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Monthly Newsletter of Vigyan Prasar

# DREAM 2047

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## VP News

## WYP 2005 – Master Resource Persons' Training Programme at Shimla

*Dr. J.J. Rawal, President, Indian Planetary Society, delivering a lecture*

As part of the countrywide campaign built around the theme "World Year of Physics 2005" (WYP 2005), Vigyan Prasar and National Council for Science & Technology Communication jointly organized a Master Resource Persons' (MRP) Training Programme for Northern Region at Shimla during the period 01-03 June 2005. Himachal Pradesh State Council for Science & Technology (HPCST) were the local host. The programme was organized at the

*Contd. on page-------21*

## Inside



## A Workshop on Innovative Physics Teaching

Vigyan Prasar and Indian Institute of Technology (IIT), Kanpur, have jointly undertaken a project entitled "Open Ended Experiments in Physics at School Level". The project started in May, 2004 at IIT, Kanpur. The objective of this project is to develop an interactive physics teaching methodology by evolving a series of experimental activities which may enhance the interest amongst students and teachers in physics. During the first year of the project, thirty eight experiments, and eight informal lab activities were developed.

Most of the experiments were developed using commonly available objects/equipment. For example, to show conservation of angular momentum, one only needs a thread, body of a ball-pen and two objects with unequal masses. Similarly, to see surface tension at work, one only needs a petri dish, soap solution and pepper powder. Experiments developed also include finding the center of mass, centripetal force,

*Contd. on page-------31*

*(From L to R) Dr. Subodh Mahanti, Prof. R.C. Budhari, Prof. Sanjay Govind Dhande, Prof. Dayal Saran and Prof. H.C. Verma*

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

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Editor : Dr. V.B. Kamble

# Protecting Our Ancient Wisdom and Heritage

Ayurveda, or the science of life, prevention of disease, and longevity, is probably the oldest medical system available on this planet. It is essentially based on the idea that the body, mind and the spirit are interconnected and that all three must be "balanced" to achieve the highest degree of health. *The Rigveda,* the oldest of the four Vedas, contains verses on the nature of health and disease, pathogenesis and principles of treatment. It also describes the use of herbs and preparations that could be used to assist an individual in overcoming various ailments of the mind and body and to foster longevity. The *Atharva Veda* even contains sections on internal medicine, surgery, opthamology, toxicology, psychiatry, paediatrics, gerontology, and the science of fertility. It is these verses that lie at the base of Ayurveda.

Over the millennia, Ayurveda grew into a respected and widely used system of healing in India. There were two main re-organizers of Ayurveda whose works are still existing in tact today - Charaka and Sushruta. The *Charaka Samhita* is the oldest of the treatises on Ayurveda and was probably first compiled around 1500 BC. It elaborates on the physiological and anatomical structure of the human body, various aetiological agents along with their role in pathogenesis, symptoms and signs of various diseases, the methodology for examination of patients, treatment, and prognosis. Sushruta is considered to be the father of surgery. In the *Sushruta Samhita*, the second major treatise on Ayurveda, one finds detailed descriptions of surgical instruments, classifications of fractures, wounds, abscesses, and burns as well as elaboration of procedures for plastic surgery and anal-rectal surgery. Sushruta has even described the procedure for dissection of the human body. The next important authority in Ayurveda after Charaka and Sushruta was Vagbhata (about seventh century AD). His treatise, *Ashtanga Hridaya*, presented a summary of Charaka and Sushruta and brought the subject up to date. He even introduced a number of new herbs and made valuable modifications and additions in surgery. Ayurveda continued to be the major system of medicine in India for several millennia, and has continued to be so even today despite the rise of modern system of medicines - allopathy in particular. It is believed that nearly eighty per cent of Indians still use Ayurveda. In the recent years, popularity of Ayurveda has significantly gone up - even in the USA. Ayurvedic remedies are now available in the USA from South Asian markets, Ayurvedic practitioners, health food stores, and even the Internet. According to an estimate, the herbal drugs industry in India is worth Rs 2,300 crore, with a global Ayurvedic products market reportedly estimated at $14.2 billion!

Occasionally, along with herbs and minerals, metals are also used in Ayurvedic herbal medical products. When such products are consumed over a long period of time, the metal content could exceed the maximum allowable limits and have an adverse effect on health. Heavy metal toxicity is most damaging to the digestive tract and the liver, and has adverse effects on the nervous system. While arsenic and mercury can cause liver failure, lead tends to affect the nerves, brain and intestines. Indeed, the problem with the metals is that even if they are taken in very small doses, they can accumulate in the body over the passage of time.

As reported in the newspapers, recently, in Delhi, a top banker's wife was admitted to hospital after doctors detected a liver malfunction. On examining the patient's blood samples, pathologists found very high levels of heavy metals — arsenic, lead and mercury. They were told that the lady, in her 50s, had been taking Ayurvedic medicines for the past five years to treat a constipation problem. A similar incident was reported in a Boston hospital a few years ago, when a patient complained of intractable seizures. Tests showed his blood's lead level to be 89 units. Normal levels for an adult are under two units. It was later found that the India-born patient, also in his 50s, was taking an Ayurvedic medicine for arthritis. The medicine was found to have high metal levels, and he had been on the dose for over six years. Could it be, that unsafe medical products are being labelled Ayurvedic giving India's ancient system of healing a bad name?

According to a study conducted by the Harvard Medical School (the results of which were published in the December 2004 issue of the *Journal of American Medical Association*) revealed that one out of five Ayurvedic herbal medical products produced in South Asia and available in Boston South Asian grocery stores contained potentially harmful levels of lead, mercury, and/or arsenic. Users of Ayurvedic medicine hence could be at risk for heavy metal toxicity. Some doctors in India also have voiced similar concerns. The authors hence recommended that testing of Ayurvedic herbal medical products for toxic heavy metals be made mandatory. Of course, the health hazards posed by these products could vary significantly depending on the degree of metallic content and the constitution of the person taking it.

**Continued on page.....19**

**Editor** : **V.B. Kamble**

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# Enrico Fermi
## Father of Nuclear Physics

❑ Subodh Mahanti
e-mail : mahantisubodh@yahoo.com

"Enrico Fermi was the greatest Italian scientist of modern times and was highly creative both as a theoretical and experimental physicist."

**The Cambridge Dictionary of Scientists, 2002**

"Having one's name permanently attached to an important physical concept or unit bestows a kind of immortality. It is hard to imagine any discussion of modern physics in which Fermi's name does not come up at least once, in terms of such as fermion, Fermi gas, Fermi momentum, Fermi temperature, Fermi surface, Fermi coupling, Fermi transition, and Fermi length. Still, because Fermi died so young—and so long ago—he has become, for the current generation of physicists, a somewhat mystical figure."

**Valentine L. Telegdi**

"Fermi devoted a great deal of his time to the graduate students…his teaching was exemplary, minutely prepared, clear, with emphasis on simplicity and understanding of the basic ideas, rather than generalities and complications…We would knock at his office door, and if free, he would take us in, and then he would be ours until the question was resolved."

**Jack Steinberger**

"Fermi had the widest scope of all the founders of quantum physics. As a theorist, he contributed decisively to quantum mechanics (Fermi-Dirac statistics) and nuclear physics (theory of beta decay). As an experimentalist, he introduced the technique of neutron bombardment to study artificial radioactivity, opening the way to the discovery of nuclear fission."

**Arturo Russo**

Enrico Fermi is regarded as father of nuclear physics. In the history of modern physics there is none who matched the versatility of Fermi. His contributions in pure theoretical physics and concrete experimental work were equally great. He could design and build, with his own hands, astonishingly useful experimental tools. He developed the mathematical statistics required to describe a large class of sub-atomic particles. He discovered neutron-induced radioactivity.In 1938, Fermi was awarded Nobel Prize in physics "for his identification of new radioactive elements produced by neutron bombardment and for his discovery of nuclear reaction effected by slow neutrons." In 1942 Fermi constructed the first nuclear reactor. He directed the first controlled chain reaction involving nuclear fission. Fermi was a great teacher and through the influence of his eminent students, in Italy and the US, Fermi effectively revolutionized the training of physicists. Fermi established a famous school (The Rome School) of nuclear physics in Rome. In Chicago also he established a vibrating school. Fermi was a central figure in the Manhattan project to build the first atomic bomb. The element with atomic number 100, discovered one year after his death, was named Fermium (Fm) in Fermi's honour.

*Enrico Fermi*

Fermi was born on September 29, 1901 in Rome. His father Alberto Fermi was a railroad engineer and his mother Ida de Gattis was a school teacher. He was the youngest of three children of his parents. Fermi learned to read and write from his mother. He studied at the local high schools. Fermi as a child displayed unusual mathematical ability and prodigious memory. His school records were excellent. Fermi was much influenced by a colleague of his father, Adolfo Amidei, who lent him books on mathematics. At the age of 17, Fermi entered the highly selective Reale Scuola Normale Superiore, an Italian advanced study and research institution. It was Amidei who advised Fermi to go for this elit institution. The institution was established by Napoleon in 1810 as a branch of the Ecole Normale Superieure of Paris. It was associated with the University of Pisa.

Fermi obtained his PhD at the age of 21 from the University of Pisa. His PhD thesis was on his research on X-rays. After his PhD he made a short visit to Rome and then left for Germany with the Fellowship from the Italian

Ministry of Public Instruction to study at the University of Gottingen under Max Born. From Germany he went to Leiden in the Netherlands, where he worked with P. Ehrenfest (1880-1933). After returning in Italy in 1924, Fermi joined the University of Florence, where he lectured on mathematical physics and mechanics.

Frédéric Joliot-Curie

Irène Joliot-Curie

In 1926, Fermi started to study statistical mechanics of particles that obey Pauli exclusion principle, such as electrons. Fermi was the first to apply Pauli exclusion principle to systems of multiple electrons not attached to atoms.The result was the so-called Fermi-Dirac Statistics, as Dirac also obtained the same conclusion.

In 1927 Fermi was appointed Professor of Theoretical Physics at the University of Rome, the post he held for 12 years. At the time of his appointment he was just 25 years old. He became the youngest full professor in Italy. He also became the first person to occupy a chair in theoretical physics. This was no mean achievement for a person of Fermi's age particularly considering the traditional and bureaucratic nature of the Italian Universities in those days. It was true that Fermi had established his reputation by publishing 30 substantial research papers. But perhaps this was not the only reason for Pauli's success in climbing the ladder of Italian science. Fermi was patronized by Orso Mario Corbino, the most distinguished Italian physicist of his time and also a senator. Corbino was all for modernizing Italian physics and thought that Fermi, in spite of his youth, was ideal man to advance his ideas. With Corbino's support Fermi organized his group of young experimental and theoretical physicists. The group, which later came to be called as the Rome School, included Edoardo Amaldi, Franco Rasetti, Bruno Pontecorvo, Emilio Segre, Oscar D'Agostino and Ettore Majorana. The Rome school changed the landscape of Italian physics, and indeed world physics.

Max Born

Fermi and his group followed up the then-new phenomenon artificial radioactivity. In 1934, Irene and Frederic Joliot-Curie had announced the production of artificial radioactive isotopes by the bombardment of boron and aluminium with helium nuclei or alpha particles. Fermi realized that neutron discovered by James Chadwick in 1932 would be a better candidate than alpha particle for creating new radio isotopes. Though neutron is less massive but because of its neutrality it could overcome the positive charge of a target nucleus. In 1934 Fermi found that neutrons slowed down in passing through light elements and if neutrons are suitably retarded they become extremely effective in carrying out nuclear transmutation. Actually Fermi had stumbled on the slow neutrons. Fermi without any advance warning, or conscious prior reasoning took some odd piece of paraffin and placed it in front of the incident neutrons. As the result of the collisions with the light hydrocarbon molecules the neutrons slowed down and as they slowed down they remained in the vicinity of the target nucleus sufficiently long to increase their absorption.

In the summer of 1938, the fascist government of Mussolini introduced racial laws modeled after the notorious German Nurenberg laws. Under the provision of these laws scientists and scholars of Jewish origin working in Italian universities were to be dismissed. Fermi was affected because his wife Laura was a Jewish. He was also publicly accused by fascist extremists of "having transformed the physics institute into a synagogue." Fermi and his family decided to leave Italy. They went to America.

Before emigrating to America in January 1939, Fermi had already visited the America several times. In 1933, he had taught a course in quantum electrodynamics at the University of Michigan. His celebrated article "Reviews of Modern Physics" was based on this course. In 1936, he was a visiting professor at Columbia University, where he taught a course on thermodynamics. Lloyd Motz edited Fermi's lecture notes into book form and which is still in use. During his visit to Columbia University in 1936, George Pegram, the Chairman of the Physics Department, offered him a permanent appointment at the Columbia University. However, at that time Fermi did not feel the urgency of leaving Italy.

Fermi was a great teacher. Commenting on Fermi's understanding of theoretical physics, the German born American physicist, Hans Bethe (1906-2005) wrote: "My greatest impression of Fermi's method of teaching in theoretical physics was its simplicity. He was able to analyse into its essential point every problem, however complicated it seemed to be. He stripped it of mathematical complications and of unnecessary formalism. In this way, often in half an hour or less, he could solve the essential physical problem involved....His approach was pragmatic....He was master of achieving important results with a minimum of effort and mathematical apparatus."

The Italian born American physicist Emilio Segre (1905-1989) wrote: "The speed at which it was possible to train a young physicist at the 'Fermi school' was incredible. Naturally a good deal of the success was due to the immense enthusiasm that had been aroused in the young people—never by exhortations or 'sermons' but by the eloquence of example. After having spent time in the institute in Via Panisperna, one became completely absorbed in physics."

*Emilio Segré*

*Orso Mario Corbino*

To know personal attributes of Fermi let us quote Valentine Telegdi, who was associated with Fermi in Chicago in the early 1950s. Telegdi wrote: "It was not easy to know Fermi intimately, in the sense of understanding his deeper motivations. Professionally, he was always accessible, but he stayed aloof on the personal level. When I knew him at Chicago, he did not seem to develop bonds of friendship with colleagues at the university. Herb Anderson and Leona Marshall were perhaps the only exceptions. Fermi avoided gossip and rarely expressed his opinions, high or low, about the practices of others. All this gave him an air of modesty that belied his full awareness of his own capabilities.

Fermi rarely made mistakes when he was talking about physics. A public mistake was a painful experience for him. The story is told that once, when writing on the blackboard in front of a class, he realized that he had gotten a certain factor wrong. He faced the audience to make some interesting remarks and, at the same time—without interrupting his delivery—he wiped out the wrong formula with his left elbow. Another story tells of a student who pointed out that Fermi had written a 'c' in the numerator rather than in the denominator where it belonged. 'Who told you', responded the great teacher, 'that I use 'c' and not '1/c' for the velocity of light?'

*Eugene Paul Wigner*

Fermi had very regular working habits and a frugal lifestyle. He usually came to work before 8 AM, either walking or biking when weather permitted. He had already been working for several hours at home. He was totally secure in his own physics talent and almost never displayed jealousy of another scientist. The only exception was Einstein. More than one, Fermi expressed annoyance at the attention Einstein received from the press."

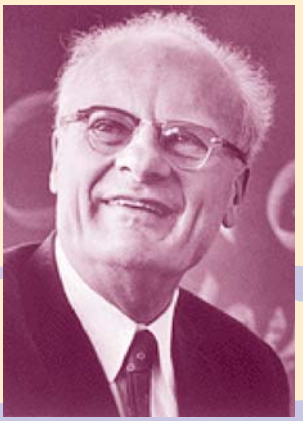
Fermi jointly with Leo Szilard and Eugene Wigner, drafted an important letter for Einstein to send to President Roosevelt explaining the dangerous military potentialities offered by nuclear fission and warning him that Germany might develop these weapons. The letter itself has become important part of history. This letter played an important role in initiating American efforts that finally produced the nuclear reactor and the fission bomb. On December 06, 1941, President Roosevelt authorized the organization of the secret project, named as "Manhattan Project". The programme, the final aim was to produce the atomic bomb, included work on chain reaction, research to develop ways of producing plutonium-239 and to find methods of obtaining enriched uranium-235. The first step of the project was to try to create a chain reaction. A fission chain reaction experiment was first performed at Columbia University under the leadership of Fermi. The project was then transferred to Chicago. But Fermi was not involved with this initiative. Fermi being an émigré Italian was considered enemy alien and he was confined to New York. Fermi's mail was subject to censorship. But then the situation was changed in 1942 when President Roosevelt declared that Italians would no longer be considered enemy aliens. Fermi was allowed to join other scientists working in the project for the atomic bomb. However, his letters were still censored.

At Chicago, Fermi and his team, succeeded in constructing the world's first nuclear reactor. On December 02, 1942, the reactor went critical. An account of the historic event was given in this way. "The clicks [of the counter] came more and more rapidly, and after a while they began to merge into a roar, the counter couldn't follow any more. That was the moment to switch to the chart recorder. Everyone watched in the sudden silence the mounting deflection of the recorder's pen. It was an awesome silence. Everyone realized the significance of that switch; we were in the high intensity regime. Again and again, the scale of the recorder had to be changed to accommodate the neutron intensity which was increasing more and more rapidly. Suddenly Fermi raised his hand. 'The pile has gone critical', he announced. No one present had any doubt about it."

Arthur Compton informed the managing committee by saying "the Italian navigator has just landed in the new world and that the natives were friendly.''

After completing the chain reaction Fermi continued to work on the project. In the preparation of the testing of the first atomic bomb named, Trinity, Fermi's role was instrumental. Segre wrote: "This was one of those occasions when Fermi's dominion over all physics, one of his most startling characteristics, came into its own. The

problems involved in the Trinity test ranged from hydrodynamics to nuclear physics, from optics to thermodynamics, from geophysics to nuclear chemistry. Often they were closely interrelated, and to solve one it was necessary to understand all the others. Even though the purpose was grim and terrifying, it was one of the greatest physics experiments of all time. Fermi completely immersed himself in the task. At the time of the test he was one of the very few persons (or perhaps the only one) who understood all the technical ramifications of the activities at Alamogordo."



*Hans Bethe*

In 1952, Fermi was elected President of the American Physical Society. On November 16, 1954, President Eisenhower presented the Atomic Energy Commission's special award for his lifetime of accomplishments in physics and in particular for the development of atomic energy.

Fermi died on November 28, 1954 in Chicago, just after his fifty-third birthday. He was survived by his wife Laura and their two children.

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## A Workshop on Innovative.... (Contd. from page----36)

weightlessness during free fall, buoyancy, terminal velocity, diffraction, static electricity, current electricity, electromagnetism and so on. Few activities like 'Get the angular speed of a motor from projectile motion', 'measuring specific heat of metals', 'resonance with plastic rings', 'moment of Inertia of an irregular shaped cardboard', 'refraction by a Prism', etc. were developed as a part of informal laboratory set up.

A National workshop on "Innovative Physics Teaching at School Level" was organized at IIT, Kanpur during the period 02-06 June, 2005. Forty teachers from Bihar, Uttar Pradesh, Madhya Pradesh, Maharashtra, Delhi, West Bengal and Jharkhand Attended the workshop.

The inaugural session was chaired by Prof. Sanjay Govind Dhande, Director, IIT, Kanpur. Prof. Dhande emphasized the need for innovative ideas and experiments while teaching in the classroom. He desired that each participating teacher should demonstrate the experiments in his/her school and will try to disseminate these activities. Prof. H.C. Verma, Co-ordinator of the project and Professor of Department of Physics, IIT, Kanpur, briefed the theme of the current workshop and its necessity. Prof. Dayal Saran, Director, Institute of Engineering and Technology, Kanpur and Prof. R.C. Budhari, Head, Department of Physics, IIT, Kanpur were also present in the inaugural session. Dr. Subodh Mahanty and Shri Rintu Nath represented Vigyan Prasar. Dr. Mahanti briefly explained different activities of Vigyan Prasar in the field of science communication and invited participation from all parts of the society in the

*Hands on practice of demo experiments during the workshop.*

untiring efforts of Vigyan Prasar to popularize science among people in general and students in particular. Shri Nath discussed about the possibilities of interfacing some experiments with computer. Some work in this regard has already been done in Vigyan Prasar.

Different sessions were organized to demonstrate experiments by resource persons, hands on practice by the participants on demonstrated experiments, discussions with participants and experts on different concepts of physics, hands on practices on informal lab activities, etc. A few participants demonstrated experiments already developed by them. Participants also prepared "Physics Show Bag" containing materials for about 20 experiments. In one session future plan and dissemination of these experiments among different schools were discussed.

# Tales of Telephone

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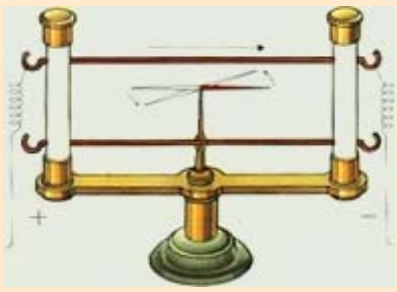
Whenever you pick up the receiver of a telephone to respond or make a call to a person at a far away place, you are indeed simultaneously acknowledging achievements of many scientists who helped us to bridge the distance between you and the caller. Scientists were always interested to send signal from one place to another distant place and telephone was one of the important inventions in that direction. The invention and related developments in telephone is a fascinating story and it shows us how small ideas were put together logically to give birth to the biggest idea of modern civilization.

*A sketch of primitive telegraph, a dozen years before Morse, reveals the essential components: an electromagnet activated by a distant battery, and a pivoted iron bar that moves to ring a bell.*

During 18th century, scientists were trying hard to communicate to distant places so that they could send messages that would be much faster and accurate than the conventional systems. In 1729, English chemist

*Hans Christian Oersted (1777 - 1851)*



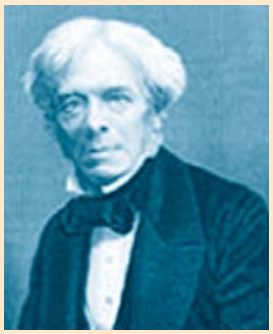
*Oersted proved that electric current sets up a magnetic field*

Stephen Gray transmitted electricity over a wire. He sent charges nearly 300 feet over brass wire and moistened thread. In 1800, Alessandro Volta produced the first battery. This was a major development since Volta's battery provided sustained low powered electric current. The battery quality was improved quickly and became the electrical source for further experimenting. Volta's battery removed one barrier in bridging the distance. It was soon realized that electric current produced by those batteries could be utilized efficiently for sending the electrical signal. But there were still some hurdles left to make the concept a reality. Two more important discoveries eased that problem.

In 1820, Danish physicist Christian Oersted discovered electromagnetism, the critical idea needed to develop electrical power and to communicate. In a famous experiment at his University of Copenhagen classroom, Oersted pushed a compass under a live electric wire. This caused its needle to turn from pointing north, as if acted on by a larger magnet. Oersted discovered that an electric current creates a magnetic field. But whether the reverse would be true? Could a magnetic field create electricity? If so, a new source of power beckoned. And the principle of electromagnetism, if fully understood and applied, promised a new era of communication.

In 1821, Michael Faraday reversed Oersted's experiment. He got a weak current to flow in a wire revolving around a permanent magnet. In other words, a magnetic field caused or induced an electric current to flow in a nearby wire. He gave the theory of induction as well as built the world's first electric generator. Mechanical energy could now be converted to electrical energy. Scientists made another important step in bridging the distance.

In 1830, the American scientist Professor Joseph Henry transmitted the first practical electrical signal. He was also the inventor of the first efficient electromagnet and the first one to show that electromagnetism could be used effectively to communicate. His experiment was very



*Michael Faraday (1791 - 1867)*

*Faraday's first electric generator (Image source: The Royal Institution of Great Britain)*

simple. He built an electromagnet by winding an iron bar with several feet of wire. A pivot mounted steel bar and then a bell were placed in order next to the magnet. From the electromagnet Henry strung a mile of wire and completed the circuit by connecting the ends of the wires at a battery. Once the circuit was complete, the steel bar swung toward the magnet, and struck the bell at the same time. Breaking the connection released the bar and it was free to strike again.

Henry did not pursue electrical signaling, but his observations influenced another scientist. In 1837, Samuel

Samuel F. B. Morse
(1791 - 1872)

Morse code transmitter

Morse code receiver

Morse invented the first workable telegraph using telegraph relay or repeater that allowed long distance operation. He applied for its patent in 1838, and the patent was finally granted it in 1848. The telegraph later helped to unite the country and eventually the world. His system used a key (a switch) to make or break the electrical circuit, a battery to produce power, a single line joining one telegraph station to another and an electromagnetic receiver or sounder that upon being turned on and off, produced a clicking noise. He completed the package by devising the Morse code system of dots and dashes. A quick key tap broke the circuit momentarily, transmitting a short pulse to a distant sounder, interpreted by an operator as a dot. A lengthier break produced a dash. In 1844, first public demonstration of Morse's electric telegraph was made which sent message from Baltimore to Washington. In 1858, first Atlantic telegraph cable was completed, but it failed after 26 days due to high voltage. The coast to coast telegraph communication in the United States started in 1861 and in next year permanent communication link was established by wire from the United States to Europe with the completion of the second Atlantic telegraph cable.

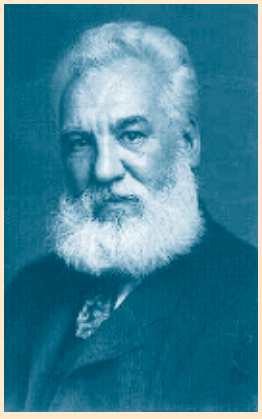
While the telegraph was making its way to world of communication and trying to bridge the distance, the idea of telephone was still in its infancy. This was because transmitting speech over a distance was not very straightforward. Reproducing speech practically relies on the transmitter making continuous contact with the electrical circuit. A transmitter varies the electrical current depending on how much acoustic pressure it gets. Turning the current off and on like a telegraph cannot begin to duplicate speech since speech, once flowing, is a fluctuating wave of continuous character and it is not a collection of off and on pulses. Hence, during early 1870s, the telephone or its kind was still not in the horizon. Inventors focused most on telegraph improvements since these had a waiting market. A good, patentable idea for telegraph was marketable during that time than developing a telephone, which was not yet fully conceived theoretically.

Most scientists were therefore trying to develop a multiplexing telegraph, a device to send several messages over one wire at once. Such an instrument would greatly increase traffic without the telegraph company having to build more lines. As it soon came out, the desire to invent one thing turned into a race to invent something altogether different.

Elisha Gray
(1835-1901)

Elisha Gray's Musical Telegraph of 1876 (Image source: www.obsolete.com/120_years/machines/telegraph)

In 1968, an expert electrician and a hard working professional inventor Elisha Gray got a telegraph related patent. He was devoted totally to electricity related research and was working on a harmonic telegraph. While working on it, he got some idea on transmitting sound and he filed a caveat (a confidential report of an invention which is not fully perfected) in the US Patent Office. Gray went on to invent the tele-autograph which transmits facsimile handwriting and drawings. In 1869, Gray becomes the partner of Shawk and Barton Company, which became Gray and Barton Company. After two years, they changed its name to the Western Electric Manufacturing Company, with Gray remaining an important person in the company.



Alexander Graham Bell
(1847 – 1922)

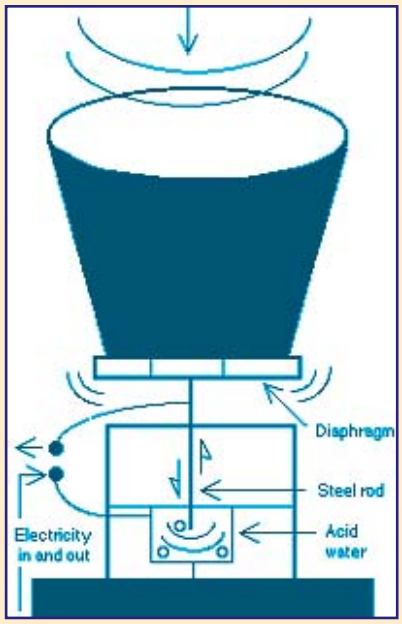
During the same time, Alexander Graham Bell was also working on an improved telegraphic device that could transmit sound. In 1870, Bell moved from UK to Canada with his parents and in 1873, Bell became a vocal physiology professor at Boston College. During the day, he taught the deaf persons the visual speech system and at night, he worked on what he called a harmonic or musical telegraph. His basic idea was to send several messages at once over a single wire that would let a telegraph company increase their sending capacity without having to install more poles and lines. Such a device would realize a great economy for the telegraph company. Familiar with acoustics, Bell thought he could send several telegraph messages at once by varying the pitch as the musicians often do in musical instruments. That was Bell's idea of so called 'harmonic

telegraph'. However, the harmonic telegraph proved simple to think about, yet quite difficult to build. But Bell did not leave the hope and tried hard to develop the device.

In the summer of 1874, Bell was working on a teaching aid for the deaf, a gruesome device called the 'phono-autograph', made out of a dead man's ear. Speaking into the device caused the ear's membrane to vibrate which in turn moved a lever. The lever then wrote a wavelike pattern of the speech on smoked glass. Bell was fascinated by how the tiny membrane caused the much heavier lever to work. He speculated that it might be possible to make a membrane work in telephony, by using it to vary an electric current in intensity with the spoken word. Such a current could then replicate speech with another membrane. Bell conceptualized the principle of the telephone and the theory of variable resistance, but applying that principle correctly took some more time.

In February 1875, Bell got financial assistance from Gardinar Greene Hubbard, a lawyer and president of the Clarke School for the Deaf, and George Sanders, a businessman, to pursue his dream further. Both became interested in Bell's experiment since nobody at that time proposed anything similar to harmonic telegraph and they thought that the harmonic telegraph might work. The financial assistance was given to Bell in return for equal shares from any patents that Bell might develop. During the same time, Bell also met with Joseph Henry in Washington who did some pioneering work on electromagnetism and helped Morse with the telegraph. Henry could visualize the future of Bell's work of transmitting speech electrically and encouraged Bell to drop all other work and get on with developing the telephone rather than harmonic telegraph. So Bell's dream of harmonic telegraph turned into dream for developing a working telephone. Thereafter, Bell began working full time on the telephone. In the spring of 1875, Bell's experimenting picked up quickly with the help of a talented young machinist named Thomas A. Watson.

On June 2, 1875, Bell and Watson were testing their harmonic telegraph when Bell heard a sound came through the receiver. Instead of transmitting a pulse, the telegraph passed on the sound of Watson plucking a tuned spring. Their telegraph, like all others, turned current on and off. But in this instance, a contact screw was set too tightly, allowing current to run continuously, the essential element needed to transmit speech. Bell realized this phenomenon and Watson built a telephone the next day based on this discovery. The Gallows telephone, so called for its distinctive frame, substituted a diaphragm for the spring. Unfortunately, it still did not work. A few odd sounds were transmitted, but no speech. Although Bell could not develop a successful telephone still in the beginning of 1876, he felt that he could describe how it could be done. So Bell continued experimenting while writing a telephone patent application since during that time the Patent Office allowed a working model for patent application. On February 14, 1876, Bell filed his patent application. It came only hours before Elisha Gray filed his Notice of Invention for a telephone as mentioned earlier.



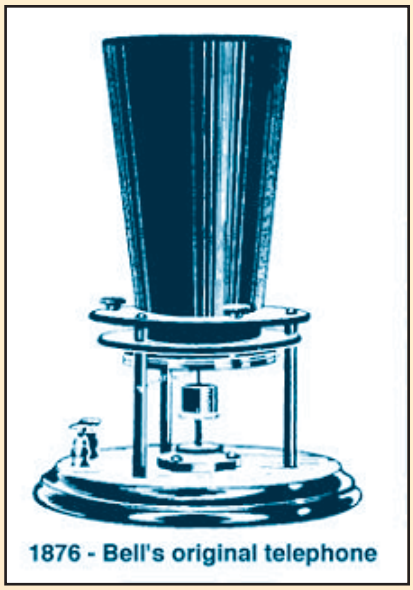

*Simplified diagram of Bell's liquid transmitter. The diaphragm vibrated with sound waves, causing a conducting rod to move up and down in a cup of acid water. Battery supplied power electrified the cup of acid. As the rod rose and fell it changed the circuit's resistance. This caused the line current to the receiver (not shown) to fluctuate, which in turn caused the membrane of the receiver to vibrate, producing sound.*

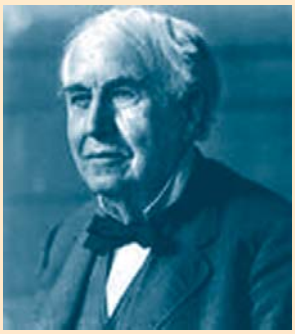
On March 10, 1876, in his lab at Boston, Massachusetts, Bell invented his dream instrument – the telephone. Watson fashioned the device itself, a crude thing made of a wooden stand, a funnel, a cup of acid, and some copper wire. But these simple parts made the way for one of the most significant instruments of mankind. Bellowing into the funnel caused a small disk or diaphragm at the bottom to move. This disk was, in turn, attached to a wire floating in an acid-filled metal cup. A wire attached to the cup in turn led to a distant receiver. As the wire moved up and down it changed the resistance within the liquid. This varying current was then sent to the receiver, causing its membrane to vibrate and thereby produce sound. The very first telephonic call "Mr. Watson, come here, I want you!" made by Bell to Watson started the era of transmitting speech that is still continuing. The telephone had been invented. Now it was time to evolve.

Bell soon improved it by using an electromagnetic transmitter, a metal diaphragm and a permanent magnet. Bell and Watson worked constantly on improving the telephone's range. They made their longest call on October 9, 1876. It was a distance of only two miles, but they were so overjoyed that later that night they celebrated. Bell and Watson improved the telephone and made better models of it, but these changes were not enough to turn the telephone from a curiosity into a needed appliance. Promoting and developing the telephone proved far harder than Bell or his financiers expected. No switchboards existed yet, the telephones were crude and transmission quality was poor. It was very difficult that time with such a gadget to convince people why they indeed need a telephone. And despite Bell's patent, broadly covering the entire subject of transmitting speech electrically, many companies sprang

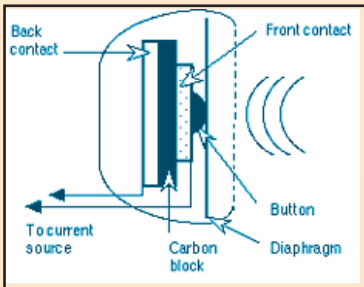
up to sell telephones and telephone service. In addition, other people filed applications for telephones and transmitters after Bell's patent was issued. Most claimed Bell's patent could not produce a working telephone or that they had a prior claim. Litigation process started with so many individuals in the fray for telephone inventions.

In the meantime, Bell lectured on and exhibited telephone apparatus at the Society of Arts, Boston; the American Academy of Arts and Sciences, Boston and the Philadelphia Centennial Exposition. In 1876, Bell received the world's first long distance telephone call at Ontario from his father and uncle at Brantford over borrowed telegraph lines though the call was one-way only. In the same year, the world's first two-way long distance telephone conversation over borrowed telegraph line took place between Cambridgeport and Boston, between Bell and Watson. In 1877, first time telephone was rented for business use, on a private line between Boston and Somerville, and first service rental paid for telephones (private use) in Charlestown, Massachusetts ($20 for 2 Telephones for 1 Year) started. The telephone business was formally organized with the formation of the Bell Telephone Company.


1876 - Bell's original telephone


*Thomas Alva Edison (1847 – 1931)*

In April 27, 1877, Thomas Edison filed a patent application for an improved transmitter, a device that made the telephone practical. To compete, Bell soon incorporated in their phones an improved transmitter invented by Francis Blake. Blake's transmitter relied on the diaphragm modifying an existing electrical current, an outside power source. This was quite different than the original invention and its improvements.




***Edison's telephone transmitter:***

*This is Edison's carbon block transmitter. It relies on an unusual property of carbon: its conductivity to electricity varies with pressure. A soft carbon button behind the diaphragm presses against the front contact. The diaphragm moves under acoustic pressure, impinging on the front contact. This causes the circuit's resistance to vary, thus converting sound into a varying electrical current.*

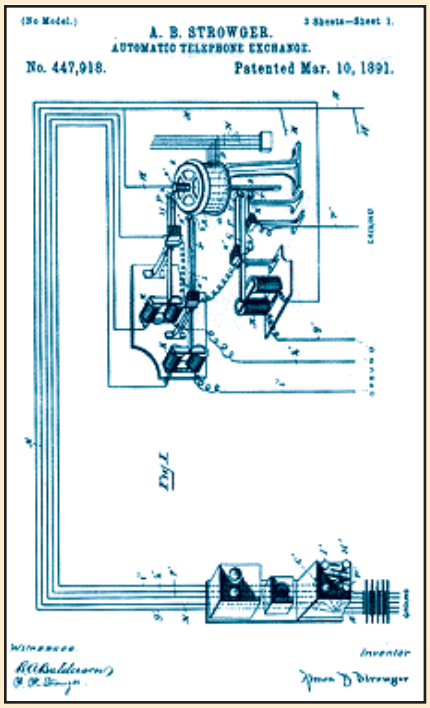
Bell's first telephone transmitter used the human voice to generate a weak electro-magnetic field, which then went to a distant receiver. Bell later installed larger, better magnets into his telephones but there was a limit to what power the human voice could provide.

In December of 1877, Western Union created the American Speaking Telephone Company. They used Edison's improved transmitter in their telephones. In the next year, there occurred a lot of telephone activities. The first commercial telephone exchange of the world was opened at New Haven, Connecticut with 21 subscribers on January 28th. The first exchange in California was opened at San Francisco on February 17th and the first telephone directory was published by the New Haven District Telephone Co. (21 Listings) on February 21st. The first exchange in New York State was opened at Albany on March 18th. The first exchange in Massachusetts started operating in Lowell on April 19th. The first telephone exchange outside of the United States was opened in Hamilton, Ontario, Canada on July 15th. The first five telephones connected with a central office switchboard in Washington D.C. took place on December 1st. These were The White House, Capitol, Associated Press, Treasury Department and the Institute for the Deaf and Dumb.

In February 17, 1878, Western Union opened the first large city exchange in San Francisco. The telephones were no longer limited to people on the same wire and now people could talk to many others on different lines. The public switched telephone network was born. In 1878, President Rutherford B. Hayes administration installed the first telephone in the White House. The first outgoing call of Hayes went to Alexander Graham Bell himself, who was in a distance of thirteen miles. In the same year, the Butterstamp telephone came into use. This telephone combined the receiver and transmitter into one handheld unit. One had to talk into one end, listen to the other end by turning the instrument. People got confused with this clumsy arrangement. Consequently, a telephone with a second transmitter and receiver unit was developed in the same year. On August 1, 1878, Thomas Watson filed for a ringer patent. Similar to Henry's classroom doorbell, a hammer operated by an electromagnet struck two bells. Turning a crank on the calling telephone spun a magneto, producing an alternating or ringing current. Previously, people used a crude thumper to signal the called party, hoping someone would be around to hear it. The ringer was an immediate success.

On 17th February, 1879, National Bell Telephone Company formed. The purpose of this organization was

to combine the first New England Telephone Company and the Bell Telephone Company into a nationwide licensing company in order to speed up the establishment of telephone service to cities throughout the country. On November 10, 1879, Bell won its patent infringement suit against Western Union in the United States Supreme Court. The National Bell took the new name American Bell Company on February 20, 1880. In 1880, the first use of telephone numbers started at Lowell, Massachusetts. In the same year, the first telephone pay stations with attended telephones opened in certain districts of New York. In the next year, the first commercially successful long distance line, 45 miles between Boston and Providence, Rhode Island, opened for business. The Chief Operating Officer of the American Bell Company, Theodore Vail began creating the Bell System, composed of regional companies offering local service, a long distance company providing toll service, and a manufacturing arm providing equipment. In February 26, 1882, American Bell took over Western Electric and started manufacturing Bell equipments.




*A.B. Strowger*
*Automatic Telephone Exchange*
*No. 447, 9918 Patented Mar. 10, 1891*
*( Source: http://www.uspto.gov/)*

In 1880, two Telephone Companies, namely, The Oriental Telephone Company Ltd. and The Anglo-Indian Telephone Company Ltd. approached the Govt. of India for permission to establish Telephone Exchanges in India. The permission was however refused on the grounds that the establishment of Telegraphs and Telephone was a Government monopoly and that the Government itself would undertake the work in the event of sufficient demand. By 1881, Govt. of India changed their earlier decision and license was granted to the original Oriental Telephone Company Limited of England for opening Telephone Exchanges at Calcutta, Bombay, Madras, Karachi and Ahmedabad. The exchange at Calcutta named "Central Exchange" was opened at third floor of the building at 7, Council House Street. On 30-06-1882, the Central Telephone Exchange had 93 subscribers.

On July 19, 1881, Bell was granted a patent for the metallic circuit, the concept of two wires connecting each telephone. Until that time a single iron wire connected to telephone subscribers, which was just like a telegraph circuit. A conversation works over one wire since grounding each end provides a complete path for an electrical circuit. But houses, factories and the telegraph system were all grounding their electrical circuits using the same earth the telephone company employed. A huge amount of static and noise was consequently introduced by using a grounded circuit. A metallic circuit, on the other hand, used two wires to complete the electrical circuit, avoiding the ground altogether and thus providing a better sounding call. In October of 1881, J.J. Carty introduced two-wire service commercially on a circuit between Boston and Providence. It cut noise greatly over those 45 miles and heralded the beginning of long distance service. In 4th September, 1884, The New York to Boston line was opened for commercial service with rates as $2.00 at daytime and $1.00 at night. By next year, the certificate of incorporation for the American Telephone and Telegraph Company was filed in New York City. The objective was to establish telephone communication to cities on the American continent and elsewhere around the world by wire, cable and other means. During this year, Theodore Vail started his own company American Telephone and Telegraph (AT&T), which provided the long distance service for American Bell. In 1888, William Gray devised the first pay telephone which required the deposit of a coin to gain access and in the next year, the first public coin telephone was installed at Hartford, Connecticut. In 1890, the Bell system began to exchange its wire plant from single wire to two-wire circuits. The process took almost ten years.

In 1891, Almon B. Strowger got the patent for his Strowger machine-switching system. He devised a central office switching system wherein the telephone user should not be dependent on the operators. The Strowger switch came to be known as the step-by-step (SXS) system. Next year, the first automatic commercial exchange using step-by-step machine opened in La Porte, Indiana. The system was provided by the Automatic Electric Company under Strowger patents. In 1893, Bell patent expired and that made it possible for anyone who so desired to make telephone equipment and sell telephone service. In 1896, the first machine switching telephones or dial telephones with finger wheels were placed in service at the city hall of Milwaukee, Wisconsin by the Automatic Electric Company. In 1897, Milo Gifford Kellogg, who was awarded 125 patents related to different aspects of telephone, founded the Kellogg Switchboard and Supply Company near Chicago. He developed Western Electric's best telephone

switchboards: a standard model and a multiple switchboard. In 1899, AT&T took over the business and property of the American Bell Telephone Company and became parent company of the Bell system while continuing as the long lines operating company.

In 1900, loading coils came into use. Michael Pupin developed the loading coils that improved long distance transmission. Spaced every three to six thousand feet, cable circuits were extended three to four times their previous length. Essentially a small electro-magnet, a loading coil or inductance coil strengthens the transmission line by decreasing attenuation, the normal loss of signal strength over distance. Wired into the transmission line, these electromagnetic loading coils keep signal strength up as easily as an electromagnet pulls a weight off the ground.

*Michael Idvorsky Pupin ( 1858- 1935)*

*Candlestick phones made between 1911-1929.*

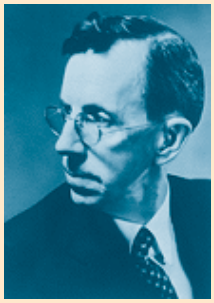
*Wall phones made between 1911-1929.*

In 1906, first telephone directory featuring classified business advertising on yellow pages issued in Detroit by the Michigan State Telephone Company. In 1908, the term 'Bell System' was introduced by AT&T to express the policy of eliminating dual telephone services, which were the result of competition after the expiry of the original Bell patents. On 25th January, 1915, the first line from New York to San Francisco was opened. Alexander Graham Bell, in New York, spoke to Tom Watson in San Francisco repeating the first complete sentence transmitted by telephone, "Mr. Watson, come here - I want you!" During August, the first trials of transmitting speech across the Atlantic began. During this time, new engineering and scientific discoveries continued within the Bell system including development of new magnetic alloys and the condenser microphone which revolutionized the radio and public address systems.

In 1917, the U.S. was at war with Germany and Austria-Hungary and Bell system engineers demonstrated one-way radio telephone transmission from airplane to ground. By August, two-way, air-ground communications was maintained for the first time and communication between two airplanes was also demonstrated. In 1918, under authority of a joint resolution of Congress, President Woodrow Wilson issued a proclamation assuming control of the telephone and telegraph systems in the United States, placing them under the direction of the Post Office Department. In 1919, the Bell System announces plans for the introduction of machine switching (dial telephones) in its exchanges. On November 8th, the first large machine switching exchange in the Bell system was brought into service in Norfolk. This exchange used the step-by-step system and was installed by the Automatic Electric Company of Chicago for the Bell System.

In August 2nd 1922, Alexander Graham Bell died at his summer home Beinn Breagh, in Cape Breton Island. On August 4th, telephone service was suspended for one minute on the entire telephone system of the United States and Canada, during the funeral service for Dr. Bell.

Most of the developments in telephone system after First World War were more related with commercialization of telephone services and technological advances within each company continued. On May 19th, 1924, the first transmission of picture over telephone wires was publicly demonstrated by Bell System engineers. A public demonstration of television by wire from Washington, D.C. to Bell Telephone Laboratories in New York City was made on April 7th. In 1930, first interstate connection for police teletypewriter systems was opened between New York, New Jersey and Pennsylvania. In 1931, AT&T Company introduces teletypewriter exchange service, TWX. On April 25, 1935, the first round-the-world telephone call was made. Walter S. Gifford, president AT&T Company, talked with T.G. Miller, vice president of Long Lines Department. In 1936, first coaxial cable installed between New York and Philadelphia made available for multi-channel telephone tests. In 1937, Dr. Clinton J. Davisson of Bell Telephone Laboratories, became the first Bell System employee to win the Nobel prize. The award, shared with Prof. George P. Thomson of London, came to Dr. Davisson for his



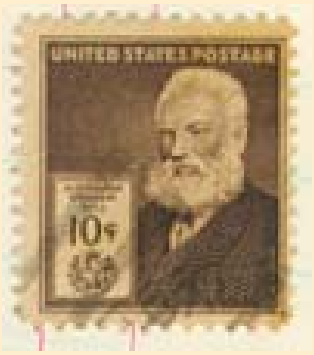
*Clinton Davisson*

*Manual Telephone Exchange*

*Automatic Telephone Exchange*

experimental discovery of the wave nature of the electron.

In 1940, broadband carrier systems were introduced allowing for simultaneous calls over a single pair of wires. On October 28th, the first sale of a new stamp honoring Alexander Graham Bell (10 cents) was introduced in Boston. In 1942, Bell Telephone Laboratories applied for a patent on an oscillator circuit, which almost at once proved of great value in radar systems, used in the war. Subsequently, in 1944, Bell Telephone Laboratories devoted its facilities to military research and conducts the School for War Training, which prepares many men for technical services such as radar maintenance. In 1946, first commercial multi-channel high frequency microwave radiotelephone system in Bell System was introduced in southern California as well as between Nantucket (MA) and the mainland. Mobile telephone service placed in commercial use in St. Louis. In 1947, telephone services from moving trains to any other telephone and along Boston-Washington highway were introduced.



*Stamp honoring Alexander Graham Bell*

In 1950, the step-by-step dial PBX 740E were introduced which were primarily used for under 100 extensions. In the next year, on a trial basis in Englewood, New Jersey, the first time the callers made their own long distance calls by direct number dialing. In the early 1950s, the Bell System developed an improved neoprene jacketed telephone cord and shortly after that a PVC or plastic cord. These replaced the cotton-covered cords used since telephony began. The wires were laid parallel to each other instead of being twisted around, which reduced the diameter and made them more flexible. On August 17, 1951, the first transcontinental microwave system began operating. A total of 107 relay stations spaced about 30 miles apart formed a link from New York to San Francisco. In 1954 over 400 microwave stations were scattered across US. And by another four years, microwave carrier made up 13,000,000 miles of telephone circuits or one quarter of the nations long distance lines. These radio routes could send 600 conversations or two television programs at once. But crossing Atlantic using microwave technology was not possible due to limitation of radiotelephony. In 1956, the first transatlantic telephone cable system started with the laying down of two coaxial cables about 20 miles apart that carried 36 two way circuits. Nearly fifty sophisticated repeaters were spaced from ten to forty miles along the way. In 1956, the Nobel Prize in Physics for that year was awarded to the inventors of the transmitter, Dr. Walter H. Brattain of Bell Laboratories, Dr. William Shockley and Dr. John Bardeen.

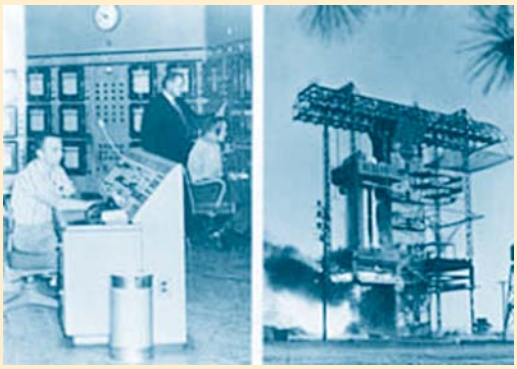

*The Ericofon was a very futuristic handset when it was introduced in 1956. (Image source : en.wikipedia.org)*

On April 17th, 1957, Bell Laboratories announced development of magnetic tape machine which was capable of transmitting 1,000 words per minute, 16 times faster than conventional teletypewriter machines. Next year, they announced the Data-Phone service, which permitted high-speed transmission of data over regular telephone circuits. In January, 1958, people in Wichita Falls, Texas, witnessed true number calling system with seven numerical digits without letters or names. On August 3rd, 1960, Bell Laboratories scientists carried on a coast-to-coast telephone conversation by 'bouncing' their voices off the moon. AT&T asked for approval of a space communications experiment using 'active' satellites. On 1st November, the first market trial of Touch Tone calling was undertaken in Findlay, Ohio and on 17th of that month, customer trials began of the world's first electronic Telephone Central Office in Morris, Illinois.

In 1961, the Bell System started working on a classic cold war project, which finally completed in 1965.


*Bell Labs at Murray Hill ( Image source: Bell System Memorial)*

It was the first coast-to-coast atomic bomb blast resistant cable and intended to survive where the national microwave system might fail. On 16th January of that year, Bell System proposed a new service called TELPAK, which would create 'electronic highways' between specific points, over which many types of communications could be transmitted. On January 18th, the FCC authorized AT&T to operate experimental radio stations for basic earth-satellite communications study, which was more commonly called as 'Project Telstar'. In March of 1962, the FCC approved 'Bellboy' radio



*A network of 24 channels with a total of more than 450 sound powered telephones, which derive their power solely from the human voice, provide the communications between the East Area central block-house (left) and the various test stands at NASA's George C. Marshall Space Flight Center. (Image Source: americanhistory.si.edu*

paging system on a developmental basis. This marked the first commercial application of the paging system. On July 10th, the world's first international communications satellite, Telstar, rocketed into space. First transmission came during Telstar's sixth orbit of the earth. On July 25th, the Bell System's 'Skyphone' air-to-ground public telephone service opened for commercial airline use for the first time when TWA introduced the service on an experimental basis. On August 31st, the Bell System's Teletypewriter Exchange Service started dial operation on a nationwide basis. President Kennedy on September 1st, signed a bill authorizing the creation of a private corporation to develop and international communications system using satellites such as Telstar.

*Rotary dial telephone receiver*

On May 7th, 1963, Telstar II was placed in orbit on in order to learn how to overcome the effects of radiation, which permanently disabled Telstar on February that year. On August 1st, NASA announced that the new Syncom II communications satellite had been used successfully to transmit voice live between the U.S. and Africa. On August 2nd, the Bell System announced the completion of field trials of 'Trimline' telephone that had the dial in the handle between the ear and mouthpieces. In November, the first commercial all-electronic switching system was placed into service at Cocoa Beach, Florida and Touch Tone service featuring ten push buttons was introduced in Pennsylvania. During this year, digital carrier techniques were introduced replacing analogue transmission. On April 20, 1964, the first transcontinental Picturephone call was made between Bell System exhibit at the World's Fair and Disneyland, California. Bell System put its star crossed video telephone into limited commercial service between New York, Washington and Chicago. However video telephone could not catch the imagination of public for long time.

*Commonly available single line telephone receiver*

In 1965, the first commercial communications satellite was launched, providing 240 two-way telephone circuits. During this year, the Bell Systems introduced first electronic switching system (No. 1ESS). The switch proved a success but there were some problems when a No. 1ESS became overloaded. In those circumstances it tended to fail all at once, rather than breaking down bit by bit. In July of 1972, the Bell System introduced Dataphone 4800 had 4800 bits-per-second transmission range. Next year in March, Bell Laboratories announced the development of Touch-a-Matic telephone that could automatically dial a call to anywhere in the U.S. at the touch of a single button. AT&T installed its first digital switch in 1976.

The first cellular subscription started in U.S. in 1983 and in the next year, Motorola sold its first portable cellular telephone. It took only four years, when US recorded one million cellular subscribers and in another five years, the figure reached to ten million. In 1988, the first transatlantic fiber optic cable was completed and the first commercial offering of ISDN service started in the US. AT&T developed the optical digital processor in 1990 and next year Bell Labs developed photonic switching. In 1992, the first color motion videophone introduced in the US. Next year, the first digital mobile network was established in Los Angeles while the first all digital cellular network was brought up in Orlando.

So telephone and its related technologies have come a long way since Bell had sent his first message to his colleague Watson. Now in the 21st century, the telecom industry is still roaring ahead with new technologies and more customer friendly options. However, the technological development is now closely related with its commercial feasibility. It is hoped that the competition and commercial interests among telecom companies will help in further development of new technologies which would make the far nearer. This would also be helpful for consumers with the availability of new technologies at affordable price tag. We fervently hope that those days are not far away when this important instrument and its allied services will reach to all the people, particularly people living in the rural areas, who still do not have accessed to it. That day we can rightly see the whole world as a global village.

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# Summer Sense

## Tips to Beat the Heat

❑ Dr. Yatish Agarwal
e-mail: dryatish@yahoo.com

With the summer sun beating at its fiery best, life becomes insufferable. The scorching heat drives you nuts and saps you off all energy. You feel utterly exhausted and drop dead even before the sun begins to set. Your body's natural control mechanisms—skin and perspiration—fail if you are exposed to high temperatures for prolonged periods.

A few practical steps can however work a coup d'état against the heat and help you maintain the cool. Summer sense is all about staying out of sun, taking sufficient fluids, maintaining body salts, dressing properly and splashing in lavender water! Read on, for some simple tips.

**Stay out of the sun :** Avoid going outside during the hottest part of the day, noon to 4 p.m. Plan your day's itinerary in such a way that you do not travel much when the sun is beating hard.

**Do not let the sun bowl you out :** Limit activity. Reserve vigorous exercise or activities for early morning or evening. A simple piece of advise for my young friends who must find ways to spend time while their school is closed for summer vacations: play indoor games or play in the shade, and drink a lot of water all the time to prevent dehydration. Do not go out to play the hot-wicket tournament, or you may be clean bowled by the sun.

**Wear 'cool' clothes :** Dress properly The colour, texture, thickness and fit of the clothes, all go into making life easier and more comfortable. Wear light-coloured apparel. Prefer whites, creams and pastels. That's because dark clothes absorb heat and add to your discomfort, while light coloured ones reflect it back and are cooler for the body. Lightweight clothing that breathes such as khaki and cotton should catch your fancy. Avoid synthetics and terry-cottons. Loose-fitting dresses are more sensible than body hugging tights.

**Protect your head :** It makes good sense to keep the heat out by keeping your head covered. The British wore hats, the men at home wore safas, and the desert nomads wear headgear. Take a leaf out of their book! Else, use an umbrella with a light-coloured top.

**Drink lots of liquids :** Perspiration is your body's most effective natural coolant. To combat the hot environmental temperature, the body cools itself through the process of vaporization. The linings of the mouth, nose and breathing apparatus participate in this process round the clock. On a normal day, this water loss is not much and approximates 50 ml per hour. On a hot day, however, the total fluid lost through perspiration may be as large as six to eight litres. A glass of water provides you 300ml. You can therefore count how many glasses can replenish this loss.

The body also loses a considerable amount of salt. There is approximately 2 g sodium chloride lost in every litre of sweat.

**Enjoy grandma's recipes :** Grannies have zillions of concoctions and mouth-watering recipes to counter the ills of the soaring mercury. The choice is yours. The most exotic of sherbets – made from unripe mangoes and popularly known as amras or panna; kuccha pyaz ka ras; nimbu pani; shikanji (sweet lime water); pudina ki chutney; chhaach (buttermilk), or Punjabi lassi – soothe not only the parched palate, but hydrate your body and also fill it on essential salts.

**Enjoy the season's natural foods :** Mother Nature has its own game plan to neutralize the heat. It offers a number of succulent fruits, salads and vegetables during the summer months. You can choose between watermelons, muskmelons, litchis, kakri, cucumber and others. They are excellent replenishment of salt and water.

**Avoid hot and heavy meals :** Food contributes to production of heat within the body. It therefore makes sense to eat frugally on a hot day! Hot foods laden with spices and condiments, curries and tikka stuff can add to your woes by accentuating perspiration.

**Avoid alcohol and caffeine :** Alcohol and caffeine–containing beverages such as cola drinks, tea and coffee cause water loss from the body by stimulating increased urine formation. They also increases sweating, and may thereby, add to your discomfort.

**Splash. Water is an energiser:** Get wet, whenever you can. A refreshing bath or shower can help you relax. The sahibs and memsahibs did that, and so did the Mughals using big, beautiful hamams. A swim can also be most invigorating.

**Maintain your mental cool :** Do not let the heat get the better of you. If you lose your mental cool, emotional excitement causes unconscious tensing of muscles and literally increases your body's temperature! Therefore, you should take care not to khayo garmi to escape the heat.

**Do not overstretch :** Even if you have tight deadlines to meet, do not overexert. Lack of sleep, alcoholic excess, gastrointestinal upsets and fasting all can accentuate the ill effects of heat.

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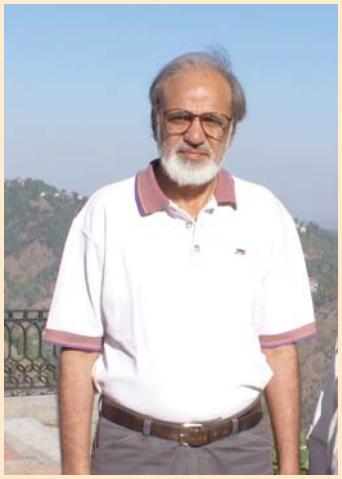
**WYP 2005 – Master Resource.....** *(Contd. from page------ 36)*

Himachal Pradesh Institute for Planning and Administration. Incidentally, this was the first in the series of 5 regional programmes to be organized in the country. Some 65 participants – most of them PGTs in Physics or college / university teachers, and a few from NGOs were trained as Master Resource Persons. The Master Resource Persons trained in turn would train resource persons within their own State, and help organize a host of S&T popularization activities built around the theme WYP 2005. The States represented were Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Delhi, Uttaranchal, Uttar Pradesh, and the UT of Chandigarh.

The programme consisted of lectures, demonstrations, activities in astronomy, and visits to R&D laboratories. The inaugural session was presided over by Shri Sanjay Gupta, Member-Secretary, HPCST. Prof. Naresh Dadhich, Director, Inter-University Centre for Astronomy and Astrophysics, Pune was the Chief Guest. Dr. V.B. Kamble, Director, Vigyan Prasar; Smt. Ujjwala T. Tirkey, Scientist, NCSTC; Dr. J.J. Rawal, President, Indian Planetary Society, Mumbai; Dr. S.S. Chandel, Scientist, HPCST; and Shri Mukesh Roy, Department of Physics, IIT, Kanpur, addressed the participants.

The highlights of the training programme consisted of demonstration of innovative experiments in Physics by Shri Mukesh Roy. These experiments are being developed as a joint project of Vigyan Prasar and IIT, Kanpur. Dr. Naresh Dadhich delivered a talk on "From Newton to Einstein and Beyond", and also a popular talk "Had Einstein been born in 1844". Dr. Ahluwalia, Head, Department of Physics, HP University, spoke on "The Discovery of Electron". Dr. V.B. Kamble delivered talks on "The Discovery of Radioactivity"



*Prof. Naresh Dadhich, Director, IUCAA, Pune*

and "The Quantum Era". Shri Biman Basu, Former Editor, Science Reporter, spoke on "Riding on Radio Waves". Dr. J.J. Rawal spoke on "Discovery of X-Rays". Smt. Ujjwala T. Tirkey demonstrated the astronomy activity kit developed by Vigyan Prasar. Dr. J.J. Rawal conducted night sky viewing programme. Shri Chander Mohan, Scientist, NCSTC, spoke on "Effective Communication".

Vigyan Prasar has brought out resource material for the MRP training programmes consisting of compilation of a set of articles on the discoveries and the makers of the discoveries during the golden decade 1895-1905 (both in Hindi and English), and a CD containing 9 PowerPoint presentations. This software, alongwith the astronomy activity kit, was distributed to the participants by Vigyan Prasar. The 3-part film *Anantyatra* produced by Vigyan Prasar and covering the discoveries made during the golden decade, and a film on the miraculous year of Einstein (1905) were also screened as part of the training programme. The innovative experiments in Physics and the software produced by Vigyan Prasar was highly appreciated by the participants.

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# Eratosthenes' Method to Measure the Diameter of the Earth

❑ Arvind C. Ranade
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What is the shape of Earth; some imagined Earth as a disc and some box-shaped. The Egyptians said it was an egg, guarded at night by the moon. But there were people in ancient Greece and India who held that Earth to be in a shape of ball- globe.

It was accidental information that led Eratosthenes, then the librarian of Alexandria, to devise a method to estimate the diameter of Earth. In 200 BC, one traveler told him about a wonder-well near present-day Aswan in Egypt. The bottom of the well was lit by the sunlight at exact noon during every summer solstice. On all other days the bottom was not lit at noon. Wonder indeed!

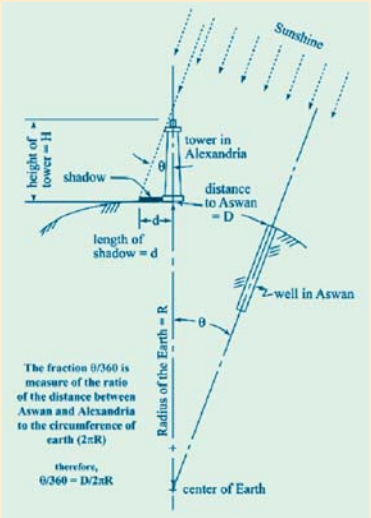


**Figure 1**

Eratosthenes realized that it is only on that day and at that moment the sun was straight overhead over that well in Aswan. This sparked in him an idea. He could measure the shadow cast by a tower in Alexandria at noon during summer solstice ($\theta$); while no shadow was being cast in Aswan. Then, knowing the distance to Aswan (D), he concluded that it would be simple to calculate Earth's radius. As explained in the figure 1, the fraction $\theta/360$ is a measure of the ratio of the distance between Aswan and Alexandria to the circumference of the Earth, which led him to the calculation of diameter of Earth. Actually his estimate was only high by 15% to that of the current estimate of Earth's diameter.

Sure this calculation involved a number of assumptions. There was no accurate timekeeping at that time. For Eratosthenes to make his observation, noon had to occur at the same time in both cities. That would happen if Aswan lay due south of Alexandria. Actually, it lies south by southeast, but the error was not great.

Improving upon Eratosthenes' method it is possible to estimate the radius of Earth, provided there is cooperation from people around the globe. Today we do not need to go in search of a wonder- well to measure the diameter. We need only gnomon of fixed length (a straight rod placed perpendicular to the plane) and precise transit time of Sun at (at least) two observation locations sufficiently far away.

In principle, when the Sun is at overhead at a given location (transit of local meridian) the gnomon makes minimum shadow length or at times no shadow. This depends on the inclination of Sun at the location at the time of measurement. Careful measurement of shadow length gives rise to gnomon angle with Sun at that location. The other value we need to know is the distance between two locations, which we can find by the latitude difference of these two.

Therefore formulation to calculate the diameter by measure of ratio method becomes,

$$\frac{\Delta\theta}{360} = \frac{\Delta x}{\text{Circumference of Earth}} \qquad \text{---------(1)}$$

## Measuring the Diameter of the Earth

During an International Astronomy Week (10-17th April 2005), on 14th April, Vigyan Prasar, New Delhi conducted the same experiment jointly with Dr. Gholamhossein Rastagar Nasab & his group from students' Research Center & Central Lab, Rey City (Iran). The experimental details are as below:

The data at New Delhi (India) and Rey City (Iran):

| At New Delhi (India) : | At Rey City (Iran): |
|---|---|
| Latitude: 28° 22' 12" N | Latitude: 35°, 36' 04" N |
| Transit of Sun: 12hr 21min 25sec | Transit of Sun: 12hr 34min 4 sec |
| Total length of gnomon: 100cm | Total length of gnomon: 100cm |
| Gnomon angle at transit time: 19.70° | Gnomon angle at transit time: 26.60° |

Calculation:

Distance between Rey City and New Delhi (From North-South Latitude calculation):

$\Rightarrow$ (Latitude of Rey City) 35°, 36' 04" N – (Latitude of New Delhi) 28° 22' 12" N = 7° 13' 52"

From Earth geometry, 1° latitude difference is equal to 111.3 km

Hence,

$\Rightarrow$ ($\Delta x$) = 7° 13' 52" will be = 7° 13' 52" X 111.3 km = ~ 804 km

Shadow angle difference at two locations:

(Calculation of shadow angle from shadow length is explained in figure 2).

$\Rightarrow$ (Shadow angle at Rey City) 26.60° – (Shadow angle at Delhi) 19.70° = 6.90°

Hence,

$\Rightarrow$ ($\Delta\theta$) = 6.90°

Angle $\theta$ will be calculated as,

$\tan\theta = y/x$

where,

y is total length of gnomon .

x is shadow length of gnomon.

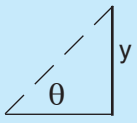


**Figure 2**

By substituting these values in equation 1.

$$\frac{6.90^0}{360^0} = \frac{804\text{ km}}{2\pi R_\oplus}$$

$$2R_\oplus = \frac{804\text{ km}}{3.14} \times \frac{360^0}{6.90^0}$$

**(Diameter of Earth) $2R_\oplus$ = ~ 13350 km**

Remember, this is the observationally calculated value of diameter of Earth with the data from New Delhi (India) and Rey City (Iran).

# Recent Developments in Science & Technology

## Study Demonstrates Feasibility of Custom-Made Stem Cells

Scientists have successfully generated new lines of human embryonic stem cells that are exact genetic matches for individual patients. The results bring researchers a small but significant step closer to using stem cell transplants to treat a variety of diseases.

Last year, a team led by Woo Suk Hwang and Shin Yong Moon of Seoul National University in Korea announced that they had harvested embryonic stem cells from cloned embryos, although their technique yielded just 30 blastocysts and a single cell line. Now the scientists report that they have made significant gains in both speed and efficiency and that they have tailored the process to create stem cells that are DNA matches for patients. Eleven male and female volunteers suffering from maladies such as spinal cord injury and diabetes donated skin cells to the researchers, who then implanted nuclei from these cells into donated eggs whose nuclei had been removed. These eggs were then cultured and allowed to grow for six days to the blastocyst stage, which contains roughly 100 cells. Stem cell lines were derived from the inner cell mass of the blastocysts.

The team produced 11 stem cell lines from 31 blastocysts using the new procedure, a tenfold increase in efficiency over their 2004 results. The age and sex of the volunteers donating genetic material did not affect the success rate, but the scientists report lower failure rates using the eggs of younger women (those from females under the age of 30 led to stem cell lines at a rate of one in 13, whereas those from women in their thirties yielded stem cells at a rate closer to one in 30.) A detailed report has been published in the journal *Science.*

*Source :scientificamerican.com*

## Fuel Cell Converts Biomass into Hydrogen

A fuel cell that uses microorganisms to break down organic matter could help provide additional fuel for a hydrogen economy. The novel design, with energy requirements amounting to less than 5 percent of those of a cell phone, can coax pure hydrogen out of biomass that is not suitable for natural fermentation processes

For conventional fermentation to yield hydrogen, the process must use carbohydrate-based biomass. But the reaction also produces other end products, such as acetic acid and butyric acid, that bacteria cannot break down further into hydrogen. Bruce E. Logan and his colleagues at Penn State University modified a version of a microbial fuel cell (MFC) that they had conceived of to clean wastewater. “However,” Logan explains, “to produce hydrogen, we keep oxygen out of the MFC and add a small amount of power into the system.” By applying a boost of just 0.25 volt, the researchers succeeded in generating four times as much hydrogen as conventional fermentation does. What is more, the cell can be used with any biodegradable dissolved organic matter.

While there is likely insufficient waste biomass to sustain a global hydrogen economy, this form of renewable energy production may help offset the substantial costs of wastewater treatment as well as provide a contribution to nations able to harness hydrogen as an energy source,” Logan says. The report has been published in a *Journal of Environmental Science and Technology.*

*Source: Scientific American.com*

## Ageing cells may lead to clogged arteries

Some people suffer from heart disease even if they take precautionary measures such as avoiding high-cholesterol foods. Part of the solution to this puzzle is supplied by a team that studied mice with clogged arteries.

As the cells in blood-vessel walls grow old, their energy-generating machinery begins to leak, says the team. This releases reactive molecules into the vessels, triggering a chain of reactions that ultimately clogs up arteries and increases the risk of having a heart attack.

The scientists believe their results could lead to improvements in dietary recommendations designed to combat the artery-clogging disease atherosclerosis, a major form of heart disease.

Cutting cholesterol from one’s diet does not always prevent cardiovascular problems, says endocrinologist Clay Semenkovich of the Washington University School of Medicine in St. Louis, Missouri. “Probably the majority of people who have heart attacks have a normal cholesterol level,” he says. “That suggests that there is something more going on.”

*Source :nature.com*

**Compelid by : Kapil Tripathi**

## Protecting Our Ancient..... (Contd. form page 35)

While allopathic drugs have to establish their efficacy and safety through trials, this is not required for Ayurvedic drugs. The remedies have only to be listed in a classical Ayurvedic text. Further, one does not require a licence to sell the Ayurvedic medicines, and so anybody can sell them! A large number of Ayurvedic medicines are available over the counter, and require no prescription. Obviously, nobody knows how long to take them and when to stop. Many manufacturers don’t bother about separation of the active ingredient in the plant. As such, the whole plant or plant part may be used in the making of the Ayurvedic tablet! Further, there are no strict regulations for labelling and packaging, requirements of inserts, and explaining side effects, if any. How do we go about it then?

There is no gainsaying the fact that we need to address the issues raised above on a war footing and protect our ancient wisdom and heritage through tighter rules. It is, however, comforting to note that the Government has initiated action in this direction.

**❒ V. B. Kamble**