — Colour adsorption tests were carried out on raw filtered groundnut oil. About 3 per cent of earth on the weight of the oil was mixed with the oil, kept constantly stirred at 60°-70° for 30 min. and filtered. Colour readings of raw and decolourized oils were obtained in red and yellow units on a Lovibond tintometer in a 1 in. cell, and the total colour calculated as yellow plus 5 red units.

The results of activation of the representative earths are given in Table 3. The results obtained with some commercial Indian and imported earths have also been included in Table 3 for comparison.

**TABLE 3 — BLEACHING TESTS ON SAMPLES OF ACTIVATED AND COMMERCIAL EARTHS**

SOURCE	ACTIVATING AGENT	COLOUR REDUCTION %
Chime-idlai (A)	HCl (5N)	53
Chime-idlai (B)	HCl (5N)	56
Korvi (A)	HCl (5N)	71
Korvi (B)	HCl (5N)	68
Sulehpeth	HCl (5N)	65
Dastapur	HCl (5N)	62
Korvi	H <sub>2</sub> SO <sub>4</sub> (25%)	62
Korvi	H <sub>2</sub> SO <sub>4</sub> (37.5%)	71
Korvi	H <sub>2</sub> SO <sub>4</sub> (50%)	73
Commercial (Indian) sample (P)	—	56
Commercial (Indian) sample (R)	—	62
Commercial (Indian) sample (S)	—	60
Commercial (British) sample	—	70
Commercial (American) sample	—	65
Commercial (German) sample	—	72

**TABLE 4 — CHARACTERISTICS OF ACTIVATED SAMPLES AND COMMERCIAL EARTHS**

	pH OF 10% SUSPENSION IN WATER	BULK DENSITY g./ml.	COLOUR REDUCTION %
Chime-idlai sample (A)	4.7	0.384	53
Chime-idlai sample (B)	5.8	0.446	56
Korvi (A)	4.0	0.658	71
Korvi (B)	3.4	0.487	68
Commercial samples (P)	5.6	0.983	56
Commercial (Indian) (R)	3.5	—	62
Commercial (Indian) (S)	3.6	—	60
Commercial (British)	3.2	0.537	70
Commercial (American)	6.3	0.526	65

*pH and bulk density* — The bleaching activity of the earths has been reported to be directly proportional to their acidity<sup>4</sup>, bulk density and particle size<sup>2</sup>. These properties were determined for some of the samples. The pH values of the samples were determined on a Beckmann direct-current instrument, model H2, using 5 and 10 per cent suspensions of earths in distilled water of pH 6.9 at room temperature.

Bulk density was determined by measuring, in a graduated cylinder, the volume occupied by a given weight of the powdered sample (Table 4).

### Results and conclusions

The deposits at Korvi and Chime-idlai can be commercially exploited as they con-

tain approximately 11,500 and 36,000 tons respectively of fairly good quality earths with comparatively small amounts of grit, sand, etc., and possess colour adsorption properties comparable to those of commercial Indian and foreign bleaching earths. The deposits at the other places are relatively small and are not of good quality due to the presence of grit and sand in appreciable amounts.

Activation with hydrochloric acid gives earths of slightly better quality than obtained by treatment with sulphuric acid. Sulphuric acid, however, gives better results if a higher percentage of the acid to earth is used and being cheaper is preferable to hydrochloric acid. The use of sulphuric acid up to 37-40 per cent on the weight of raw earth gave activated products of good quality with colour adsorption properties comparable both to the hydrochloric acid-activated product and to commercially used samples.

pH and bulk density do not appear to be correlated with colour adsorption properties. The effect of particle size on colour adsorption properties is being studied.

### Acknowledgement

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# Stabilization of Edible Fats by Spices: Part III

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The antioxidant action of turmeric, dried ginger, cinnamon leaves, onions and a few other spices has been studied on refined lard. A yellow solid material isolated from onion possessed the maximum activity which is, however, much lower than that of hydroxy-chavicol, isolated from betel leaves.

A NUMBER of spices have been reported to be effective in stabilizing vegetable oils<sup>1</sup>. The results of studies on the specific ingredients of red chilli, clove and betel leaf, that contribute to this activity, have been reported in Part II of this series<sup>2</sup>. The results of studies conducted on similar lines with turmeric, cinnamon leaves, nutmeg fruit, onions and garlic are presented in this communication.

## Experimental procedure

Fresh lard was refined by treatment with a mixture of decolourizing carbon and activated earth, and stored at *c.* -2°C. The stability of treated and untreated lard samples, determined by the standard A.O.M. test<sup>3</sup>, was taken as the time required to attain a peroxide value of 20 m. eq./kg. and from this data the stability indices of different fractions of the spices were calculated.

The methods of preparation of extracts and active principles of the spices tested are given below:

*Turmeric* — Benzene extract was prepared by cold percolation of the material with the solvent and subsequent removal of the latter by distillation. From the dark red semi-solid benzene extract, the hexane soluble matter was removed by repeated washing. The yellow phenolic principle of turmeric, viz. curcumin, was also tried.

*Dried ginger* — Alcohol, benzene and hexane extracts were prepared as in the case of turmeric. The phenolic fraction of the alcoholic extract was obtained by digesting it with 5 per cent cold alkali solution and isolating it by the usual procedure.

*Cinnamon leaves* — The benzene extract, essential oil and the phenolic portion of the latter were tested for antioxygenic activity.

*Nutmeg fruit* — Benzene extract of the powdered nutmeg consisted of a large amount of fat which was removed with hexane. The total benzene extract and its hexane soluble portion were separately shaken with alcohol and the isolates were obtained by distillation of the solvent. The whole powdered fruit was also extracted with alcohol. After distillation of the solvent, the residue, on cooling, separated into liquid and semi-solid fractions which were separated mechanically.

*Onions* — Onions chopped into small pieces were kept overnight in benzene and the residual material extracted with acetone. The ether soluble portion of the acetone extract was isolated as a yellow powder decomposing at 245°-50°C. This product was also obtained in a less pure condition by shaking the onions with hexane and treating the extract with the help of acetone and ethyl ether. The hexane soluble portion was removed from the total acetone extract of onions, the residue shaken with ethyl ether and the solvent distilled off from the soluble fraction.

Extracts of garlic and black pepper were also prepared and tested.

The extracts and isolates that have been found to possess pronounced antioxygenic activity are given in Table 1.

## Discussion

The results given in Table 1 and those obtained for other extracts and isolates of the various spices show that the antioxidant properties of turmeric are entirely due to the phenolic colouring matter curcumin<sup>4</sup>; the essential oil and the alcohol and hexane extracts have very little antioxygenic activity.

Weak stabilizing properties exhibited by dried ginger are due to the phenolic consti-

**TABLE 1—A.O.M. TESTS WITH VARIOUS FRACTIONS OF SPICES ON REFINED LARD**

SPICES	FRACTION AND ITS WT. (%)	STABILITY INDEX
Turmeric	Curcumin (0.005)	2.7
	Curcumin (0.05)	7.2
	Curcumin (0.1)	10.3
	Curcumin (0.1)+citric acid (0.1)	11.0
	Curcumin (0.05)+methionine (0.05)	13.4
	Curcumin (0.1)+methionine (0.05)	18.2
	Benzene extract (0.1)	5.0
	Benzene extract washed with hexane (0.1)	5.5
Dried ginger	Hexane extract (0.1)	3.0
	Benzene extract (0.1)	3.0
	Alcohol extract (0.1)	3.0
	Alcohol extract, phenolic portion (0.05)	2.3
	Alcohol extract, phenolic portion (0.1)	5.0
	Oleoresin (0.1)	3.0
Cinnamon leaf	Benzene extract (0.1)	2.0
	Essential oil (0.1)	5.6
	Essential oil, phenolic portion (0.05)	3.0
	Essential oil, phenolic portion (0.1)	6.0
	Eugenol (0.05)	3.5
	Eugenol (0.1)	6.0
Nutmeg fruit	Alcohol isolate of benzene extract (0.1)	6.5
	Alcohol isolate from hexane soluble portion of benzene extract (0.1)	6.0
	Alcohol extract, liquid portion (0.1)	6.0
	Alcohol extract, solid portion (0.1)	1.5
Onion	Acetone extract after extracting with benzene (0.05)	2.5
	Ether soluble portion of acetone extract obtained after extraction with benzene (0.05)	24.0
	Ether soluble portion of acetone extract obtained after extraction with hexane (0.05)	15.0
	Ether isolate from the residue obtained after extracting off the hexane soluble portion from the acetone extract (0.01)	4.0
	Ether isolate from the residue obtained after extracting off the hexane soluble portion from the acetone extract (0.05)	24.0

tients present. The non-phenolic portions of the alcohol extract and the essential oil of the spice have negligible antioxidant effect.

The stabilizing activity of cinnamon leaves is due to the phenolic fraction, eugenol (70-87 per cent), present in its essential oil<sup>5</sup>. The non-phenolic portion of the essential oil and the alcohol and hexane extracts of the material have almost no protective action.

The feeble antioxidant action of nutmeg fruit is concentrated in the liquid fraction

isolated from its alcohol extract. The essential oil is devoid of any such activity.

Benzene, acetone, hexane and alcohol extracts of onions show almost negligible protection. Even the acetone extract of the residue of onions after benzene extraction exhibited very weak activity. The ethyl ether soluble portion of the acetone extract, however, exhibits significant antioxidant properties. Onions were also successively extracted with benzene, acetone and ethyl ether. The last extract, after complete removal of the solvent, separated into solid and liquid fractions both of which were found to be inactive. The inactive constituents of onions mostly remain in the benzene extract and the ethyl ether insoluble part of the acetone soluble fraction. In the total ethyl ether extract some pro-oxidants may be present.

Except for the slight antioxidant property of the essential oil, no other fraction of garlic exhibited any activity. The anti-rancidity principle of black pepper has been found to be mostly present in its oleoresin, which is known to contain tocopherols<sup>6</sup>.

Out of the seven spices studied the ethyl ether soluble portion of the acetone extract obtained after a single extraction of onions with benzene has been found to possess the maximum antioxidant property. But it is far less than that of hydroxychavicol isolated from betel leaf<sup>2</sup>. Studies are under way to prepare this and allied compounds synthetically and to evaluate their stability and carry-over properties in various edible oils and fats.

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# A Comparative Study of Indian & Foreign Silica Bricks

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The chemical and physical properties of two indigenous brands of open hearth roof quality silica bricks have been compared with those of some foreign bricks. The indigenous bricks compare favourably with most of the foreign bricks. Suggestions have been made to improve their quality further to bring them in line with super-duty silica bricks of foreign make.

THE present investigation was undertaken to compare the properties of indigenous silica bricks with those of some well-known imported bricks with a view to determine the drawbacks of indigenous bricks, if any, and to suggest improvements so as to bring them on par with super-duty silica bricks. The chemical and physical properties of six foreign brands of open hearth roof quality silica bricks — two each from England and America, and one each from Germany and Japan — have been compared with those of the indigenous products.

## Experimental procedure

The physical properties of the specimens were determined by the standard A.S.T.M. methods. Permeability to air was tested through one skin. Reversible thermal expansion up to 650° was measured in an NBS type dilatometer. Differential thermal analysis was carried out with temperature variation from room temperature to 600° using an alumina holder with calcined alumina as the

inert material and a chromel alumel differential couple. A rate of rise of 8°/min. was maintained and the differential e.m.f. was recorded on a differential recorder. Blank tests were run with inert material in both cups and necessary corrections were applied to differential thermal curves. Refractoriness underload was tested by the D.I.N. method using a carbon resistance furnace and a load of 2 kg./sq. cm. Reheat expansion was determined after firing the specimen at 1450° for 2 hr. in a gas-fired kiln. Thin section and powder mounts were studied under the petrological microscope.

## Results and discussion

*Chemical analysis and refractoriness underload* — The refractoriness underload of a silica brick is chiefly influenced by its contents of deleterious fluxes like alumina and alkalis. The deleterious flux contents of the bricks are given in Table 1. The refractoriness underload values given in Table 2 correspond closely with the deleterious flux contents. While the American super-duty brick with the lowest alumina content has the highest underload value, the British brick No. II, which has the highest alumina content, has the lowest underload value. In keeping with their moderate alumina and alkali contents, the two indigenous specimens (No. 1 and 2) have a fairly high underload value and compare well with the German

TABLE 1 — CHEMICAL ANALYSES OF SILICA BRICKS

No.	SOURCE	LOSS ON IGNITION %	SiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	CaO %	MgO %	TiO <sub>2</sub> %	ALKALIES %
1	Indian, I	0.08	95.34	1.15	0.96	2.29	Trace	0.05	0.28
2	Indian, II	0.02	95.50	1.28	0.44	2.52	do	Trace	0.28
3	British, I	0.23	94.74	1.85	0.62	2.04	do	0.05	0.55
4	British, II	0.24	92.81	2.08	1.08	3.16	do	0.08	0.49
5	American (conventional type)	0.30	93.88	1.65	0.73	3.01	do	0.05	0.43
6	American (super-duty)	0.19	96.09	0.19	0.38	2.70	do	0.05	0.23
7	German	0.10	94.80	1.12	0.35	2.36	do	0.73	0.38
8	Japanese	0.16	94.80	0.44	1.76	2.47	do	Trace	0.38

TABLE 2 — PHYSICAL PROPERTIES OF SILICA BRICKS

No.	SOURCE	TRUE SP. GR.	APPARENT SP. GR.	BULK DENSITY	APPARENT POROSITY %	PERMEABILITY TO AIR C.G.S. unit	P.C.E. (ORTON CONE)	REHEAT EXPANSION AT 1450° (2 hr.) %	REFRACTORINESS UNDERLOAD		COLD CRUSHING STRENGTH lb./sq. in.	QUALITY INDEX
									$t_a$ , °C.	$t_c$ , °C.		
1	Indian, I	2.320	2.316	1.73	24.20	0.032	32	0.26	1665	1700	1891	38-00
2	Indian, II	2.335	2.330	1.80	22.60	0.023	31-32	0.23	1670	1690	1998	37.96
3	British, I	2.418	2.403	1.80	25.00	0.104	31	1.25	1650	1670	2116	47.20
4	British, II	2.319	2.300	1.62	27.20	0.153	30-31	0.25	1620	1640	1779	52.16
5	American (conventional type)	2.330	2.300	1.60	30.30	0.205	31-32	—	1640	1700	2160	50.10
6	American (super-duty)	2.323	2.290	1.80	21.60	0.043	32	0.22	1700	1720	1764	23.88
7	German	2.361	2.350	1.95	16.95	—	31	0.64	1650	1660	—	30.39
8	Japanese	2.331	2.320	1.95	15.40	0.008	31	—	1660	1680	3136	20.63

specimen having approximately the same amount of deleterious impurities; the latter has a much higher titania content which should enhance its spalling resistance as has been reported in the case of South African silcrete bricks<sup>1</sup>.

*Pyrometric cone equivalent (P.C.E.)* — The British specimen No. II has the highest flux content and consequently the lowest P.C.E. The slightly lower P.C.E. of the British specimen No. I as compared to that of the American conventional type of brick (No. 5) may be due to the higher alkali and alumina contents of the former. Compared to the normal type of silica bricks, the two indigenous specimens were low in fluxes and hence possessed a high P.C.E. The Indian specimen I (No. 1) has the same P.C.E. as the American super-duty brick though the latter has much lower alumina content. This may probably be due to the lower lime content of the former.

*Specific gravity, bulk density and apparent porosity* — The true and apparent specific gravities of the different specimens are quite close to each other; this was to be expected since silica bricks are known to have very few sealed pores. The true specific gravity is an index of the degree of conversion. The bulk density varies from 1.60 in the case of American conventional type of brick to 1.95 in the case of the German and Japanese bricks and their corresponding apparent porosity varies from 30 to 17 and 15 per cent respectively. Though the German specimen has a higher apparent porosity than the Japanese specimen, both possess the same bulk density. This is due to the higher true specific gravity of the German bricks. Though the British specimen I has an apparent porosity of 25 per cent, its bulk density (1.8) appears to be high due to its high true specific gravity (2.418). The bulk density and apparent porosity of the two indigenous brands compare well with those of the normal types of bricks like the British specimens I and II and the American conventional type of bricks.

*Permeability of air* — The permeability varies considerably (up to 50 per cent) depending upon the axis along which the specimen is cut from the brick. This can be attributed to the difference in orientation of particles in the mould, which gives rise to more channel pores in one direction than in the other. Specimens from the

same batch of bricks, when cut along the same direction, gave consistent results. The average permeability values for a number of specimens cut along the three axes are given in Table 2. Among the bricks tested, the Japanese specimen has the lowest permeability (0.008 C.G.S. unit) and the American conventional type of brick the highest (0.205 C.G.S. unit). The two indigenous brands have permeability values (0.032 and 0.023 C.G.S. units) lower than that of even the American super-duty brick. Though normally permeability is high if the porosity is high, this has not always been found to be true<sup>2</sup>. Silica roof bricks are reported to have usually specific permeability between 0.03 and 0.06 C.G.S. units<sup>3</sup>. While there may not be much scope or need for improvement of the permeability of the two indigenous brands of bricks, lowering of the porosity may bring about some improvement in permeability because of the squeezing out of channel pores by proper grain size packing and high pressure forming.

The flux content of silica bricks should be low in order to get good service life in open hearth roofs. Even after a few weeks' service in the open hearth roof, zone formation takes place in the roof bricks due to the migration of fluxes. Alumina, titania, ferric oxide and lime migrate at different

rates and concentrate in different zones in the brick depending upon the eutectic melts they form with one another and with silica, as also upon the temperature gradient set up in the brick. While the amount of liquid formed at the working temperature depends upon the flux content, its migration into the brick depends mostly on the latter's porosity and the permeability and viscosity of the liquid. Hence, it is desirable to have low porosity and permeability together with low flux content to get good service performance.

*Texture of the bricks* — The texture of a brick is reported to have a direct influence on its reheat change values<sup>4</sup> and thermal shock resistance<sup>5</sup>. Cut sections of the brick specimens are shown in Fig. 1. Specimens 1, 2, 3 and 8 have coarse grains, the maximum grain size being about 5 mm. Specimens 4, 5 and 6 are more fine grained, the minimum grain size being less than 2 mm.

*Cold crushing strength* — The Japanese specimen has the highest strength (Table 2) which may be attributed to its low porosity, fairly high (*c.* 15 per cent) glassy bond (Table 3) and good texture (Fig. 1). The comparatively low strength of the American super-duty brick may be due to its low glassy bond and rather loose texture. In spite of a much higher porosity, the American conventional brick has a fairly high crushing strength

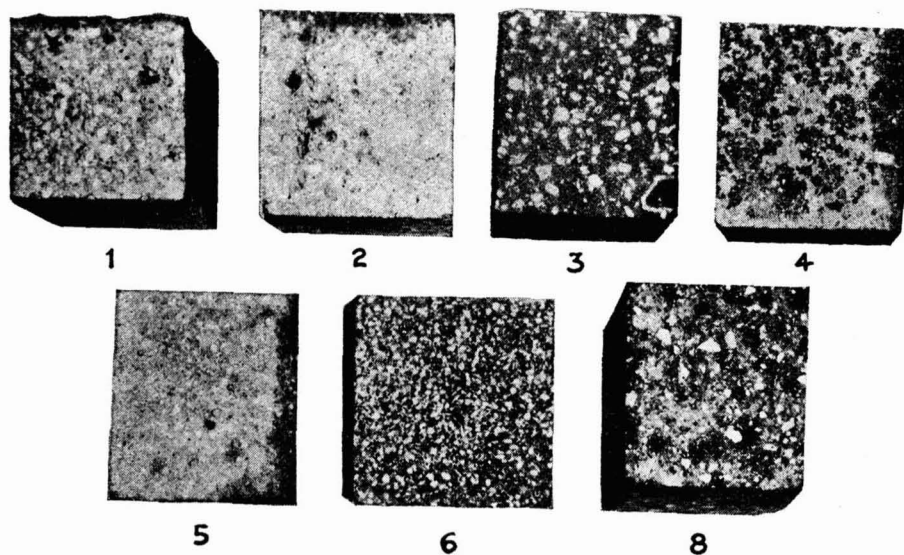


FIG. 1 — CUT SECTIONS OF SILICA BRICKS



**TABLE 3—MINERAL CONSTITUENTS OF SILICA BRICKS**

No.	SOURCE	(Wt. basis)		TOTAL TRIDYMITE AND CRISTOBALITE %	MAJOR CONSTITUENTS
		GLASS %	QUARTZ %		
1	Indian, I	13.98	5.13	81.00	Cristobalite predominates
2	Indian, II	13.50	8.10	78.40	do
3	British, I	15.33	19.70	65.00	Equal amounts of tridymite and cristobalite
4	British, II	20.67	5.15	74.18	Tridymite predominates
5	American (conventional type)	17.61	1.05	81.34	Cristobalite predominates
6	American (super-duty)	10.65	nil	89.35	Tridymite predominates
7	German	14.82	13.00	72.18	Equal amounts of tridymite and cristobalite
8	Japanese	15.60	8.15	76.25	Cristobalite predominates

which may be due to a higher glassy bond and a smooth texture with a fine matrix. The crushing strengths of the two indigenous brands are slightly less than 2000 lb./sq. in.

**Mineral composition**

*Glassy phase*—As suggested by Rigby *et al.*<sup>6</sup>, the glass contents of the specimens have been calculated as three times the flux contents. The British specimen II has the highest (20.67 per cent) and the American super-duty specimen the lowest glass content (Table 3). The glass contents of the two indigenous brands are 13 and 14 per cent.

*Residual quartz content*—The D.T.A. and reversible thermal expansion curves of the specimens are shown in Figs. 2 and 3 respectively. From the reversible thermal expansion figures for pure quartz given by Travers and Galubinoff<sup>7</sup> (Table 4) and the observed reversible thermal expansion of the specimens between 500° and 600° (Table 5), the approximate quartz content has been calculated by the following relation<sup>6</sup>:

$$\frac{L_1 X_v}{100} = \frac{L_2(100 - X_v)}{100} = Y$$

$$X_w = \frac{X_v \times d_Q}{d_S}$$

where  $L_1$  is (per cent) linear expansion of quartz between 500° and 600°C.;  $L_2$ , the (per cent) linear expansion of cristobalite, tridymite and silica glass between 500° and 600°C. (Table 4);  $X_v$ , quartz (per cent by vol.) in

the specimen;  $X_w$ , quartz (per cent by weight) in the specimen;  $Y$ , actual (per cent) linear expansion between 500° and 600°C.;  $d_Q$ , sp. gr. of pure quartz; and  $d_S$ , sp. gr. of the specimen.

The true specific gravities of the specimens, the quartz inversion peaks in the

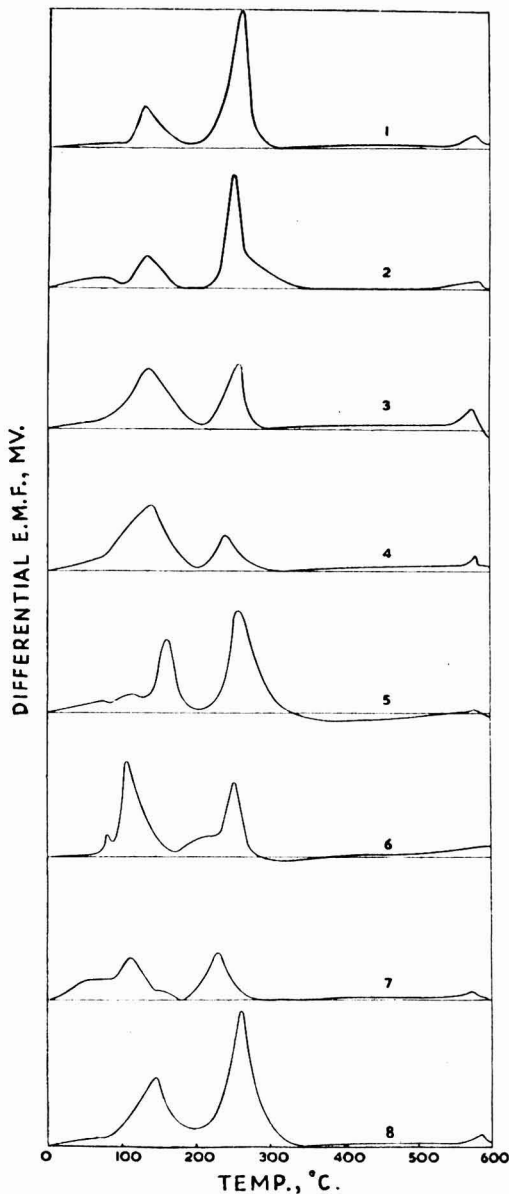


FIG. 2—DIFFERENTIAL THERMAL ANALYSIS CURVES OF THE DIFFERENT SILICA BRICKS

D.T.A. curves and the reheat expansion values agree, in general, with the residual quartz content calculated from the reversible thermal expansion values. The British specimen II has the maximum amount of unconverted quartz and the German specimen follows next; the two American specimens have the least amount. The two Indian specimens appear to be fairly well converted, their

residual quartz contents being 5 and 8 per cent respectively.

*Tridymite and cristobalite contents* — From the linear thermal expansion figures for the different polymorphic forms of silica and siliceous glass (Table 4), it is clear that the reversible thermal expansion due to cristobalite inversion between 200° and 300° is much higher than that of tridymite inversions between 100° and 200°. Hence, mixtures having equal proportions of tridymite and cristobalite or a higher proportion of cristobalite over tridymite are expected to have a higher reversible expansion in the cristobalite inversion range than in the tridymite inversion range. But from the expansion figures given in Table 5 it is evident that the expansion between 200° and 300° is less than the expansion between 100° and 200° in almost all the cases. This leads to the conclusion that in all the specimens tridymite is the predominant mineral, though the D.T.A. curves indicate otherwise. However, this apparent anomaly is due to the partial accommodation of the cristobalite expansion during inversion by the voids present<sup>8</sup> and also due to the influence of the glassy bond<sup>9</sup> in preventing the expansion and contraction of the cristobalite during inversion. Such suppression in the case of tridymite inversion is much less. The estimation of cristobalite and tridymite in silica bricks from their reversible thermal expansion, therefore, is likely to lead to erroneous results.

From the D.T.A. curve it appears that the two Indian specimens, the Japanese and the American conventional type (curves 1, 2, 8 and 5) have more cristobalite than tridymite. The American super-duty specimen and the British specimen II (curves 6 and 4) appear to have more tridymite than cristobalite. The British specimen I and the German specimen show tridymite and cristobalite in about

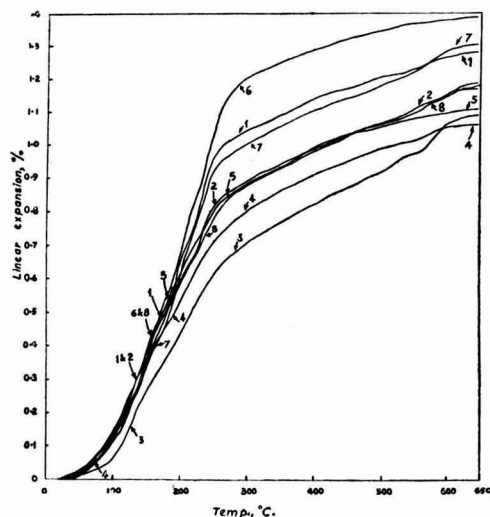


FIG. 3 — REVERSIBLE THERMAL EXPANSION CURVES OF SILICA BRICKS

TABLE 4 — REVERSIBLE THERMAL EXPANSION OF POLYMORPHIC FORMS OF SILICA

POLYMORPHIC FORM OF SILICA	% LINEAR EXPANSION BETWEEN THE RANGE (°C.)		
	100-200	200-300	500-600
Quartz	0.17	0.16	0.60
Tridymite	0.54	0.17	0.04
Cristobalite	0.24	1.12	
Silica glass	Coefficient of linear expansion $4 \times 10^{-6}$		

TABLE 5 — REVERSIBLE THERMAL EXPANSION OF SILICA BRICKS

No.	SOURCE	% REVERSIBLE THERMAL EXPANSION								% EXPANSION BETWEEN		
		100	150	200	300	400	500	600	650	100°-200°C.	200°-300°C.	500°-600°C.
1	Indian, I	0.12	0.37	0.65	1.04	1.14	1.20	1.27	1.28	0.53	0.39	0.065
2	Indian, II	0.14	0.36	0.59	0.89	0.99	1.07	1.15	1.19	0.45	0.29	0.080
3	British, I	0.06	0.26	0.43	0.70	0.82	0.92	1.06	1.09	0.37	0.27	0.140
4	British, II	0.11	0.33	0.53	0.80	0.91	0.99	1.05	1.06	0.42	0.27	0.065
5	American (conventional type)	0.13	0.39	0.62	0.88	0.99	1.05	1.10	1.11	0.48	0.26	0.045
6	American (super-duty)	0.14	0.36	0.66	1.20	1.29	1.35	1.38	1.39	0.52	0.54	0.035
7	German	0.12	0.34	0.59	1.00	1.10	1.17	1.28	1.30	0.47	0.41	0.105
8	Japanese	0.13	0.36	0.59	0.88	0.98	1.07	1.15	1.18	0.46	0.29	0.080

equal proportions. The approximate values for the combined tridymite and cristobalite content, obtained by difference, after accounting for glass content from the chemical analysis and the quartz content from the reversible thermal expansion data are given in Table 5.

The study of thin sections and powder mounts under the petrographic microscope confirmed, in general, the conclusions arrived at from other data like D.T.A. and thermal expansion regarding the mineral composition of the bricks. As single grains were commonly made up of two and sometimes all the three minerals with a quartz nucleus and cristobalite and tridymite in the periphery, no attempt was made to assess quantitatively the proportions of the different minerals present. From the viewpoint of service life of silica bricks, especially for the open hearth roof, the question whether a high tridymite or a high cristobalite brick is preferable, is controversial. At operating temperatures of the open hearth roof, cristobalite being the stable phase, even an all-tridymite brick will change over, in the first few days of service, to cristobalite at the hot zone. The other zones change over to the crystal phases most stable at the temperature gradients within the brick. Hence, but for the fact that a predominantly tridymite brick can be heated more safely in the initial heating up of the furnace, it confers no special advantage, and this deficiency in the cristobalite brick also can be overcome by taking due care in heating.

*Quality index* — In the absence of actual service performance data on the different brands of bricks studied in this investigation, a rough idea of their quality can be had from the quality index calculated according to Konopicky's suggestion<sup>3</sup> that the overall figure of porosity plus twelve times the alumina content was usually less than 40 for normal roof quality bricks and less than 25 for bricks used in fast operating furnaces. From the point of view of quality index, the Japanese brick is the best and the American super-duty bricks come next; the German brick and the two Indian brands I and II fall within the normal silica roof brick and the other three are of lower quality.

#### Summary and conclusions

There is very little difference in quality between the two brands of indigenous silica

bricks. They compare well in all respects with foreign silica bricks of the conventional type and have much lower permeability than others except the Japanese bricks. Their cold crushing strengths are almost equal to the average value for all the samples. The Indian specimen I is a fairly well converted brick with about 5 per cent residual quartz and an apparent porosity of 24 per cent which is normal for the conventional type of silica brick. The Indian specimen II has a slightly higher residual quartz content (*c.* 8 per cent) and lower porosity (22.6 per cent). The alumina and other deleterious flux contents of the two indigenous brands are almost equal to the average value for the conventional type of silica brick and both have fairly high underload values.

There is scope for improvement in the porosity of the indigenous bricks from their present level of 22-24 per cent to 15-16 per cent. This can be achieved by proper grain packing and high pressure forming provided the raw material has a low porosity after firing. By dense packing the crushing strength can be improved further.

The refractoriness underload can be further improved by more stringent selection of low alumina raw materials, more thorough washing and incorporation of low alumina-high silica sands, especially in the matrix.

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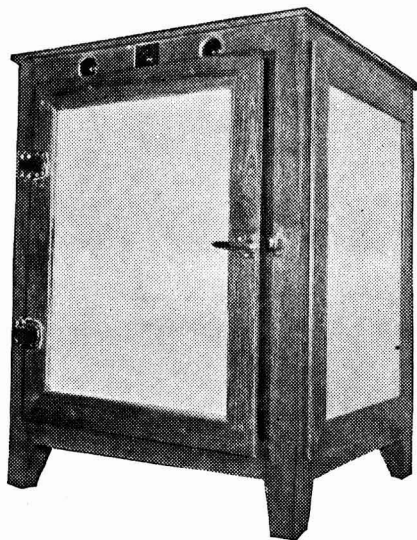
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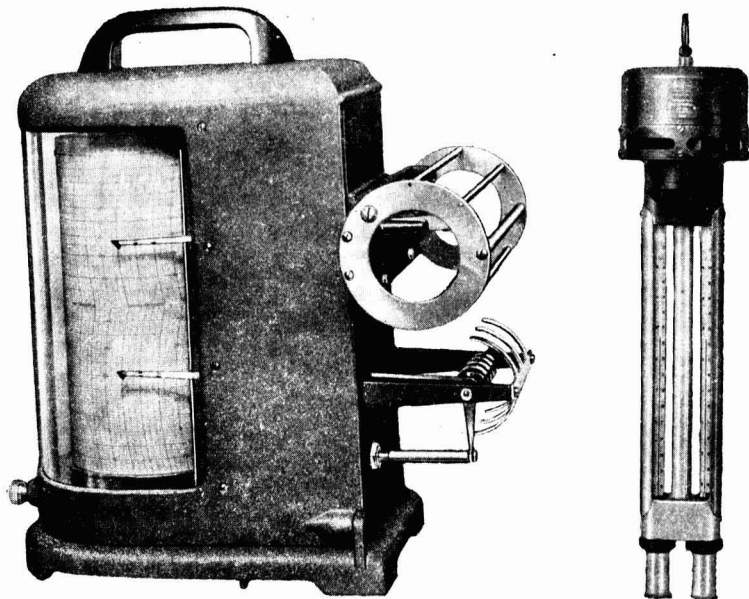
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