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SCIENCE REPORTER

JUNE 1977

QUEST FOR FUSION POWER

BINARY SYSTEM OF CALCULATING MACHINES

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IS LEAF SYNTHESIS POSSIBLE ?

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- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper, the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper
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VOL. 14 JUNE 1977 NO. 6

SCIENCE REPORTER

Cover: Male caribou at the Boston Zoo bearing a prominent palmate brow tine

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LETTERS

The strange world of viruses

Sir, In "Science for the Young" (*S.R.*, September 1976) the author has mentioned that viruses were nucleic proteins containing RNA or DNA or both. This is not correct, as viruses contain either RNA or DNA, but certainly not both. This important difference distinguishes viruses from other microorganisms which contain both DNA and RNA.

Nothing has been mentioned about the highly fatal rabies disease caused by a neurotropic myxo virus. All warm-blooded animals including man are susceptible to this infectious disease, which is primarily a disease of dogs, wolves and jackals and transmitted to other animals by bites. In human beings this disease is referred to as hydrophobia.

In South America, the blood-sucking vampire bats are known to be reserviors of this virus. They transmit the virus to human beings and animals while biting and sucking blood. Dogs carry the virus in saliva without exhibiting in the least the typical symptoms of rabies. It was reported that a dog lived upto two years carrying the rabies virus without actually suffering from the disease. Hence all dog-bite cases irrespective of the fact whether the dogs are rabid or non-rabid should be treated immediately for anti-rabies therapy; this disease is liable to spread quickly. Once the disease sets in there is no cure at all for the patient, and his sufferings are dreadful and heartrending.

S. AYYAMPERUMAL
Asstt. Lecturer
Department of Physiology
Madras Veterinary College
Madras-7

Ascorbic acid

Sir, I read the article, **Deterioration of ascorbic acid in diseased fruits** by D. P. C. Rao (*S.R.*, Feb. 1977) with interest. I would like to add the following points.

The nutritive value of fruits and vegetables depends largely upon their vitamin C (ascorbic acid) content. Of the common Indian fruits, mango, papaya and *Litchi* occupy an important position as sources of ascrobic acid.

R. H. Singh (1968) of Allahabad University, working with Shukul variety of mango, R. S. Bilgrami (1970) of University of Bihar, Muzaffarpur, with China and Sahi varieties of litchi, and P. S. Bisen (1972) of University of Jabalpur, with Edward and Keshari varieties of apple showed hundred per cent loss of ascorbic acid in 10 days after infection with *Aspergillus niger*.

The loss of ascorbic acid under pathogenesis may be due to the production of suitable ascorbic acid degenerating enzymes, either by the fungus alone or by the interaction of host-pathogen complex. This degeneration could be catalyzed by many enzyme systems including polyphenol oxidases, ascorbic acid oxidases, peroxidases and cytochrome oxidases.

U. C. JHA
Department of Post-Graduate Studies and Research in Botany
University of Jabalpur
Jabalpur

Spiders

Sir, In **How spiders catch their Prey** (*S.R.*, 19 Feb. 1977) B. L. Bradoo has given a lot of interesting information. I would like to add more. *Thalassivs spenceri*, the most interesting spider, was first discovered in Natal, and has since been found in the Persian gulf and elsewhere. It is a member of the family *Pisauidae*, has very long legs and lives close to water. It takes up its position with its two posterior legs resting on a stone ashore, and the other six are spread out upon the surface film. In this position the spider waits. Its long legs are wrapped round the fish, which is bitten and dragged ashore. The spider then eats the fish with unusual speed, leaving nothing except the backbone. It has also been seen to eat tadpoles of the toad—*Bufo cavens*, and adults of the small frog *Rhappia marmorta* (*The Biology of Spiders*—Theodore H. Savroy).

Again, the little swimmer, which scientists call *Argyroneta aquatica*, is one of the most unusual among the world's 30,000 known species of spiders. It lives almost its entire life beneath the surface of water, building air-filled domicles to dine, sleep and even hatch its young. It plunges into the water depths. Instead of carrying aqua lung, it wraps a glistening bubble of air around its abdomen and its breathing pores. It reaches the bottom and when its eight myopic eyes sight a shadowy movement it lunges to seize the quarry, an inch-long rainbow guppy fish. Injecting venom with its fangs, it kills the fish, and then seems to waltz in triumph with it across the aquarium floor. Later, it devours it at leisure in its submerged home (*National Geographic*, May 1972, p. 694.)

S. THIAGARAJAN
Assistant Professor of Zoology
Rajah Serfoji Govt. College
Thanjavur
Tamil Nadu 5613005

Alternative to sex ?

Sir, Thanks for the article **Alternative to sex** by N. S. Rangaswamy and Akhilesh Shrotria (*S.R.*, September 1976). The article is extremely informative to biology students and also useful to botanists, agriculturists, horticulturists and plant breeders. I request you to publish an article on androgenesis in plants. The androgenetic plants of rice, tobacco and potato which have already been raised in the test-tubes by botanists of Japan and India should also be described.

S. N. Dey
Machkhowa, Gauhati-781009
Assam

Rosalind Franklin

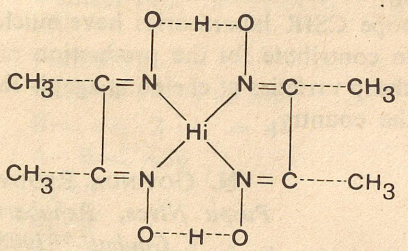
Sir, Sneh Prabha Mehta's article entitled **The woman behind the DNA scene—Rosalind Franklin** (*S.R.*, September 1976) has been well written. Last year a book entitled *Rosalind Franklin and DNA* was published (Norton, New York, \$8.95). The authoress A. Sayre, who was a close friend of Franklin, spent three years in researching Franklin's contribution in the elucidation of the structure of DNA. Sayre believes that, had Franklin lived, she would have been awarded the Nobel Prize in recognition of her contribution to the unlocking of molecular mystery of the genetic material.

R. K. Datta
Beth Israel Medical Center
New York, N. Y. 10003, U.S.A.

Hydrogen bond

Sir, Regarding **Hydrogen bond** (*S.R.*, Sept. 1976) I would like to know the following.

1. In almost all H-bonds the proton is not equidistant from the two atoms linked to it, but is nearer to the atom with which it is covalently linked. But, in very few cases like the familiar Ni $(DMG)_2$ complex the H-bonded proton is equidistant from the two oxygen atoms.



In fact, it is difficult to say which oxygen is H-bonded and which one is covalently linked. Is there any reason for this ?

2. Increase in the electronegativity of an atom enhances its capacity to form H-bond. Is this 'capacity' in any way related to H-bond strength? If so, why O—H......N hydrogen bond is stronger than O—H.........O hydrogen bond ? Though both chlorine and nitrogen have the same electronegativity values, the former is less effective in forming H-bonds. Why ?

3. Why are 'intramolecular' H-bonds weaker than 'intermolecular' H-bonds?

Kalipada Das
5 South Park, Jadavpur
Calcutta-700032

On the basis of pure electrostatic interaction, one may conclude that increasing the electronegativity of an atom increases its power of forming hydrogen bonds. The tendency for atoms to take part in hydrogen bond formation decreases in the order F, O, N, Cl and S. Though chlorine has the same electronegativity as nitrogen, it has only a very small H-bondforming power; this is attributed to its bulkiness which causes its coulombic interaction to be weaker than those of nitrogen. H-bonding interactions depend on the external conditions imposed upon them by the molecules involved and by the surrounding molecules. The resultant electron distribution in a molecule may polarize the proton donor group to produce a hydrogen bond. For example, the C—H bond, in general, is not sufficiently polarized to produce a hydrogen bond. But in HCN and $HCCl_3$, where the electron distributions in the molecules are such as to make carbon quite electronegative. Moreover in H-bonding, in addition to the major electrostatic interaction, delocalization, dispersion and repulsive interactions also play an appreciable role. The strength of an H-bond in A—H......B is determined by all these factors.

The two heavy atoms A and B have a tendency to shorten their mutual distance down to a minimum when free to do so. That is why the proton in FHF-ions and in nickel dimethyl glyoxime complexes is at the centre of the bond. These are called symmetrical hydrogen bonds. In such bonds, potential energy curves have only a single minimum, since the hydrogen bond is characterised by a deep minimum in the potential energy of the proton belonging to atom A and a high potential barrier.

In chelation, intra-molecular H-bonding inhibits the free rotation of the donor group. Even then, H-bond strength in chelation is very weak on account of the long H...B distance. Also it is theoretically established that the most stable configuration is the one with A—H bond along the lone pair direction. It indicates that the non-linear H-bonds in chelation must be weaker than that of inter molecular H-bonds.

M. Meyyappan
Assistant Professor of Physics
Government College (Men)
Kumbakonam (T.N)

Quiz

Sir, *S.R.* is of special interest and importance to all science students, particularly to younger students.

LIBRARY

University examination questions at present, specially on science subjects, are of 'quiz' type rather than the traditional broad questions. Besides university examinations in most competitive examinations science students have to face 'quiz' questions. Quiz questions are very interesting and they often offer better understanding.

My suggestion is that if you open a small, new section in *S. R.* on 'quiz' questions from experts in various science subjects, it will be of much interest to students as well as to others. Of course, space might be a problem and in that case I suggest 'quiz' can replace crossword puzzle in alternate issues.

KALIPADA DAS
5, South Park, Jadavpur
Calcutta-700032

Earwig

Sir, My thanks to Kumar Rajendra Singh for his article "Earwig" (*S.R. Nov. 1976*). The article is very interesting, but I would like to make a few comments.

Earwig (*Forficula anricularia*) should not be called a 'pest', because according to a recent concept, pests are those organisms which cause economic loss. We know that earwigs feed on dead and decaying animals and vegetables. Some have reported damage to crop plants, but the damage is below threshold injury level. So it is not a pest.

The name 'earwig' is due to semicircular ear-shaped hindwing.

Z. R. KHAN
Indian Agricultural Research Institute
New Delhi-110012

Chelating agents

Sir, I read the article **Chelating agents** by V. V. R. Sastry (*S.R.*, Oct. 1976). The article is concise and informative. It gives encouragement for the industrialists to start manufacturing various chelating agents for different applications. I hope CSIR laboratories have much to contribute for the production of cheap varieties of chelating agents in the country.

N. GOVINDA REDDY
Puspa Nivas, Rehabari
Gauhati-781008

Birds and ants

Sir, I would like to add the following to the **Science oddities** by Indira Rajagopal (*S.R.*, November 1976). Many song birds perform "anting" every two or three days, taking several minutes. Usually a bird picks up ants in beak and uses as a kind of spray can. The ant is capable of spraying the acid from its poison glands upto 20 cm. As this is a quick procedure, it has not been possible to study how the bird performs this toilet act. It has been beautifully filmed by Dr. Anke Querengasser of West Germany. The spray of acid appears to be most pleasurable to the birds and gives them a tingling sensation. During spraying, the bird closes its eyes to prevent the acid getting in and searing its cornea. When spraying is over the bird flings the ant away or gobbles it up.

Young starlings begin using ants as spray cans at the age of about five to six weeks. They tend to be timid about it at first and continue the procedure for a few seconds only. But by two months of age they are capable of using several ants at one time. By the time they are eighty days old they can spray themselves with twenty ants at a time. When the unfortunate insects are dead they are replaced by twenty new ones. This procedure may last upto twenty minutes. Some ornithologists are of the opinion that this behaviour is an instinct, but observations of ethologists do not confirm this conclusion. Young birds kept in captivity pick up variety of objects such as cigarette bits, mothballs, beetles and worms. When they realise that those objects could not provide the desired formic acid they throw them away and are not fooled again. Once a bird has a successful "fix" of formic acid it becomes "hooked" and is likely to try the trick again two or three days later.

Ornithologists are at present baffled by what the birds get out of this strange toilet act. One beneficial effect is to kill off irritating ticks in the wings and tail feathers. Yet the rump feathers, where most ticks are to be found, are never given the formic acid treatment. So, the real purpose must be something entirely different. One theory is that the formic acid is a medicinal preventive treatment to protect the birds from rheumatism to which their wing joints are particularly susceptible in cold weather. The use of formic acid in the treatment of rheumatics in human beings has long been known.

G. M. NATARAJAN
Deptt. of Zoology
Rajah Serfoji College
Thanjavur (Tamil Nadu)

Filariasis—its cause and control

Sir, I read the article **Filariasis—its cause and control** by Dr. Samar Chakrabarti (*S.R.*, December 1976) with much interest. The article was informative, written in an easily understandable manner and contained recent findings. Please publish more articles on other human parasites for the benefit of medical students.

SUBHABRATA ROY
Calcutta Medical College
Calcutta

Divisibility rule and remainder

Sir, K. R. Rajagopalan in his letter on "Divisibility rule" (*S.R.*, April 1977) has stated that "the divisibility rule by 11 will not admit of a method to find the remainder." The method for finding the remainder, in case the number is divided by 11 without actually dividing it, has been worked out by me and is given below :

Total the alternate digits starting from unit's digit. Let this total be 'A'.

Total the other set of alternate digits. Let this total be 'B'. Let A–B =C.

If (i) 'C' is a single digit and positive, the remainder, in case the number is divided by 11, will be C.

(ii) 'C' is a single digit negative, the remainder will be 11+C.

(iii) 'C' is more than one digit number. The above process is repeated giving a new set $A_1 - B_1 = C_1$. 'C_1' will, however, be a single digit number if the original number has less than 25 digits and will be the required remainder. In numbers of more than 25 digits C_1 may be two or more digited and the above process may have to be repeated.

Example:

1. 487693
   $A=3+6+8=17$
   $B=9+7+4=20$
   $A-B=C=-3$
   Since it falls under second category (single digit, negative), remainder will be $11+C=11-3=8$
2. 918290618
   $A=8+6+9+8+9=40$
   $B=1+0+2+1 = 4$
   $A-B=C=36$
   $A_1=6$
   $B_1=3$
   $A_1-B_1=C_1=6-3=3$ which is the remainder in case the number is divided by 11.

SURESH SAINANEE
Project Engineering Division
Engineering Projects (India) Ltd.
New Delhi-110001

Suggestions

Sir, I read with great interest **Improvements in gene isolation techniques** (*S.R.*, Aug. 1976). It helped me very much in my study. Now I want to see an article on hormones and enzymes and their activities in the living body.

K. JEEVAN RAO
College of Agriculture
Warora (M.S.)

II

Sir, I thank K. K. Tandon and Pushpinder Kaur for their article **A tale of tails** and Indira Rajagopal for her very interesting articles under **Science-oddities** in Nov. and Dec. 1976 issues respectively.

I request you to publish an article on Exoskeletons. We want to know how some animals use horns for their protection.

BRAJENDRA MISHRA
17-B, Philadelphia Hostel
E.C.C. Allahabad-211003

III

Sir, I request you to publish an article on viral diseases, especially on viral encephalitis with the latest treatment for the same.

S. D. SHARMA
G.G.S. Medical College
Faridkot (Pb)-151203

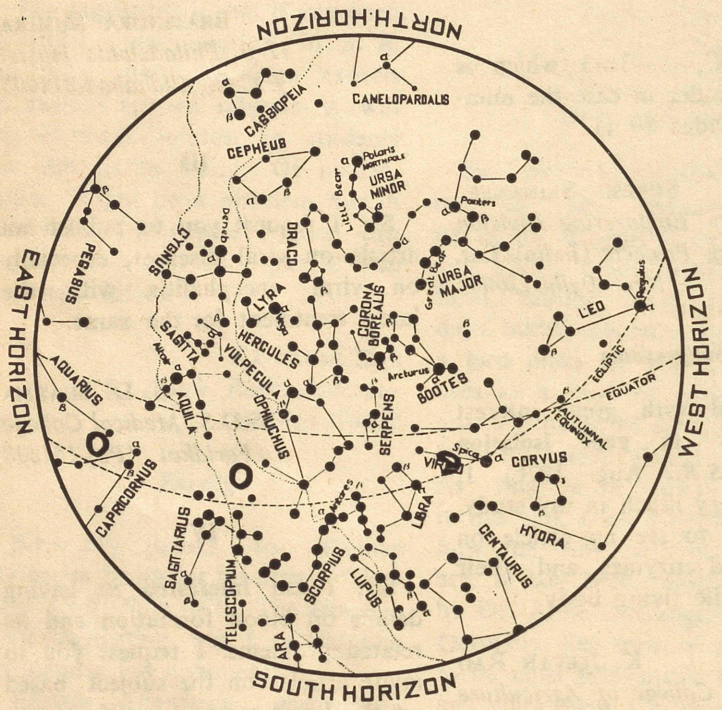
IV

Sir, I am interested in having details on blood formation and its related problems. I request you to invite articles on the subject based on the latest research work.

AJOY KUMAR PAUL
Deptt. of Zoology
University of Kalyani
Kalyani, Nadia (W.B.)

Planets and their positions

JULY 1977



MAGNITUDES

-1 0 +1 +2 +3 +4 +5

MOON

○ FULL MOON 1st & 30th

☽ FIRST QUARTER 24th

The moon

FULL moon occurs on 1st at 8-54 a.m. and again on 30th at 4-22 p.m. and new moon on 16th at 2-07 p.m. I.S.T. The moon passes about two degrees south of Mars on 11th, about a degree south of Venus on 12th, four degrees south of Jupiter on 14th, about six degrees south of Mercury and five and a half degrees south of Saturn on 18th. The lunar crescent becomes first visible after the new moon day in the evening of 18th.

The moon is at apogee or farthest from the earth on 12th and at perigee or nearest to it on 28th.

The earth is at aphelion or farthest from the sun on 6th.

The planets

Mercury (Budha) is too near the sun to be visible during the first quarter of the month. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes about half a degree north of Saturn on 20th. It also passes very close to the star Regulus (*Magha*) on 28th. It moves from Gemini (*Mithuna*) to Leo (*Singha*) through Cancer (*Karkata*). Its visual magnitude varies from -1.1 to $+0.3$.

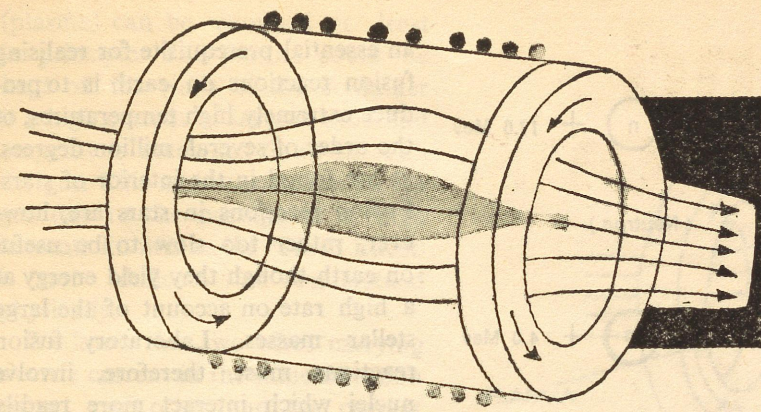
Venus (Sukra), visible in the morning sky, rises about two hours after local midnight during the month. It passes about three degrees north of the star Aldebaran (*Rohini*) in the early hours of 16th. It also passes about one and a half degrees south of Jupiter on 30th. It moves from Taurus (*Vrisha*) to Gemini (*Mithuna*). Its visual magnitude is about -3.7.

Mars (Mangala), a morning star, rises about an hour after local midnight during the month. It moves from Aries (*Mesha*) to Taurus (*Vrisha*). Its visual magnitude is about $+1.2$.

Jupiter (Brihaspati), visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month and about two and a half hours before it during the second half. It moves from Taurus (*Vrisha*) to Gemini (*Mithuna*). Its visual magnitude is about -1.5.

Saturn (Sani), an evening star, sets about one and a half hours after sunset during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It is in Cancer (*Karkata*). Its visual magnitude is about $+0.7$.

(*Source :* Nautical Almanac Unit of the Meteorological office, P-546 Block'N', New Alipore, Calcutta-53)



QUEST for fusion power

S. P. TALWAR

Due to acute shortage of conventional fuels serious efforts are being made to exploit nuclear fusion for energy

FROM times immemorial man has been using conventional fuels like coal for meeting his daily needs. However, due to rapid industrialisation in the world, there has arisen an acute shortage of conventional fuels. The world is facing an energy crisis and a search for alternative sources of energy is afoot.

The present world consumption of energy is estimated at about 0.2 Q per year and is increasing by 3 to 5 per cent every year. A rough picture of the global energy consumption in the past is given in the Table 1 alongwith the extrapolated consumption rate during the first half of the 21st century. We note with concern that a rate of 1 Q per year is fast approaching, and, naturally, enquire if the world has enough fuel to meet the demands of future. The coal, gas and oil reserves of the world are estimated at 40 Q and are therefore likely to be completely exhausted soon. Alternative sources of power are solar energy, geothermal energy, wind power, tidal power and nuclear power. At present serious efforts are being made to exploit them for the benefit of mankind.

Nuclear fuels

During atomic and hydrogen bomb explosions, both fission and fusion forms of nuclear energy are respectively released instantaneously. However, the energy so released is uncontrolled and thus not useful. What is, therefore, needed is to 'tame' these reactions so that the energy is released at a more leisurely rate rather than in an explosive manner. The fission energy, arising due to fragmentation of heavier nuclei of uranium, thorium, etc., has since been tamed and is available in a controlled manner from various atomic reactors. However, the entire deposits of the fissionable materials in the world are roughly 10^8 tons (equivalent to 600 Q), which, if fully exploited, should serve the human needs for the next several hundred years—a rather small interval of time on the geological scale. In addition, there is the problem of radioactive waste as also the problem of quite a few 'have not' countries who will have to depend on others for the supply of the fissionable material.

Fusion material, deuterium (an isotope of hydrogen), on the other hand, is abundantly available in the form of sea water; it amounts to about 10^{14} tons (roughly equivalent to 10^{10} Q). This should then be able to supply one thousand times the present power consumption for one billion years. Other additional factors in favour of controlled fusion energy are the comparatively low cost in production; a number of

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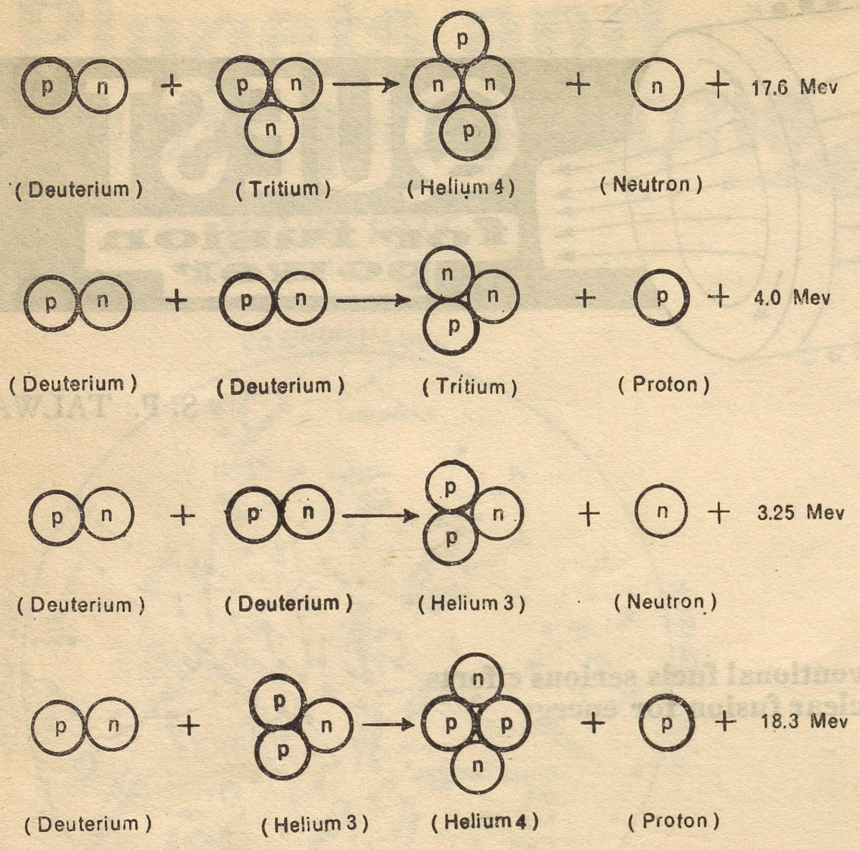


(1 Mev = 1.6×10^{-13} joules of energy)

Fig. 1. Fusion reactions

'have not' countries, the distribution of water reasonably uniform the world over; and essentially negligible radiation problems. Unfortunately, fusion energy is not yet possible to obtain in a controlled manner. If it were possible in some way to accomplish a fusion reactor, this surely would have solved the energy problem for almost all time to come.

Fusion reactions

To answer the question as to why it has not been possible so far to obtain controlled fusion, we need to understand the process of fusion of two nuclei. It is clear that the fusion of two deuterium nuclei is possible only if they can approach very close to each other (less than about 10^{-12} cm), when they can feel the strong short range nuclear forces. This, however, cannot happen unless the charged nuclei strike against each other so hard as to overcome their mutual repulsive Coulomb force arising due to the positive charge of the nuclei.

Fusion reactions take place in the interior of stars and are now believed to be responsible for the energy release from stars. In stars, light nuclei fuse together to form heavier nuclei, releasing a corresponding energy for the loss of mass during the process. The energy so released is given by Einstein's famous mass-energy equivalence relation, $E=mc^2$ (where m=mass loss and c=velocity of light). So in most stars hydrogen forms the 'fuel' and helium the 'ash'. Fusion reactions take place in stars on account of their extremely high temperatures. It is thus clear that an essential prerequisite for realising fusion reactions on earth is to produce extremely high temperatures, of the order of several million degrees, as are found in the interior of stars. Fusion reactions in stars are, however, rather too slow to be useful on earth though they yield energy at a high rate on account of the large stellar masses. Laboratory fusion reactions must, therefore, involve nuclei which interact more readily like deuterium and tritium (the two isotopes of hydrogen) (Fig. 1)

The magnetic bottle

The problem of generating extremely high temperatures in laboratory is essentially similar to that faced by the alchemists, who, apart from being interested in making gold from the base metals, wanted to evolve a universal solvent which could dissolve all material substances. However, before they could think of such a substance, they had to bother about a bottle to contain that, because otherwise the bottle itself would be dissolved ! Surely, what bottle could hold a fluid that would dissolve everything ? The situation with regard to ultra-high tem peratures is similar, though not that hopeless. How do we contain such hot stuff, having million degrees temperature, even if it were somehow available. The physicists have, however, found an answer. They have been able to evolve what is known as a 'magnetic bottle' in which an ionized gas

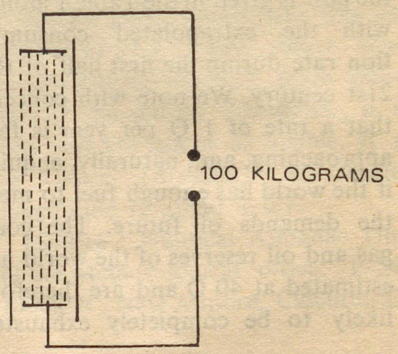


Fig. 2. The linear pinch

(plasma) can be confined at least in principle. The plasma could be kept off the walls of the container if a high current of several thousand amperes is made to flow through the gas. This self-constriction in the gas due to the passage of a high current, known as the 'Pinch Effect' is not difficult to understand physically.

We know that two wires carrying electric current in the same direction attract each other and the current flowing in the gas could be regarded as being made up of a large number of such wires carrying parallel currents. In principle the pinch effect looks docile but in practice causes headaches. It is true that a 'magnetic bottle' is possible, but the difficulty is that the plasma, being kept off the walls, becomes violently unstable (Fig. 2). It wriggles back to the walls within a few microseconds, so that the nuclear reactions are not possible. The 'magnetic bottle' thus turns out to be 'leaky'.

A quantity of interest in thermonuclear work is the Lawson parameter given by the product NT of the number of particles per c.c. N in the plasma and the time of stable confinement T. For net output of energy the value of this parameter should exceed 10^{14} cm^{-3} sec. With number density (N) in the range 10^{13}-10^{17} per c.c., the time of stable confinemet (T) should thus lie in the range of 10-10^{-3} sec. A major part of the present research in controlled fusion is devoted to finding ways and means for extending the confinement time to a reasonable fraction of a second so that thermonuclear reactions could take place.

The promising CTR devices

Several controlled thermonuclear (CTR) devices have been suggested and tried since 1958 when the secrecy restrictions on fusion work were removed. Many of them have since been rejected as futile attempts while some others are still regarded as promising ; for example, the minimum B-geometry and the Tokamak. All these devices make use of magnetic fields as a confining agency for the charged particles (electrons and ions) constituting a plasma. They are based on a well-known fact that a charged particle gyrates around the lines of force.

The minimum B-geometry is based upon the magnetic mirror concept. In it a longitudinal magnetic field is applied externally to the

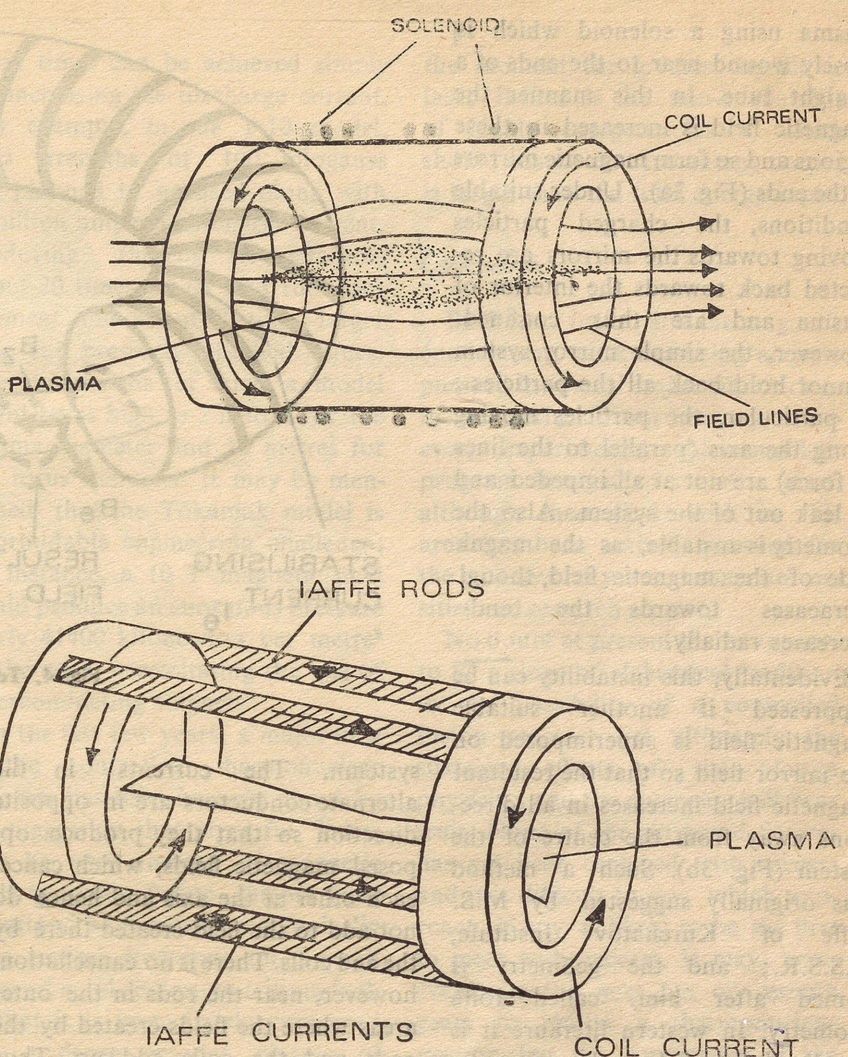
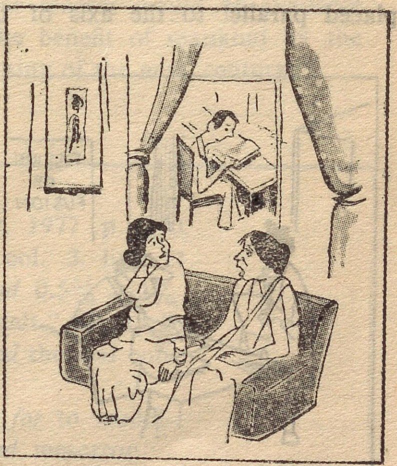


Fig. 3. Mirror (*top*) and Ioffee (*bottom*) geometry



"First he worked on fission which led him to a split personality. On my suggestion, he is now working on fusion to regain his unified personality"

plasma using a solenoid which is closely wound near to the ends of a straight tube. In this manner the magnetic field is increased in these regions and so form magnetic mirrors at the ends (Fig. 3a). Under suitable conditions, the charged particles moving towards the mirrors are reflected back towards the interior of plasma and are thus confined. However, the simple mirror system cannot hold back all the particles ; in particular, the particles moving along the axis (parallel to the lines of force) are not at all impeded and so leak out of the system. Also the geometry is unstable, as the magnitude of the magnetic field, though increaeases towards the ends decreases radially.

Evidentally, this instability can be suppressed if another suitable magnetic field is superimposed on the mirror field so that the resultant magnetic field increases in all directions away from the centre of the system (Fig. 3b). Such a method was originally suggested by M.S. Ioffe of Kurchatov Institute, U.S.S.R.; and the geometry is named after him, called Ioffe geometry. In western literaure it is usually designated as the minimum B-geometry. It consists of four conducting rods carrying current placed parallel to the axis of the

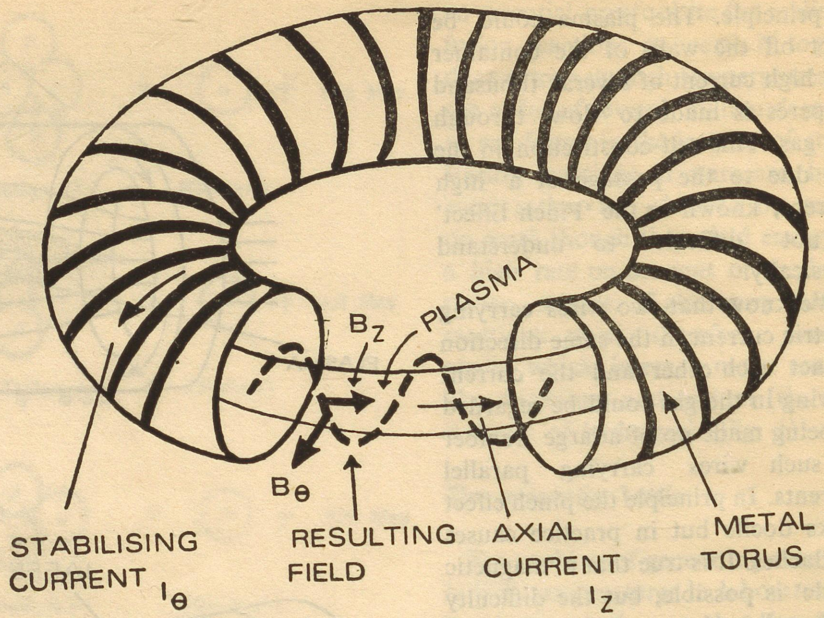
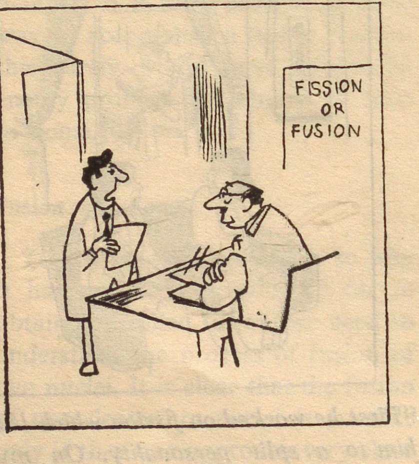


Fig. 4. Tokamak geometry

systemn. The currents in the alternate conductors are in opposite direction so that they produce opposed magnetic fields, which cancel each other at the axis and hence do not add to the field created there by the end coils. There is no cancellation, however, near the rods in the outer areas where the fields created by the rods and the coils add up. Thus the magnetic field is weakest at the centre and bcomes stronger towards the walls, so that the particles are reflected inward, no matter where they seek to escape.

Tokamak is perhaps the most promising CTR device which uses magnetic confinement. It is a toroidal (endless) system in the form of a doughnut (Fig. 4). In the open CTR devices like the mirror, the confinement time is limited as the charged particles leak through the system along the lines of force. These end leaks are naturally absent in endless systems and the only way the plasma can escape from this trap is by crossing the lines of force. This crossing is carried out either by diffusion process or an interchange instability in which the plasma and the magnetic field change places. This expulsion of the plasma can, however, be minimised by using helical magnetic fields as in a Tokamak. Tokamak also originated in the U.S.S.R., though at present several laboratories in the world are working on improved versions of this geometry.

The special features of Tokamak are: a doughnut shaped vacuum chamber, a toroidally wound solenoid carrying current (I_o) which provides a strong magnetic field (B_z) around the torus, and a transformer threading the torus such that the plasma ring inside it acts as the secondary. A plasma current (I_z) is induced around the torus on energising the transformer. This current does a two-fold job: it heats the plasma by Ohmic dissipation while simultaneously provides the confinement of the plasma column through the force arising due to interaction with its self magnetic field (B_z). The strong toroidal magnetic field (B_z) parallel to the current (I_z) helps in preventing the instability of the plasma column.



"My thesis is on:"Diffusion of confusion over fission and fusion"

Table 1

World energy consumption

Time	*Energy consumed*
Upto 1850	<10Q
1850—1950	4Q
1950—2000	15Q
2000—2050	100Q

World energy reserves

Fuel	*Energy potential*
Conventional fuels	
gas,oil and coal	40 Q
Fission fuels	600 Q
Fusion fuels	1010Q

$1Q = 10^{21}$ joules of energy
(enough to raise the temperature of 2400 Km^3 of water from 0° C to 1000° C without boiling it).

The work on the first generation of Tokamak models has produced ion temperatures of about 10 million degrees and the Lawson parameter NT as 10^{12} cm^{-3} sec. Work is currently in progress in several laboratories in the world on the second generation of Tokamaks; T-10 model in the U.S.S.R., PLT model at Princeton, U.S.A. and Divertor model at Culham, England. The reason for the optimism shown towards the Tokamak is that higher temperatures and longer confinement times can be achieved simply by increasing the discharge current. For example, in the T-10 model, field strengths of 100 kilogauss are planned to be used along with a million amperes discharge current, producing thereby temperatures about 20 times larger and the confinement time about 50 times larger than the presently attained values. The dimensions of such a model might be as high as 2 metres for the plasma diameter and 10 metres for the torus diameter. It may be mentioned that the Tokamak model is a formidable engineering challenge; for instance, a 10 T magnetic field would produce an enormous pressure nearly 41400 kilonewton per $metre^2$ on the coils, necessitating the use of superconducting magnets.

In the last few years, a major turn to the controlled thermonuclear program has been brought about by the suggestion that powerful lasers may be used instead of magnetic fields to realise fusion. Intense laser radiation is focussed isotropically from several directions on a small pellet of solid deuterium-tritium fuel, so that it is immediately converted into a dense gaseous plasma of density in the range of 10^{19}-10^{22} particles per c.c. With this high density the thermonuclear reactions may be sustained without any external confinement. However, at the moment the greatest hurdle in laser fusion is the non-availability of highly energetic lasers, which should ensure that the energy output is larger than the total energy input.

Conclusion

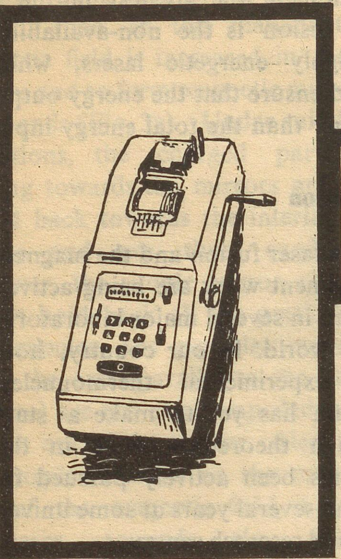
Both laser fusion and the magnetic confinement work are being actively pursued in several major laboratories in the world. In our country, however, experimental thermonuclear program has yet to make a start, although theoretical work in this area has been actively pursued for the past several years at some universities and research centres.

No doubt at present there appears to be a tinge of alchemical tradition to the possibility of a controlled fusion reactor, but ultimately the sustained efforts of the plasma physicists and the engineers will bear fruit. None of the proposed devices has yet been crowned with success and it is difficult to say, which approach, if any, is likely to be the first to meet with success. It may however take the next ten or twenty years to realize a thermonuclear reactor, but the importance of the problem in itself justifies a major effort. One hopes that a thermonuclear reactor would be available for the benefit of mankind by the beginning of the next century.

CORRIGENDA

1. Ref. Article "Organotin chemicals in industry". SR May, 1977 p. 290, col. 2, line 3 *for* R_3 SnX_2, R_2 SnX_3 *read* R_3SnX, R_2SnX_2 and col. 3. line 11 *for* o cyte *read* octyl. p. 293, col. 1, line 16 *for* 0.5% =2% *read* 0.5% – 2%
2. Ref. (*i*) Article "Sodium — the uncommon metal from common salt." SR April, 1977, p. 233 col.1, line 1. *for* thermal conductivity at 20°C *read* thermal conductivity at 200°C

(*ii*) Article "History of particle physics". p. 219, para 4, line 11 *for* to modifications *read* no modificatios; p. 220, col. 2 line 21 *for* mestron *read* mesotron
(iii) Article "IMS — a potent mutagenic agent" SR April 1977, p.248, para 1 line 3 and 4 *for* Stadler working on common shrub (Datura), *read* working on barley (*Hordeum vulgare*); p. 244 col. 2 para 1, line 25 for (X-or α-rays) *read* (X-rays or γ-rays).



BINARY SYSTEM

THE BASIS OF CALCULATING MACHINES

Binary system is an important device for transformation and transmission of information process

BHARATI BANERJEE

ONE of the most fascinating features of the present rapid technology is the 'information processing' system—the technology based on the transformation and transmission of information. With the development of new technologies, the mathematicians became more aware of the importance of the binary system, which is an essential factor for digital computers. It is one of the most important devices for transformation and transmission of information process.

The computer is like a human brain but works million times faster for solving problems. The binary system is not only useful for computer but is also an important tool for elementary advanced mathematics.

Binary system is nothing new, only its importance has increased tremendously in recent years. The system was known in ancient China. The Britishers used the binary system in their weighing units of pounds with the help of 1 lb., 2 lb., 4 lb., 8 lb. and 16 lb.; maximum weight of 31 lbs. could be weighed.

The pure mathematicians were also fascinated with two and powers of two. There are several instances of fascinating nature of two. For example, consider Pascal's Triangle. (Table 1)

We find a distinct relationship between the total and the number of lines. If there are 7 numbers of lines, the total would be 2^7 if there are n numbers of lines, the total would be 2^n.

We are also familiar with surprising growth of 2 under the process of doubling it. If we put a grain of wheat on the first square of a chess board, 2 grains on the 2nd square, 4 grains on the 3rd square and so on, the last square will need 2^{64-1} number of grains, which is equal to 18, 446, 744, 073, 709, 551, 616.

Binary system

The binary system deals with two number symbols 0 and 1. The number system we are using in our every day life is known as 'denary' or decimal system. In this system we are using ten basic number symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Probably ten fingers in a man's hands is the cause of adopting ten number symbol. The system was invented by Hindus, and Arabs spread it over the Western countries. This system is concise and economic. We can express any number however small or large it may be with the help of only these ten basic number symbols. The symbol "Zero" invented by Hindus

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Table 1. Pascal's triangle

Lines	Sequence	Total	Powers of two
0	1	1	2^0
1	1 1	2	2^1
2	1 2 1	4	2^2
3	1 3 3 1	8	2^3
4	1 4 6 4 1	16	2^4
5	1 5 10 10 5 1	32	2^5

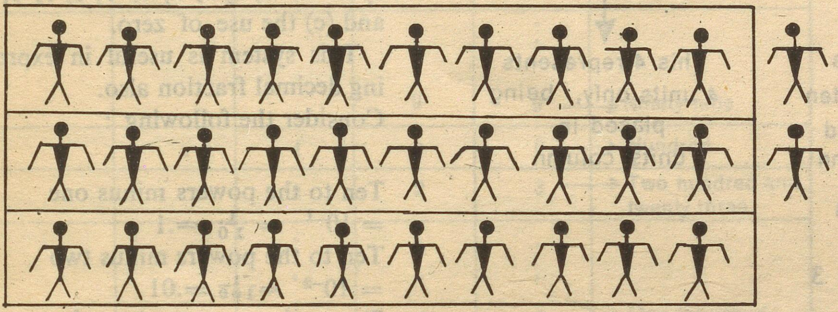

Fig 1. 3 groups of ten + 2 groups of one

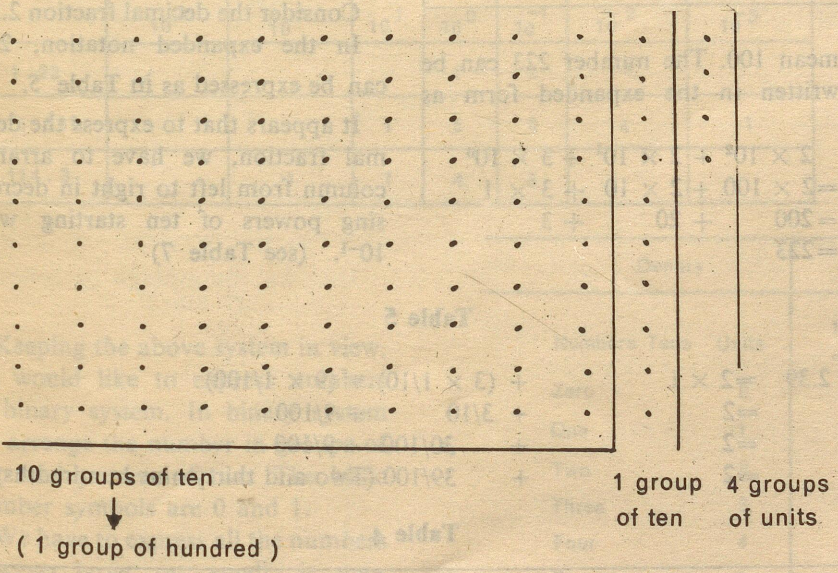

Fig. 2

plays the key role in this system.

If we understand the nature of decimal system, it will be easier for us to have a proper concept about the binary system. In decimal system, we use ten basic symbols, in binary only two symbols, in octal we use the eight basic symbols 0, 1, 2, 3, 4, 5, 6, 7.

In decimal system we arrange the numbers in 'groups of tens' and consequently in 'powers of tens'. If we have 9 marbles, we can count from 1 to 9 and represent it with these numbers from 1 to 9. If we have ten marbles, then to represent this we use the idea of one group of ten and write as 10.

Look at the figure 1 representing the number of persons in a group.

If we group these persons in tens, we find there are 3 groups of tens and 2 groups of one. So we write 32, which means $3\times10+2\times1$. Look at the array of dots in Fig. 2.

In Fig. 2 we have arranged the dots in groups of tens. There are ten groups of ten (representing one group of hundred), one group of ten and 4 groups of units. In all they represent 114. We can arrange them in columns as shown in Fig. 3 (next page).

Since 'ten' is the basis of grouping in 'denary' system, we can have columns arranged in powers of tens. (see Table 2 next page)

Hence, with this notation Fig 3 becomes Table 3 (next page)

Consider now the Table 6. From this table, it is clear that the number from 0 to 9 are placed in units column. For ten, we are writing 1 in the column of ten and '0' in the column of units. This indicates only one group of ten and zero group of unity. For twenty, we mean two groups of ten. For ninety

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Table 2

Ten to the power zero = 10^0 $=1$
Ten to the power one = 10^1 $=10$
Ten to the power two = $10^2 = 10 \times 10$ $=100$
Ten to the power three $= 10^3 = 10 \times 10 \times 10$ $=1000$
and so on.

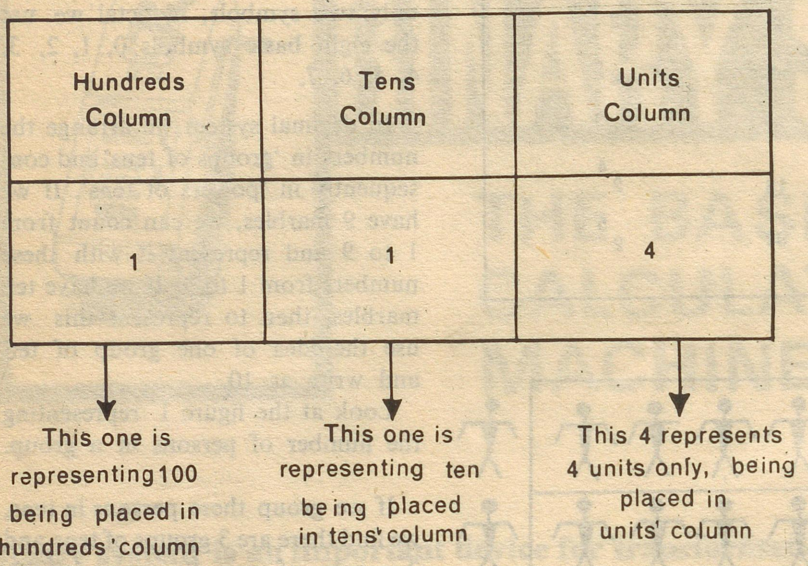


Fig. 3

Table 3

10^2 1000	10^1 10	10^0 1
1	1	4

nine, we are writing 9 in the column of ten and 9 in the column of units indicating nine groups of ten and nine groups of unity.

In the expanded notation, this can be expressed as

$$9 \times 10^1 + 9 \times 10^0 = 9 \times 10 + 9 \times 1$$
$$= 90 + 9$$
$$= 99$$

Hence the numbers from 10 to 99 are expressed by the two columns of ten and units respectively. Hundred means one group of hundred, zero group of 10 and zero group of units. 1 written in place of 10^2, 0 in place of 10^1, and 0 in place of 10^0 mean 100. The number 223 can be written in the expanded form as

$$2 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$$
$$= 2 \times 100 + 2 \times 10 + 3 \times 1$$
$$= 200 + 20 + 3$$
$$= 223$$

It is clear now, how zero plays a key role in decimal or denary system and how we are utilizing the place value system. In the number 223, 2 being placed in hundreds' column represents 200, 2 in tens' column represents 20 and 3 in unit's column represents 3 units only.

From the above examples, it is apparent that we can continue increasing number of columns having consecutive powers of ten in increasing order and as such we can express any number however large it may be. Hence the basic features of denary system are: (a) arrangements of numbers in groups and powers of ten; (b) the use of ten symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9; and (c) the use of zero.

This system is useful in expressing decimal fraction also.

Consider the following :

Ten to the powers minus one
$= 10^{-1} = \frac{1}{10} = .1$
Ten to the powers minus two
$= 10^{-2} = \frac{1}{100} = .01$
Ten to the powers minus three
$= 10^{-3} = \frac{1}{1000} = .001$

To express the number 1.2 see Table 4.

Consider the decimal fraction 2.39. In the expanded notation, 2.39 can be expressed as in Table 5.

It appears that to express the decimal fraction, we have to arrange column from left to right in decreasing powers of ten starting with 10^{-1}. (see Table 7)

Table 5

$$2.39 = 2 \times 1 + (3 \times 1/10) + (9 \times 1/100)$$
$$= 2 + 3/10 + 9/100$$
$$= 2 + 30/100 + 9/100$$
$$= 2 + 39/100 \text{ (Two and thirty nine hundredths)}$$

Table 4

Number	Units place	One tenth place
1.2	1	2

Table 6

Ten thousands 10^4	One thousands 10^3	Hundred 10^2	Tens 10^1	Units 10^0 1	Numbers
				0	Zero
				1	One
				:	
				9 →	Nine
			1	0 →	Ten
			:	:	
			1	5 →	Fifteen
			:	:	
			2	0 →	Twenty
			:	:	
			9	9 →	Ninety nine
		1	0	0 →	Hundred
		2	2	3 →	Two hundred and twenty three
		:	:		
	1	0	0	0 →	One thousand

Table 7

Number	Thousands 10^3	Hundreds 10^2	Tens 10^1	Units 10^0	Tenth 10^{-1}	Hundredth 10^{-2}	Thousandth 10^{-3}
1.23				1	2	3	
15.541			1	5	5	4	1
114.3		1	1	4	3		

Keeping the above system in view, we would like to express numbers in binary system. In binary system we arrange the number in groups of two and powers of two. The basic number symbols are 0 and 1.

We have to express all the numbers however large or small it may be with the help of two symbols 0 and 1 only. Thus in binary system one is 1; two is one group of two and written as 10; 2 is 11 (one group of 2 and one unit); four is 100 (one group of 2, zero group of 2 and zero group of units) and so on. Consider the Table 8.

Consider the array of dots as shown in Table 9 (next page. Therefore, the number of dots in the array expressed in binary system is (11 11) two.

To differentiate binary numbers from denary numbers, we use a suffix of 2 with binary number. So the above number in binary system would be (11 11) two.

Now let us compare the number in binary and denary system by doubling the member.

Denary 0 1 2 4 8 16
Binary 0 1 10 100 1,000 1,0000

We find that when we are doubling the denary number we are adding one zero to the corresponding binary number. If we arrange the number in different columns, denoted by the different powers of 2 to indicate different place, we find multiplying by two means shifting one place to the right. This property is useful in calculating machines and so multiplication becomes as easy as addition.

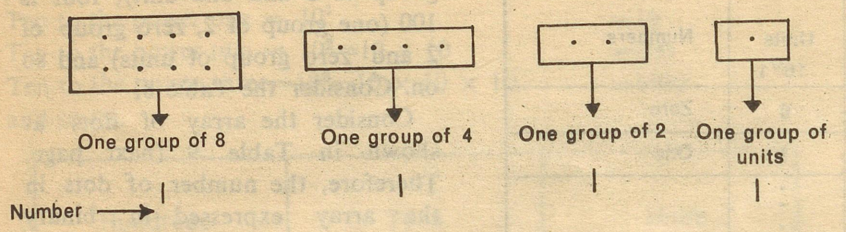
Conversion of denary number to a binary number

Since in binary system arrangements are made in groups and powers

Table 8

Denary			Binary				
Numbers	Tens	Units	16's $=2^4$	8's $=2^3$	4's $=2^2$	2's $=2^1$	Units $=2^0$
Zero		0					0
One		1					1
Two		2				1	0
Three		3				1	1
Four		4			1	0	0
Five		5			1	0	1
Six		6			1	1	0
Seven		7			1	1	1
Eight		8		1	0	0	0
and so on							

Table 9



of two, we divide a denary number by 2 and continue the process until the remainder is zero.

Consider the denary number 25 expressed as $(25)_{10}$

We first divide 25 by 2 to find how many groups of two are there and how many units are left.

Division $\quad 2/25 \quad$ Remainder 1
$\overline{12}$
Quotient

We find that there are 12 groups of two and one unit. So the digit in the unit's place will be 1. Now all twelves cannot be expressed in the two's column, we divide 12 by 2 again and see how many groups of four (2×2) there are and what will be the remainder

Division $\quad 2/12 \quad$ Reminder 0
$\overline{6}$
Quotient

We see that there are 6 of (2×2) grouping and the reminder is 0. We place the reminder 0 in two's column.

We continue dividing in this manner, since we cannot record 6 of the (2×2) grouping in the 4's column. Consider now Table 10. What we get in that is being represented in Table. 11.

Hence the corresponding binary number is $(11\ 00\ 1)_2$

Consider the number $(15)_{10}$ in Table 12.

Table 12

2	15	
2	7	Reminder 1 units place
2	3	Reminder 1 two's place
2	1	Reminder 1 four's place
	0	Reminder 1 eight's place

So the number will be $(11\ 11)_2$

Conversion of a binary number into number

Consider the binary number $(11\ 00\ 1)_2$-The number can be arranged in columns of twos as ni: Table 13

In the expanded notation

$$(11\ 00\ 1)_2 = 1\times16+1\times8+0\times4+0\times2+1\times1 = 16+8+0+0+1 = (25)_{10}$$

This can be done in another way also. Multiply repeatedly by 2 beginning from the left and add in the next digit each item. (See Table. 14 next gage).

We know that in our well known denary system four fundamental operations are addition, substraction, multiplication and division. In binary system also we have four fundamental operations.

1. Addition : For the binary addition we have to remember that arrangements are done in group of two. We have zero, one; instead two we write $(10)_2$ as one group of 2

Hence

$0+0=0$
$0+1=1$
$1+0=1$
$1+1=(10)_2$ one group of two

Table 13

32's 2^5	16's 2^4	8's 2^3	4's 2^2	2's 2^1	Unit 2^0
	1	1	0	0	1

Table 10

2	6	
2	3	—Reminder 0, this will be placed in 4's column
2	1	—Reminder 1, this will be placed in 8's column
		—Reminders 1, this will be placed in 16's column
	0	

Table 11

Place	16's	8's	4's	2's	1's
Number	1	1	0	0	1

This we can arrange as follows:

Operation		Column 1	Column 2
Operation	+	0	1
Row 1	0	0	1
Row 2	1	1	10

Table 14

1	1	1	0	1
$1 \times 2 = 2$				
	$3 \times 2 = 6$			
		$7 \times 2 = 14$		
			$14 \times 2 = 28$	
			29	

Hence $(111\ 01)_2 = (29)_{10}$

Start with the number 0 in row 1, to be added to the number 0 in column 1. We write down the result $0+0=0$ in the intersection of row 1 by column I. If we like to add 1 in row 2 to 1 in column 2, the result is $1+1=(10)_2$ recorded in the intersection of row 2 and column 2.

Example: $(11)_2+(11)_2$
$= (10\ 10)_2$

(2) *Substraction*: Since substraction is an inverse operation of addition, we can remember the basic facts.

Subtraction
$0-0=0$
$1-0=1$
$1-1=0$
$(10)_2 -1=1$

Addition
$0+0=0$
$0+1=1$
$1+0=1$
$1+1=(10)_2$

Example :

$(101)_2 - (11)_2 = (10)_2$

Table 15

Operation		Column 1	Column 2
Operation	×	0	1
Row 1	0	0	0
Row 2	1	0	1

(3) *Multiplication :* The basic facts to be remembered for multiplication are the following :
$1\times1=1$
$1\times0=0$
$0\times0=0$
$0\times1=0$

This can be written as shown in Table 15

Consider the number 0 in row 1 to be multiplied by the number 1 in column 1. The product is 0 and recorded in the intersection grid of row 1 and column1. If we want to multiply 1 in row 2 by 1 in column 2, the product is recorded in the intersection grid of row 2 and column 2

Example:

$$
\begin{array}{r}
(110)_2\times(10)_2 \\
110 \\
10 \\
\hline
000 \\
110\times \\
\hline
1100 \\
\hline
\end{array}
$$

Hence $(110)_2\times(10)_2=(1\ 100)_2$

(4) *Division* : Since division is an inverse operation of multiplication, we can perform division by remembering basic facts of multiplication and subtraction of binary numbers.

Binary system and its uses

The above discussion, in short, shows that the binary number follows all the four fundamental operations. This can be readily used in elementary mathematics as well as higher and advanced mathematics.

The binary system is now being very effectively used in computers and thereby helps in the development of various branches of mathematics.

The abacus probably is the earliest mathematical machine. Blaise Pascal, of France, in 1642 invented first calculating machine. In 1671, German mathematician and philosopher Leibnitz invented a machine which was useful for four fundamental operations, namely, addition, subtraction, multiplication and division. In England, Engineer Charles Babbage, in 1833, designed a machine named as Analytical Engine, which was more sophisticated and useful in nature. He tried to develop it further but probably the reason for lack of development was the use of denary system. Leibnitz pointed out the advantage of binary system of representing numbers but he never used the idea himself. The binary computer came into existence in 1940-50 and since then binary system is gaining ground in helping the growth of modern technology.

The electronic digital computers have two basic components : (1) Memory element, (2) Logical elements (switching elements). These elements are binary. The circuit that stores the information to solve a particular problem is known as "Memory". The recording is done on magnetic tape or on punched card or on a magnetic revolving drum. These devices are basically binary inform.

It is also useful for simple logic. In the logical choice 'yes' or 'no' the two symbols 1 and 0 can be used precisely. The machine can be adjusted for 'and', or and 'neither' decision only.

(*Continued on page 407*)

SUPERHEAVY ELEMENTS OF THE FUTURE

RABIN TARAFDAR

Recently the discovery of some super heavy elements has been claimed and existence of many new metals has been announced

In recent years there have been claims for the discovery of super heavy elements. Recently (*Physical Review Letters*, July 1976), a group of scientists in the U.S.A. announced the existence of element No. 126 and a doubtful evidence even for elements No. 114, 116, 124, 125 and 127 in a Madagascan sample of mica on the basis of X-ray spectra. First, we should know if there is any scope to synthesise new elements; second, which positions of the Periodic Table are relatively easy to fill up and likely to be filled up in the near future (or which elements need a rigorous search in nature) and third, what the chemical properties of such elements will be.

On the earth we have only 92 elements in different isotopic forms. The remaining 11 members of the existing Periodic Table are all laboratory, made, and all of them are potentially unstable. In fact, filling up of the Periodic Table was started just after its publication by Mendeleev in the year 1869, when he left deliberately a number of gaps in it which were filled up later on. After the advent of atomic particle accelerator machines the extension of the Table started and all the elements from 93 to 103 were synthesised. In fact, some of the lower elements, namely, 43 and 61 are also synthetic elements.

When the two stable components of an atomic nucleus, proton and neutron, jointly called nucleons (neutron is semi-stable, outside the nucleus it ultimately decays to proton and electron with half life period of about 12 minutes), come closer to a distance of about 10^{-13}cm., they exhibit a very strong, attractive force called nuclear attractive force. The nature of this force is still not completely known, but it is the strongest of all the known forces like gravitational and electromagnetic forces.

These forces of attraction within the nucleus operate between any two nucleons irrespective of their charges, i.e., between proton and neutron, neutron and neutron, proton and proton. But in the last case, in addition to the attractive force, the coulombic repulsive force between the similar charges does exist. The distance-dependent nature of these two forces, nuclear attractive force

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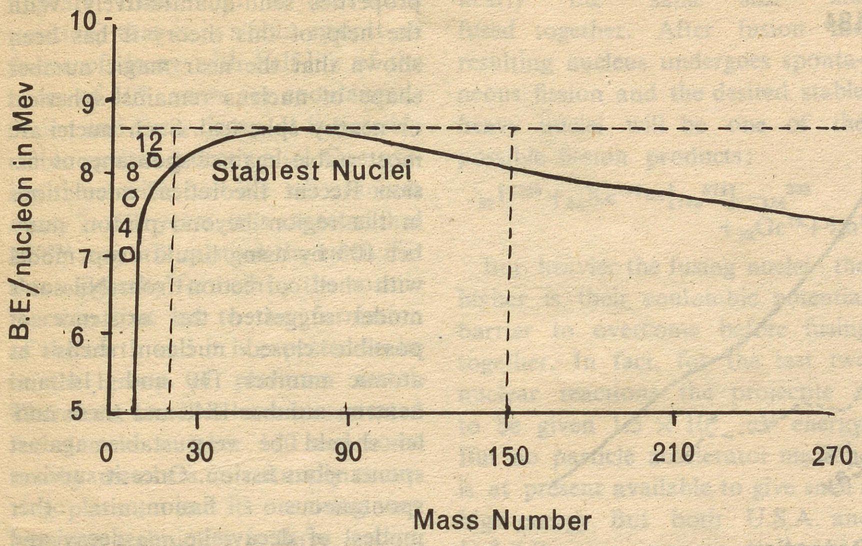


Fig. 1

and coulombic repulsive force, between the protons is different. The latter is inversely proportional to the square of the distance but the former varies still more rapidly. Consequently, when distance between two protons is about 10^{-13} cm, the two forces are nearly the same. But at still smaller distances nuclear force becomes much stronger than repulsive force. At greater distances, the coulombic repulsive force becomes more stronger.

Consequent upon this short-range nature of nuclear force each nucleon will interact strongly only with its nearest neighbours, say 8 to 12 nucleons. But the coulombic repulsive force between the protons is long-range type. So each proton will repel every other proton in the nucleus and tends to break down the nucleus. That is why starting from the nucleus of hydrogen atom, as the number of proton and neutron increases, stability of the resulting nuclei at first increases, but after a certain mass number stability decreases with the further addition of nucleons. This decreasing stability restricts the number of elements in nature. Thus, when one more proton is added to a nucleus of $_{82}Pb^{208}$ which has 82 protons, it experiences attractive nuclear-interaction from only a limited number of nucleons due to short-range nature of the nuclear force. However, it repels each of the 82 existing protons. Therefore, addition of protons in heavy nuclei increases the destabilising force more rapidly than the stabilising force. If we plot the stability per added nucleon against the mass number, we get a curve (Fig. 1) popularly known as binding energy curve per nucleon. The stablest nuclei have mass numbers from 20 to 120.

To understand the interaction of the nucleons in the nucleus, Danish Scientists, Niels Bohr and J.A. Wheeler, developed in 1939 the "Liquid Drop Model" for nucleus. The central idea of this model is that the nucleons in the nucleus are held together by the nuclear force and assume a spherical shape (like small drops of liquids of high surface tension). When the shape is spherical, the surface area is minimum and a minimum number of nucleons

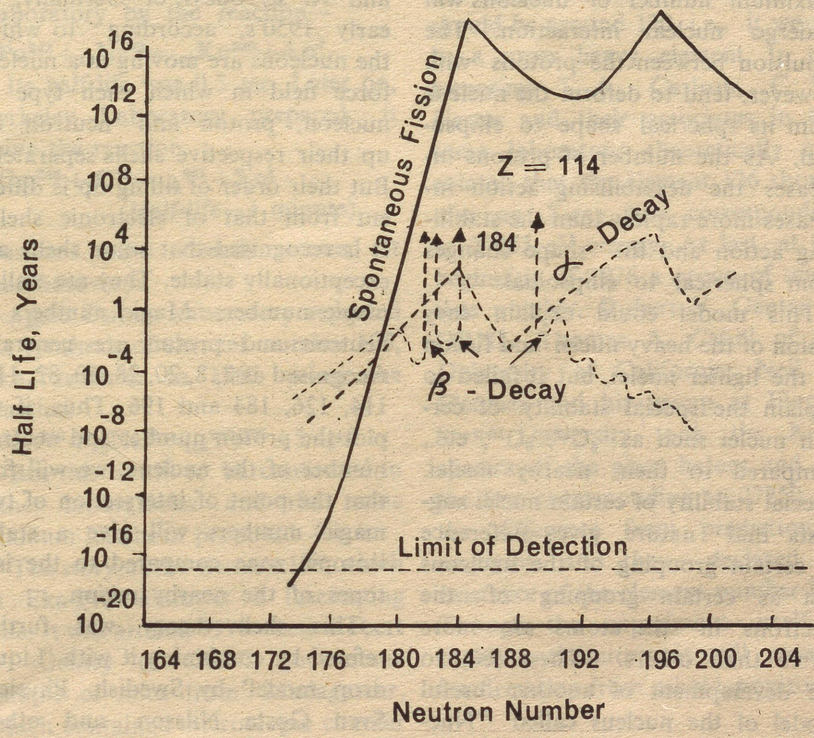


Fig. 2

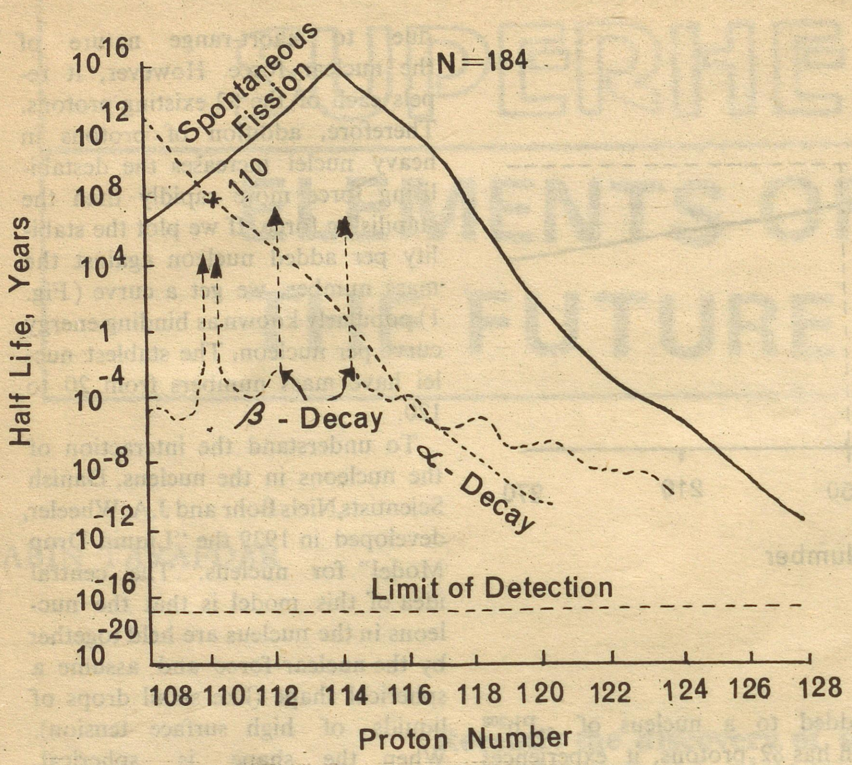


Fig. 3

will be on the surface and a maximum inside the drop. Consequently maximum number of nucleons will undergo nuclear interaction. The repulsion between the protons will, however, tend to deform the nucleus from its spherical shape to ellipsoidal. As the number of protons increases the destabilising action increases more rapidly than the stabilizing action and the shape changes from spherical to ellipsoidal.

This model could explain easy fission of the heavy nuclei and fusion of the lighter nuclei, but it failed to explain the special stability of certain nuclei such as $_6C^{12}$, $_8O^{16}$, etc., compared to their nearby nuclei. Special stability of certain nuclei suggests that nature gives preference to certain grouping of the nucleons just as certain grouping of the electrons in the atoms are more stable than others. These led to the development of another useful model of the nucleus called "Nuclear Shell Model", developed by Maria Goeppert Mayer of U. S. A., and O. P. L. Haxel, J. H. D. Jensen and H. E. Suess of Germany, in early 1950's, according to which the nucleons are moving in a nuclear force field in which each type of nucleon, proton and neutron fill up their respective shells separately. But their order of filling up is different from that of electronic shells. It is recognised that some shells are exceptionally stable. They are called magic numbers. Magic numbers of neutron and proton are generally recognised as 2, 8, 20, 28, 50, 82, 110, 114, 126, 184 and 196. Thus, if we plot the proton number and neutron number of the nucleus, we will find that the point of intersection of two magic numbers will give a stable isotopic zone compared to the isotopes of the nearby region.

This shell theory was further refined by combining it with 'Liquid drop model' by Swedish Physicist Sven Gosta Nilsson and others during the year 1959. This unified model now can predict many nuclear properties semi-quantitatively. With the help of this theory it has been shown that the near magic number shape of nucleus remains spherical or nearby spherical. Such nuclei are most stable against spontaneous fission. Recent theoretical calculations in the region beyond proton number 103 by using liquid drop model with shell correction from Nilsson's model suggested the existence of possible closed nucleon shells at atomic number 110 and 114 and neutron number 184, and these nuclei should be very stable against spontaneous fission. Once it survives spontaneous fission, other modes of decay, i.e., α-decay and β-decay become more important. Therefore, Nilsson and his associate Chin-Fu-Tsang calculated the stability of the nucleus against these modes of decay in this zone and their results are presented in Fig. 2 and Fig. 3.

In Fig. 2 half-life of different modes of decay of the element Z=114 is plotted as the function of number of neutrons. Here as the neutron number increases the life against spontaneous fission also increases, and reaches maximum at N=184 and 198 and life against-decay reaches maximum at N=184. Again the life against-decay becomes maximum at N=184 and at 197. Thus, for Z=114 the stablest nucleus will be at N=184. Similarly, in Fig. 3 half-life of different modes of decay for the nuclei containing 184 neutrons is plotted against number of protons (Z). Here we get two detectably stable nuclei at Z=110 and 114. Thus, Z=114 and N=184 represent an isotope which is quite stable against all sorts of decay. Its half-life for spontaneous fission is 10^{16} years, half-life for α - decay is greater than 1 year and that for β-decay is also high whereas the apparatus used to detect the super heavy elements, can detect a particle which exists even only for 10^{-9} secs. More hopeful is the isotope 110^{294}, It appears from Fig. 3 (star-mark position) that it is stable against all forms of decay with half-life of the order of 10^8 years for spontaneous fission and for α-decay. It is possibly stable against β-decay also. Comparing these with half-life of uranium decay 7×10^8 years, it is expected that 110^{294} may still exist on the earth if it was originally formed by the cosmic reaction that led to the formation of the earth and it is expected to be in the group of platinum metal. Therefore, searches have been started for element number 110 and some nearby members in naturally occurring platinum and its ore using very sensitive techniques in three leading laboratories of the world, namely, Lawrence Radiation Laboratory, Berkeley; Oak Ridge National Laboratory(ORNL) and Joint Institute of Nuclear Research, Dubna, U.S.S.R. So far no trace has been found and the technique of detention indicates that if it is at all present it must be less than one part in ten billion parts of platinum. Flerov and his associates in Dubna, however, claim that they have discovered spontaneous fission in lead sample that may be due to element number 114 (homologue of lead). In fact, around Z=110 to 114 if the half-life of α-decay be somewhat greater than that estimated in Fig. 3, then it is quite expected that they may exist in nature in trace.

Methods of synthesis of super heavy elements

Scientists are at present thinking of two techniques to produce super heavy elements : (1) Bombarding a neutron-rich transuranic nuclei with another neutron-rich relatively lighter nuclei of proper proton number such as—

$$_{96}Cm^{248}+{}_{18}Ar^{40}={}_{114}{}^{284}+4_0n^1$$
$$_{94}Pu^{244}+{}_{20}Ca^{48}={}_{114}{}^{288}+4_0n^1$$

But these techniques will barely reach the required mass number; (2) Two neutronrich nuclei of nearly the same size are fused together. After fusion the resulting nucleus undergoes spontaneous fission and the desired stable heavy nuclei will be one of the possible fission products:

$$_{92}U^{238}+{}_{54}Xe^{136}=[_{146}{}^{374}]—_{114}{}^{298}+{}_{32}Ge^{72}+4_0n^1$$

But heavier the fusing nuclei the higher is their coulombic potential barrier to overcome before fusing together. In fact, for the last two nuclear reactions the projectile is to be given 1.5×10^9 eV energy. But no particle accelerator machine is at present available to give such a high energy. But both U.S.A. and U.S.S.R. may improve the existing machines to carry out such reactions.

The recent super-heavy elements 104, 105 and 126 deserve a special mention. The element number 105 which is expected to be grouped in group IV-B below Hafnium and, following the fashion of Mandeleev, may be called Eka-Hafnium. This element was synthesised by Flerov and his associates in 1964 in Dubna Laboratory by the reaction—

$$_{94}Pu^{242}+{}_{10}Ne^{22}={}_{104}Ku^{260}+4_0n^1$$

Its half-life was 0.5 sec. Later on, Berkeley Laboratory prepared it using the reaction

$$_{96}Cm^{248}+{}_8O^{18}={}_{104}{}^{261}+5_0n^1$$
(Half-life=1 minute)

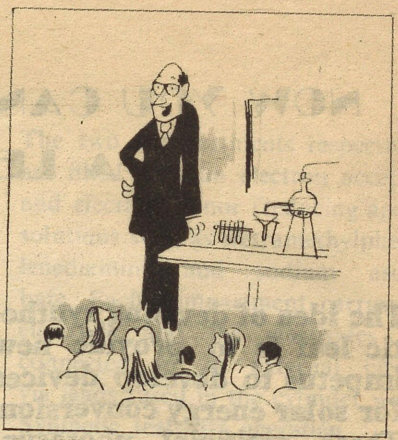
Russians have already named it Kurchatovium.

Again Dubna Laboratory reported the synthesis of element number 105, Eka-Tantalum in 1967 using the reaction

$$_{95}Am^{243}+{}_{10}Ne^{22}={}_{105}{}^{260}/{}^{261}+5/4_0n^1$$

But this is still to be confirmed in other laboratories and the name Hanium has been proposed for it.

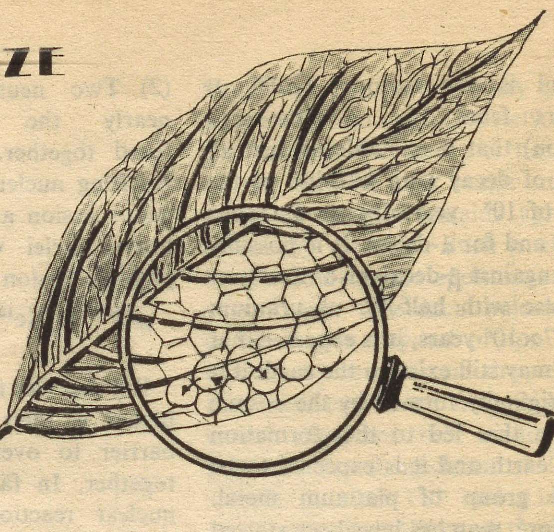
The story of the element 126 which is Eka-Plutonium is a fascinating one. It was around 1970 when Robert V. Gentry of ORNL got some sample of mica from Madagascar, which contained microscopic circular patches (30 to 60 micron; 1 micron= 1×10^{-4} cm) known as haloes. The haloes are always present in the rocks containing radioactive elements. It is due to the α-ray emitting radioactive inclusion and each α-ray emitter has its characteristics haloes. But some of the haloes of his mica sample were abnormally large (more than 110 micron compared to 30 to 60 micron which normally occurs), and could not be assigned to any known element, so he concluded that it must be due to some new element or elements present in these mica and the atomic number of the element should be around 120, i.e., it would be a super heavy element. In the meantime T. A. Carlson, C. W. Nester and their associates in the same laboratory theoretically calculated that the element 126 should give an X-ray line corresponding to 27253 eV energy. At last, at the beginning of 1976 a group of scientists notably, Robert V. Gentry of ORNL, Thomas A. Cahill of the University of California, Neil R. Fletcher and his group at Florida State University took the X-ray spectra of the giant haloes and got the line corresponding to 27250 eV, the difference from prediction is negligible and they declared the existence of the element number 126. Though the experiment itself is highly satisfactory, it still requires confirmation from other laboratories.



"The work on superheavy elements of the future has run into heavy weather at present"

(*Continued on page 393*)

NOW YOU CAN SYNTHESIZE A LEAF



The idea of devising synthetic leaf is to provide new impetus to develop devices for solar energy conversion. These artificial photosynthetic units can convert light energy into electrical energy

S. SEENI

To absorb light is the primary act of photosynthesis. The main pigments of photosynthesis for absorbing light in higher plants are chlorophylls. Robert Emerson and William Arnold (1932) of the University of Illinois (USA), considered chlorophyll molecules to be distributed in the form of numerous clusters or units. Molecules of each group work together to bring out the evolution of O_2. This led to the concept of photosynthetic unit (PSU) : a group of 250-300 closely packed chlorophyll molecules capable of effecting a photochemical act. Functionally the chlorophyll molecules comprising the PSU can be divided into two types namely antenna and reaction centre molecules. They constitute 99% and 1% respectively of the total chlorophyll molecules.

Antenna chlorophyll molecules serve to absorb incident photons (light energy concentrated in small particles) of the sunlight. Light energy absorbed by the antenna chlorophyll is converted into electronic excitation energy which is transferred via adjacent chlorophyll molecules until it reaches the specialized chlorophyll *a* molecules, perhaps only two in number—called energy traps or reaction centres. The reaction centres utilize the excitation energy to pump electrons from electron donors to electron acceptors in the electron transport chain. The photosynthetic unit and the primary photoact at the reaction centre are shown in Fig. 1.

The *in vivo* mechanism of conversion of light energy by chlorophyll molecules in the leaf known as for the past few years has of late been analysed on an entirely different perspective by Dr. Joseph J. Katz and his associates at Argonne's Laboratory, USA. They have designed a synthetic approach to delineate the functions of chlorophyll in photosynthesis. The idea is mainly based on assembling a well defined *in vitro* system which is comparable in all respects to the *in vivo* preparations or even whole leaf cells. Their attempts have provided a new impetus to develop devices for solar energy conversion. The first elegant device of the kind developed and employed by the group to use the *in vitro* analogues of the *in vivo* components is a synthetic leaf. The synthetic leaf provides a simple system where the photosynthetic units are artificially constructed and the chlorophyll device so formed can convert light energy into electrical energy. It faithfully mimics the light conversion phenomenon in the leaf cells of higher plants.

In vitro synthesis of PSU

The Argonne scientists have proposed well defined models for the artificial synthesis of photosynthetically active antenna and reaction centre chlorophyll molecules respectively and their potential use in the synthetic leaf device.

(*a*) *Model for the antenna*: Chlorophyll *a* molecules, when suspended in aliphatic hydrocarbon solvents like carbon tetrachloride or octane, are capable of self-aggregation and produce oligomeric species that are active in transferring light energy. The formation of oligomers or dimers becomes feasible by the coordination of the magnesium atom in an acceptor chlorophyll molecule to the ring-V, ketocarbonyl group of adonor molecule (Fig. 2). Such a bonding permits the stringing together of many chlorophyll molecules to form long chains of antenna with the sequence chl/chl/chl/chl/chl/chl/.

(*b*) *Model for the reaction centre*. The long chains of antenna chloro-

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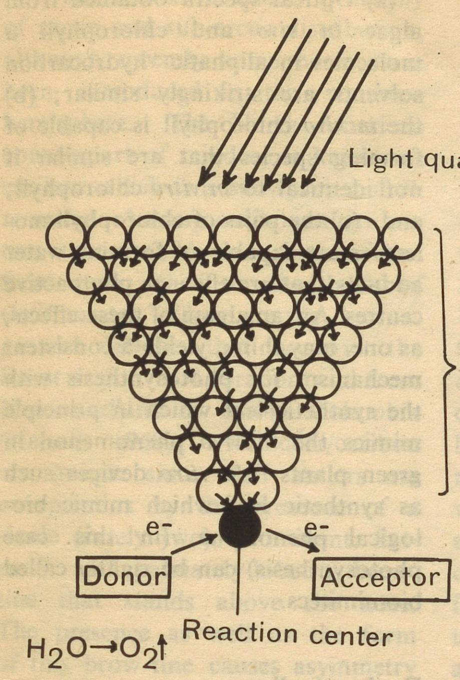


Fig. 1 A photosynthetic unit

phyll molecules under the circumstances described can terminate in a particular pair of molecules that forms the photoactive centre through water adduction. In other words, when chlorophyll-water adducts are suspended in an aliphatic hydrocarbon solvent, water plays an important role in cross-linking a terminal pair of chlorophyll molecules to form a reaction centre. Water acts as a bifunctional ligand (an agent capable of donating electrons to a metal cation). It can coordinate to the central magnesium atom of a chlorophyll molecule with the available oxygen atom and its two hydrogen atoms are then freely available for binding to another chlorophyll molecule. The interaction of water with a chlorophyll oligomer results in the formation of adduct having the following structure : chl/HOH/chl. Such a chlorophyll-water adduct has been experimentally shown to be active upon irradiation.

The models of the antenna and reaction centres can be usefully combined to form PSU of the following structure which can act as an electron pump :

—chl/chl/chl/chl/chl/chl/chl

antenna

chl/HOH/chl

reaction centre

Synthetic leaf—its components

The synthetic leaf with its ability to convert light energy into electrical energy supports and makes use of the models described above. An outline diagram of this device is given in Fig. 3.

The synthetic leaf device is nothing but a type of photoelectric cell which employs chlorophyll as the primary element. It is a glass cylinder partitioned into two compartments by a plastic semipermeable membrane or aluminium foil. A chlorophyll-water adduct is impregnated in the membrane or deposited on one side of the metal foil by evaporation from an aliphatic hydrocarbon solvent like octane suspension of the adduct. The two compartments respectively are filled with an electron acceptor and electron donor (reducing agent) solutions such as tetramethylphenylenediamine and sodium ascorbate. Each compartment carries an electrode and the electrodes are connected to an external circuit via leads fused in the cylinder walls.

Synthetic leaf—its operation

The synthetic leaf, to start with, is thermally equilibrated in the dark. The photoactive chlorophyll impregnated on the membrane or the metal foil is irradiated with white or red light and one could easily record and analyse the electrical effects in the external circuit. Dr. Katz observed a potential difference across the cell on irradiation. Also ob-

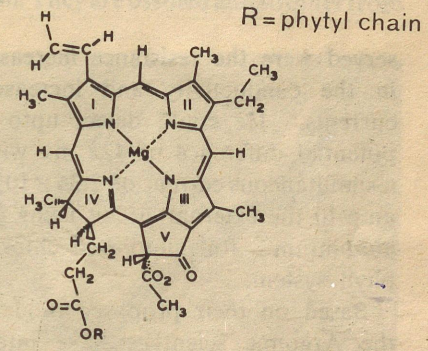


Fig. 2. Structure of chlorophyll *a* showing ring-V ketocarbonyl group

"And the priority should be on synthesizing tea leaves and betel leaves"

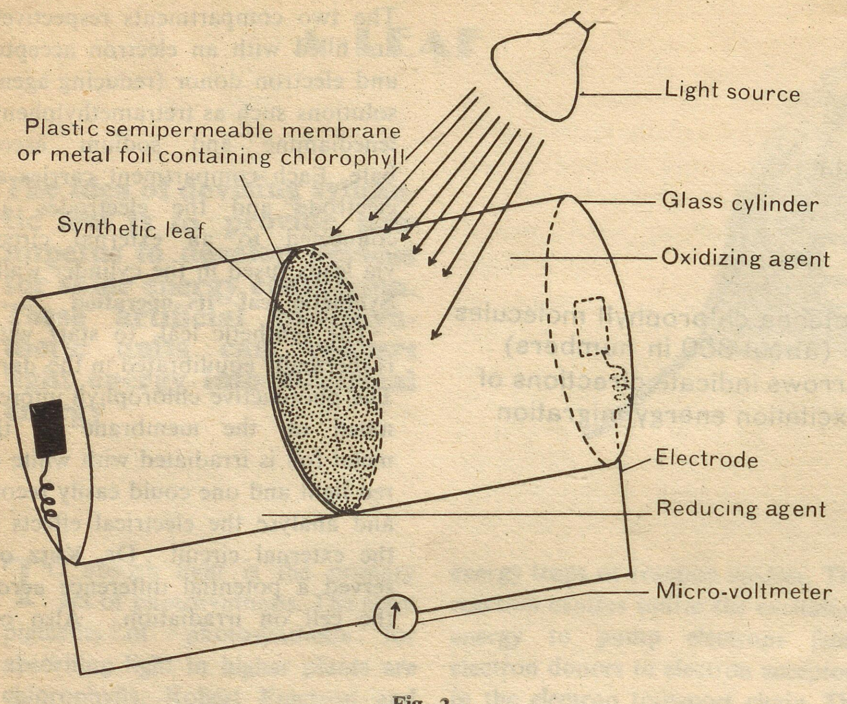


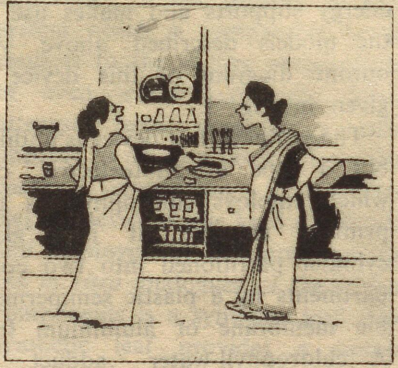
Fig. 3

served were the resistance increases in the conductivity and increased currents. He could detect upto a potential difference of 422 mv with a simultaneous current of 2.36×10^{-5} amp in the external circuit using an aluminium foil supported chlorophyll system.

Based on their proposed models, the Argonne scientists have interpreted the results obtained in the synthetic cell and compared them with the *in vivo* mechanism. Light quanta are easily harvested by the *in vitro* formed antenna chlorophyll molecules and the excitation energy is transferred to the special pair of chlorophyll (reaction centre) at the terminus where oxidation and reduction can occur. The terminal reaction centre consisting of chl/HOH/chl is a valid functional structure since the available evidences tend to point out that light conversion *in vivo* occurs at a special pair of chlorophyll molecules constituting the photoreactive centres. However it has not been unequivocally proved that the two chlorophyll molecules *in vivo* are linked water to form a kind of chlorophyll-water sandwich.

Synthetic leaf—supporting evidences

Modern spectroscopic studies provide the following supporting evidences for the functional integrity of the *in vitro* antenna—reaction centre chlorophyll system of the synthetic leaf :



"While he tries to make a leaf in the lab., I try to make a loaf in the kitchen"

(a) Optical spectra obtained from algae *in vivo* and chlorophyll *a* molecules in aliphatic hydrocarbon solvents are strikingly similar; (b) the *in vivo* chlorophyll is capable of forming species that are similar if not identical to *in vitro* chlorophyll; and (c) the pairs of chlorophyll molecules are capable of forming water adducts that are efficient photoactive centres. An amalgam of these effects, as one may think, yields a consistent mechanism for photosynthesis with the synthetic leaf which in principle mimics the *in vivo* phenomenon in green plants. *In vitro* devices such as synthetic leaf which mimic biological phenomena (in this case photosynthesis) can be rightly called biomimitecs.

Further reading

1. Govindjee and Rajni Govindjee (1975), Introduction to Photosynthesis, In: *Bioenergetics of Photosynthesis*, Academic Press, USA.
2. 'Synthetic leaf mimics plants' light conversion, *Chemistry & Engineering News*, Vol. 54, No. 7.

It pays to advertise in Science Reporter

THE reindeer (*Rangifer tarandus*) is a mammal primarily of arctic and sub-arctic distribution, although recently some herds have been introduced in the southern hemisphere. The North American counterpart of reindeer is known as caribou which is a sub-species of *R. tarandus*. Among caribou, there are two types which are distinguished from each other on the basis of their habitat. These are the barren-ground caribou that occupy the forest region of Labrador, and from Newfoundland to British Columbia (Kelsall, 1968). Reindeer/caribou are unique since their antlers are conspicuous by the presence of a single (rarely two), prominent, flattened, and palmately-lobed brow tine that stands above the nose. The presence as well as the form of this brow tine causes asymmetry of the head of the cervid. The following account highlights this aspect.

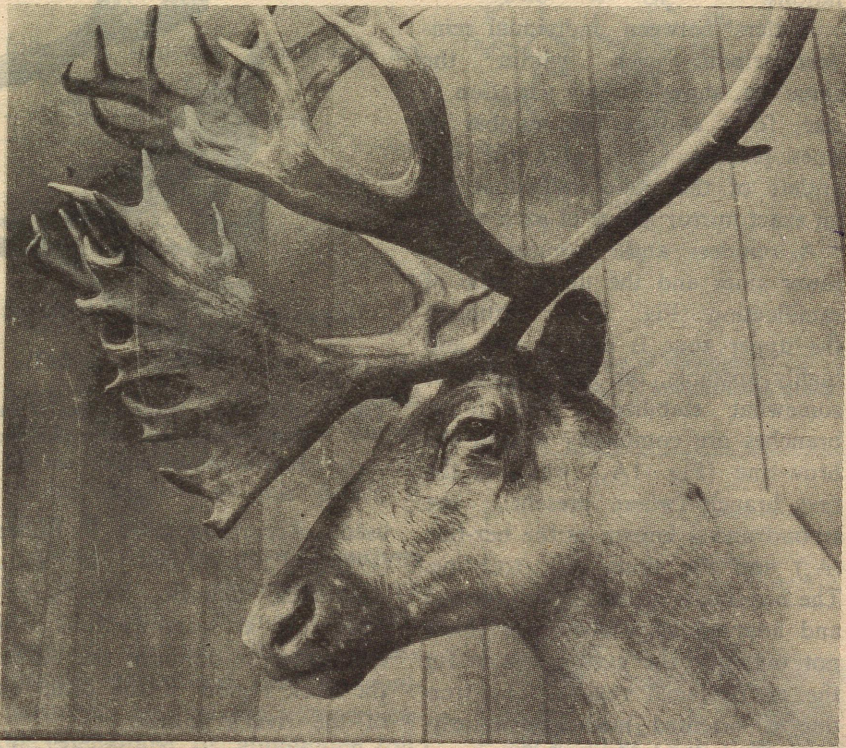
Morphology of reindeer antler

Reindeer differs from all other living deers from the fact that both the sexes possess antlers, although in the females they are smaller with fewer tines. In other deers, only the male develops antlers. According to J. Henshaw (1968) of the University of Alaska, antlers permit the females to be highly competitive during winter when tenable space is considerably reduced. These cephalic adornments enhance the social ranking of the females at a time when the males have shed their antlers, and enhance their abilities during competition for restricted food supplies, thereby contributing to their survival. It is also clear, according to Henshaw, that the functions of antlers in parent females are not even associated with the protection of the offspring or of the latter's quest for food during severe winter. This is due to the fact that the presence of antlers in the calves exhibit a marked degree of precocity and independence of maternal care during adverse seasons. However, the above theory will run into difficulties to account for the fact that in most reindeer populations, there are a few antlerless females. According to A.W.F. Bansfield (1961 of Brook University, Ontario, in some populations of forest caribou in North America and reindeer in Asia, the percentage of antlerless females may be as high as 40.

Antlers are solid, bony outgrowths arising from the frontal bones of the cranium. They have become almost status symbols and are used as offensive weapons by males during rutting season. They are ossified and so differ from

T. ANTONY DAVIS

HANDEDNESS OF REINDEER ANTLERS



Reindeer/caribou is unique because of its prominent, flattened, brow tine antlers above the nose. Antlers make it more competetive during restricted food supplies

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horns which are cornified. Further, antlers are branched, elongate on their ends, and are dead once they shed the velvet, while horns are generally unbranched, grow from their base, and are living.

In reindeer/caribou, only the basic antler pattern seems to be genetically controlled. Considerable differences in the morphology of the antler are brought about by differing nutritional levels. It is also well-known to trophy hunters that the mineral content of the soil and the availability of food control the size of the cervid antlers. In view of the great variability on antlers because of sex, age, nutritional level, physiological conditions arising from castration and pregnancy, as well as mineral content of the local soil, recent taxonomists do not consider antler formations as diagnostic characteristics of reindeer/caribou populations.

Antlers between individual reindeer/caribou, even within the same sex, show extreme variation in size, form and in the number of tines present. Not even the two antlers of the same individual are an exact mirror image of each other.

A reindeer antler comprises the lower tines and the upper zone of ramification (Fig. 1A). Although the upper zone is complicated and highly unstable, the lower region is somewhat stabilized. The lower branches are commonly termed the brow-tine (Fig. $1A_1$) which is the first branch (where present), the second one is known as the bez-tine (A_2) and the third one, trez-tine. The bez-tine is generally well-formed and adapted as a protective shield not only for the eyes but also for the entire facial region. The trez-tine is oriented medial-posteriorly. In some individuals it is large and bifurcated while in others it is usually small (Fig. 1A) or even absent. The frequent damage to the third tine of the male reindeer/caribou indicates that it is often

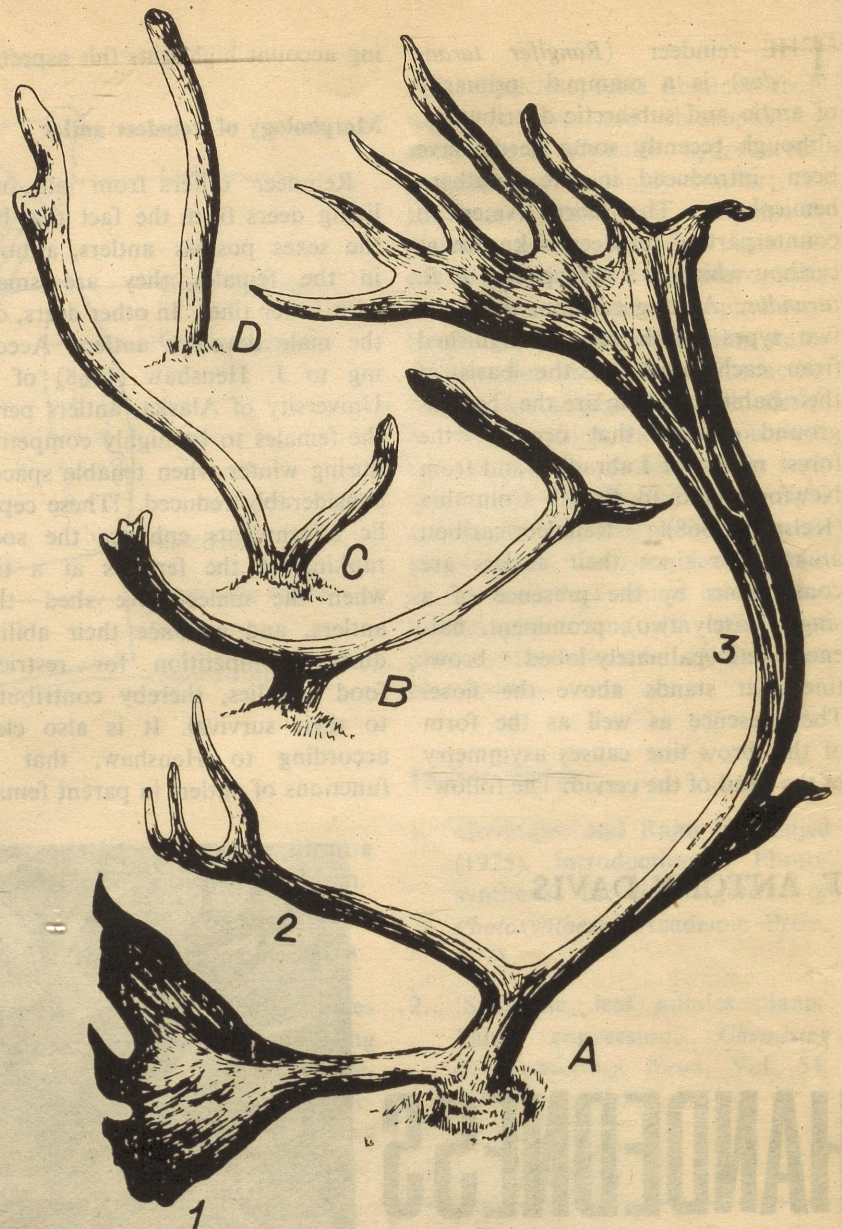


Fig. 1. (A-D) Four different types of antlers in reindeer/caribou: A, that of a healthy male showing prominent brow-tine, bez-tine and upper ramification. Young animals and females usually display antlers of types B-D

used. According to A. B. Bubenik (1972) of the Ministry of Natural Resources, Ontario, they serve as hooks or at least as foils which can parry or diminish the blows in the neck region of the distal ends of the rival's antlers.

The upper zone of antler (Fig. $1A_3$) shows two kinds of ramifications which are the single beam (monopodium) with tines, or anterior and then posterior edge of beam; and the forked (dichotomous) beam. Beams and tines can grow in palms or fork to the third grade of branching.

In young animals, only a single tine represents an antler (Fig. 1D), and in females the antlers are usually simpler as shown in Figs. 1B and C.

Functions of the brow-tine

It is a common notion that reindeer make use of the brow-tine for digging out snow deposit to reach the lichen (*Cladonia* sp.)

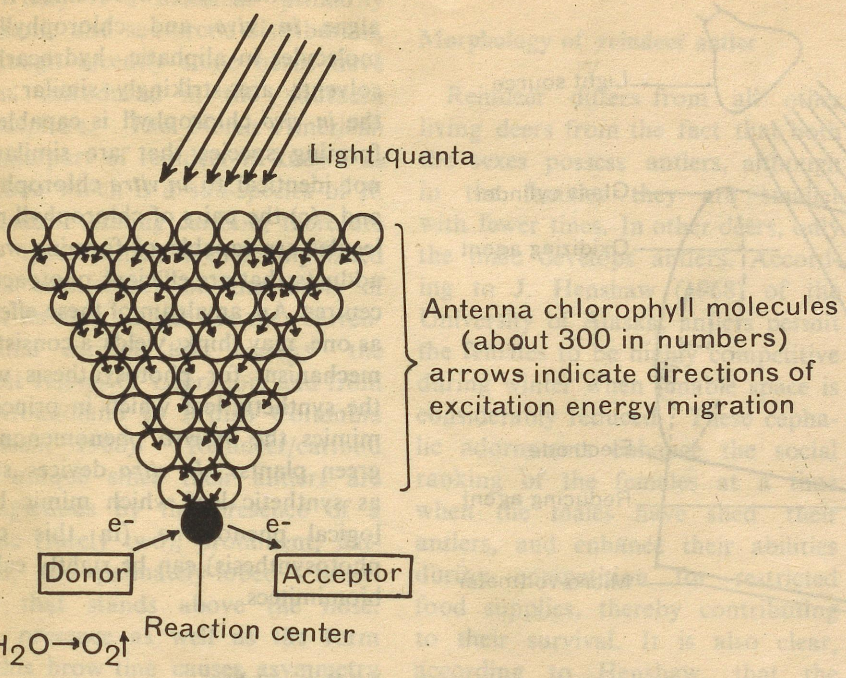


Fig. 1 A photosynthetic unit

phyll molecules under the circumstances described can terminate in a particular pair of molecules that forms the photoactive centre through water adduction. In other words, when chlorophyll-water adducts are suspended in an aliphatic hydrocarbon solvent, water plays an important role in cross-linking a terminal pair of chlorophyll molecules to form a reaction centre. Water acts as a bifunctional ligand (an agent capable of donating electrons to a metal cation). It can coordinate to the central magnesium atom of a chlorophyll molecule with the available oxygen atom and its two hydrogen atoms are then freely available for binding to another chlorophyll molecule. The interaction of water with a chlorophyll oligomer results in the formation of adduct having the following structure : chl/HOH/chl. Such a chlorophyll-water adduct has been experimentally shown to be active upon irradiation.

The models of the antenna and reaction centres can be usefully combined to form PSU of the following structure which can act as an electron pump :

—chl/chl/chl/chl/chl/chl/chl

antenna

chl/HOH/chl

reaction centre

Synthetic leaf—its components

The synthetic leaf with its ability to convert light energy into electrical energy supports and makes use of the models described above. An outline diagram of this device is given in Fig. 3.

The synthetic leaf device is nothing but a type of photoelectric cell which employs chlorophyll as the primary element. It is a glass cylinder partitioned into two compartments by a plastic semipermeable membrane or aluminium foil. A chlorophyll-water adduct is impregnated in the membrane or deposited on one side of the metal foil by evaporation from an aliphatic hydrocarbon solvent like octane suspension of the adduct. The two compartments respectively are filled with an electron acceptor and electron donor (reducing agent) solutions such as tetramethylphenylenediamine and sodium ascorbate. Each compartment carries an electrode and the electrodes are connected to an external circuit via leads fused in the cylinder walls.

Synthetic leaf—its operation

The synthetic leaf, to start with, is thermally equilibrated in the dark. The photoactive chlorophyll impregnated on the membrane or the metal foil is irradiated with white or red light and one could easily record and analyse the electrical effects in the external circuit. Dr. Katz observed a potential difference across the cell on irradiation. Also ob-

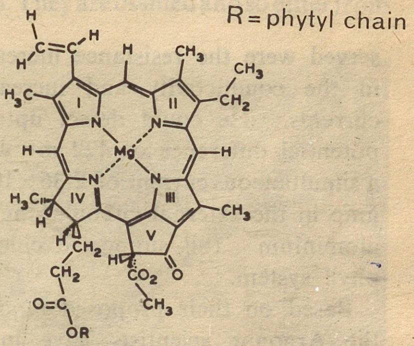


Fig. 2. Structure of chlorophyll *a* showing ring-V ketocarbonyl group

"And the priority should be on synthesizing tea leaves and betel leaves"

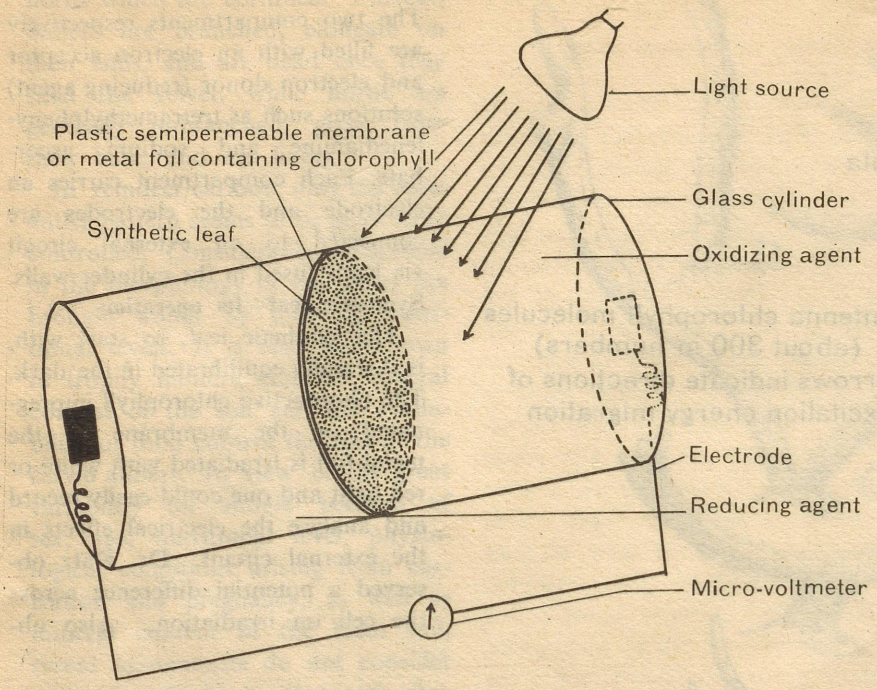


Fig. 3

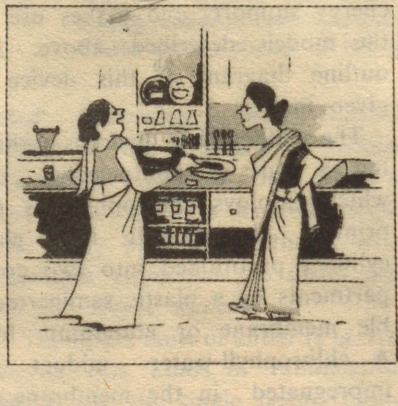
served were the resistance increases in the conductivity and increased currents. He could detect upto a potential difference of 422 mv with a simultaneous current of 2.36×10^{-5} amp in the external circuit using an aluminium foil supported chlorophyll system.

Based on their proposed models, the Argonne scientists have interpreted the results obtained in the synthetic cell and compared them with the *in vivo* mechanism. Light quanta are easily harvested by the *in vitro* formed antenna chlorophyll molecules and the excitation energy is transferred to the special pair of chlorophyll (reaction centre) at the terminus where oxidation and reduction can occur. The terminal reaction centre consisting of chl/HOH/chl is a valid functional structure since the available evidences tend to point out that light conversion *in vivo* occurs at a special pair of chlorophyll molecules constituting the photoreactive centres. However it has not been unequivocally proved that the two chlorophyll molecules *in vivo* are linked water to form a kind of chlorophyll-water sandwich.

Synthetic leaf—supporting evidences

Modern spectroscopic studies provide the following supporting evidences for the functional integrity of the *in vitro* antenna—reaction centre chlorophyll system of the synthetic leaf :

(a) Optical spectra obtained from algae *in vivo* and chlorophyll *a* molecules in aliphatic hydrocarbon solvents are strikingly similar; (b) the *in vivo* chlorophyll is capable of forming species that are similar if not identical to *in vitro* chlorophyll; and (c) the pairs of chlorophyll molecules are capable of forming water adducts that are efficient photoactive centres. An amalgam of these effects, as one may think, yields a consistent mechanism for photosynthesis with the synthetic leaf which in principle mimics the *in vivo* phenomenon in green plants. *In vitro* devices such as synthetic leaf which mimic biological phenomena (in this case photosynthesis) can be rightly called biomimitecs.



"While he tries to make a leaf in the lab., I try to make a loaf in the kitchen"

Further reading

1. Govindjee and Rajni Govindjee (1975), Introduction to Photosynthesis, In: *Bioenergetics of Photosynthesis*, Academic Press, USA.
2. 'Synthetic leaf mimics plants' light conversion, *Chemistry & Engineering News*, Vol. 54, No. 7.

It pays to advertise in Science Reporter

THE reindeer (*Rangifer tarandus*) is a mammal primarily of arctic and sub-arctic distribution, although recently some herds have been introduced in the southern hemisphere. The North American counterpart of reindeer is known as caribou which is a sub-species of *R. tarandus*. Among caribou, there are two types which are distinguished from each other on the basis of their habitat. These are the barren-ground caribou that occupy the forest region of Labrador, and from Newfoundland to British Columbia (Kelsall, 1968). Reindeer/caribou are unique since their antlers are conspicuous by the presence of a single (rarely two), prominent, flattened, and palmately-lobed brow tine that stands above the nose. The presence as well as the form of this brow tine causes asymmetry of the head of the cervid. The following account highlights this aspect.

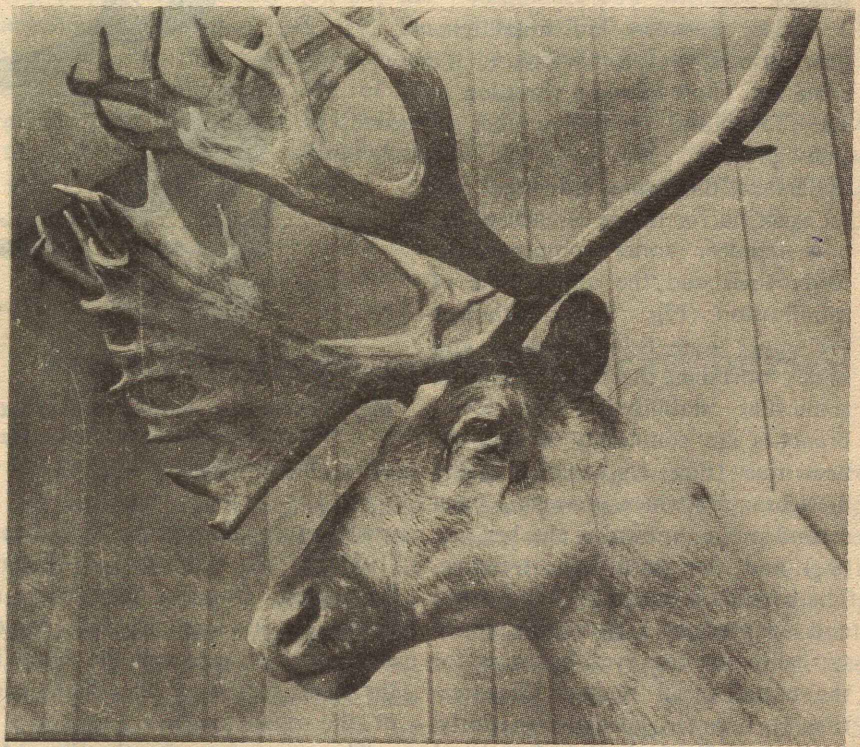
Morphology of reindeer antler

Reindeer differs from all other living deers from the fact that both the sexes possess antlers, although in the females they are smaller with fewer tines. In other deers, only the male develops antlers. According to J. Henshaw (1968) of the University of Alaska, antlers permit the females to be highly competitive during winter when tenable space is considerably reduced. These cephalic adornments enhance the social ranking of the females at a time when the males have shed their antlers, and enhance their abilities during competition for restricted food supplies, thereby contributing to their survival. It is also clear, according to Henshaw, that the functions of antlers in parent females are not even associated with the protection of the offspring or of the latter's quest for food during severe winter. This is due to the fact that the presence of antlers in the calves exhibit a marked degree of precocity and independence of maternal care during adverse seasons. However, the above theory will run into difficulties to account for the fact that in most reindeer populations, there are a few antlerless females. According to A.W.F. Bansfield (1961 of Brook University, Ontario, in some populations of forest caribou in North America and reindeer in Asia, the percentage of antlerless females may be as high as 40.

Antlers are solid, bony outgrowths arising from the frontal bones of the cranium. They have become almost status symbols and are used as offensive weapons by males during rutting season. They are ossified and so differ from

T. ANTONY DAVIS

HANDEDNESS OF REINDEER ANTLERS



Reindeer/caribou is unique because of its prominent, flattened, brow tine antlers above the nose. Antlers make it more competetive during restricted food supplies

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horns which are cornified. Further, antlers are branched, elongate on their ends, and are dead once they shed the velvet, while horns are generally unbranched, grow from their base, and are living.

In reindeer/caribou, only the basic antler pattern seems to be genetically controlled. Considerable differences in the morphology of the antler are brought about by differing nutritional levels. It is also well-known to trophy hunters that the mineral content of the soil and the availability of food control the size of the cervid antlers. In view of the great variability on antlers because of sex, age, nutritional level, physiological conditions arising from castration and pregnancy, as well as mineral content of the local soil, recent taxonomists do not consider antler formations as diagnostic characteristics of reindeer/caribou populations.

Antlers between individual reindeer/caribou, even within the same sex, show extreme variation in size, form and in the number of tines present. Not even the two antlers of the same individual are an exact mirror image of each other.

A reindeer antler comprises the lower tines and the upper zone of ramification (Fig. 1A). Although the upper zone is complicated and highly unstable, the lower region is somewhat stabilized. The lower branches are commonly termed the brow-tine (Fig. $1A_1$) which is the first branch (where present), the second one is known as the bez-tine (A_2) and the third one, trez-tine. The bez-tine is generally well-formed and adapted as a protective shield not only for the eyes but also for the entire facial region. The trez-tine is oriented medial-posteriorly. In some individuals it is large and bifurcated while in others it is usually small (Fig. 1A) or even absent. The frequent damage to the third tine of the male reindeer/caribou indicates that it is often

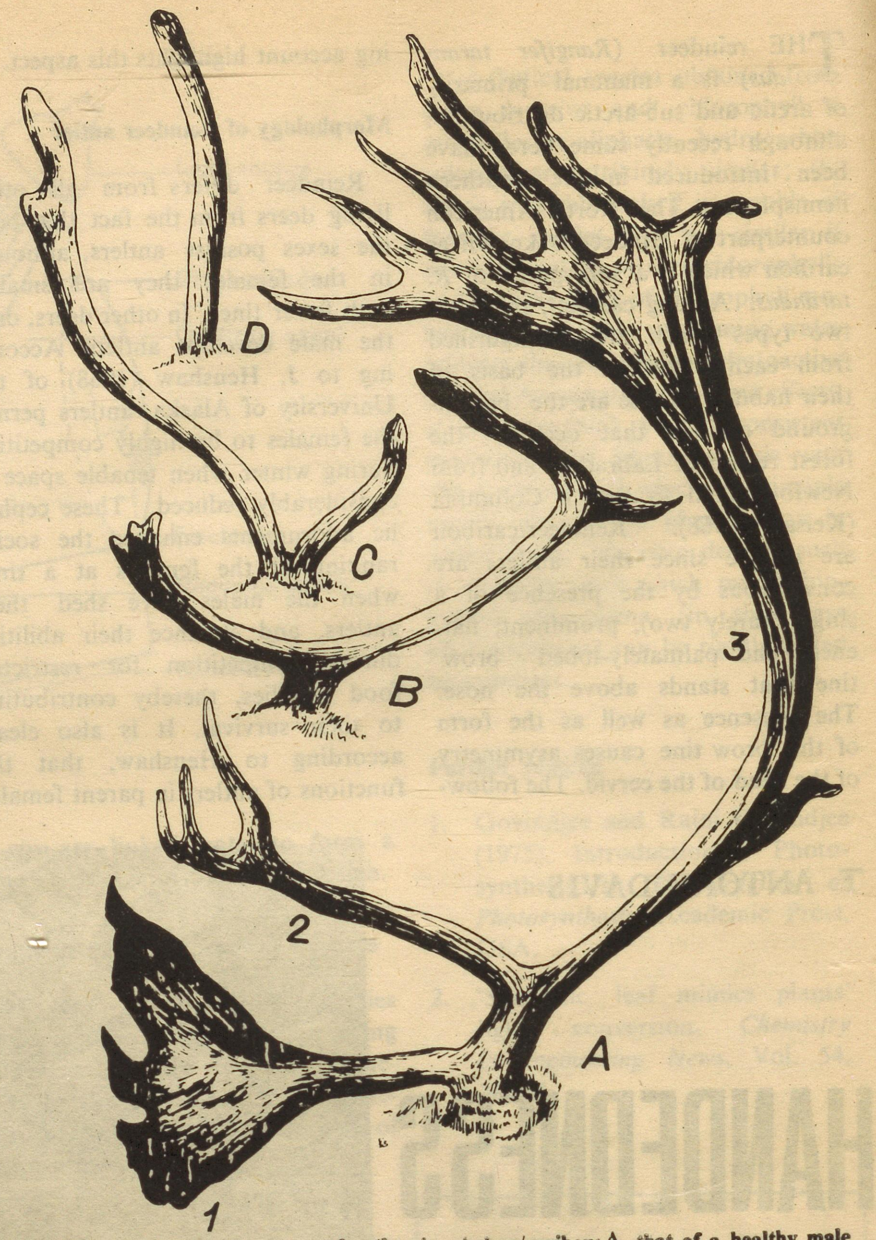

Fig. 1. (A-D) Four different types of antlers in reindeer/caribou: A, that of a healthy male showing prominent brow-tine, bez-tine and upper ramification. Young animals and females usually display antlers of types B–D

used. According to A. B. Bubenik (1972) of the Ministry of Natural Resources, Ontario, they serve as hooks or at least as foils which can parry or diminish the blows in the neck region of the distal ends of the rival's antlers.

The upper zone of antler (Fig. $1A_3$) shows two kinds of ramifications which are the single beam (monopodium) with tines, or anterior and then posterior edge of beam; and the forked (dichotomous) beam. Beams and tines can grow in palms or fork to the third grade of branching.

In young animals, only a single tine represents an antler (Fig. 1D), and in females the antlers are usually simpler as shown in Figs. 1B and C.

Functions of the brow-tine

It is a common notion that reindeer make use of the brow-tine for digging out snow deposit to reach the lichen (*Cladonia* sp.)

Table I

Ellipsoid Name	Equatorial Radius 'a' in meters	Flattening	Where used
Krassowsky (1940)	6,378,245	1/298.3	Russia
International (1924)	6,378,388	1/297.0	Europe
Clarke (1880)	6,378,249	1/293.5	France, Africa
Clarke (1866)	6,378,206	1/295.0	North America
Bessel (1941)	6,377,397	1/299.15	Japan
Airy (1830)	6,376,542	1/299.30	U.K.
Everest (1830)	6,377,276	1/300.8	India

The main reason for different ellipsoids is the anomalous mass distribution, i.e., variation of gravity from place to place. It is here that the satellites have helped a great deal in arriving at a more precise value of the equatorial radius and the flattening. As the man-made satellites go round in inclined or polar orbits, they are effected by the varying earth's gravity. As a result the satellite orbit is altered. This perturbation can be used to determine the geometry of the earth. Mathematically, the gravity at a point can be expressed as an infinite series, consisting of complex terms involving the latitude and longitude of a point, its distance from the center of earth and other parameters.

The value of gravity can be obtained from satellite as it moves and behaves under the Newtonian laws of motion. The change in the gravity can be determined as the satellite orbit changes due to changes in earth's gravity as the satellite passes over it. These changes in gravity can mathematically be equated to the changes in the elements of a satellite orbit, namely, (i) the orbital inclination (*i*), (ii) the orbital period (*T*), (iii) the eccentricity (*e*), (iv) the argument of perigee (*w*), (v) the longitude of the ascending node (Ω), and (vi) the time 'T_0' of the perigee pass. The results, as obtained till 1970, from satellite observations are :

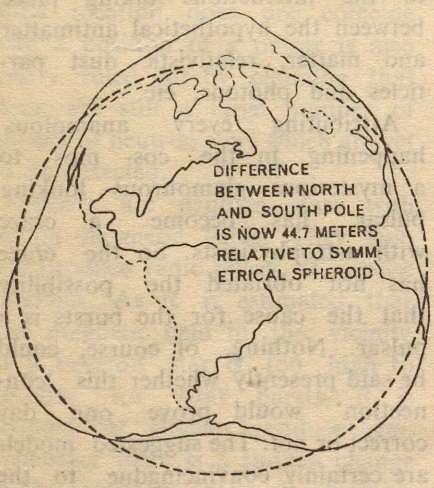

Fig. 3

a=6378140 N_{max}= ± 100 m
f=1/298.258

The satellite observations have revealed the following :

(a) The earth's equatorial diameter exceeds the polar diameter by 42.77 km which is 170 meters different for the earlier value obtained from non-satellite observations.

(b) There is a depression around the South Pole, a bulge south of the equator and also around the North Pole indicating that the earth is 'Pear shaped' (Fig. 3).

(c) There is a depression south of India, of about 113 m, elevation near New Guinea (81 m) and the elevation centered in England and south Atlantic. While we could describe the shape of the earth and its gravity field by 4 parameters in the pre-satellite era, today in the age of computers and satellites, we use as many as 250 parameters to describe the pear shapedness of our earth.

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Puzzlers from cosmos: γ-ray bursts

ABOUT 13 years ago two *Vela* satellites were launched to keep a watch on the signatories of the 1963 Nuclear Test Ban Treaty. In the orbit of earth, the detectors the satellites were carrying, each "watching" a hemisphere, could tell whether a nuclear device has been exploded or not by monitering the nuclear radiations. In 1969 when the data they had picked up in 1967 was studied, there lay a surprise for astrophysicists and astronomers. Today that surprise, an astronomical serendipity, has become one of the stimulating problems in astrophysics. It is called. cosmic gamma ray burst. It has been found that powerful bursts of gamma rays whose origin is somewhere in the vast cosmos occur infrequently. While they last, only for nearly 10 seconds or so, they dominate all other celestial sources of gamma rays.

Since the discovery about 55 such bursts have been recorded and, on an average, a dozen every year. As for gamma rays it is well-known that they are electromagnetic radiations emitted spontaneously during nuclear fission or fusion. Also, their origin could be thermal radiations or energetic neutrons. The bursts of such rays are so powerful that, ironically enough, nothing is yet known about them. For want of adequate data their position in the sky, their distance, other characteristics, and the astrophysical phenomenon producing them—all could only be guessed.

Astrophysics, or, for that matter astronomy, is the subject which is totally dependent upon observations, in particular upon spectroscopy, in interpreting the characteristics of a celestial object from the radiations it is emitting. In so far as the "spectral signatures" of cosmic gamma rays bursts are concerned, nothing is known except that all appear alike. It has, however, been found that each burst comprises of one to five or more distinctly separate pulses, each lasting for 0.002 to greater than one second. Astounding is the finding that the pulses start or stop within a few milli-second, reaching their peak within the same time. It could be inferred from this that the diameter of the source of these bursts is not much, in the range of 300 to 1500 km only, which is many times smaller than the earth's diameter.

It has been ascertained that, on an average, each burst contains 10^{-4} erg/sq. cm/sec. of energy. Estimating from this value the energy generated at the source, it is found that it depends upon how far the source is from us. For instance, if the source is at the same distance as that of the nearest star, nearly 3.6 lightyears away, then 10^{34} erg/sec of energy might be getting generated at the source; if the distance of the source is taken as 1000 parsec (3260 lightyears) then the energy-generation value at the source is estimated about 10^{40} ergs/sec. The latter value is some million times greater than the total sun's energy radiations ! In case the source of the bursts is still distant, say, in other galaxies, then the energy generated at its source would be many orders of magnitude more. At this rate, if we consider that the size of the source is smaller than that of earth, a unit of it would generate energy 10 billion times that released by a unit of sun's surface !

Though distances of the sources are still vague, the most probable guess is that they are some 1000 parsec away.

Models

What might be causing the cosmic gamma ray burst is still a mystery. About 30 models, galactic and extra-galactic, arising due to the uncertainty prevalent in the distance, have been put forward, though none could be singled out as flawless.

For obvious reasons, the extra-galactic models, that assume the sources of the bursts outside our galaxy *Milky Way*, were the first to be propounded. It was Stirling Colgate of New Mexico Institute of Mining and Technology, U. S. A., who claimed that they arise due to supernova explosions. As a star begintos collapse, to produce an explosion (*S.R.*, Oct. 76), its density begins to decrease, while subsequently the velocity of shock waves that it generates increases. The incoming X-rays as a result achieve relativistic velocities, which get Doppler shifted to produce a pulse of soft γ-rays. This model, though appealing, does not stand valid as it does not account for either the high energy emitted in the burst or the fine structure of the pulse.

The second extra-galactic model comes from J. Cohen, of University of Pennsylvania, and Reuven Ramaty, of Goddard Space Flight Center. According to them bursts are given off during the collapse of a white-dwarf star into a neutron star. When a white-dwarf star accretes matter from the surrounding space, so much so that it cannot stand any more due to the gravitational burden plied on itself, it begins to collapse rapidly. While its density approaches to that of a typical neutron star, about 10^{14} gm/c.c., its surface temperature approaches 10^{9} degree K. In this state the object becomes a source of soft γ-rays, emitting them in flashes. This model is, however unable to explain why the bursts occur randomly as observed. Though such a collapse as mentioned could occur in any galaxy, even in our own, the frequency of such happenings is too low to explain the large number of the observed random bursts.

The most galactic models, that explain away the bursts production in the celestial sources present in a galaxy, are, however, superficial. In fact, to call them models, based on so minute details, would be a misnomer. Nowadays, such models are preferred to be named as scenarios. Most of them are a result of the superficial similarities observed between solar flares and γ-rays bursts. It has been claimed that X-ray bursts are generated when low-energy photons are accelerated to higher energies during a flare occurring in a commoner type of star; or when putative flares on a white-dwarf star react with strong magnetic fields. There are also some scenarios which attribute the bursts to the interactions taking place between the hypothetical antimatter and matter, relativistic dust particles and photons, etc.

Attributing every anamolous happening in the cos- mos to a mysterious glamourous- looking pulsar has become a craze with astrophysicists. So the craze has not obriated the possibility that the cause for the bursts is a pulsar. Nothing, of course, could be said presently whether this 'connection' would prove one day correct or not. The suggested models are certainly convincingdue to the mystery surrounding both the "emis-

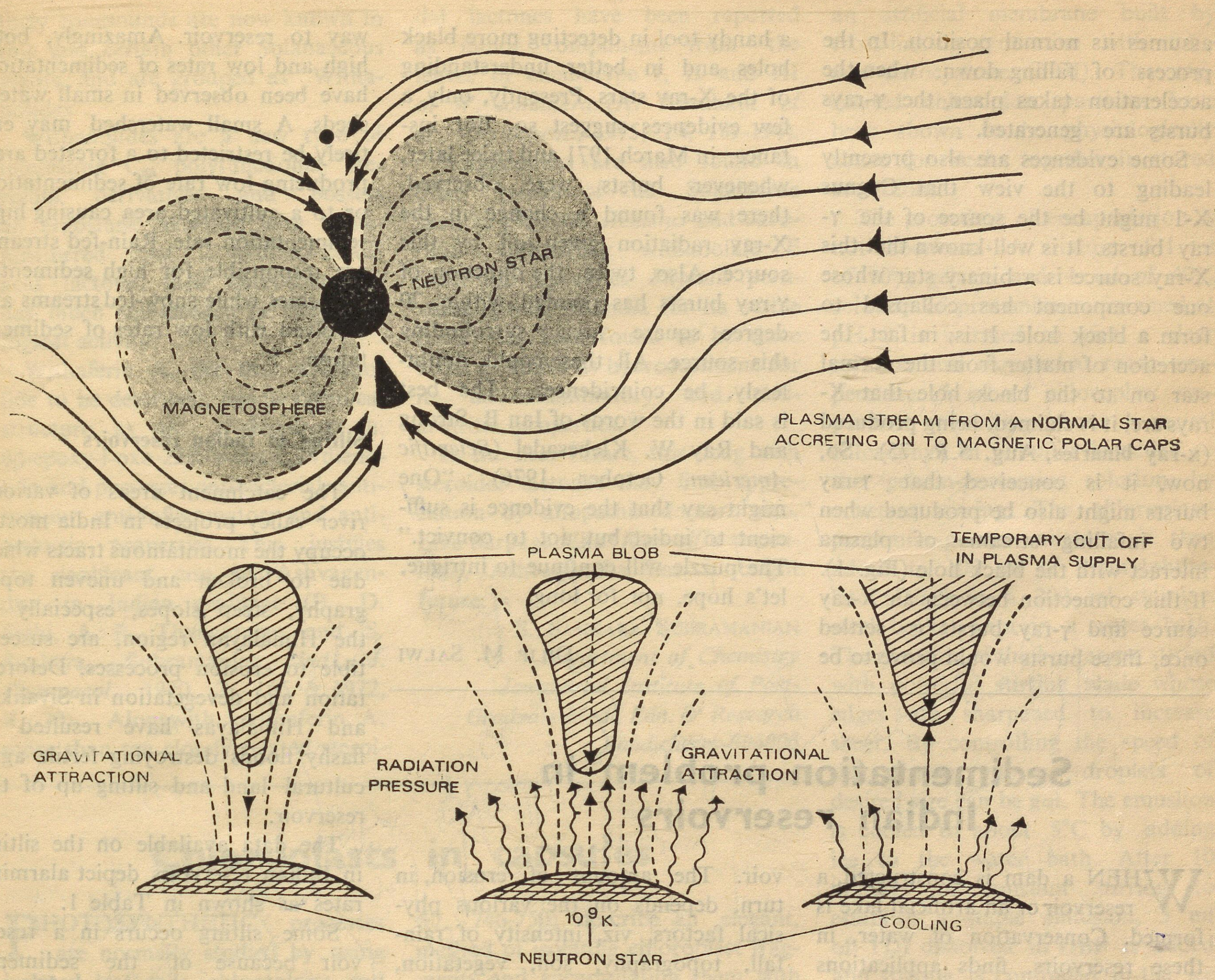

Fig. 1

sion", the γ-ray bursts, and the "generators", the pulsars. The strongest objection as to why a single burst location does not coincide with a position of a pulsar is also nearly ruled out by claiming that there are still a large number of pulsars or neutron stars which are yet to be detected.

Pulsars are neutron stars with strong magnetic fields. They spin and produce radio pulses at precise intervals. As it is estimated that the magnetic field in the vicinity of a neutron star is too high to account for γ-ray bursts, it is claimed that "glitches" produce them. Whenever there is a sudden change in the rotational speed of a neutron star, a "glitch" is said to occur. According to Franco Pacini of European Southern Observatory, and Martin A. Ruderman, of Columbia University, the energy dissipated during a "glitch" is low enough to produce a γ-ray burst. It is, however, still inconceivable how this comes about. This is the handicap of the model and that is why other models that consider the pulsars as the origin for the γ-ray burst appear equally good. Starquakes, volcanic activity, or sudden changes in size or shape, or like phenomena, according to them, occur also on a neutron star producing the requisite γ-ray bursts randomly.

The most appealing, and seemingly cogent, model is the one that claims that γ-ray bursts could be produced when matter from somewhere, say, a normal star, is swept off on to the surface of a nearby neutron star or white dwarf star or black hole. It is a well-known fact that one hydrogen atom falling onto a white dwarf produces one million electron volt energy (MeV), while on a neutron and black hole it is about 100 MeV. This same scenario has been conceived of in a variety of ways. One of the most accepted is that blobs of plasma (accreted from some nearby source) hang over the magnetic poles of a neutron star, just as a magnet of opposite polarity could. Whenever a glitch occurs, it allows the blob to fall down to restore equilibrium and when the glitch is overcome the blob

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assumes its normal position. In the process of falling down, when the acceleration takes place, the γ-rays bursts are generated.

Some evidences are also presently leading to the view that Cygnus X-1 might be the source of the γ-ray bursts. It is well-known that this X-ray source is a binary star whose one component has collapsed to form a black hole. It is, in fact, the accretion of matter from the normal star on to the black hole that X-rays are, it is claimed, being produced (**x-ray binaries**, Aug. *S.R.*, 75). So, now, it is conceived that γ-ray bursts might also be produced when two infalling streams of plasma interact with the black hole (Fig. 1). If this connection between an X-ray source and γ-ray bursts is settled once, these bursts would prove to be a handy tool in detecting more black holes and in better understanding of the X-ray stars. Presently, only a few evidences suggest so. For instance, in March 1971 and twice later, whenever bursts were observed, there was found a change in the X-ray radiation given off by this source. Also, twice, the direction of γ-ray bursts has pointed within 20 degree square area surrounding this source. All these could, doubtlessly, be coincidences. The best is said in the words of Ian B. Strong and Ray W. Klebesadel (*Scientific American*, October 1976): "One might say that the evidence is sufficient to indict but not to convict." The puzzle will continue to intrigue, let's hope, not for long.

DILIP M. SALWI

Sedimentation problem in Indian reservoirs

WHEN a dam is constructed, a reservoir or an artificial lake is formed. Conservation of water, in these reservoirs, finds applications in power generation, irrigation, flood control, water supply, etc. Multipurpose reservoirs, built at great costs for the economic development of a region, are invaluable national assets because dam sites are scarce. Water in the reservoir basin is collected as the run-off or surplus water through the drainage network in the area. This run-off from the catchment area carries sand and silt load along with it into the reservoir basin. As the water is stored in the reservoir its capacity to hold sand and silt gets completely lost causing the sediment to settle down on the bed of the reservoir. The rate of silting in the reservoir depends on the amount of erosion in the watershed and the capacity of the streams to transport the eroded material into the reservoir. The amount of erosion, in turn, depends on the various physical factors, viz, intensity of rainfall, topography, soil, vegetation, landuse, hydro-physical conditions of the drainage network, etc. The accumulation of silt not only reduces the storage capacity of the reservoir, but also affects the life of the reservoir.

The high erosion rate in the watersheds of the reservoir plays an important role in silting. Soil erosion became a problem due to man's interference with the environmental processes. Cutting and burning of forests, overgrazing of grasslands by ruminants, unwise agricultural practices, deforestation and improper methods of tillage have added much to this grave problem.

Scientific studies have shown that average rate of sedimentation decreases as the size of the watershed increases. Also, the larger the watershed, the higher is the possibility of sediment deposition occurring in the way to reservoir. Amazingly, both high and low rates of sedimentation have been observed in small watersheds. A small watershed may entirely be restricted to a forested area producing low rate of sedimentation or to a cultivated area causing high sedimentation rate. Rain-fed streams are responsible for high sedimentation rates while snow-fed streams are involved with low rates of sedimentation.

Silting in Indian reservoirs

The catchment areas of various river valley projects in India mostly occupy the mountainous tracts which due to broken and uneven topography, steep slopes, especially in the Himalayan region, are susceptible to erosion processes. Deforestation and devegetation in Sivalikas and Himalayas have resulted in flashy floods destroying fertile agricultural land and silting up of the reservoir.

The data available on the silting in Indian reservoirs depict alarming rates as shown in Table 1.

Some silting occurs in a reservoir because of the sediments brought by the stream into it. For this reason some percentage of the total capacity (nearly $\frac{1}{4}$th) of the reservoir is left as dead capacity, during its construction. On the basis of assumed rate of silting, the life of a reservoir is estimated, and, the assumed rate of silting is calculated on the basis of gross erosion in the catchment area. While the observed rate of silting is measured after utilisation of the reservoir, any increase in the assumed rates of silting directly affects the storage capacity and the life of the reservoir.

Table 1 shows the highest silting rate (about 23 times the assumed rate) in Nizamsagar which has lost almost 40% of its live storage capacity. The Ukai and Maithon reservoirs register 8 to 9 times the assuforty compounds are now known in this and certain other Solanaceous plants, and are grouped as "Withanolides".

Withanolides are a new type of interesting C_{28} polyfunctional steroidal derivatives and possess an ergostane skeleton with a six-membered ring 22-hydroxy-26-oic acid lactone; their stereochemistry has much significance in their biological activity.

Withaferin A, the first withanolide to be described, has its chemical structure as 4β, 27-dihydroxy-5β, 6β-epoxy-l-oxo-22R-witha-2,24dienolide and possesses antibacterial, antitumour, anti-inflammatory and antiarthritic properties. This justifies the significant use of Ashvagandha in Indian medicine (P. D. Sethi, A. R. Thyagarajan and S. Sankara Subramanian, *Ind. J. Pharmacol.*, 1970, **2**, 165 & 1972, **4**, 30). Alongwith withaferin A, more than ten closely related steroidal lactones have been reported as minor components from the leaves of chemotype I, II and III of *W. somnifera* (A. Abraham *et al.*, *Phytochem.*, 1975, **14**, 189-194).

Withanolides are also found in other genera of the Solanaceae such as *Physalis*, *Acnistus* and *Jaborosa*. 4β-hydroxy withanolide E from the leaves of *Physalis peruviana*, grown in India for its edible fruits, has been found to be three times as active as hydrocortisone for its anti-inflammatory and anti-arthritic properties.

In the near future, this drug with steroidal lactones may find appreciation by allopathic doctors also. Like Sarpagandha (*Rauwolfia serpentina*), Ashvagandha has a bright future.

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Chloroplasts in capsules

PHOTOSYNTHETIC processes are normally studied by using isolated leaf cells, chloroplasts and sub-chloroplast particles. However, it has been a difficult task for plant physiologists to retain the activity of these experimental materials even under the most controlled conditions. In other words, these experimental materials (say chloroplasts) have to be used for experimental analysis soon after their isolation and on further storage they are always bound to lose their stability and hence their photosynthetic activity. No suitable procedure was available to maintain the stability of these materials under stored conditions for a long time. Kitajima and Warren L. Butler of the Department of Biology, University of California, USA in a recent paper (*Plant Physiology*, 1976, 57, 746-750) describe an elegant, method of isolating chloroplast fragments and encapsulating them with an artificial membrane built by cross-linking protamine with toluene diisocyanate (TDI). The capsulated chloroplast particles have been shown to be physiologically active for weeks together in stored conditions.

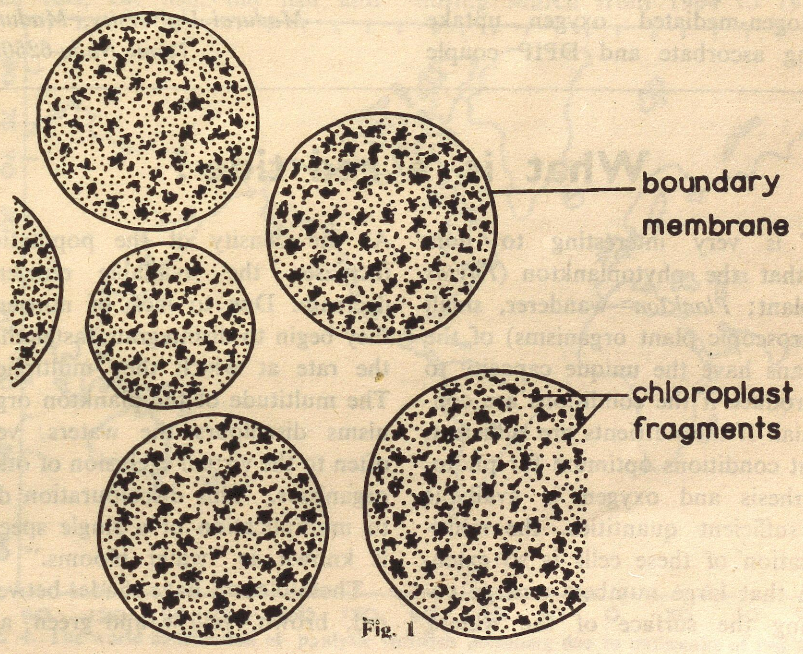

Fig. 1

The procedure of encapsulation is not laborious. A mixture of 1 ml of 10% gelatin and 4 ml of 40% solution of protamine maintained at pH 8 is warmed to give a clear solution and recooled at room temperature. 5 ml of chloroplast suspension containing about 1 mg/ml chlorophyll in a buffer is added to the gelatin-protamine solution by constant stirring. The chloroplast-protamine-gelatin mixture is then added to 100 ml of dibutylphthalate (DBP) in a 200 ml stainless steel beaker kept in a water bath. The contents of the beaker are stirred with powerful stirring blade whose edges are sharpened to increase sheer. By controlling the speed of the stirring motor, droplets of desired size can be got. The emulsion is cooled to about 5°C by adding ice to the water bath. After 10 minutes of constant stirring to establish a stable emulsion, 5 ml of TDI dissolved in DBP is added and stirring is continued in the ice bath for further 10 to 15 hours. Under these experimental conditions, the TDI cross-links amino-groups of the protamine and slowly builds up a polymer membrane at the emulsion interface. This results in the formation of capsules containing sheared chloroplasts and can be recovered from DBP by petroleum ether treatment and centrifugation. The pellet fraction is dispersed in glycerol and spun again at 1000g for 10 minutes. Among the three layers, viz., upper organic phase, middle green capsules, bottom glycerol formed, the middle layer containing the capsules can be easily transferred to a suitable buffer and used for photosynthetic studies.

Characteristics of the capsules

Light microscopic observations (Fig. 1) show the capsules to be uniform green spheres ranging in diameter from 10 μm to 50 μm. Numerous chloroplast fragments could be seen within the polymer membrane. Electron microscopy reveals each capsule to be a single boundary membrane. The encapsulated chloroplast fragments are found to be physiologically active and retain the photosystem I activity of methyl viologen-mediated oxygen uptake using ascorbate and DPIP couple as electron donor over a period of 4 weeks in refrigerator. Apart from chloroplasts, microencapsulation of PS I particles with soluble proteins and also with the enzyme hydrogenase prepared from the bacterium *Chromatium vinosum* have also been successfully made.

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These blooms have shades between red, brown, yellow and green, and are known as "Red tides." Dinoflagellates, a group of phytoplankton, are mostly responsible for the red tide phenomenon. The blooms may cause great destruction to invertebrate animals and fishes. Most oceanic dinoflagellates are found at depths of less than 50 metres. Estuarine (the organisms in an estuary—where the river water mixes with the sea) and neritic forms (the organisms which are found upto a depth of less than 200 meters) need less depth than the oceanic forms (found beyond 200 meters). The salinity tolerance largely determines the distribution of the dinoflagellates as estuarine, neritic and oceanic forms. In neritic and estuarine areas salinity varies greatly because of the influence of land drainage.

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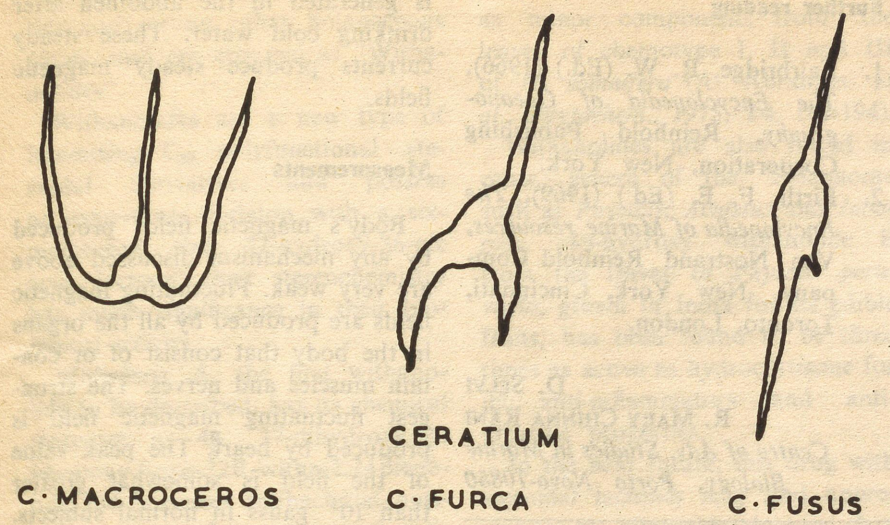

Fig. 1. Three different species of ***ceratium***

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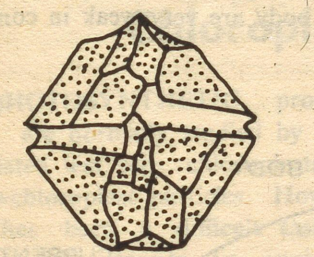

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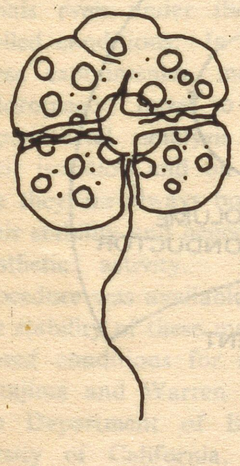

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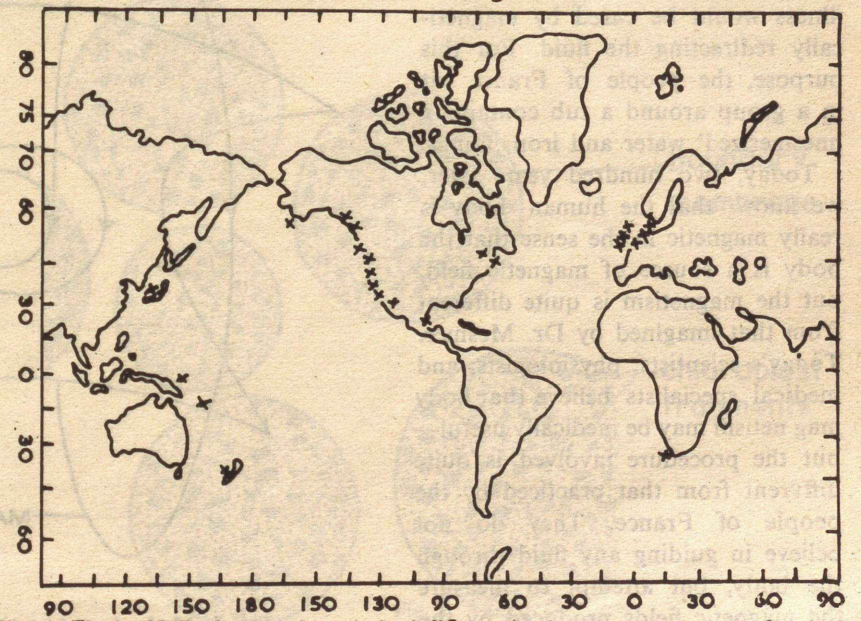

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The blooms were found to occur in a stretch of about 6 to 25 meters in width and extended up to 12 to 48 km (9.7 to 23.97 nautical miles). These blooms appeared between 7 to 15 fathom lines. The colour of the bloom was found to be gray with some pink-to-light red patches. Such blooms also appear on the Mangalore coast and around Laccadive Islands. Though there are reports of their occurrence on either sides of coastal India there is no report of their toxic effects or any report on significant mortality of fish or other marine life.

Further reading

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Magnetic fields in human body

ABOUT two hundred years ago the people of France believed in the cure of diseases with the application of magnetic fields to their bodies. This was due to Dr. Mesmer who preached that magnetism of the human body controlled the flow of a universal fluid through the body and that when the flow of the liquid was obstructed due to some reason illness followed. The illness would be cured by magnetically redirecting the fluid. For this purpose, the people of France sat in a group around a tub containing 'mesmerized' water and iron filings.

Today, two hundred years later, we know that the human body is really magnetic in the sense that the body is a source of magnetic field, but the magnetism is quite different from that imagined by Dr. Mesmer. Today's scientists, physiologists, and medical specialists believe that body mag netism may be medically useful—but the procedure involved is quite different from that practiced by the people of France. They do not believe in guiding any fluid through the body, but attempt to measure the magnetic fields produced by the human body and to interpret them.

In some cases, such as injury, some excitable tissues generate steady ion currents. An important case is heart when it is deprived of its blood supply. Steady ion-current is generated in the abdomen after drinking cold water. These steady currents produce steady magnetic fields.

Measurements

Body's magnetic fields produced by any mechanism discussed above are very weak. Fluctuating magnetic fields are produced by all the organs in the body that consist of or contain muscles and nerves. The strongest fluctuating magnetic field is produced by heart. The peak value of the field is somewhat greater than 10^{6} gauss in normal subjects. The fields may be larger for some abnormal subjects. Some muscles, when flexed, produce high frequency magnetic fields whose peak value is 10^{7} gauss. The strongest magnetic field from the nerve tissue is from brain. A normal brain produces its largest fields during sleep. It has an amplitude of 3×10^{8} gauss. Epilepsy can produce much larger fields. The magnetic fields produced in the body are very weak in compari-

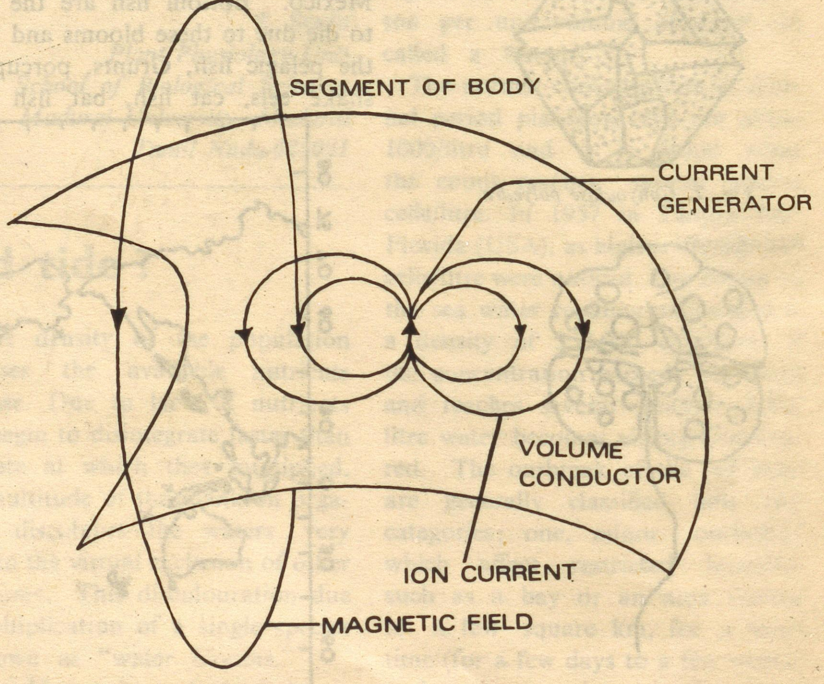

Fig. 1. Mechanism of production of magnetic field in he human body

forty compounds are now known in this and certain other Solanaceous plants, and are grouped as "Withanolides".

Withanolides are a new type of interesting C_{28} polyfunctional steroidal derivatives and possess an ergostane skeleton with a six-membered ring 22-hydroxy-26-oic acid lactone; their stereochemistry has much significance in their biological activity.

Withaferin A, the first withanolide to be described, has its chemical structure as 4β, 27-dihydroxy-5β, 6β-epoxy-l-oxo-22R-witha-2,24dienolide and possesses antibacterial, antitumour, anti-inflammatory and antiarthritic properties. This justifies the significant use of Ashvagandha in Indian medicine (P. D. Sethi, A. R. Thyagarajan and S. Sankara Subramanian, *Ind. J. Pharmacol.*, 1970, **2**, 165 & 1972, **4**, 30). Alongwith withaferin A, more than ten closely related steroidal lactones have been reported as minor components from the leaves of chemotype I, II and III of *W. somnifera* (A. Abraham *et al., Phytochem.*, 1975, **14**, 189-194).

Withanolides are also found in other genera of the Solanaceae such as *Physalis*, *Acnistus* and *Jaborosa*. 4β-hydroxy withanolide E from the leaves of *Physalis peruviana*, grown in India for its edible fruits, has been found to be three times as active as hydrocortisone for its anti-inflammatory and antiarthritic properties.

In the near future, this drug with steroidal lactones may find appreciation by allopathic doctors also. Like Sarpagandha (*Rauwolfia serpentina*), Ashvagandha has a bright future.

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Chloroplasts in capsules

PHOTOSYNTHETIC processes are normally studied by using isolated leaf cells, chloroplasts and sub-chloroplast particles. However, it has been a difficult task for plant physiologists to retain the activity of these experimental materials even under the most controlled conditions. In other words, these experimental materials (say chloroplasts) have to be used for experimental analysis soon after their isolation and on further storage they are always bound to lose their stability and hence their photosynthetic activity. No suitable procedure was available to maintain the stability of these materials under stored conditions for a long time. Kitajima and Warren L. Butler of the Department of Biology, University of California, USA in a recent paper (*Plant Physiology*, 1976, **57**, 746-750) describe an elegant, method of isolating chloroplast fragments and encapsulating them with an artificial membrane built by cross-linking protamine with toluene diisocyanate (TDI). The capsulated chloroplast particles have been shown to be physiologically active for weeks together in stored conditions.

The procedure of encapsulation is not laborious. A mixture of 1 ml of 10% gelatin and 4 ml of 40% solution of protamine maintained at pH 8 is warmed to give a clear solution and recooled at room temperature. 5 ml of chloroplast suspension containing about 1 mg/ml chlorophyll in a buffer is added to the gelatin-protamine solution by constant stirring. The chloroplast-protamine-gelatin mixture is then added to 100 ml of dibutylphthalate (DBP) in a 200 ml stainless steel beaker kept in a water bath. The contents of the beaker are stirred with powerful stirring blade whose edges are sharpened to increase sheer. By controlling the speed of the stirring motor, droplets of desired size can be got. The emuslion is cooled to about 5°C by adding ice to the water bath. After 10 minutes of constant stirring to establish a stable emulsion, 5 ml of TDI dissolved in DBP is added and stirring is continued in the ice

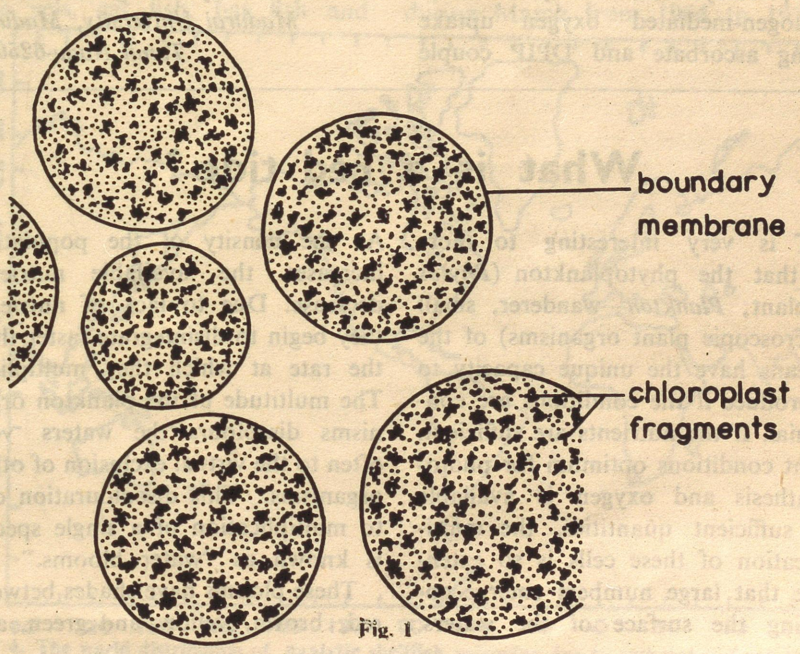

Fig. 1

bath for further 10 to 15 hours. Under these experimental conditions, the TDI cross-links amino-groups of the protamine and slowly builds up a polymer membrane at the emulsion interface. This results in the formation of capsules containing sheared chloroplasts and can be recovered from DBP by petroleum ether treatment and centrifugation. The pellet fraction is dispersed in glycerol and spun again at 1000g for 10 minutes. Among the three layers, viz., upper organic phase, middle green capsules, bottom glycerol formed, the middle layer containing the capsules can be easily transferred to a suitable buffer and used for photosynthetic studies.

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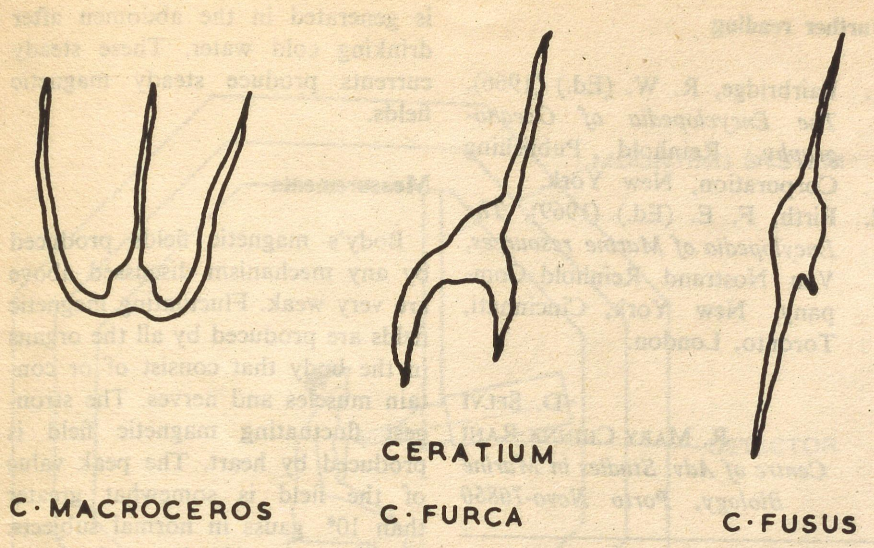

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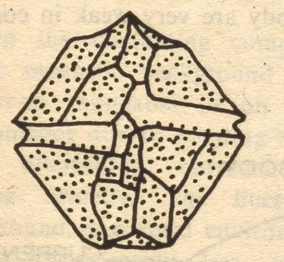

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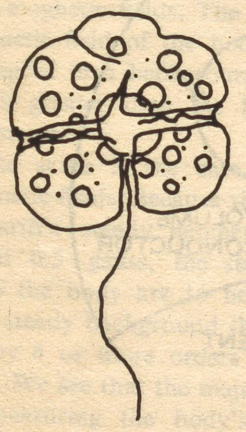

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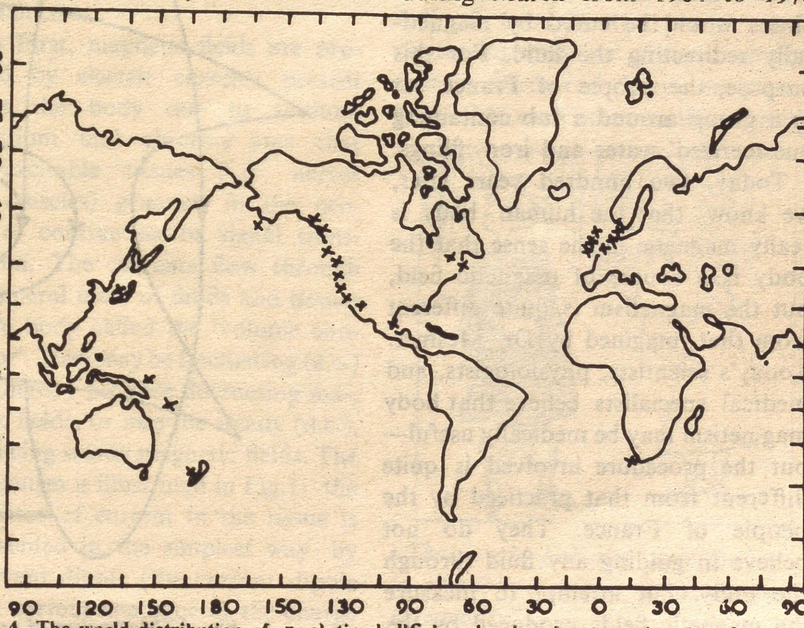

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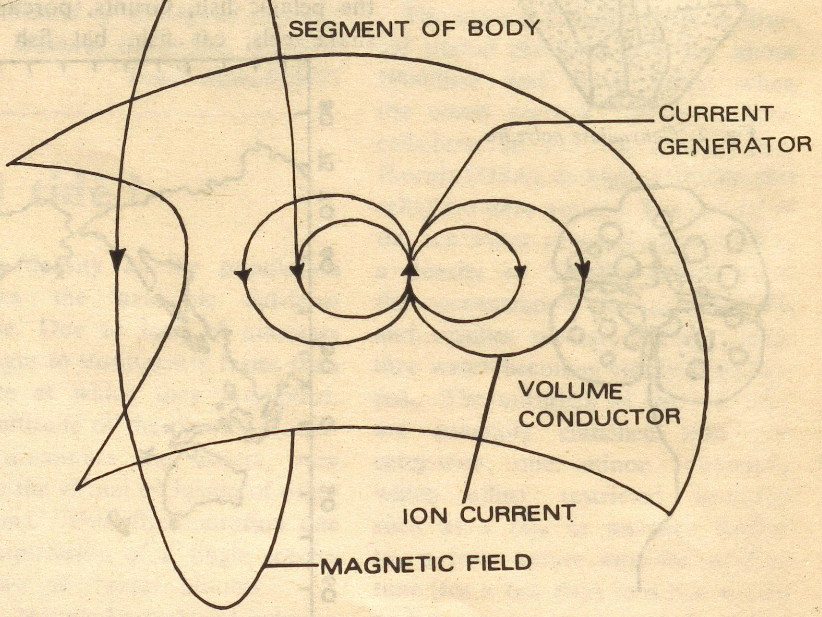

Fig. 1. Mechanism of production of magnetic field in he human body

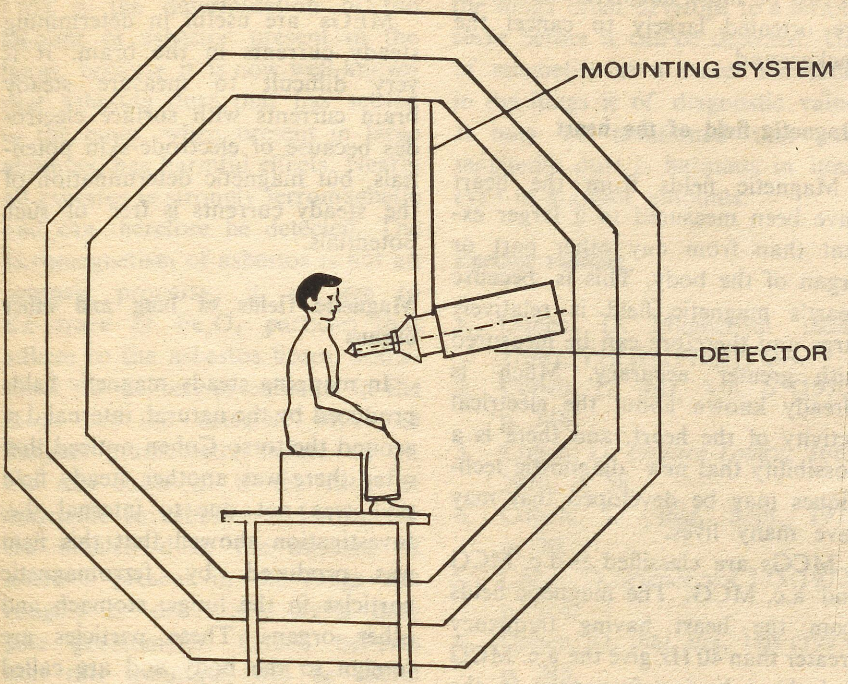

Fig. 2. Measurement of the magnetic field of the heart using a shielded room

son to the fluctuating component of the magnetic background which is several milligauss in an urban environment due to rotating machinary, alternating currents, and moving vehicles. The fluctuating background in a rural environment, though considerably less, is still much greater than the body's fluctuating magnetic fields. The fluctuating magnetic field of the body is to be measured in a background which is much greater than the field to be measured.

The same is the case of steady magnetic fields. Because the strength of earth's steady magnetic field is about 0.5 gauss, the steady fields from the body are to be measured in a steady background that is greater by 4 or more orders of magnitude. We see that the major problem in measuring the body's magnetic field is the presence of a large background.

Mechanisms

A question naturally arises: How are magnetic fields of the body produced? There are two different mechanisms.

(1) First, magnetic fields are produced by electric currents present inside the body due to sodium, potassium and chlorine ions that the excitable tissues (i.e., nerves and muscles) generate in the process of contraction or signal transmission. The currents flow through the general mass of fluids and tissues of the body called the 'volume conductor'. They may be fluctuating (a.c.) and thereby produce fluctuating ma-, gnetic fields, or may be steady (d.c.), producing steady magnetic fields. The mechanism is illustrated in Fig.1; the generator of current in the tissue is represented in the simplest way by a current dipole (the current dipole is the current analogue of the charge dipole.). It is well-known that heart and brain generate ion currents. The current from the heart muscle, when measured with electrodes on the skin, gives electrocardiogram (ECG). The magnetic field around the torso produced by this current, when measured, gives the magnet-ocardiogram (MCG). The current from brain gives electro-encephalogram (EEG) at the scalp and also produces a magnetic field around the head which, when measured, gives the magnetoencephlogram (MEG). As blood is electrically neutral, there is no current associated with the blood flow and hence no magnetic field.

(2) The other reason for the production of the body's magnetic field is the presence of magnetic materials in the body. In general, magnetic materials produce magnetic fields when subjected to a magnetic field. We confine our attention to ferromagnetic substances only and will deal with their remnant fields after the removal of the applied magnetic field. These particles do not occur naturally in the body but are contaminants.

The first measurement of a magnetic field from human body was of the magnetic field produced by the heart. The detectors used consisted of two identical coils, each containing millions of turns around a heavy ferrite rod. They were placed parallel to each other on the subject's

"That is why I always describe you in all public meetings as a magnetic personality"

chest and were connected in opposition in order to largely cancel the background fluctuations. The induced voltages from a distant background disturbance would presumably be identical in the two coils, hence they would be cancelled. On the other hand, the heart's field, because of its gradient, would produce a net measurable voltage. The inherent coil noise and the problem of balancing the two coils exactly against the background are the main defects of this method.

David Cohen of the Massachusetts Institute of Technology used a different approach in dealing with the magnetic background. He and his colleague Lester Wingsberg constructed a magnetically shielded room. When a technique was employed to increase the permeability of the shielding layers, the room was effective in reducing the background, often below detectibility. The detector was a single coil which measured one component of the field instead of the gradient. This system readily gave the heart's signal and also the fields from other organs.

Later, D. Cohen and coworkers constructed at the Massachusetts Institute of Technology, a heavily shielded room that reduced the background much further. A newly developed super-conducting quantum interference device (SQID) magnetometer was installed in the room. It measured the heart's magnetic field with greater clarity and sensitivity than was previously possible. Its frequency response was from d.c. to 500 Hz. The r.m.s. value of the internal detector noise, which defines the limit of sensitivity, is about 1.6×10^{-10} gauss $Hz^{-\frac{1}{2}}$ and is low enough to allow measurement of all the body's fields except the weaker ones from the brain.

Although a body's magnetic fields can be measured more accurately by the SQID, one-component magnetometer, gradiometers are now being used because of their advantage that they can be used with little or no shielding. They consist of two or more magnetometers that are oriented largely to cancel the background.

Magnetic field of the heart

Magnetic fields from the heart have been measured to a larger extent than from any other part or organ of the body. This is because heart's magnetic field is relatively large and therefore can be measured with greater accuracy. Much is already known about the electrical activity of the heart, and there is a possibility that new diagnostic techniques may be developed that may save many lives.

MCGs are classified as d.c. MCG and a.c. MCG. The magnetic fields from the heart having frequency greater than 40 Hz give the a.c. MCG and those having frequency in the range d.c. to 40 Hz give the d.c. MCG.

a.c. MCG maps have been recorded for many normal and abnormal heart subjects as a part of a programme to obtain the new fundamental or diagnostic information in the MCG that is not available in the ECG.

The d.c. MCGs are used to investigate heart when it is injured by the curtailment of blood supply. It generates a steady injury current. Ischemia is the associated condition in which blood supply to heart is diminished. It can lead to angina or infarction. This current is interrupted for a short period in each heart cycle and therefore has an a.c. component which makes it detectable on the ECG. This a.c. component is important in the diagnosis of angina and infarction.

Magnetic field of the brain

Due to various reasons, EEGs give relatively less information of the brain than the ECGs give about the heart. Hence MEGs have more general applications to the brain than that of the MCG for the heart.

MEGs are useful in determining steady currents in the brain. It is very difficult to measure steady brain currents with surface electrodes because of electrode-skin potentials, but magnetic determination of the steady currents is free of such potentials.

Magnetic fields of lung and other organs

In mapping steady magnetic fields produced by the natural, internal d.c. around the torso Cohen noticed that often there was another steady field that was not due to internal d.c. Investigation showed that this field was produced by ferromagnetic particles in the lungs, stomach and other organs. These particles are foreign to the body and are called ferromagnetic contaminants (FC). It was suggested that magnetic measurement of FC in the human lungs may be medically useful.

Reasons for measuring fields

We have seen that measurement of a body's magnetic fields is very difficult. A question, therefore, arises: Why then should we measure these fields?

The first advantage is that the measurement of the body's magnetic field gives some information about the organs of the body that cannot be obtained by potential measurements on the skin, particularly in lungs and brain. Body's magnetic fields are measured for medical diagnosis to find the level of harmful substances present in the lungs for physiological research, etc., One consideration in determining their clinical usefulness is the ease with which these measurements can be made. From this point of view measurements of the magnetic field of the lungs have the greatest potential. Next are the MCGs.

Measurement of Fe_3O_4 particles in the lungs is useful for two reasons. First is the determination of the amount of asbestos present in the lungs, because it is now well-known that asbestos dust that has settled in the lungs, when present in large amounts, has harmful effects. Nearly all asbestos is strongly ferromagnetic and can therefore be detected. The ferromagnetism of asbestos is not an intrinsic property; it is due to the trace of Fe_3O_4 particles that adhere to the asbestos fibres. Sometimes the deposit of asbestos in the lungs can be detected with the fluxgate gradiometer before an X-ray can show it. If the ratio of magnetite to asbestos is known for the inhaled dust, the amount of asbestos present in the lungs can roughly be determined by a fluxgate gradiometer. Cohen believes that this technique will be useful to the asbestos mining industry, where the ratio of magnetite to asbestos is large.

The second use of magnetite in the lungs is as a harmless tracer in determining rates of lung clearance and other processes. Disease in the lungs often develops to a serious stage before it can be detected. Use of magnetite as a tracer substance in the lungs is of diagnostic value. It may be mentioned that pure magnetite dust is harmless in lungs even in gramme amounts.

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'Pace-maker' cells in brain regulate aging

APPARENTLY much progress has been made in gerontology in recent years, but little has been achieved by way of either extending the human life span or preventing the decline in vigour that accompanies aging. Investigators nonetheless are trying hard to understand the basic causes of aging. It remains almost as much a mystery today as ever.

The nervous system and the brain in particular are the primary sites to look for the origin of aging changes in the body. The brain acts as the regulating and co-ordinating centre for the different body processes. It also is the site of origin of several hormones, some of which are known to regulate aging in target organs. The study of aging in brain is interesting from another angle too. Unlike most other tissues in the body which can either periodically or continuously undergo cell division (intermitotics) brain is a fixed post mitotic tissue i.e. it loses its mitotic capacity early in life. Further growth in such cells can occur only by an increase in size. For example, the maximum number of nerve cells in human brain already obtains at the time of birth. There is little increase in its number afterwards. Such post-mitotic tissues as the brain and muscle are subjected to more intense aging changes than the continuously dividing cells like those of liver.

Not only the capacity to undergo cell division is limited in brain, there is also progressive loss of neurons from the brain. Horton Johnson and Stuart Erner (1972) of the Health Sciences Centre, State University of New York have reported that the number of 5.5 million neurons in the young mouse brain drops to its one third in extreme old age. From this they conclude that irreparable loss of cells to the most vital organ in the body is perhaps a factor in limiting life span. Recently, Kalidas Nandy and others of Emory University, Atlanta, Georgia have shown the presence of brain specific antibodies on mouse servum as a function of age which may account for such losses of neurons.

On the contrary, Caleb Finch (1972) of Cornell University Medical College and Leonard Franks of the Imperial Cancer Research Fund, London and others believe that the life-span is controlled by a small group of 'pace-maker' cells in the brain, changes initiated by these cells affect other target organs throughout the body via afferent nerves or through their influence on pituitary hormones. Loss of these essential cells could lead to the death of the individual.

Evidence for this in part has already been provided by Bernard Strehler (1975) of the Division of Biological Science, University of Southern California at Los Angeles who has observed loss of genes from selected areas in the brains of old beagle dogs with age.

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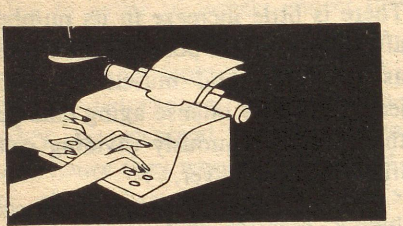


NEWS & NOTES

Prof. Ramachandran elected F.R.S.

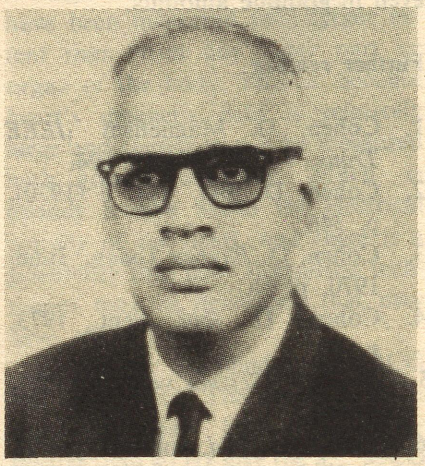
PROF. G. N. Ramachandran, Professor of Bio-Physics at the Indian Institute of Science, Bangalore, has been elected Fellow of the Royal Society, London.

This award is the latest in the chain of several distinctions earned by Dr. Ramachandran for his significant contributions to the understanding of the structure of biological macromolecules. Dr. Ramachandran's main contribution has been the study of the structure of collagen which forms the essential constituent of connective tissues such as skin, tendon, bone, etc. Collagen accounts for more than half the proteins in the animal system.

His studies have revealed the exact role played by the amino acid, hydroxyproline, which occurs only in collagen and in no other protein, and whose role was not known previously. His team has attributed to hydroxyproline the role of interconnecting the three chains of the triple helix by means of hydrogen bonds. In addition, using the techniques developed for biopolymer analysis, his group has worked out a new method of solving crystal structures, namely, by packing the molecules in the known unit cell of the crystal and by checking that there are no short-contacts between each molecule and its neighbours.

The Department of Molecular Biophysics at the Indian Institute of Science was created by Dr. Ramachandran five years ago.

His initial work on the structure of collagen was done at the Department of Physics at the University of Madras.



Prof. Ramachandran

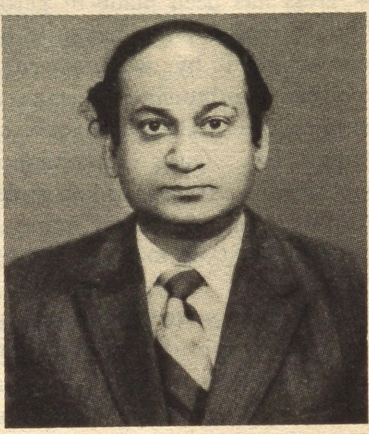
Professor Ramachandran is a graduate of the University of Madras from where he took his M. A. and M.Sc. degrees, after which he worked for his doctorate with Prof. Sir C. V. Raman at the Indian Institute of Science, Bangalore. In addition to the D.Sc. from Madras, he is also the recipient of Ph.D. from the University of Cambridge, England, where he worked under the celebrated discoverer of X-ray diffraction, Prof. Sir Lawrence Bragg. After returning to India in 1949 he was Assistant Professor at the Indian Institute of Science for three years, after which he was appointed Professor and Head of the Department of Physics at the University of Madras at the early age of 30.

An Interview

Prof. K.P. Sinha

"LIKE Max Born of Germany, J. Robert Oppenheimer of U.S.A., Lev Landau of Russia, Indian scientists should strive to build new Schools—and not new Institutes," says the eminent theoretical physicist Prof. Krityunjai Prasad Sinha, of Indian Institute of Science, Bangalore, the winner of the Bhatnagar Award in Physical Sciences for the year 1974. By new schools he means nurturing a group of students along a specific "style of thinking and research," so that they trigger a sort of chain reaction, attracting more students to their school and way of research.

Who could be more confident of talking about all this than Prof. Sinha? Apart from his notable contributions to physical chemistry, particle physics, gravity, cosmology and astrophysics, he has also produced some brilliant students in the country who are presently doing commendable research. And what is more interesting about him is that with almost every student he changes his research problem as well. The reasons? There are two.



Prof. Sinha

First, of course, is the interest of the student. His shifting from one subject to another with appreciable contributions in all becomes apparent when one comes to know that his students are not necessarily physicists. One, Dr. N. Kumar, for instance, who has done some brilliant work with him in superfluidity and superconductivity is an M. Tech. in microwave. On the other hand, C. Sivaram with whom he has done research in strong and weak gravity and its impact on astrophysics is basically a mechanical engineer.

Secondly, he changes his subject of research once he realises that he has done his best work in that field. His outstanding work in the last few years has been on the quantum theory of solid-solid interactions, phase transition in solids, mechanisms of exchange interactions in magnetic crystals, phonon-magnon and electron-magnon interactions and relaxation processes in para, ferro, ferri and antiferromagnetic solids, electron-phonon interactions and the transport properties of semiconductors, the origin of giant magnetic moments and resistance minimum phenomenon in dilute alloys, mechanisms of superconductivity, in particular, the development of the concept of nonequilibrium processes involving photon-induced superconductivity which shows great promise for getting room temperature superconductivity, non-radiative electron hole recombination processes, electronic phase transitions and exciton condensation. In recent years, Prof. Sinha has developed a new approach, involving general relativity and strong gravity, in the study of elementary particles and cosmological models.

But, how did he get interested in science? Prof. Sinha, on much persistence, said that popular science lectures given at his school had impressed him and coaxed him into taking science as a career. A few teachers, for example, Prof. G. I. Finch, a former Director of National Chemical Laboratory, Pune, and Prof. M. H. I. Pryce, of Bristol University, U.K., were also a source of inspiration for him.

Today, apart from being a visiting scientist to various foreign Institutes, Prof. Sinha has the distinction of being recognised as a brilliant physicist of the University of Bristol.

What is the secret behind his commendable research work? Besides hard work, Prof. Sinha claims that he takes "every student as a separate individual and his treatment varies from one to another." He believes in making the student interested in a problem first and then tackling it together.

DILIP M. SALWI

Phycologist R. N. Singh passes away

DR. Rama Nagina Singh, former Professor and Head of the Department of Botany, Banaras Hindu University and an internationally known Phycologist, died on March 9, 1977 in Varanasi. He was well known as a researcher in the field of Phycology. He was equally well known for his *Role of Blue-green Algae in the Nitrogen Economy of Indian Agriculture* published in 1961 by the Indian Council of Agricultural Research, New Delhi. His contributions to phycology started with systematics, autecology and limnology and turned through ultrastructure, physiology and biochemistry to the genetics of blue-green algae and their viruses. Prof. Singh had the opportunity of working in several foreign laboratories. His research publications with Prof. Hans Ris and R. H. Burris of the United States formed the pioneering reports on the ultrastructure and biochemistry of nitrogen-fixing blue-green algae. Genetical studies on blue-green algae, which started with his report in 1957 on an X-ray induced mutant, were finally given an orientation by him towards understanding of the possible relationship between nitrogen fixation and heterocyst differentiation in these organisms; the advantages they could provide in terms of genetic compatibility for their use as starting experimental organisms for physiologic/genetic transfer of the nitrogen fixation ability to otherwise distant taxa.

Born on August 8, 1915 at Deoria in U.P. in a zamindar family, Dr. Singh studied upto high school in Udai Pratap College, B.Sc. at Ewing Christian College, Allahabad University and obtained his M.Sc. and D.Sc. from Banaras Hindu University. He joined the Department of Botany, Banaras Hindu University, and served the University in various capacities. He retired as a Senior Professor and Head of the Department of Botany on August 8, 1976. Before his retirement, he was elected President of Botany section at 61th Indian Science Congress held at Nagpur in 1974. After his retirement he was devoting his entire time to completing the book entitled *The Algae* under the U.G.C. book writing scheme. He told me personally, two days before his death, that the writing work of the book was almost complete and was ready for the press.

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Drs. Yalow, Ahlquist, Black and WHO get Lasker Award

THE $10,000 Lasker Awards are among the most prestigious prizes in American medicine. Since 1945, when they were first awarded, a total of 25 Lasker awardees were later awarded Nobel Prizes. The 1976 Lasker Awards in Medicine have recently been awarded to Dr. Rosalyn S. Yalow who developed a new laboratory tool that has led to detection of many body metabolites and drugs; Dr. Raymond P. Ahlquist and Dr. James W. Black who developed a drug that is widely used in the treatment of heart disease and high blood pressure; and the World Health Organization (WHO) which has virtually eradicated smallpox in the world.

Dr. Yalow got the Lasker Basic Medical Research Award for her role in developing with late Dr. Solomon A. Berson the radioimmunoassay technique at the Bronx Veterans Administration Hospital in New York. This technique is now routinely used to measure concentrations in minute amounts of hundreds of metabolites, hormones, vitamins, viruses, enzymes, and drugs and to help determine changes between normal and diseased states. The radioimmunoassay that uses radio isotopes to measure the concentrations of various substances in a variety of body tissues and fluids is an application of nuclear physics to medicine. Dr. Yalow was the first woman and the first nuclear physicist to win the basic medical research award.

Dr. Ahlquist of the Medical College of Georgia in Augusta, and Dr. Black of the University of London, shared the Lasker Clinical Medical Research Award for their independent research that led to the development of a class of drugs called beta blockers. Propanolol, an example of this class, is used by thousands of people to prevent irregular heartbeats and to lower their blood pressure.

The WHO in Geneva received the rarely awarded Lasker Public Health Service Award for "the imminent eradication of smallpox—the first and only disease ever to be eradicated from the Earth." Now smallpox exists in just one country—Somalia. Health workers are trying to search every house in an effort to eradicate the last cases in Mogadishu, Somalian capital. Dr. Halfdan T. Mahler, a Danish physician who is Director-general of the WHO, and Dr. Donald A. Henderson, an American who is Director of the WHO's global smallpox eradication programme, accepted the Award for the WHO in a recent ceremony in New York when Mrs. Albert D. Lasker, President of the Albert and Mary Lasker Foundation, presented the awards.

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REINDEER ANTLERS (*Continued from page 370*)

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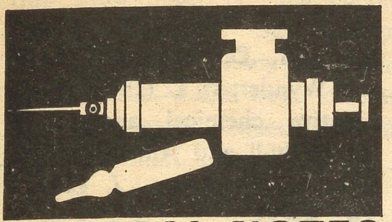

MEDICAL NOTES

All about smoking

NEUROLOGISTS rightly believe that smoking is one of the most dangerous hazards that mankind faces today. It not only damages brain and interferes with the chemical control of blood constituents, but also causes cancers of lip, tongue, lung, etc. and produces peptic ulcers. Nicotine, a major constituent of the smoked or unsmoked tobacco, in some individuals exerts an excitatory effect upon gastric secretion thereby releasing more of the gastric acid; the latter causing erosion and ulceration of the gastrointestinal tract. Smoking also aggravates hypertension, bronchial cough, Buerger's disease (clotting of blood in big arteries and veins of limb), and Raynaud's disease (bluish turning of the digits).

The relationship of cigarette smoking to lung cancer, and tobacco-chewing to mouth cancer are not well established. It has been predicted that for a man aged 40 who smokes 20 or more cigarettes per day, the risk of dying of lung cancer before the age of 80 is of the order of 8 chances in 100, and that this is between 7 and 30 times as high as the chance for a non-smoker. How tobacco and tobacco preparations caused cancer was hitherto not exactly known. The problem now appears to have been solved decisively. At the Naylor Dana Institute of Disease Prevention, New York, a subsidiary of American Health Foundation, Dr. Dietrich Hoffmann and his associates in 1974 have unambiguously identified N^1-nitroso-nornicotine which is a potential carcinogenic (cancer-producing) compound. The amount of this hazardous substance in common U.S. tobacco products is between 1.9 and 88.6 ppm (parts per million), one of the highest values of an environmental nitrosamine yet reported. The amount of this substance in food and drink rarely exceeds 0.1 ppm. N^1-nitroso-nornicotine is in fact the first example of a potential organic carcinogen isolated from tobacco. Previously the incidence of cancer of lungs and other respiratory organs in tobacco-addicted persons was credited to nicotine, a major constituent of tobacco smoke. The latter is also accompanied by several other harmful gaseous substances, such as hydrocyanic acid (HCN), pyridine bases, ammonia, carbon dioxide, carbon monoxide, organic acids, aldehydes, hydrocarbons, and "tobacco tar" and "tobacco resins." Many smokers inhale the tobacco smoke into their lungs, while others allow it to remain in the mouth and expel it through the nostrils and mouth. It is quite obvious that inhalation promotes the absorption of the cancer-causing compound N^1-nitroso-nornicotine; prolonged contact of this substance with the membranes of the lungs provide a direct opportunity for the development of cancer. Smokers are therefore warned to mend their smoking pattern, that they should not inhale cigarette smoke into their lungs, or if possible they must refrain from smoking too.

A similar study on the effect of smoking on longevity made by Dr. R. Pearl in 1938 involved 6913 men. The study revealed the following results which were both interesting and shocking : 50% of the heavy smokers were dead in 17.5 years after the starting age of 30 years; it was 26 years before 59% of the moderate smokers were dead; and it took 28 years before 50% of the non-smokers died. These findings even today stand unchallenged, and signalize a grave warning to heavy and chain-smokers. However, it is also true that habits and human behavioural patterns do not change merely by occasional publication of such scientific results and data. Moreover, there had been hitherto no practical way available to stop smoking.

Now the question is why do people smoke? Several hypotheses have been propounded for finding an answer to this intriguing question. It has now been proved, more or less conclusively, that people smoke because they need nicotine, a poisonous alkaloid and a major component of cigarette tobacco. This need is purely physiological. Under stress and strain, the smoker smokes a greater number of cigarettes, which suggests that the body actually demands more of this addictive alkaloid. Research workers in Sweden have demonstrated how nicotine acts ? It goes straight to the brain and stimulates it for about 5 minutes. In another 10 minutes the brain gets depleted of this drug as it is metabolized in the liver and kidneys, and then excreted through urine. Dr. J. H. Weatherby had demonstrated in 1942 that the smoking of one cigarette by a habitual smoker produced the following transient physiological changes in the body: (i) increase in systolic blood pressure by 10 to 25 mm; (ii) acceleration of pulse by 5 to 20 beats per minute; and (iii) drop in skin temperature by 2°C to 5°C (in fingers) and 3°C to 7°C (in toes). The complete removal of nicotine from the cigarette is the only way to annihilate most of these and other deterimental effects of smoking.

Several attempts have been made in various parts of the world to save people from the harmful effects of smoking, but without much success. The "denicotinized" cigarettes, containing about 40% of the normal nicotine content, are now available in several European countries. Dr. L. B. Johnson in 1942 experimented with a series of smokers by giving them a hypodermic injection of pure nicotine instead of allowing them to smoke. Following nicotine injection, smokers felt quite pleasant, and found it as an adequate substitute for smoking. In some European nations, tablets containing chemicals which leave a bad taste in the mouth are available. This can obviously help break a smoker's habit provided he continues to take pills. Similarly, in Germany, chewinggums containing silver acetate (0.2 part), ammonium chloride (0.7 part) and enzyme cocarboxylase (0.003 part) have been manufactured which when chewed by smokers will produce a tendency to abandon the habit of smoking. The effect of nicotine has also been simulated by another harmless, incompletely or completely consumable chewing material containing sedative substances, e. g., hops extract (which contains 32% humulone and 45% lupulone) and stimulating substances e.g., cola extracts (containing 10% caffeine) (German Patent No. 1,901,277, August 6, 1970). Group therapy, and in certain cases psychotherapy have also been tried to stop smoking habit. Another reasonable solution is to develop a safe cigarette, actually an imitation of the latter. A non-tobacco fag with a little caffeine added for a kick is being tried in Britain. Two big companies—a chemical firm and a tobacco concern—are carrying out trials with a tabacco-less cigarette. If the trials succeed, some of the terrors of smoking can be eliminated. Recent intensive tests by an American psychologist on the link between smoker's urine and the frequency of smoking show that by modifying the pH (acidity) of the urine the number of cigarettes smoked may be reduced. It is suggested that if a smoker consumes alkaline salts (like sodium bicarbonate) and foods, the depletion rate of nicotine from the body is considerably reduced, and hence he can reduce smoking. In this way without smoking too much, the brain's requirements for nicotine are met, avoiding simultaneously the excess intake of dangerous constituents of cigarette (like tar). What is now desirable on the part of smokers ? They should start taking more of non-acidic and alkaline items of food.

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Vinylidine chloride causes kidney cancer

In a recent study, Dr. Cesare Maltoni at the Institute of Oncology in Bologna, Italy, exposed rats, hamsters, and mice to vinylidine chloride gas at much higher levels, starting at 10 parts per million for upto one year and found that kidney cancers developed in about 20 per cent of the male Swiss mice, but in none of the other animals. Three years ago, Dr. Maltoni's studies showed that viny chloride, another plastic chemical like vinylidine chloride, caused cancer in rats and mice. Shortly afterwards, vinyl chloride was pinpointed as the cause of a rare, fatal liver cancer in exposed factory workers. Vinylidine chloride is a gaseous chemical which, when polymerized with vinyl chloride, makes up flexible wrap. (Other packaged plastic wraps are made of polyethylene). The vinylidine choride-vinyl chloride copolymer, called 'saran' is used to wrap commercially prepared meats and cheeses. It is said that about one-third of the flexible plastic packaging for food in grocery stores is saran, representing an annual market of 150 to 200 million pounds of plastic. The finding of an Italian researcher that vinylidine products in some plastic food wraps can cause cancer in mice prompted cancer experts in several countries to alert the public and Government agencies to the needfor closer scrutiny of this chemical which is related to two other cancer causing chemicals, vinyl chloride and trichloroethylene. The U.S's Dow Chemical Company researchers say, however, that studies of foods wrapped in plastics made from vinylidine chloride show none of the chemical migrating from the wrapping to the food. They contended that the tests would have disclosed contamination if it exceeded 10 parts of vinylidine chloride in one billion parts of food.

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Ancient medicine in eye diseases

RASAUT is the Hindi name of the plant, *Berberis aristata*. The plant is described in the ancient Indian literature as useful in prevention and cure of eye diseases. The Ayurvedic Treatise strongly recommend prophylactic washing of the eyes every fifth, seventh or eighth night with dried, aqueous extract of the plant. The chief alkaloid of *B. agistata* is berberine.

Trachoma is an important disease affecting about 20-80 per cent of the population in many provinces in our country. The current therapy of trachoma involves the use of drugs like sulfonamides and antibiotics, which are however prolonged and expensive.

The first ever clinical application of pure berberine was made by R.L. Verma (*Indian Med. Gaz*, 68, 122, 1933) who had applied it to chronic trachoma patients by interaconjunctival injections (injunction into the conjunctiva membrane of the eyes). He had found the drug highly effective. Some scientists at the All India Institute of Medical Sciences New Delhi, recently conducted experiments on this drug and have concluded that "berberine may prove a practical remedy for large scale use in trachoma patients" (*Indian J. Med. Res.* 8 August 1977).

ZAKA IMAM

SUPERHEAVY ELEMENTS (*Continued on page 363*)

Now a question arises : What will be the highest possible nuclear charge ? One line of thinking is that as the nuclear charge increases, size of the electronic shell closest to the nucleus decreases; and at Z-150 or so, size of this electronic orbital will be about the size of the nucleus so that element number 150 or like would be expected to be the last member of the Periodic Table. Scientists are quite hopeful to synthesise or discover newer elements particularly of the atomic numbers 110, 114, 118 and 126, but all these elements will be always in micro amounts and potentially unstable.

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FOR HER

Contraceptives that kill sperms

IN 1960's there was wide spread use of oral contraceptives and intra-uterine contraceptive devices. But in later years, in many parts of the world, people lost interest in local vaginal contraceptives. Again, in 1970's, an era of new methods of contraception started. Many new approaches were made which included methods like subdermal implants of long acting progestagens, post-coital drugs and pregnancy vaccines comprising of human chorionic gonadotrophin secreted by the chorionic layer of early human placenta. When analysed chemically the gonadotrophin was found to be composed of two chains of amino acids, α-and β-subunits. Antibodies raised against α-subunits were found to be inactive but antibodies against β-subunits were found to terminate pregnancy in the early parts of its development.

But none of the above methods is perfect, and all have some side effects. Under these circumstances, it is advisable to use old methods of contraception with some modifications. So, before someone desires to use vaginal contraceptives, the following important points need consideration.

Vaginal contraceptives are basically spermicidal in action and are divided into three groups: (i) vaginal contraceptives having surface active agents as chief ingredients; (ii) vaginal contraceptives having organometallic or bactericides as chemical constituents; and (iii) vaginal contraceptives composed of weak acids such as acetic, boric and tartaric acid in the formula.

Most popular among them are the surface active agents which are divided into anionic, non-ionic and cationic types. These agents probably attach themselves to sperms and check the utilization of oxygen and fructose by them. This results in the breaking up of the sperm wall, making sperms incapable for fertilization. The most common example of such an action is nonylphenoxy ethanol, or nonoxynol-9, which is generally used as the main chemical ingredient in about 80% of the vaginal creams. Organometallic compounds or bactericides include metallic salts like phenyl mercuric salts or quinine salts and other metallic salts. Probable mode of action of these salts is by breaking up the sulphide bonds or by stopping fructolysis, i.e., utilization of fructose by ejaculated spermatozoa. Weak acids are used in vaginal douches and vaginal foaming tablets which change the pH of the vaginal fluid. The change in pH makes life of viable sperms impossible.

These chemical ingredients cannot act independently, and need a media in which they may be incorporated. Vehicle of a vaginal spermicide has been assigned many roles. For example, it may not only act as a physical barrier but also prohibit sperm penetration into the cervical mucus and promote a longer exposure time to the spermicide.

If one is convinced that vaginal spermicides can be used for contraception, there are some important criteria for an ideal vaginal contraceptive. For example, (i) it should act rapidly and efficiently, (ii) it should kill or immobilise all sperms on contact, (iii) it must render the sperm incapable of fertilization, and (iv) on being absorbed from the vaginal epithelium into the blood vascular system it should not show any untoward action in the body; should not be irritating to the mucus membrane of the vaginal and penile surfaces, and also it must not have any adverse effect on the developing foetus (in case of pregnancy not having been detected.

Vaginal contraceptives available in the market in India and abroad are in the form of jelly, creams, foaming tablets, aerosol foam, soluble c-film, etc.

Foaming tablets consist of bicarbonate of soda and tartaric acid, and glycerine as base material. On coming in contact with vaginal secretions, carbon-dioxide is released giving a rich foam. Foam carries spermicide which disperses over the full vaginal surface killing sperm in minimum possible time.

Aerosal foam contains oil and water emulsions stored under gas pressure. The liquefied gas is released producing a lot of foam, and foam acts as a spermicide.

Soluble c-film consists of polyvinyl alcohol, glycerine and base carboxymethylcellulose or a rice paper to carry these above spermicides. When this paper-like material containing spermicide is exposed to vaginal secretions, it is dissolved in about 30 minutes. So, it is always inserted ½ an hour before coitus to have a desirable effect.

Orthogynol is the most preferred and popular jelly in foreign countries. Its composition is different from nonoxynol-9 which is widely used in creams like Antenin, Conceptrol, Dalf and Immolin.

Recently, the Central Drug Research Institute, Lucknow has formulated a vaginal cream containing saponins derived from *Sapindus mukorosii* (soop-nut), 'Ritha' fruits. It is hoped that this formulation will be cheap and effective.

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SCIENCE FOR THE YOUNG

Communication in animals

ANIMALS belonging to different species use the most noisy shows to make themselves understood. Mostly the message given by one species to another is a warning, so that theother species must stay out of its way or keep out of its private territory. Usually such a warning is backed up with punishing action, for example, the growl of a dog, whir of a rattle snake, etc.

A very interesting example—a blue jay, finding a great horned owl near its nest, goes for attack. The blue jay, who is much smaller could do no real harm to the immensely stronger owl. But in this case, the breakdown in communication works to the advantage of the jay. The owl does not have any natural enemy. So it is not able to reply the attack of the jay. The jay's behaviour confuses the owl and momentarily short-circuits the owl's normal predatory response without its knowledge. The owl grows uneasy. If it is bothered enough, it will retire and run away.

Postures and patterns

Human beings, besides being able to communicate through speech, also have expressive smiles, tears, attitudes of body and manual gestures. Man can communicate with all these signs without talking as people of different languages do. Similarly, many animals are capable of conveying a fantastic amount of information to their fellows without making any sound.

A goose or a hen, depends almost entirely on posture to express itself. Similarly, a fresh water fish of *Cichlid* family not only changes the position of fins to express various emotions but actually changes its colour and pattern as well.

Communication under water

When we just look at the sea, we think that the world below its surface is silent. But it is not so. Rather there are sounds of whistles, moans and chirps—much beyond the limits of human ears. In the sea, light is poor and visibility nil. Animals rely increasingly on sound as their need for communication increases. Fishes are relatively stupid and communicate only slightly, if at all. They "hear" through their bodies, have little sense of the direction of a sound and most of them are silent.

The whales, porpoises and dolphins are highly intelligent and lead complex social lives. As they are mammals, they also have ears which are basically similar to ours and their hearing is far keener. Their ability to determine the position of an object, such as a reef, without being able to see in the same way as the bat does by echo location—is an extraordinary feature. They are capable of communication through a wide variety of sounds.

Signals and responses

In the animal kingdom, much of the communication is simple and direct but in higher species it becomes more complex. Most of their actions take place automatically without thinking. It is so with amoeba or paramecium and to a lesser degree with man. For example, give a prick to a *Homo sapiens*, and he jumps. In the case of fiddler crab, the male is ready to have any mate just so long as it is a female of the same species. When sexually urged this male crab begins to wave its claw, a characteristic feature and the female, seeing it, automatically approaches.

When a young one of a bird feels hungry, it gapes. That is the only language it knows. The parent bird automatically responds and begins to stuff it with food.

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Interesting results in recreational mathematics

THE following two groups of numbers 0, 5, 5, 10 and 1, 2, 8, 9 have an interesting property that the sum, sum of squares and sum of cubes of one group equals the sum, sum of squares and sum of cubes respectively of the other group. Thus

$0+5+5+10=1+2+8+9$

$0^2+5^2+5^2+10^2=1^2+2^2+8^2+9^2$

$0^3+5^3+5^3+10^3=1^3+2^3+8^3+9^3$

It may be noted that the two groups of five numbers 1, 4, 12, 13, 20 and 2, 3, 10, 16, 19 have also the aforesaid property. In other words,

$1+4+12+13+20=2+3+10+16+19$

$1^2+4^2+12^2+13^2+20^2=2^2+3^2+10^2+16^2+19^2$

$1^3+4^3+12^3+13^3+20^3=2^3+3^3+10^3+16^3+19^3$

2. In the following results

$9+9=18,\quad 9\times9=81$

$24+3=27,\quad 24\times3=72$

$47+2=49,\quad 47\times2=94$

$497+2=499,\quad 497\times2=994$

it is seen that the product of two numbers is the same as their sum when the digits of the resulting products are written in reverse order.

3. In each of the three following additions, the interesting thing is that 4 digits only occur in different orders:

4671	2493	2853
+1476	+2439	+2385
6147	4932	5238
+1467	+4392	+3285
7614	9324	8523

4. Factorial of any number n is defind as $1\times2\times3\times4\ldots(n-1)\times n$ and is written as either $\angle n$ or $n!$ Thus

$1!=1=1$

$2!=1\times2=2$

$3!=1\times2\times3=6$

$4!=1\times2\times3\times4=24$

$5!=1\times2\times3\times4\times5=120$

$6!=1\times2\times3\times4\times5\times6=720$

$7!=1\times2\times3\times4\times5\times6\times7=5040$

$8!=1\times2\times3\times4\times5\times6\times7\times8=40320$

and so on for other numbers. The factorial of 0, i.e., 0! is taken as 1.

Now consider the number 145 The factorials of the digits composing the number are

$1!=1,\ 4!=24$ and $5!=120$

Adding up, $1!+4!+5!=1+24+120=145$

which is the same as the number itself. Likewise it will be seen that the same property holds for the numbers 1 and 2.

For,

$1!=1$

$2!=2$

The next number for which this property, namely, the factorials of the composing digits add up to the number itself holds is 40585.

For

$0!=1,\ 4!=24,\ 5!=120,\ 8!=40320$

"I took mathematics as a recreation, Dad, but the results are far from interesting"

Adding up $4!+0!+5!+8!+5!$ one gets the number 40585.

There is no other number with this property apart from the above four numbers 1, 2, 145 and 40585. This has been demonstrated with the assistance of a computer (*Mathematical Review*, April 1973, U.S.A).

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Smoke detector : how it works

WHEN you hear about fire at some place, you imagine a disastrous situation covered with smoke and flames. Loss can be saved to a great extent by the use of early fire alarm devices. Smoke detector is an indispensable gadget for every home and industrial complex. This device can avert fatal fires.

Fire process

Fire develops in the following four stages.

Incipient stage. The heat produces invisible tiny particles in the process of thermal decomposition.

Smouldering stage. The combustion increases the size and quantity of particles. The smoke is now visible.

Flame stage. The gases and particles produced in the process of thermal decomposition ignite themselves. The flame gradually builds up.

High heat stage. This follows immediately after the flame stage. The rapid expansion of flames causes damage to property.

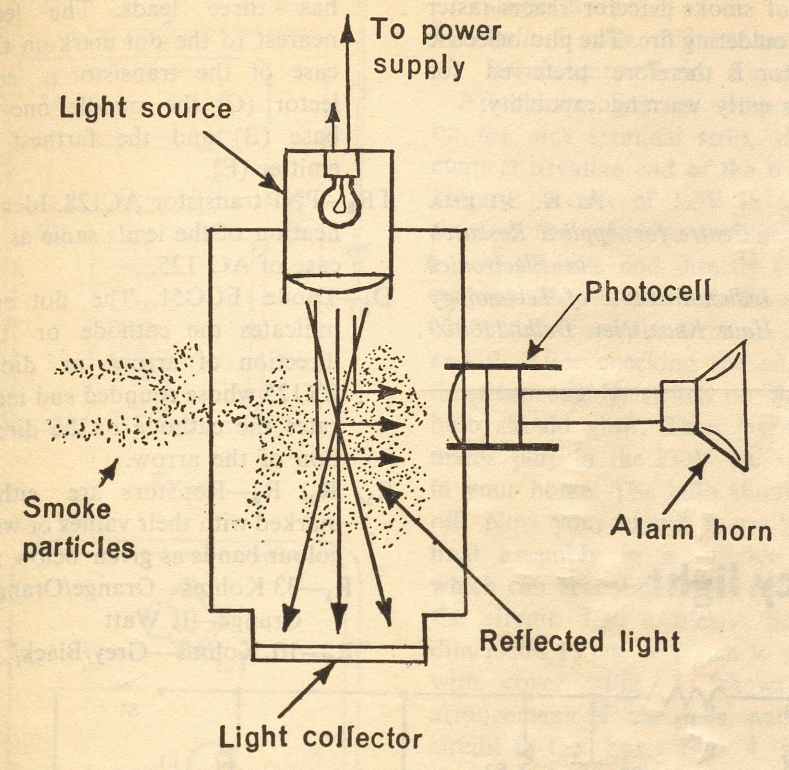

Fig. 1. Photocell type smoke detector

So fire can be detected by 'smoke' or 'heat' produced in the process. As the fire should be detected in the initial stage, smoke detectors are used. The smoke detectors help quicker control of fires.

Operation of smoke detector

Two types of smoke detectors are available. The principle of operation is photoelectric principle or ionization principle.

Photoelectric type

The basic principle of operation in this type is scattering of light by smoke particles.

As shown in Fig. 1, such detectors consist of a light source (incandescent bulb or light-emitting diode), light collector or absorber, photocell for detection of smoke particles.

In the absence of fire the chamber is full of clean air. The beam of light travels across the chamber and is absorbed by a light absorber. The intensity of light in this case is insufficient to cause any change in photocell resistance.

In the case of fire, the smoke produced gets filled up inside the chamber. The small smoke particles scatter the light in all directions. A portion of the reflected light therefore falls on the photocell. The change in the resistance of the photocell is used to initiate an alarm by means of an electronic circuit.

Ionization type

In the ionization type of smoke detector, the smoke particles cause a decrease in the current resulting from the flow of ionized air.

The typical configuration of this type of detector is shown in Fig. 2. The electrodes in the center of the chamber cause ionization of air. These ionized air molecules travel across the chamber and produce a small ionization current.

When smoke enters the perforated chamber, the positive and negative ions now attach themselves to smoke particles. Since the smoke particles

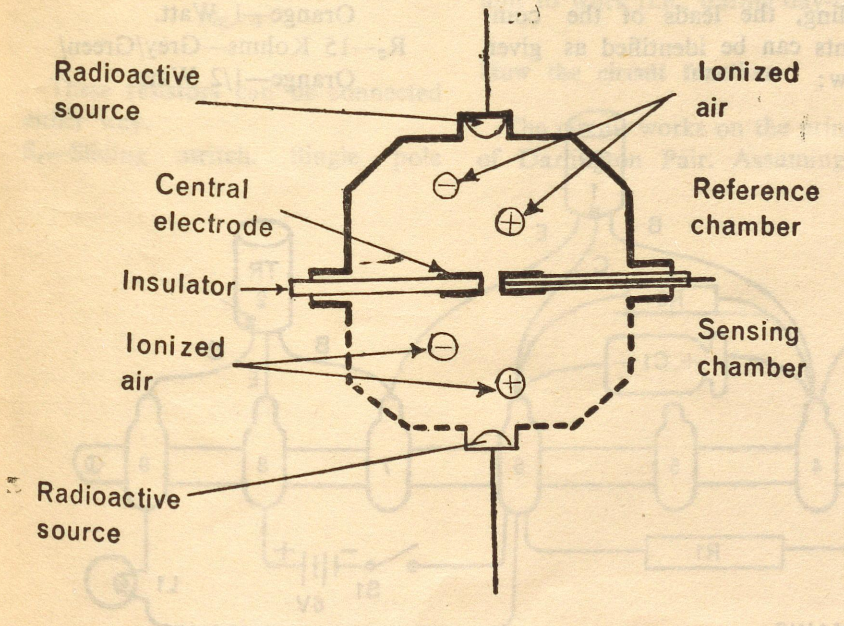

Fig. 2. Ionization type smoke detector

are larger than the size of air molecules, they travel very slowly across the chamber. This causes decrease in the ionization current. This decrease is used to initiate an alarm using an electronic circuit.

Both types of a smoke detectors are inexpensive lifesaving systems. They greatly enhance detection of fire in the early stage. It is observed that ionization type of smoke detectors are sensitive to flaming fires, while the photoelectric type of smoke detector reacts faster to smouldering fire. The photoelectric detector is therefore preferred for better early warning capability.

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Do it at home

Mini emergency light

YOU must have seen emergency light in theatres or cinema halls which glows when the mains supply goes off. The cheapest costs about Rs. 250/-. But the *mini emergency light* which could be made at home, will cost you Rs. 15/- only. Its construction is very simple. Fig. 1 represents the electronic circuit whose components are easily available. Fig. 2 shows a simple layout of components on a nine terminal strip. While assembling, the leads of the components can be identified as given bellow:

TR_1—PNP transistor AC125. It has three leads. The lead nearest to the dot mark on the case of the transistor is collector (C) the middle one is base (B) and the farthest is emitter (E).

TR_2—PNP transistor AC128. Identification of the leads same as in case of AC 125.

D_1—Diode ECO51. The dot end indicates the cathode or the direction of arrow or diode BY125 whose rounded end indicates the cathode or the direction of the arrow.

R_1, R_2, R_3—Resistors are either marked with their values or with colour bands as given below :

R_1—33 Kohms—Orange/Orange/Orange—1 Watt

R_2—10 Kohms—Grey/Black/Orange—1 Watt.

R_3—15 Kohms—Grey/Green/Orange—1/2 Watt

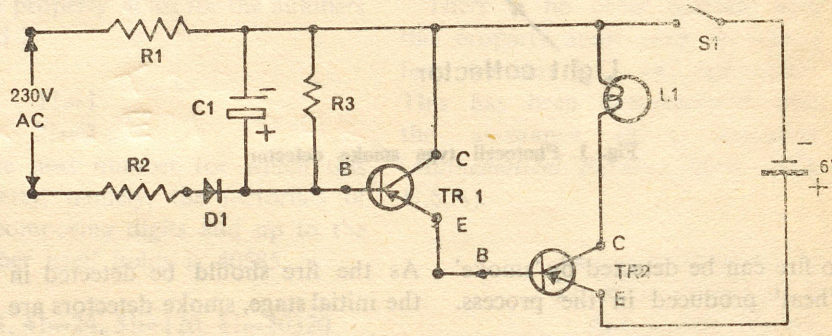

Fig. 1

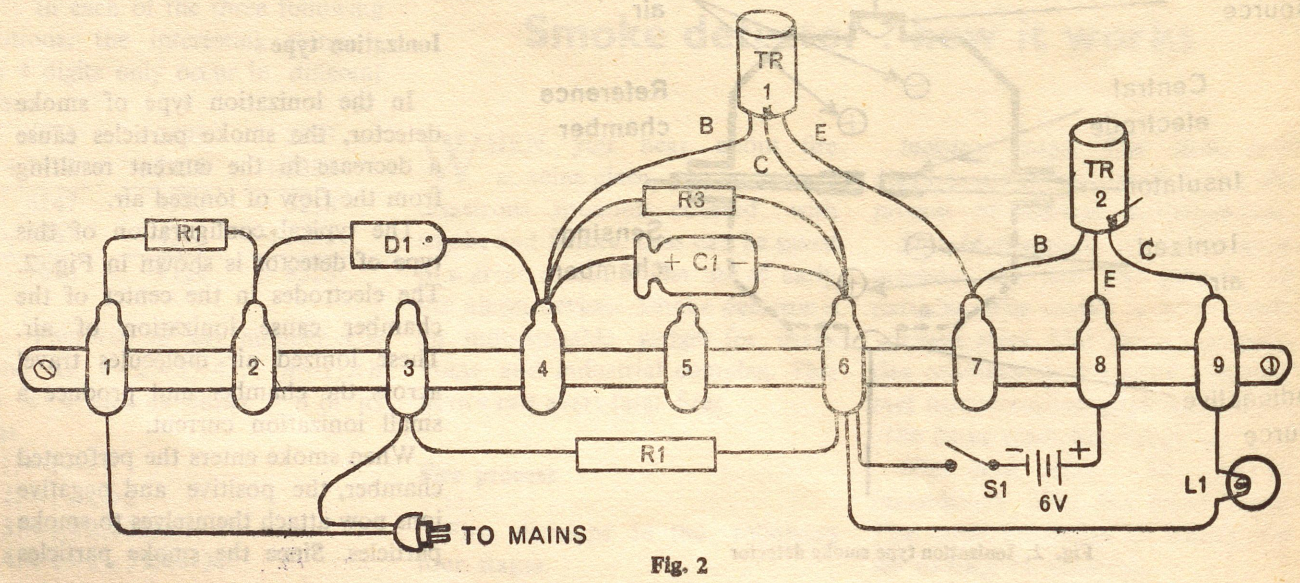

Fig. 2

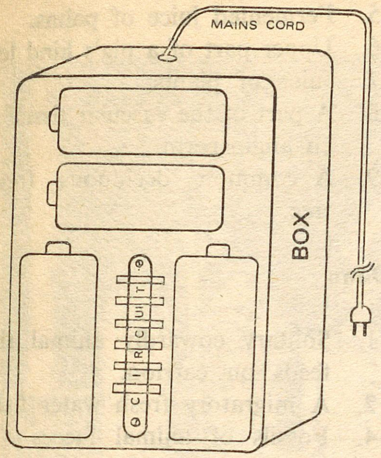

Fig. 3

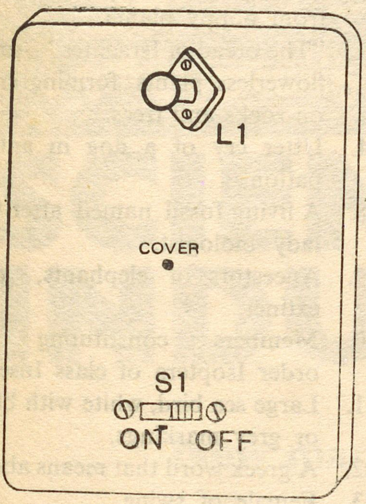

Fig. 4

These resistors can be connected either way.

S_1—Sliding switch. Single pole single throw.

L_1—Bulb 6 volts. 150 mAmps or 300 mAmps. Screw Type.

After assembling the components on the nine terminal strip, simply connect negative end of the 6 volts battery (4 cells of 1.5V in series) through the switch to terminal No. 6 and positive end directly to the terminal No. 8., the bulb should be connected across the terminal No. 6 and 9. After checking the connections thoroughly, switch on S_1, the bulb should glow. Then insert the mains plug in the 230V a.c. socket in your home. The bulb should go off. Now your circuit is ready for final assembly in a suitable box which can accommodate 4 cells and the circuit. Use a plastic box of dimension 18 cm × 15 cm × 5 cm with cover. Fig. 3 shows the arrangement of the cells and the circuit in the box. Fig. 4 shows the mounting of the bulb and the switch on the cover.

For wiring the bulb and switch, use a convenient length of wire, about 20 cm. Do not touch any point of the circuit when the unit is connected to 230V a.c. Switch off S_1 when you don't want the unit to work (i.e., during day-time).

How the circuit functions

The circuit works on the principle of Darlington Pair. Assuming the mains supply off and switch S_1 'on' (Fig. 1), the resistor R_3 biases the transistor TR_1 to conduct by making its base positive with respect to collector but negative with respect to emitter. As the emitter of TR_1 is connected to the base of transistor TR_2, the first drives the second into conduction and so current starts flowing through the collector causing the bulb L_1 to glow.

Now insert the mainsplug in 230V a.c. socket. Resistor R_1 and R_2 reduces the mains voltage to 6V a.c. which is then rectified and filtered by diode D_1 and capacitor C_1. This provides about positive 6 volts at the base of TR_1 making the base positive with respect to the emitter and so the transistor stops conducting. Simultaneously TR_2 also stops conducting, causing the bulb to go off as long as the mains supply is available.

When the mains supply goes off the bulb automatically starts glowing. Thus the circuit works as an emergency light.

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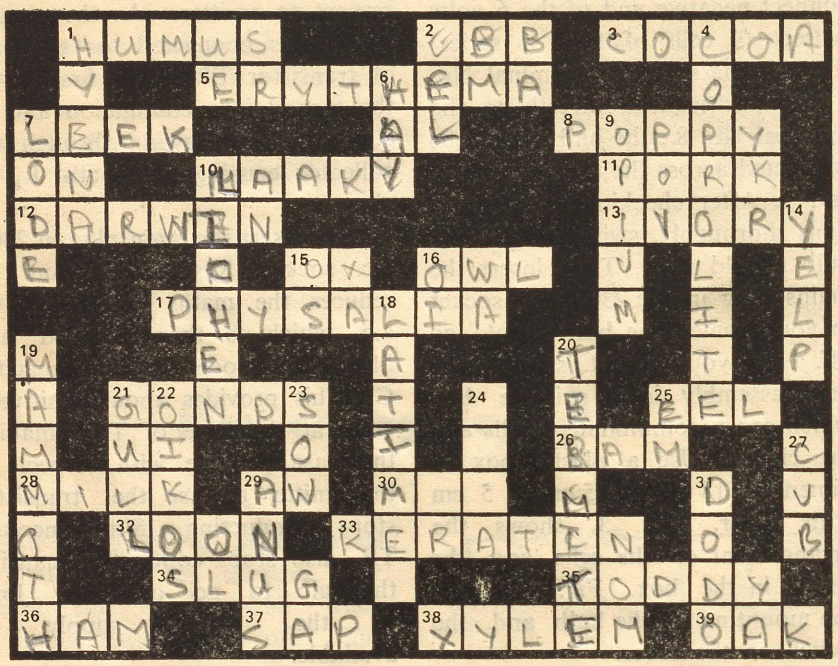
SCIENCE CROSSWORD PUZZLE



CLUES

Across

1. Decayed leaves and other organic debris.
2. After an - - - a large number of shells are exposed on the seashore.
3. Narcotic cocaine is obtained from this plant.
5. A skin disorder due to UV rays of the sun.
7. Seems like onion, but long instead of round.
8. Opium is extracted from this plant.
10. He found out a fossilised human skull.
11. Flesh of a pig.
12. He is called the Newton of Biology.
13. Tusk is of - - - - -.
15. Cloven-footed and horned farm animal.
16. A binocular, night bird of prey.
17. This is called the "Portuguese-man-of-war".
21. Means very old and gave origin to the word Gondwana.
25. See clue No. 2 Down.
26. A male sheep.
28. Protein, casein, is present in it.
30. Stomach of a cow.
32. Large diving bird with a wild cry.
33. This protein is in hair.
34. A land snail without a shell.
35. Fermented juice of palms.
36. Upper part of a pig's hind leg.
37. Juice of plants.
38. A part of the vascular tissue of an angiosperm.
39. A common deciduous forest tree.

Down

1. Solitary cowardly animal that feeds on carrion.
2. A migratory fresh water fish.
4. Fossils of animal faeces.
6. "Make- - -while the sun shines."
7. Vein of ore.
9. A sedative narcotic extracted from poppy plants.
10. "The bread of Israelites"—small flowerless plants forming crust on rocks and trees.
14. Utter cry of a dog in anticipation.
18. A living fossil named after this lady biologist.
19. Ancestors of elephants, now extinct.
20. Members constituting the order Isoptera of class Insecta.
21. Large sea bird, white with black or grey markings.
22. A greek word that means abode.
23. Female of swine.
24. *Australopithecus sinanthrapus* was found in this land.
27. Young of a tiger.
28. *Bisan betularia*. is a - - - - -.
29. The end of the alimentary canal that excretes the bowels.
31. A flightless bird that has been exterminated by human intervention.

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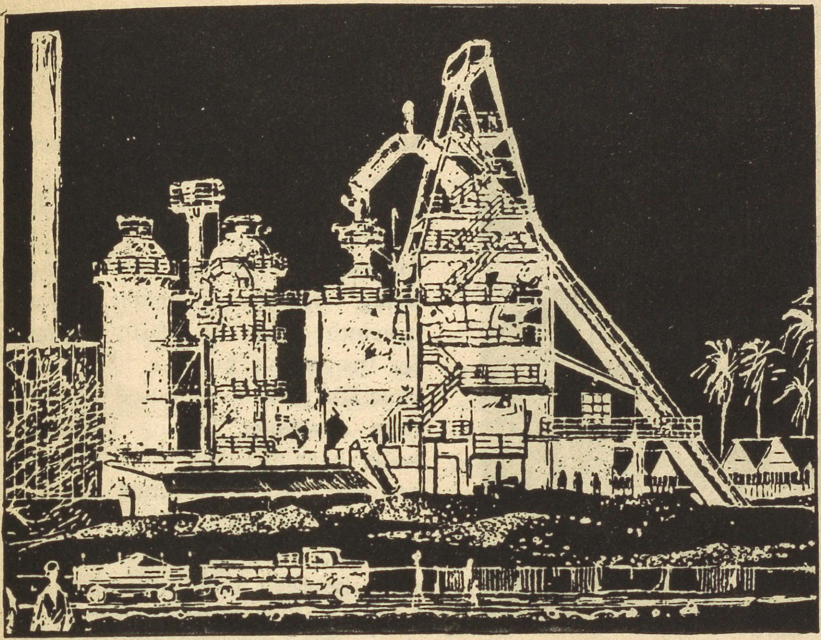
Proto Novo-608502



SCIENCE IN INDUSTRY

New machines and tools developed by CMERI

DURING 1976, the Central Mechanical Engineering Research Institute, Durgapur concentrated its R&D efforts on development of products and processes suitable for adaptation in rural areas. Side by side, a few projects were undertaken for development of some industrial machinery with a view to import substitution.

Some of the projects relating to rural development which deserve special mention are : development of 10 HP tiller, development of deep well hand pump, utilisation of water hyacinth for gas production, development of smokeless domestic oven, and development of namda making machine.

Among industrial machinery, mention may be made of cable lapping machine and leather shaving machine.

10 HP tiller

The development of power tiller was taken to facililate Japanese method of cultivation in India. The tiller developed by CMERI has a 10 HP water cooled, light weight diesel engine. It has six forward and two reverse speeds. Tilling width is 54-60 cm and the average acreage tilled per day in 8 hours is 3.5 acres. The tiller is specially suitable for small land holdings and wet land cultivation.

Deep well hand pump

The project was jointly sponsored by WHO/UNICEF/Government of India with a view to evolve deep well hand pump suited for community use in rural areas and also to find ways and means of reducing the cost of the pump. The deep well hand pump, designed and developed by the Extension Centre of CMERI at Madras, makes extensive use of non-metallic raw materials, thereby minimising damage due to corrosion. Costly non-ferrous ma-

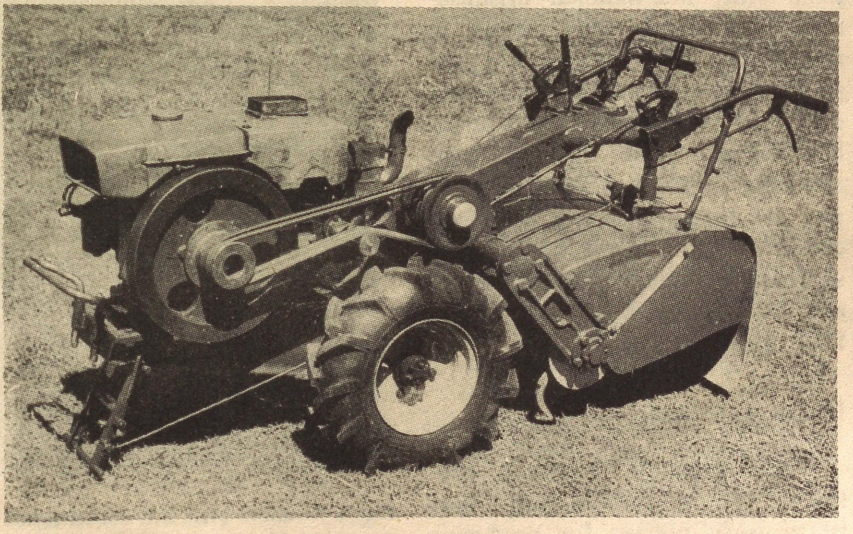


Fig. 1. 10 HP agricultural tiller. It facilitates cultivation of small land holdings and wet lands

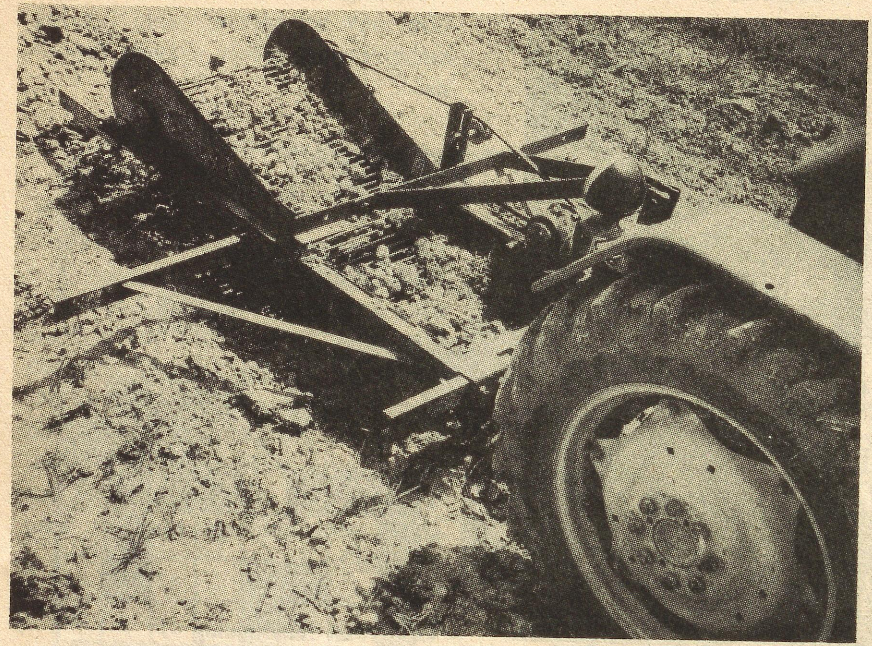


Fig. 2. Potato digger. It can conveniently be drawn by a tractor

terials have been eliminated. Components used are suitable for mass manufacture thereby ensuring standardisation and interchangeability. The pump head and the hand lever mechanism have been so designed that minimum human effort is required to operate the pump. Maintenance cost has been substantially reduced.

Besides WHO and UNICEF, some other international organisations have shown keen interest in the project. The project has immense socio-economic advantage not only for a developing country like India, which has a high incidence of rural population, but also for many other less developed countries of the world where water shortage is acute. 1000 prototypes are under production for extensive field tests.

Use of water hyacinth

Water hyacinth, erstwhile considered as a trouble-weed, may be properly utilized for producing laboratory and domestic fuel (gas) from it. From available data it is known that 2,00,000 acres of land in Bihar, 30,000 acres of land in West Bengal are covered by water hyacinth.

Cowdung gas plant is already known all over the country. To keep a cowdung gas plant in operation, cowdung 5 cows/ oxen will be required for a family of five people. It is however not possible for each villager to have 5 cows. Being readily available, water hyacinth may be easily utilized for the above purpose. Moreover, hyacinth gets decomposed quicker than cowdung. During summer, water hyacinth takes 3 days to decompose while cowdung takes 8 days. During winter the same period is 4 and 12 days respectively. The ratio between the total volume of gas evolved from decomposed water hyacinth and cowdung under identical time and temperature conditions is 5 :3 (summer) and 5:1 (winter) respectively. Unlike cowdung compost, the water hyacinth

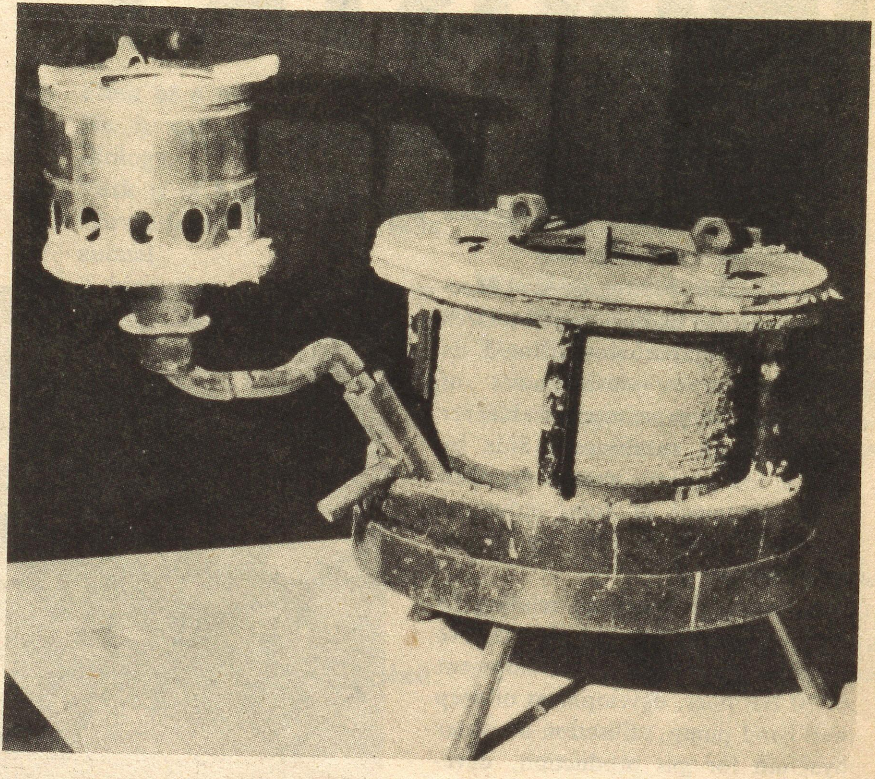


Fig. 3. Domestic oven. It is smokeless and obtains additional burner flame for simultaneous cooking

compost has a rotten smell which, however, is minimised to a great extent when water hyacinth and cow-dung mixture is used for producing the fuel gas.

CMERI is presently designing a prototype where water hyacinth, singly or mixed with cowdung, may be used for the production of fuel gas. The rate of production of gas will be higher if cowdung and water hyacinth are put together. The compost of water hyacinth may be effectively used as a good manure comprising nitrogen, phosphate and potash.

Smokeless domestic oven

CMERI has also developed a domestic oven which utilises coal dust or particles as main fuel instead of domestic coal. The oven produces semi-coke from coal dust and charcoal from wooden chips in the annular chamber around the core chamber. And it provides the useful coal-fire for cooking. The volatile matters liberated from the coal dust are burnt in a gas burner thus simultaneously providing a gas fire besides the main coal fire. The charcoal produced in the annular chamber is used for subsequent ignition of semi-coke in the core chamber which effectively reduces the smoke formation.

Namda making machine

The Institute's MERADO Centre at Ludhiana took up in collaboration with RRL, Jammu, the development of a low-cost machine for making *Namda* (a kind of woollen mattress). A prototype of the machine has been fabricated on the basis of MERADO design and is now under testing.

Namdas are almost exclusively made in the country on cottage scale and the operations followed are mostly manual, requiring arduous labour. Indian namdas have a good export potential. During 1973-74, namdas worth rupees 55 lakhs were exported out of a total production value of Rs. 75 lakhs.

Paper lapping machine

CMERI has designed a high speed machine for insulating copper conductors used in telephone cables and for insulating bare copper wire either with paper or with paper and string. Conductor sizes used in this machine are 0.4 to 1.3 mm. in dia. Each machine consists of a supply stand, paper lapping head, string head, capstan and take up. The production rate of this machine is 20 km length of conductor per 8 working hours of each machine.

Leather shaving machine

A hydraulically operated wide leather shaving machine has been developed by MERADO, Madras, using only indigenous materials and parts. The project was sponsored by NRDC.

Design drawings of the machine have been completed and handed over to the collaborator. The fabrication of the prototypes is nearing completion.

Books Received

1. **ELECTROMAGNETISM, ELECTRON THEORY AND SPECIAL THEORY OF RELATIVITY** by Arun Kumar Dutta, *Macmillan Co. of India Ltd.*, 2/10, Ansari Road, New Delhi-110002, Pp. 332, Rs. 20.
2. **ANTI-CHANCE** by E. Schoffeniels, *Pergamon Press*, Headington Hill Hall, Oxford 0X3 0BW, England, Pp. 123, $ 5.90
3. **RADIATION & LIFE** by Eric J. Hall, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 201, $ 6.95
4. **REFLECTIONS ON BIOCHEMISTRY** Ed. by A. Kornberg, B. L. Horecker, L. Cornudella & J. Ore, Pergamon Press, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 465, $ 9.50.
5. **A MANUAL OF VIRUS DISEASES OF TROPICAL PLANTS** by S. P. Raychaudury, *Macmillan Co. of India*, 2/10, Ansari Road, Daryaganj New Delhi-110002, Pp. 299, Rs. 44.25
6. **A TEXTBOOK OF BOTANY** by Nathawat, Sharma and Sahni, *Ramesh Book Depot*, Jaipur, Pp. 679, Rs. 20.00
7. **AN INTRODUCTION TO THE TAXONOMY OF ANGIOSPERMS** by Tiagi and Kshetrapal, *Ramesh Book Depot*, Jaipur, Pp. 444, Rs. 24.00
8. **PROGRAMMING IN FORTRAN IV** by K. D. Sharma, *Affiliated East-West Press Pvt. Ltd.*, 104, Nirmal Tower, 26 Barakhamba Road, New Delhi-110001, Pp. 240, Rs. 25
9. **THE IMPACT SCIENCE TEACHING** by Narendera Vaidya, *Oxford & IBH* Publishing Co., N-88, Connaught Circus, New Delhi-110001, Pp. 326, Rs. 14.50
10. **HOW CHILDREN DISCOVER KNOWLEDGE** by Narendera Vaidya, *Oxford & IBH Publishing Co.*, N-88, Connaught Circus, New Delhi-110001, Pp. 315, Rs. 11.00
11. **RESHAPING OUR SCHOOL SCIENCE EDUCATION** by Narendera Vaidya & J. S. Rajput, *Oxford& IBH Publishing Co.*(Address same as above), Pp. 258, Rs. 15.00

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BOOK REVIEWS

THE WEATHER WEAPON *by* N. Seshagiri, *National Book Trust*, A-5 Green Park, New Delhi-110016, Pp. 190, Rs. 10.00

RECENT advances in computers and space technology have made the job of the meteorologist much easier. Weather satellites today provide instant pictures of the cloud cover, hurricanes and potential storm areas, while networks of ultrafast computers can within minutes process all the available data. This has not only helped scientists in understanding the weather phenomenon better but has also shown possible ways for artificial weather modification. It is this latter possibility, especially the sinister aspect of it, that has prompted the author, a defence analyst, to write the present book. He collected all available information and then carried out computer simulation of 'models' of possible applications as weapons. His conclusion: "as a political weapon it may far exceed in effectiveness the much talked about nuclear blackmail".

But going through the dozen odd chapters, the author's highly biased views and his over-pessimistic outlook become evident. He does not analyse the possibilities and limitations objectively but sees a potential danger lurking behind each of them, often without any valid reason. Many of his statements can at best be called fanciful.

Take for example, artificial rain-making. The author sees in it a tremendous possibility of creating flash floods in enemy territories. But in reality, the efficacy of artificial seeding of clouds to induce rain is yet to be established beyond doubt. Past attempts have been at best only partially successful.

The author's views on the effect of seeding are also inconsistent. On page 48, for example, he says, "By implanting seeds of silver iodide in clouds on a massive scale it is possible to release the latent heat of fusion (of ice crystals) so suddenly that the clouds start growing vertically and cause rainfall." While on page 94 we find, "Such a meticulously performed (seeding) experiment showed that with silver iodide seeding rain actually decreased in the seeded area !"

There is a scheme for artificially creating tornadoes, the funnel-shaped swirling storms that can blow a house apart. Any success so far ? In an experiment in the United States, 48 giant burners, after 15 hours of operation, created a funnel-shaped column which lasted only 4 minutes ! How does one steer a tornado into the enemy territory ? The author does not provide the answer, but he is confident that a way can be found.

Can we modify climate by altering the ocean currents ? What about melting the polar ice caps by diverting the warm ocean currents towards them ? What will be the effect of blocking the Bering Strait, or widening the Panama Canal or the Strait of Gibraltar ? Considering the dependence of weather on the oceans there is no doubt any of these actions will effect the weather. But the point is, can such effect be localised to any specific territory, as will be necessary if it is to be used as a weapon ? Obviously the answer is, No. What about the secrecy of such projects. Could they be carried out without the knowledge of the 'enemy' countries ? These are some of the vital questions to which this book does not provide the answers.

Many of the experiments referred to in the book are being primarily developed for peaceful applications. The misuse of some of them cannot be entirely ruled out, but suitable safeguards can be devised. But to magnify the threats out of proportions by taking a one-sided view is, to say the least, to mislead and misinform the public.

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ELECTRONIC INVENTIONS 1745-1976 *by* G. W. A. Dummer, *Pergamon Press*, Headington Hill Hall, Oxford OX3 OBW, England, Pp. 164, $ 7.50.

WHO's the inventor of TV? The name that comes immediately to our mind is J. L. Baird. Go through this reference book and you will find there is not only one name associated with this 20th Century invention. There are four. And, on top of it, Baird is taken as the inventor of only the mechanical scanning system of this device. The electronic theory behind the working of TV, the book mentions, was given by the English man A. A. Campbell-Swinton in 1908, the half-baked electronic system and iconoscope were invented by the American Vladimir Zworykins in 1919 and 1923 respectively. Then came the Baird's invention in 1925. In 1927 Philo Farnsworth, an American, gave the finishing touch to the TV as a complete "Idiot box".

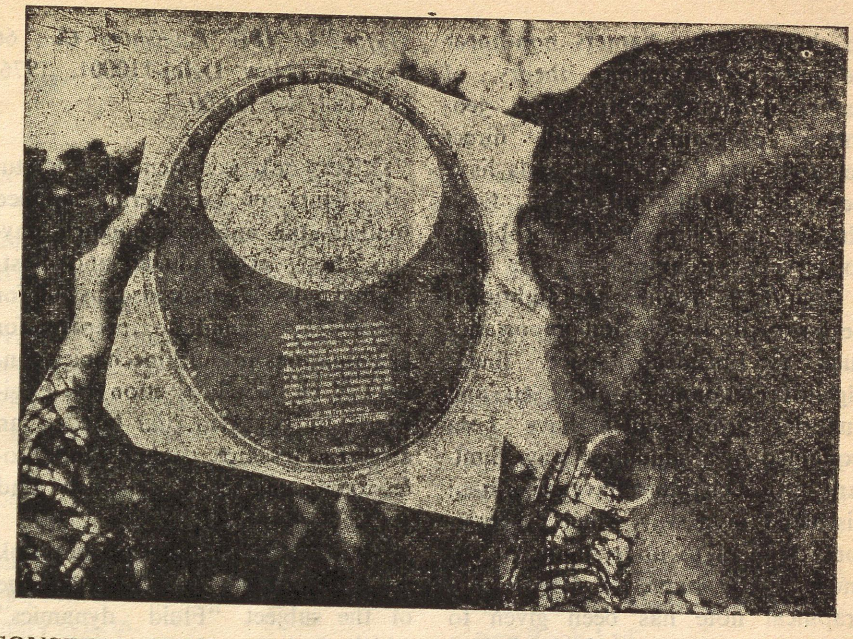
Is not this list of TV inventors a rude shock to the layman, or for that matter, any budding inventor striving to make as miraculous invention as that Baird is claimed to have made? Such rude shocks one gets time and again as one goes through this systematically and chronologically written book.

The purpose of the book is to cater to the needs of patent authorities, research organisations, universities, technical colleges and manufacturers. It is a handy encyclopaedia which informs who patented a particular invention and when, and the source-material from which its history of development could be digged out. However, the author has by including with each invention a brief note regarding its historic development till patented, made it all the more a stimulating book. It would take away monotony which otherwise is very much present in such type of books. The book, therefore, would doubtlessly interest both electronically oriented layman and technician.

Besides the list of some 295 electronic inventions mentioned in the book, the author also gives a glimpse into the invention-rate during the period considered, the effect of brain drain from Europe to U. S. A., microelectronics development, etc., by presenting them in a graphical manner. Then there is also a list on inventors, on useful books on inventors, on inventions in date order, etc. Photographs or circuit diagrams of the inventions are given wherever necessity arise.

In the Preface the author has duly acknowledged the fact that some dates and inventors "cannot be accurate" because of the passage of time and conflicting claims. Also, the list of inventors is confined to ones from Europe and the U.S.A. only ; many rival claims which come particularly from Russia and Japan have not been included. The funny thing seen in the book which this reviewer fails to understand is why in the "Sources" mentioned with every invention are there additional headings such as "See also", followed by "Also", and, sometimes, by another "Also". Either the purpose for doing so should have been made explicit or a single heading would have served the purpose.

DILIP M. SALWI



CONSTELLATION AND STAR FINDER by B. V. S. Rao, *Higginbothams Pvt. Ltd.*, Mount Road, Madras-600002. 1977, Pp. 42, Rs. 7.00.

THE sky above has always fascinated man. He has wondered what the millions of the twinkling stars are. He observed the phases of moon and some other luminous bodies. His curiosity to know the unknown was aroused which led him on to the path of knowledge and civilization. Astronomy therefore is rightly called the mother of all sciences.

The sky still fascinates us, but few can identify even the planets belonging to our solar system. Then there are constellation and stars. Every issue of *Science Reporter* carries an astronomical chart for those interested in locating planets of our solar system.

Star gazing is one thing and to locate planets, stars and constellation is quite different. It needs expert guidance and knowledge.

Fortunately, we have the publication by Shri B. V. S. Rao which will help even lay persons in locating the heavenly bodies above our head. The publication is also accompanied with a star finder. It is fixed on hard board and is handy and durable and, above all, easy to use. Shri Rao must be congratulated for having produced this handy device which one can hold in hand and locate heavenly bodies millions of lightyears away from us.

OPTIMIZATION METHODS in Operational Research and System Analysis *by* K. V. MITTAL, *Wiley Eastern Limited*, AB 8, Safdarjang Enclave, New Delhi-110016, Pp. 259, Rs. 15.50.

THE book under review is an elementary mathematical introduction to linear and nonlinear programming, dynamic programming, geometric programming, direct research methods and theory of games, which is based on the lectures given to M.Sc. and M.E. classes and on short term courses under the Refresher Courses Department and the Quality Improvement programme at the University of Roorkee.

The book has been divided into ten chapters. In the first five chapters, mathematical preliminaries, extrema of functions, linear programming, transportation problems, flow and potential in networks have been discussed in detail, while in the last five chapters non-linear convex programming, theory of games, dynamic programming, geometric programming and direct research and gradient methods have been thoroughly discussed. Each chapter is followed by problems to serve as exercises.

Chapter I provides the additional necessary topics of vital importance such as Euclidean space, linear algebric equations, convex sets and quadric forms, which have been explained in a simplified way. Similarly, other chapters have also been discussed in a way which is easier for a student to understand. At the end of every chapter, a short bibliographical note has been given to guide the readers to a few standard books for further consultation. A comprehensive bibliography at the end of the book has also been given to guide the student and research scholar for further study. Most of the chapters can be studied independently of each other.

The book is very well written and will serve as a suitable text book for the students of mathematics, operational research, engineering, economics or management, whose course of study includes the topics discussed in the book. In short, this book is strongly recommend to the students of mathematics, engineering operational research, etc., who already have the knowledge of algebra, calculus and geometry upto the under-graduate standard.

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AN INTRODUCTION TO FLUID DYNAMICS *by* R. K. Rathy, *The Oxford & IBH Publishing Co.*, 66 Janpath, New Delhi-110001, 1976. Pp. 684, Rs. 24.00.

THE book is intended for students of engineering, applied mathematics and mathematical physics, both at graduate and postgraduate levels. It is also useful for those who intend to prepare for examinations in fluid mechanics conducted by the Institution of Engineers (India). Also, the book is an asset for research students and professional engineers, scientists and teachers.

The first six chapters of the book are devoted to basic knowledge of the subject "Fluid dynamics" which includes physical properties of fluids, thermodynamics of fluids, kinamatics of fluids, stresses in fluids, constitutive equations and conservation laws. The next eight chapters deal with the behaviour of fluid flow under various conditions and different fields of applications. These are irrotational and rotational flows, incompressible viscous fluids flows, compressible fluid flows, non-Newtonian fluid flows, dynamical similarity and small Reynolds number flows, boundary layer theory, stability theory and turbulence. The last chapter is an introduction to hydromagnetics which is also called MHD (magneto hydrodynamics). MHD is presently much debated as an alternate source of energy.

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MATHEMATICS FOR CHEMISTS *by* D. M. Hirst, *The Macmillan Press Ltd.*, Representative in India: *Macmillan Co. of India*, 2/10, Ansari Road, New Delhi-110002, 1976, Pp. 303; £4.95.

THE book under review presents mathematics required for the study of chemistry at post-graduate level of Indian universities. The approach of the book has been descriptive with emphasis on applications of mathematical techniques in chemistry. The book is unique in its kind; wherever possible the author has illustrated the ideas with examples from chemistry. An elegant discussion on various topics like matrices, differential equations and partial differential equations has been presented. Concepts of eigenvalues and eigenvectors, which are commonly used in quantum mechanics and theory of molecular vibrations, have been discussed in the chapter on matrices. Taylor-Maclaurin series, orthogonal functions and Fourier series have been discussed nicely. These techniques are frequently used in spectroscopy and quantum mechanics. The last chapter of the book on elementary statistics and error analysis gives an introduction to the ideas used in analysing experimental data and in assessing accuracy of the results. In this chapter, author has discussed the various forms of errors which are present in experimental measurements. Statistical methods used to analyse random errors have been discussed in detail.

The format of the book is good. The book represents a significant contribution in the field of mathematics for chemists.

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BINARY SYSTEM (*Continued from page* 359)

There are simple connections between algebra of logic and computers. Boolean algebra invented in 1854 by George Boole of England in which he used two symbols 0 and 1, has tremendous impact on automation of telephone system, railway signalling, switch gear, machines and electronic computer.

For a long period, pure mathematicians devoted time to the fascinating area of number theory. Some of the intersesting numbers are Mersenne number and Fermats numbers. Mersenne numbers are of the form 2^n and Fermats numbers are of the form 2^{2n+1}. These numbers if expressed in binary notation appear simple and can be calculated with the help of computer. One of the largest number containing 967 digits was derived with the help of a computer in the form of 2^{2317-1}. Integers divisible by three also contain an even number of "one" when expressed in binary symbol.

The binary system is also helpful in the problem involving combinational analysis. New relationship in different areas of number theory can be explored with the help of computer and numbers expressed in binary system.

Study of binary number at the school level ensures better understanding of the number system. This has also recreational value. Many numerical tricks are based on binary system.

We find the importance of study of binary system increases as we advance in technology and science.

Further reading

1. Harry M. Davice, Mathematical Machines *Scientific American*, April 1949.
2. W. D. Lewis, *Mathematics Make Sense*, Heinemann Education Book Ltd.
3. Stanislaw, Ular, Computer, *Scientific American* Sept. 1964.

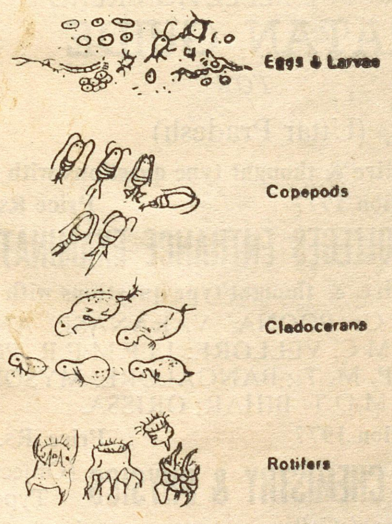

Illustration on page 316 (*S. R.*, May 77 Fig. 2. Zooplankton) is wrong. The Correct is as given above

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