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CONTENTS

TO THE READERS & CONTRIBUTORS—

* All articles on Science, Technology and Society are welcome.
* Articles are to be typed, double spaced on one side of a foolscap paper keeping 1" margin.
* It will not be possible to send back rejected articles and so authors are requested to send articles keeping a copy.
* The journal will be bi-lingual, i.e. Bengali and English from coming issues.
* Annual subscription rate will be Rs. 10/- and is to be sent to Break-through, 55/1B, Selimpore Lane, 1st Floor, Calcutta-31.

Letters and criticisms on all the articles are welcome. All the issues will contain a column on 'Letters to the Editors', And the rejionder, if any may be expected in the consequent issue.

LETTERS TO EDITOR

REPLY FROM Dr. M. BHATTACHARYA

"I sincerely thank Sir S. Vajpayee for his letter (vide Break-through Vol I, No. 2, June 85 p. 27) where he took the pain of x-raying the article ("An Engineer and his loud thinking") authored by the undersigned and took profuse liberty in advising me to think "the matter loudly but more deeply." On going throuh his letter I am amused to note that his thinking also materially does not vary with mine as one would surely understand if my article has been carefully gone through that the causes of all the malaise and maladies were righty fixed on the ruling class and that no attempt was made to utter this in a round-about way.

"But how can Dr. Bhattacharyya.....to severe market crises"—the statement is not at all understandable and as such I refrain frrm making any comment on the second paragraph of Mr. Vajpayee's letter.

Dr. Madhusudan Bhattacharyya
Professor of Mechanical Engineering
Jadavpur University Cal-32

A REJOINDER FROM Dr. SAMIR SAHA

As published in the Vol. 1. No. 2 of Break-through, Sri Banerjee must be rightly commended for pointing out some of the new technologies and their impact on the power system of West Bengal. But he seems to have missed the basic point that in West Bengal, the demand of power far out strips the supply. The author is well aware of the existence of base load plant/intermediate load plant/peak load plant. But Sri Banerjee seems to be contradicting his own stand when he says that base load plants of 500 MW capacity are to be run by low quality coals. How mueh of ash content of coal can a power plant handle ? Certainly, even with better designs, a conventional power plant can't handle coal of higher ash content than 20%. As regards Fluidised bed Combustion Boilers, Sri Banerjee must be well aware that they are yet of very low capacities. Thus, economy of scale favours large plants but with high ash content coal, large plants can't be run !

The debate between large and small plants is a long one and one can look at China to see the impact of of low capacity plants and their advantage as also the impact of alternative energy technologies.

A computerised load despatching system can go a long way in solving part of the problem. But what the author has tried to emphasize is the need for a system based approach which is totally lacking for solving this problem of the large system, i. e., the analysis af interactions between sub-systems in a Power System.

Dr. S. Saha
Reader, ME Dept. JU.

from EDITORS DESK

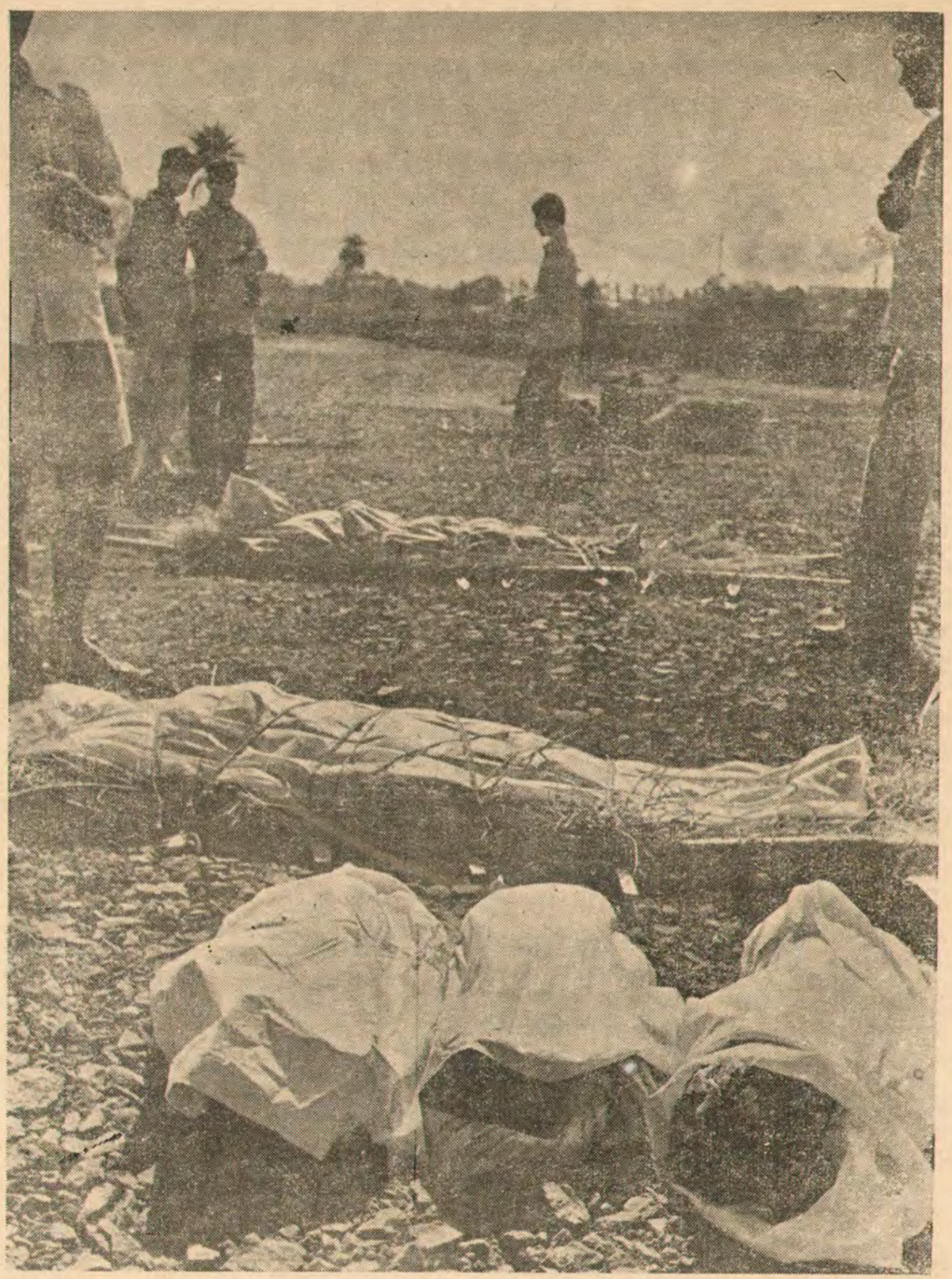
A spectre has been haunting Bhopal through out the year—the spectre of conspiracy, secrecy and agony. History has witnessed so many wars and catastrophe and even Hirosima-Nagasaki. But perhaps for the first time, history witnessed an undeclared war against the poor and innocent people of Bhopal on the night of 2nd-3rd December' 84. All on a sudden the killer MIC (a highly toxic gas) which leaked out of Union Carbide Plant at Bhopal took away at least 5000 to 7000 lives leaving at least 2 lakhs of people maimed and deranged and the genetic effect will continue for generations to come. The question is : is it simply an accident or a sabotage, a premeditated genocide or a test case of chemical warfare ?

The authority of UCIL is trying hard to prove it to be a sabotage in order to shirk its responsibility. But inspite of previous warnings and repeated accidents they did not introduce adequate and properly operating safety system—the modern computerised safety system which is already there in the mother plant in the U.S.A. Add that there is a strong charge against the plant management for storing the toxic chemical for a long time in the first place, then for shutting down the chilling plant, malfunctioning of instruments in the control panel, inadequate neutralization systems, and the lack of warning. This is the worst example of unbound callousness and criminal negligence. Also the role of the Indian Government is very dubious. Their connivance with the UCIL authority becomes palpably clear when we see their attempt to conceal the whole occurrence and to reduce the gravity of the incident.

Doctors in Bhopal continue to complain that they have still not received detailed information on the results of scientific investigation carried out earlier by U.C.C. This, and the significant visit of Mr. Brayan Ballantyne, the gas-war specialist of America as a member of the two medical teams which visited Bhopal after the holocaust, raise very obviously a question—is it a test case of chemical warfare ?

After the Bhopal tragedy a confused section of people considering the tragedy to be the inevitable result of industrialisation and science and technology have become a curse to the society. But they have forgotten the struggle of development of science. Science and technology emerged in the society to unchain man from the slavery of nature. History reveals the glorious struggle of Bruno, Galileo and so many other scientists and technologists who laid down their lives for this noble cause. But at a certain stage of development of society, particularly at the stage of capitalism-imperialism, science and technology have become the tool of exploitation in the hands of the capitalist class. The mad hunt for super profit of the capitalists and industrialists is the main cause of such horrifying industrial disasters. To earn maximum profit is their sole aim. They are least concerned about the life and future of the poor people. Bhopal has thus become the worst victim of the mad race for profit making of these multinationals in countries like ours.

To conclude, we urge upon all the scientists,technologists and right thinking people to ponder over and come forward to create pressure upon the government and the concerned authorities so that no more Bhopal may occur in future.



Victims of Bhopal gasocide—awaiting cremation

USE OF WASTE MATERIAL IN CONCRETE CONSTRUCTION

Dr. Somnath Ghosh*

1. Introduction :

Concrete is one of the oldest man-made construction material, and used in wide range of forms and types. It is probably the most widely used building material in world today. Scientists, engineers and technologists are continuously on the look out for materials which can be used as substitutes for conventional materials or which possess such properties as would enable their use for new designs and innovations. Concrete using alternative materials fall under the first category. The raw materials for making binding material, i.e., cement and aggregates are essentially limitless, since practically all of the earth's crust can be utilised, if associated costs and energy requirement can be complied with. In the developing and third world countries, the requirements are not always for high technology materials or applications, and these countries face a continuous shortage of cement, skills and technological know-how. It would be inappropriate to transfer modern technology directly to these situations, rather the need is for adaptation of recent development in material science and technology to suit local conditions and requirements. Another fator, often overlooked, is that in construction technology the inherent properties of the materials have a strong influence over the design performance of structure utilizing these materials, and their serviceability. Material characteristics must be incorporated into design procedures, and the implications of design should relate in the maintenance durability of the structures.

The disposal of agricultural, urban and industrial wastes is a serious problem of our country. Each ton of paddy produces of 200kg husk. The annual production of coconut pith in our country is estimated to be about 4000 MN, which is waste product from the coir industry obtained during the dehusking operation of coconuts. Coconut pith has been successfully used for the thermal insulation composition for roofs, expansion joint filler, insulation board and high density particle board. The successful utilization of waste material depends on its use being economically competitive with alternative natural material. These costs are primarily made up of handling processing and transportation. Some of the waste materials have been tried with some success whilest others are yet to be tried regarding the feasibility of using them in concrete making. The form in which they are used is wide and varied—they may be used as a binder, as partial replacement of conventional portland cements or directly as aggregates in their natural or processed state. This article deals briefly with the state-of-the-art on the use of waste materials in concrete construction.

2. Organic Wastes (agro-wastes) :

Under this category, the organic materials are of plant origin namely sawdust, cork granules, coconut pith and rice husk. There are many other potential organic material derived mainly from agro-wastes such as ground-nut husk, palm husk, wheat husk and coconut shell, which may also be used in concrete making. Wastes derived from animals such as leather wastes from leather industries may be another source of organic wastes for use in concrete.

2.1. Sawdust :

Natural organic materials such as sawdust and paddy husk have been used from time to time for making light weight concrete. Sawdust is abundantly available in most places but it is often contains substances which retard the hydration and hardening of concrete. The very high drying shrinkage of sawdust cement limits its use, where freedom of movement is possible. The introduction of sand into cement/sawdust mix has been found to reduce the drying shrinkage but at the expense of reducing thermal insulation property and increasing density. Sawdust cement products show a relatively higher percentage of volume change as reflected from its high moisture movement percentage equal to 0·55% compared to that of any other light weight concrete (moisture movement, 0·06% to 0·08%).

Still then saw-dust concrete has received much attention as light weight concrete in building construction. Some pretreatment is being done to ensure that extractable material in the sawdust do not interfere with the hardening of concrete. Sometimes the particles are boiled in water to which ferrous sulphate has been added. Some interesting properties of saw dust concrete are shown in table 1.

2.1.1. Application :

The Central Building Research Institute, Roorkee, India has developed a process of making door and window frame by using sawdust and magnesium oxychloride cement. It was found that these frames possess adequate strength, machinability, good screw holding and paint holding properties and such frames can be easily cast and erected at the construction site. The use of sawdust, wood chips and tree bark will result in a light weight concrete and low cost concrete suitable for low demand applications.

2.2. Cork granules :

Cork granules are available as waste product in the cork industry as well as in the form of throw away material when used as a packing material for fragile or perishable products. In our country waste cork granules are used to manufacture rubberized cork sheets. Recent publications reported on the feasibility of using waste cork granules to make light weight concrete for various potential applications of Civil Engineering.

Some properties of cork granule concrete are shown in table 1.

2.3. Coconut pith :

Coconut pith is available as a by-product of the coir industry. At the end of the retting period the husk are taken out, washed and beaten with wooden mallet when the fibres separate out from the ground tissue which falls as granules and dust. The coconut pith extracted from retted husk consists mostly of lignin and cellulose. Concrete pith is usually grey in colour and a durable material, not easily destroyed by microbiological action. It can be used in making light weight concrete, thermal insulation composition of roof slabs etc. Moisture movement percentage is much lower than concretes made of other agro-wastes and very near to conventional light weight concrete (0·06 to 0·08%). A mix with one part of coconut pith with

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two parts of cement having a density 1100 to 1200kg./m³ is most suitable for walling purpose. Cement bonded panels made from coconut pith and ground-nut husk have been used for partitions, ceiling and non-load bearing walls in low cost housing. Some interesting test results of coconut pith concrete are shown in table 2.

2.4. Rice husk and rice husk ash :

It has a very low density and requires large space for storage and hauling. As the protein content of the husk is very low, it is not suitable as fooder for animals, but is a very good in gradient to produce a light weight concrete. Precast blocks, slabs for walls and partitions are made with husk concrete. Some properties of cement bonded panels from rice husk is shown in table 3.

Burning of rice husk in open fields or as fuel in a steam generator forms a simple method of disposal. Satisfactory hydraulic acid resistant cements can be made from the reactive rice husk ash by simply blending the previously ground ash with ordinary portland cement. The Central Building Research Institute, Roorkee has developed a cheap binder from the burning of rice husk and waste lime sludge available from sugar and paper industries. No extra fuel other than the waste rice husk itself is required. The cakes of mixture of sludge and rice husk are dried in the sun and then burnt, material yields a fast-setting grey coloured cementitious material. Substantial saving would result if this binder is used in place of cement or lime. Rice husk cement show excellent resistance to acdic environment. Rice husk has been found suitable for masonary mortar, foundation concrete and mass concrete works. Rice husk cement along with calculated quantity of sand, lime and water can be used to cast bricks. These bricks can be used for low demand and low cost housing projects. Some encouraging test results of hydraulic cement produced from rice husk ash are shown in table 3.

3· Conclusion :

In retrospect, it has been evident that technology has developed to a stage through which a wide spectrum of waste material can be gainfully used in concrete construction. It is likely that further rapid urbanization and industrialization will yield a new series of waste materials and by-products in future which merit possible utilization in concrete construction. This ultimately is intended to make the environment free from pollution, a social benefit of rapidly increasing urgency and importance.

Table 1 : **Properties of sawdust concrete, cork granule concrete and coconut pith concrete.**

Concrete *made of*	Compressive Strength *at 28 days in N/mm²*	Modulus of Rupture *in N/mm²*	Split Tensile Strength *in N/mm²*	Density *in kg/m³*
Saw dust	31·0	5·0	2·7	720—740
Cork granules	11·0—12·0	—	1·85—2·0	870—890
Coconut Pith	0·75	0·36	—	530—540

* Waste material : Ordinary portland Cement = 1 : 1 by volume.

Table 2 : **Composition and properties of Cement bonded panels from Coconutpith, ground-nut husk and rice husk.**

Composition	Coconut Pith-Cement Panels (*300mm × 300mm × 25mm*)	Ground Nut Husk Cement Panels (*300mm × 300mm × 25mm*)	Rice Husk Cement Panels (*300mm × 300mm 25mm*)
Waste *in gms*	800	800	800
Cement *in gms.*	1600	1600	1600
Flexural Strength *N/mm²*	2·68	1·62	3·4
Compressive Strength *N/mm²*	3·28	3·06	8·8
Linear Swelling %	0·52	0·85	0·36
Water Absorption %	19·6	29	23·4

Table 3 : **Strength of Hydraulic Cement produced from Rice husk Asb.**

Proportion of constituents (% by weight)			Compressive Strength at 28 days
Rice husk ash	Port land Cement	Quick Lime	*in N/mm²*
80	0	20	35·9
70	30	0	44·0
50	50	0	59·2
30	70	0	60·4
20	80	0	61·3
0	100	0	43·6

4. Reference :

(i) Burks, S. D ; "will concrete be the leading building material of the future"—proceedings of American concrete institute 68, 1971, 321-326.

(ii) CBRI Report ; Coconut pith cement concrete for thermal institution"—Building material, Note 9, Roorkee, India, 1968.

(iii) Paramasivam. P & Loke, Y.O ; "study of sawdust concrete"—proceedings of international conference on materials of construction for developing countries, Bangkok, August 1978, Vol 1., 169-179.

(iv) Portland Cement and concrete association of Australia ; "Sawdust Concrete"—information, Noil-2.

(v) Mohan, D & Sing, S. M ; "Low cost construction material from coconut husk and rice husk"—proceedings of the international symposium on New Horizon in constructional materials—Envo publications co. inc. USA, Nov. 1976, 481.

(vi) Mehta P. K ; "Properties of blended cements made from rice husk ash"—Journal of American concrete Institute, 74 (9), 1977, 440-442.

(vii) Swamy R. N. ; "Construction Technology & Design ; New concrete Materials", Vol 1, Surrey University Press, 1983. □

INTERVIEW

SOIL EROSION, SOIL POLLUTION : IS THERE ANY SOLUTION ?

Dr. Sushil Mukherjee Talks on The Burning Problems of Agriculture

[Dr. Sushil Kumar Mukherjee, Ex-Vice Chancellor of Calcutta University, Chairman of the advisory committee of our journal, is an internationally famous scientist in the field of Soil-Chemistry. On an invitation from the government of Vietnam, recently he visited that country to study the long term effects on agriculture and soil of the chemical warfare launched by the United States imperialist power for decades together during their last war of aggression. After his return from Vietnam some members of the editorial board called at his Jodhpur Park appartment with some questions on soil-erosion, soil-pollution, modern chemical warfare and also on recently proposed policies of educational reforms. We publish here the discussion on soil-erosion and soil-pollution only. The conversation was originally in Bengali. The editorial board will be responsible for any error entered into the text while rendering : Ed. Board]

Q. What are the causes behind soil-erosion ? Does it act upon the fertility of soil ?

Ans. The soil contains organic (mainly the minerals like silicate) particles with varying sizes. Those with diameter ranging within 2×10^{-4} cm. are said to be 'clay'—the finest constituent of the soil which decides its characteristics. The dead plants and the residue of the decomposed animal organism constitute the source of organic content. The clay particles remain side by side with comparatively larger sized silt and sand particles while organic particles providing the binding effect in between. The normal rain or flow of water can in no way damage this bond. But during heavy rain, the drops exert sufficient thrust to weaken the said bond. As a result, the smaller and finer particles are forcibly washed out and carried away through rivers upto seas. In case of a sloping land, it happens still more quickly. And you know, this smaller particles are responsible for the fertility of our soil. The Phosphate, Potash, Calcium etc., the necessary food for plant bodies are also lost along with clay particles. The nitrate, sulphate etc. which are soluble in water automatically meet the same fate. So obviously the erosion in soil adversely affects its fertility.

Q. Then how to check it ?

Ans. A number of tools are ready at our hand to combat it. The sheild of extensive plantation and mixing of sufficient amount of organic matters with soil, are conventionally the best approach to check soil erosion. In sloping regions the large scale forestation is the best solution of the problem. Forest ensures two fold services—on the one hand the organic compounds produced through decomposition of plant bodies strengthen the bond in between the soil contents and the bunch of roots of the trees erect the wall of resistance on the other. Construction of small

two parts of cement having a density 1100 to 1200kg./m³ is most suitable for walling purpose. Cement bonded panels made from coconut pith and ground-nut husk have been used for partitions, ceiling and non-load bearing walls in low cost housing. Some interesting test results of coconut pith concrete are shown in table 2.

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IN MEMORY OF NIELS BOHR

Dr. Samir Kr. Saha*

Most often than not, scientists are thought to be specialised men, isolated in their studies and with no concern for what is happening to humanity in general. Yet, studying in depth, we find it is not the whole truth. Many of the greatest minds in science were also concerned with the welfare of their fellow human beings, and some even risked their own positions. Lives and works of Madame Curie, Albert Einstein, Meghnad Saha etc. fall under such category. One other such philosopher—scientist—humanist was Niels Bohr, whose birth centenery passed very quietiy on October 7, 1985.

Born to Danish parents in Copenhagen 100 years back, in an 'academic and open' atmosphere, Niels Bohr grew to be one of the greatest Scientists of our time. In retrospective a thread can be found interconnecting all his work which ultimately culminated in the Rutherford-Bohr Atomic model, and then onwards to the model of nuclear fission in 1939.

Only at the age of 22, in 1907, Bohr's paper 'Determination of the surface tension of water by the method of jet vibration' was awarded the gold medal of the Royal Danish Academy of Science. His M.S. thesis in 1909 'on the applications of the electron theory to explain the physical properties of metals' led ultimately to his PHD work entitled 'Investigations of the Electronic Theory of Metals' in 1911.

It was glorious era of international collaboration in Atomic Physics. Bohr, on a scholarship visit to the U. K., had the opportunity of working under J. J. Thompson, the father of electron, at the Cavendish Laboratory in Cambridge and then with Earnest Rutherford at Manchester University. He came back to Copenhagen to marry in 1912 but again went back to the U. K. as a visiting professor at Manchester to work with Rutherford. It was in this period from 1914-1916 that most of the work for the Rutherford-Bohr Atomic model was done.

In 1916, he joined the University of Copenhagen as a professor and ultimately established and became the Director of the Institute of Theoretical Physics, Copenhagen. His brilliance lay in the reconciliation of Rutherford's concepts to that of Planck's quantum mechanics and in 1922, he was awarded the Nobel prize in physics 'for his service in the investigation of the structure of atoms and of the radiation emanating from them'.

Look at the galaxy of names who worked with Bohr till the end of thirties—Heisenberg, Dirac, Meitner, Born, Jordan, Frisch, Gamow, Pauli, Weiz Sacker, Teller; all the names which glorify the pages of Atomic Physics. How did Bohr, who was neither a pedagogue, nor a good teacher, help them? To quote Jungk, "He was one of those rare teachers who knew how to apply caution, and, if necessary, force, to the task of liberating the slumbering genius in each man's mind. Like Socrates, whose expression of thought through dialogue he considered exemplry, Bohr was a midwife of ideas".

In 1939 Bohr went to the U. S. A. where he met Fermi at the Columbia University. Here, he worked out the detailed theory of nuclear fission, jointly with Wheeler of Princeton University on the basis of liquid drop model.

He returned to Copenhagen for a short while from 1939-43, but was forced to flee from the country to the U. S. A. in November, 1943 when Germans occupied Denmark. Briefly, he was associated with 'Manhattan project' for making the Atom Bomb. But when he came to realise the destructive power of the atom, the saner, logical and humanist side of him woke up. He visioned a nuclear arms race and proposed to stop it by exchanging ideas with the Russians. Though he was given a patient hearing by Roosevelt in 1944, Churchill became wary of the idea and even became supicious of this great scientist! His efforts were in vain and the war ended soon with bomb blasts over Hiroshima & Nagasaki.

But Bohr's love for peace grew more and more. Returning to Denmark in 1945, he continued with his good work. He chaired the 'First International Congress on peaceful uses of Atomic Energy' in 1955 and was given the first 'Atoms for Peace' award in 1957. His quiet death occured at Copenhagen in 1962.

Bohr's life illuminates us on the versatility and humanitarian qualities of a great scientist. A lover of the game of foot ball, he represented his national team! He was an addict of western movies! Hitch-hiking was also his hobby! But what makes him great compared to other scientists?

Not his collaboration with so many great students to build up, block by block, the edifice of Atomic Physics? Nor giving birth to a son, who would later become a Nobel-Laureate! *It was his vision of the 'arms race', and his efforts to stop it. It was his pioneeriug efforts for peaceful uses of atomic energy by international collaboration.* To day, when the two super powers are locked in debate over the use of sophisticated weapons etc., his letter to the U. N. O. in June 1950 can serve as one of the most farsighted documents of this age, where he says, "Full mutual openness only, can effectively promote confidence and guarantee common security." Let the scientific community celebrate his birth centenary by upholding his ideals. □

References :

1. Brighter than a Thousand Suns—Robert Jungk.
2. 100 Great Scientists—J. E. Greene, Ed.
3. Giants of Science—Philip Cane & Samuel Nielson.
4. "Science Age"—October, 1985
5. Tribute to Niels Bohr—Kamal Dutta, Statesman, 13.10.85.

*Reader, M. E. Deptt. J. U.

INDIAN RURAL ECOLOGY—A FEW POINTS

A. K. Mukherjee*

Practically urbanisation is very restricted in India. Most of the land comes under rural condition. Thus the rural India is a vast area under almost all different types of climatic conditions i.e. arid, semi-arid, tropical, sub-tropical, sub-temperate and temperate. Therefore, climatically it is so different that it is very difficult to conceive about climatic rural India. So also the edaphic rural India is very difficult to conceive as there are so many varied types of soils, available in India and the varied natural sources of their formation. So rural India may not be taken as an ecological unit for its vastness and varied problems.

It is better to take up a village in a particular climatic zone as an unit for study of its ecology.

Village Ecology means the study of the village according to its environmental conditions. The environment of a village may be divided into two—physical and biological. The major factors of physical environment are soil, water and air. The biological environmental factors are plants and animals including man. The interactions of the physical and biological factors constitute the village ecology.

Particularly we know nothing about these interactions of the physical and biological factors. Theoretically we may assume that all the ecological factors are interelated. As an example we can cite a case of biological chain related to each other. Earthworms feed on the organic matter present in the soil during daytime. At night they come out, collect fresh vegetable matter and carry them under the soil for future consumption. Thus they add fresh organic matter to the soil. The borrowing of the soil helps in aeration of the rhizosphere of the plants growing in the field. Earthworms breed in soil rich in organic matter. Small earthworms serve as food for small frogs and toads. The small frogs and toads serve as food for small snakes. Mature snakes feed on frogs, toads and field-rats.

If there is any break in this food chain series i.e. if earthworm or frog & toad can not breed properly, the snake population would go down and the rat population would increase. This rat population increase may take away the benefit of higher yield of crop production by the application of costly inorganic fertilizers and pesticides.

Most of the villages of India are situated in the tropical belt. The high temperature for a long period of the year helps the bacterial decomposition of soil organic matter. Therefore, on an average, organic matter content is not more than 0·2% which is insufficient to give high crop yield. So we are bound to use inorganic Nitrogenous manure for higher yield. Application of higher dose of inorganic Nitrogen makes the crop plants prone to pathogenic attack. To save the crops from the pathogens we are to use pesticides. These pesticides and inorganic fertilizers are toxic to other biological entities of the soil.

The toxic effect of the pesticides and inorganic fertilizers bring down the populations of earthworms, frogs, toads and snakes. Thus the population of rat increases which in turn destroys the crops enormously.

The inorganic fertilizers and pesticides used for higher production of crops are not used up by the crops totally. A major portion of these toxic substances goes into the deeper layer of the soil or washed down to the water sources and ultimately to the rivers hampering the equilibrium of the aquatic ecosystem of the area.

The solution of most of these problems, is to apply sufficient quantity of organic manure in the soil in the form of organic compost prepared using scientific methods. Most of the manural values of the organic matter is lost if it is not composted according to scientific methods. The organic matter gives double benefit to the soil. It gives direct supply of Nitrogen and other minerals to the crop in one hand and induces the atmospheric nitrogen fixing bacteria to grow and fix atmospheric nitrogen to the soil on the other. The organic fertilizer does not induce pathogenic attack on crop plants as in the case of application of inorganic nitrogen.

How to produce large quantity of organic compost in the villages? The general practice in our villages is to dump cow dung, farm yard seeping and other vegetable matter inside a pit. This dumped material is used in the field during ploughing of the soil for cropping. In this method of treatment most of the nutritive value of the organic matter is lost owing to over action of anaerobic bacteria in the manure dump. To get the maximum strength of the organic manure all the organic matter should be treated using scientific procedure of composting. According to this procedure cow dung and fresh vegetable matters are arranged layer by layer providing a thin layer of soil in between the layers till the height of the rectangular dump attains about three feet. A few holes are made after regular distance of two feet or so for release of gases. The whole dump is covered with a thin layer of soil coating to prevent oxygen supply. The temperature of the dump is checked after every 12 hours. If the temperature goes up very high cold water is sprinkled to lower it to the required level. In this condition the anaerobic bacteria becomes very active in the dump. The time required for the completion of the action of anaerobic bacterial action is available in the literature (say 2-3 weeks). After this the organic matter is exposed to air by slicing and spreading around for the action of aerobic bacteria. When this action is complete the compost looks deep-brown and without any bad smell. This air dried compost can be stored in gunny bags for further use in the fields.

If we like to provide sufficient amount of compost to our fields all the cow dung produced in a village should be saved only for composting. No cow dung should be used as fuel. Villagers should be taught the use of alternative fuels. The supply of fresh vegetable matter is also a problem. Due to acute shortage of fuel in the villages most of the trees and shrubs have already been cut down. To get out of this problem the village people should be provided with coal and kerosene oil at least for the next 10 years. In the mean time the villagers should be induced to grow fast growing plants in the villages which would provide them green leaves for composting and after 10 years they would get sufficient amount of fire wood. Trees should be planted every year. After 10 years the oldest tree should be cut down and fresh trees should be planted in their place.

To save the fuel consumption the villagers should be induced to start community canteen run by the village Cooperative Society. Without cooperative movement in the villages no improvement in the village ecology is possible. □

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From The Pages Of History

WHY SCIENTIFIC & SECULAR EDUCATION

—Iswar Chandra Vidyasagar

[Here we publish a letter of Vidyasagar written to the Secretary of Council of Education in 1853. The letter reminds us the golden days of Indian Renaissance movement when Rammohan, Vidyasagar were fighting for introducing secular and scientific education in our country in place of religious and bigotted education begetting an idealist concept of life and world. When Vidyasagar was the principal of Sanskrit College, Calcutta, he introduced English along with Natural Science, Mathematics, Mill's books on Logic etc. But the Britishers who were then trying to tighten their grip of colonial rule over India, were against this, and invited Dr. J. R. Ballantyne, principal of Govt. Sanskrit College, Venaras to visit Calcutta Sanskrit College and place a report to suggest about remodelling the later. In his letter he pointed out inter alia : (1) Sanskrit and English should not be taught jointly, (2) if European system should at all be introduced one should prefer Bishop Berkley's idealist philosophy namely 'Inquiry'. When Vidyasagar got this report he expressed his strong resentment and sent a note to the council which clearly underlines his explicit opinion as regards Scientific and Secular education.

We reproduce this Note with the hope that when means are being increasingly adopted to orient our education with religions, obscurantist and spiritualistic bias in the name of Indian culture and tradition, it would illumine what should have been the correct course to secularise the education system in the true sense of the term : Ed. Board]

I have the honour to acknowledge the receipt of your letter no. 1494 dated 29th ultimo enclosing Report on this Institution from Dr. Ballantyne, Principal of Government College, Venaras and requesting me to report upon the same.

2. In reply I beg leave to state that I am very happy to observe that all the measures lately introduced into this institution have met with the entire approbation of a man of Dr. Ballantyne's talents and abilities.

3. With regard to the adoption of class-books recommended by Dr. Ballantyne, I regret to say I cannot agree with him on all points. He appears to recommend the adoption of his abstract of Mill's Logic in substitution of the original. Under the present state of things the study of Mill's work in the Sanskrit College is, I am of opinion, indispensible. Dr. Ballantyne's principal reason for recommending the abstract seems to be the high price of Mill's work. Our students are now in the habit of purchasing standard works at high prices. So we need not be deferred from the adoption of this great work on that consideration. Dr. Ballantyne's abstract might be read, to quote his own words, 'as introductory to the perusal of that work'. But

the great author himself, in his preface, strongly recommends Archbishop Whatley's treatise on Logic as the best introduction to his work. I, therefore, leave the matter to the decision of the council. Dr. Ballantyne also recommends to adopt as class-books three text-books of each of the three systems of philosophy,—Vedanta, Nyaya, and Sankhya—printed with the English versions and notes. Of these *Vedantasara*, text-book on Vedanta, is already a class-book here, and its version in English might be read with advantage. The two other text-books recommended by him, the *Tarkasangraha*, the text-book on Nayaya, and the *Tattwasama*, that on the Sankhya, are very poor treaties in our curriculum. With regard to Bishop Berkley's *Inquiry*, I beg to remark that the introduction of it as a class-book would beget more mischief than advantage. For certain reasons, which it is needless to state here, we are obliged to continue the teaching of the Vedanta and Sankhya in the Sanskrit College. *That the Vedanta and Sankha are false systems of philosophy is no more a matter of dispute.* These systems, false as they are, command unbound reverence from the Hindus. Whilst teaching these in the Sanskrit course, we should oppose them by sound philosophy in the English course to counteract their influence. Bishop Berkley's Inquiry, which has arrived at similar or identical conclusions with the Vedanta or Sankhya and which is no more considered in Europe as a sound system of philosophy, will not serve that purpose. *On the contrary, when, by the perusal of that book, the Hindu Students of Sanskrit will find that the theories advanced by the Sankhya and Vedanta systems are corroborated by a philopher of Europe, their reverence for these two systems may increase instead of being diminished.* Under these circumstances, I regret I cannot agree with Dr. Ballantyne in recommending the adoption of Bishop Berkley's work as a class-book.

4. I also beg leave to state that I cannot quite agree with Dr. Ballantyne when he admits that both the Sanskrit and English courses in the Calcutta Sanskrit College are good and yet desiderates 'sufficient provision for obviating the danger that the two courses may end in persuading the learner that 'truth is double'. 'This danger', says Dr. Ballantyne, 'is no chimerical one', 'To take an example,' he continues, 'I am acquianted with Brahmans who being well-versed in Sanskrit literature and also familiar with English, are aware that European theory of logic is correct, and also the Hindu theory, while at the same time they cannot grasp the identity of the two in such a way as to be able to represent the processes of the one in the language of the other.' I believe, the danger that Dr. Ballantyne apprehends, is not so inevitable in the case of an individual who has intelligently studied both English and Sanskrit sciences and literatures. Truth is truth if properly perceived. To believe that 'truth is double' is but the effect of an imperfect perception of truth itself—an effect which I am sure to see removed by the improved courses of studies we have adopted at this institution. It must be considered as a singular circumstance if an intelligent student cannot perceive identity of truths where there is real identity. Suppose students read logic or any other department of science or philosophy both in Sanskrit and English. If they be found to assert, 'that the European theory of logic is correct and also the Hindu theory, while at the same time, they cannot grasp the identity of the two in such a way as to be able to represent the processes of the one in the language of the other', the hearer is naturally

led to conclude that either they could not comprehend the subject with sufficient clearness, or that their familiarity with the language, in which they are found unable to express themselves, is not sufficient. It must be confessed, however, that there are many passages in Hindu Philosophy which cannot be rendered into English with ease and sufficient intelligibility only because there is nothing substantial in them.

5. I further beg leave to state that I regret I cannot but differ a little from Dr. Ballantyne when he observes 'that the very constitution of the present Sanskrit College with its English course and its Sanskrit course implies the understanding that it is desirable to train up a body of men qualified to understand both the learned of India and the learned of Europe and to interpret between the two, removing unnecessary prejudice by pointing our real agreement where there was seeming discordance, and conciliating acceptance for the advancing science of Europe by shewing that European science recognizes all those elementary truths that had been reached by Hindu speculation'. It is not possible in all cases, I fear, that we shall be able to shew real agreement between European Science and Hindu Shastras. Even if we take it for granted that we shall be point out agreement between the two, it appears to me to be a hopeless task to conciliate the learned of India to the acceptance of the advancing science of Eupore. They are a body of man whose longstanding prejudices are unshakable. Any idea when brought to their notice either in the form of a new or in the form of the expansion of truths, the germs of which their Shastras contain, they will not accept. It is but natural they would obstinately adhere to their old prejudices. To characterize them as a class I can do no better than quote the words of Omaar. When Amru, the Arab General the conqueror of Alexandria wrote to Omar about the disposal of the Alexandrian library, the Caliph replied 'The contents of those books are in conformity with the Quran or they are not. If they are, the Quran is sufficient without them ; if they are not, they are pernicious. Let them, therefore, be destroyed'. The bigotry of the learned of India, I am ashamed to state, is not in the least imperior to that of the Arab. They believe that their Shastras have all emanated from Omniscient Rishis and therefore they cannot but be imfallible. When in the way of discussion or in the course of conversation any new truth advanced by European Science is presented before them, they laugh and ridicule. Lately a feeling is manifesting among the learned of this part of India, especially in Calcutta and its neighbourhood, that when they hear of a scientific truth, the germs of which may be traced out in their Shastras, instead of shewing any regard for that truth, they triumph and the superstitious regard for their own Shastras is redoubled. From these considerations, I regret to say that I cannot persuade myself to believe that there is any hope of reconciling the learned of India to the reception of new scientific truths. Dr. Ballantyne's views may be successfully carried out in the North-West provinces where his experience has made him arrive at his conclusions with regard to the learned of India.

6. But in Bengal the case is very different. His remarks that 'regard be had to the different circumstances of the two places' and that 'the bed of Procrustes is not the type of administrative wisdom' are very judicious. The local circumstances of this part of India compel us to persue a different course for the dissemination of sound knowledge. I have with

care and attention observed the state of things here, and my impression is, that we should not at all interfere with the learned of the country. We do not require to get them reconciled because we do not require their assitance in any shape. We need not fear the opposition of a body declining in their reputation Their voice is gradually becoming more and more feeble. There is little chance of their regaining their former ascendancy. To whatever part of Bengal is the influence of education extending, there the learned of the country are losing their ground. The natives of Bengal appear to be very eager to receive the benefit of education. The establishment of colleges and schools in different parts of the country has taught us what we can do, without attempting to reconcile the learned of the country. What we require is to extend the benefit of education to the mass of the people. Let us establish a number of vernacular schools, let us prepare a series of vernacular class-books on useful and instructive subjects, let us raise up a band of men qualified to undertake the responsible duty of teachers and the object is accomplished. The qualification of these teachers should be of this nature. They should be perfect masters of their own language, possess a considerable amount of useful information and be free from the prejudices of their country. To raise up such a useful class of men is the object I have proposed to myself and to the accomplishment of which the whole energy of our Sanskrit College should be directed. That the students of our Sanskrit College, when they shall have finished their college course will prove themselves men of this stamp we have every reason to hope. Nor is this hope an illusive one. That the students of the Sanskrit College will be perfect masters of the Bengali language is beyond any possible doubt. If the contemplated new organization of the English Department be sanctioned, there is every possibility of their being able to attain considerable proficiency in the English language and literature and thereby acquire a considerable amount of useful information. It is very gratifying to observe that they have lately begun to think in such a way as to promise that hereafter every qualified student will be found free from all the prejudices of his countrymen. As a specimen of what may be expected from the Sanskrit College here, I beg leave to enclose herein an English translation of a Bengali Essay of the past session by a senior student of this institution who has still about three years to finish his collegiate course and has yet made but little progress in the English language and literature ... □

ON FEVER—A GENERAL PHYSICIAN'S VIEWPOINTS

Dr. Gobinda Chakraborty

The most common problem we ever meet in general practice is fever. Common people consider fever—a disease. But they fail to understand that fever is not a disease but a manifestation of many diseases. Sometimes people in general, gets anxious with high fever and insist the family physician to attend the case as early as possible.

But if we could know the common cause behind the ailment and its treatment to begin with, in case of high temperature, it would help us a lot. Heat regulating centre in human body is situated in the Hypothalamus of the brain.

Although a large amount of heat is produced and lost from the body constantly, body temperature remains fixed within a limited range.

Temperature of the body is regulated by two processes—

(1) by adjusting heat production.
(2) by adjusting heat loss.

Heat production may be due to

(1) hot food
(2) shivering (movement causes heat production)
(3) atmospheric temperature (high)
(4) metabolic rate
(5) muscular exercise

Heat loss may be due to

(1) Radiation
(2) Excretion
(3) Convection
(4) Conduction
(5) Evaporation.

Normal 'body temperature' range is 98°F to 98·8°F Or 36·6°C to 37·2°C (under the armpit). Any temperature above 99°F is called PYREXIA or FEVER or Febrile condition.

Temperature above 107°F is called

HYPERPYREXIA

Temperature chart in both Scales given below :			
Normal	36·6—37·2°C	— 98°F	— 98·8°F
Subnormal	below 36·6°C	— below	— 98°F
Febrile	above 37·2°C	— above	— 99°F
Hyperpyrexia	above 41·6°C	— above	— 107°F
Hypothermia	below 35°C	— below	— 95°F

In Fever there is increased heat production and decreased heat loss.

Fever may occur due to infection by bacteria (Bacterial Pneumonia, Typhoid), Virus, Protozoa (Malaria, Kalazar), some Inflammatory foci (Boils & abscess), Injury to Nervous System, Dehydration (Vomiting & Diarrhoea), Tissue destruction and due to toxic effect of some drugs or chemicals.

Toxin from the various agents mentioned above acts onthe bloodcells (called *phagocytes*) resulting in the production of various endogenous *pyrogens*. There are also various exogenous pyrogens produced by micro-organisms and other chemical agents. Entering the brain these pyrogens act on the temperature regulating centre of '*Hypothalamus*' and release a locally acting substance known as *Prostaglandin* which causes fever.

As a result of sudden high fever, shivering or rigor occurs as in Malaria, urinary tract infection etc. All animals, birds, reptiles and fish suffer from fever.

Our internal body temperature is higher than the surface temperature of the skin. To record the temperature accurately it is necessary to keep the thermometer well covered by skin fold for an adequate time (2 to 3 minutes). Oral temperature is usually 0·5°C higher than that of *axilla* and rectal temperature by about 0·8°C.

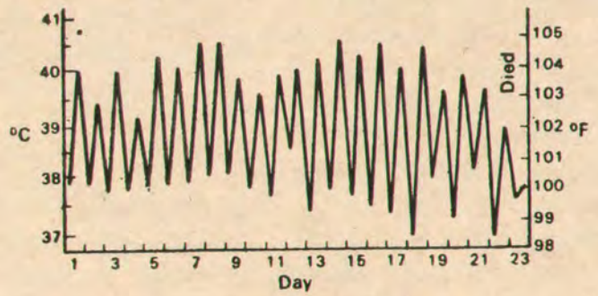
When we put the thermometer inside the mouth under the tongue we should be sure that no hot or cold drink has been taken by the patient just prior to it. A temperature chart at an interval of four hour should be maintained for the family physician. In case of children, thermometer may be held in the groin, the thigh being flexed to abdomen for the purpose. The normal body-temperature is lowest at about 4 *A. M.* and highest at about 8 *P. M.* after *days work*. This is called *Diurnal Variation and is a physiological* phenomenon. It tends to be lower in old age and higher during infancy, especially after crying.

There are three types of pyrexia.

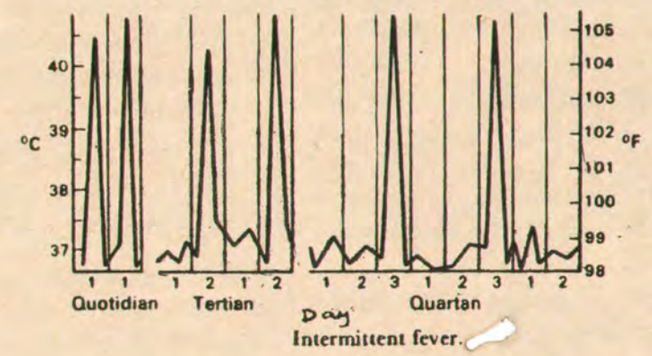
(1) Continued or continuous fever is that when the temperature never touches normal level and does not fluctuate more than 1·5°F in 24 hours, e. g. in Typhoid.

(2) Remittent fever—when the diurnal variation is greater than 1·5F and the temperature never comes to normal, it is called remittent fever.

(3) Intermittent fever—when the temperature at some time of the day is normal or subnormal and at another time of the day, usually in the evening, is raised to one or more degrees it is known as intermittent, e.g. Malaria (fever comes on alternate days).



Remittent fever.



Intermittent fever.

When a paroxysm of intermittent fever occurs daily, the type is quotidian ; when on

alternate days tertian ; when two days intervene between consecutive attacks, quartan (Fig. given). However, with the use of antibiotics and other specific drugs these classical types of fever are not often seen.

If temperature rises to 102°F or above then treatment for lowering the body temperature becomes necessary.

Treatment of Pyrexia or Hyperpyrexia

(1) Heat production may be diminished and heat loss may be increased to some extent by means of drugs known as anti-pyretics.

Common drugs used :

(a) Paracetamal (Crocin, Calpal, Metacin, Pyrigesic etc.)

(b) Aspirin (Disprin, Mycropyrin) ASPRO etc.

For Adult Full Tablets, for Children half a Tablet and for infants 1/4th of a Tablet may be used as required.

(2) Tepid Sponging :

The patient is laid over a blanket and sponged gradually all over the body with tepid water (75°C). Half of the body is done at a time, the other half being covered up to continue the process for 20 to 40 minutes until the fever is reduced.

(3) Application of icebags on head, chest and abdomen.

(4) Sometimes washing the head with cold water, which can be done at any time during day or night, lowers the temperature.

Tepid Sponging is the most harmless and dependable method of lowering the body temperature.

(5) Diminishing the heat production by controlling the diet. e. g. taking plenty of fluids by mouth and adopting liquid diet e. g. Milk, Barley, Electral, Horlicks, water etc. Sometimes high fever causes convulsion, haemorrhage, so prompt control in the primary stage is urgently needed. When temperature is high, hands and feet may turn to be cold. In such cases hands and feet must be wrapped up with warm clothes and head should be washed with cold water.

In case of subnormal temperature hot drinks, covering with warm clothes, massaging, application of hot bags and oral administration of Veritol or Coramin drops (5 to 8 drops 6 hourly may help).

* Do not get nervous with high temperature.
* Treat any temperature above 102°F as advised previously.
* Do not use Antibiotics without consulting your physician.
* Note all symptoms associated with Fever e.g. Vomiting, Diarrhoea, Cough & Cold, Aches & Pains for subsequent treatment of the cause.
* Record the temperature & pulse rate per minute and keep a hourly chart.
* Take advice of your family physician.□

THE SCIENCE OF VIOLIN

Debabrata Roy*

The history of the development of violin dates back to the Renaissance in Italy when two new families of musical instruments stemmed from primitive stringed instruments of the Middle ages such as the rebec and lute. The earlier of the two groups to emerge was the viols, later, following about a century afterwards was the violins. The violin was not an outgrowth of the viol but a somewhat later development from similar sources. Composer wrote distinctive music for each kind of instrument and each had its virtuoso performers. Eventually the violin family having a richer and more powerful sound, supplanted the older group—except for the largest and lowest-pitched instrument which survives as the bass viol.

Exactly who invented the violin is not known. It may have been Andrea Amati who founded the great Cremona school of violin-makers. He died around 1580 and within 150 years and so his descendants and their pupils, particularly Antonio Stradiran and Giuseppe Guarneri, had brought the art of violin making to such an extraordinary high level that it is only now that one dares dream of equaling or surpassing it. These early masters had an open mind towards the title that was known in their time about the physics of sound, a cult in accordance with the evolutionary changes in society..

Modern acoustics is making it possible to account for the exquisite performance of the violin made by the Italian masters.

In essence a violin as well as its larger & deeper-voiced relatives—the viola and the cello—is a set of string mounted on a wooden Box containing an almost closed air space. Some energy from the vibration induced by drawing a bow across the string is communicated to the box and the air space, in which is set up corresponding vibration. These in turn set the air between the instrument and the listner into vibration ; in other words they produce the sound waves that reach the ears. The sound of a violin, putting aside the acoustics of the room in which it is played and the skill of the player depends on the transfer of vibration from string to sounding box and from sounding box to air.

The violin strings are usually made of metal, pig gut or gut wound with five silver or aluminium wire. The sounding Box consists of a front plate and a back plate both arched slightly outword to form broad bell-like shapes, and the supporting ribs or sides. The back plate is craved with chisel, plane and scaper, traditionally from a block of curly maple seasoned for at least ten years and kiln dried. It can be made of a single piece or carefully joined pieces. The thickness of the back plate varies from about six millimeters in the centre to almost two millimeters just inside the edges. The sides are pieces of matching curly maple, thinned down to one millimetere all over, bent into shape and glued to spruce or willow blocks set in the corners and at the forword and rear ends of the plates.

The top plate, usually spruce, is split lengthwise from a log and then joined so that the wood of the outside portion of the tree is

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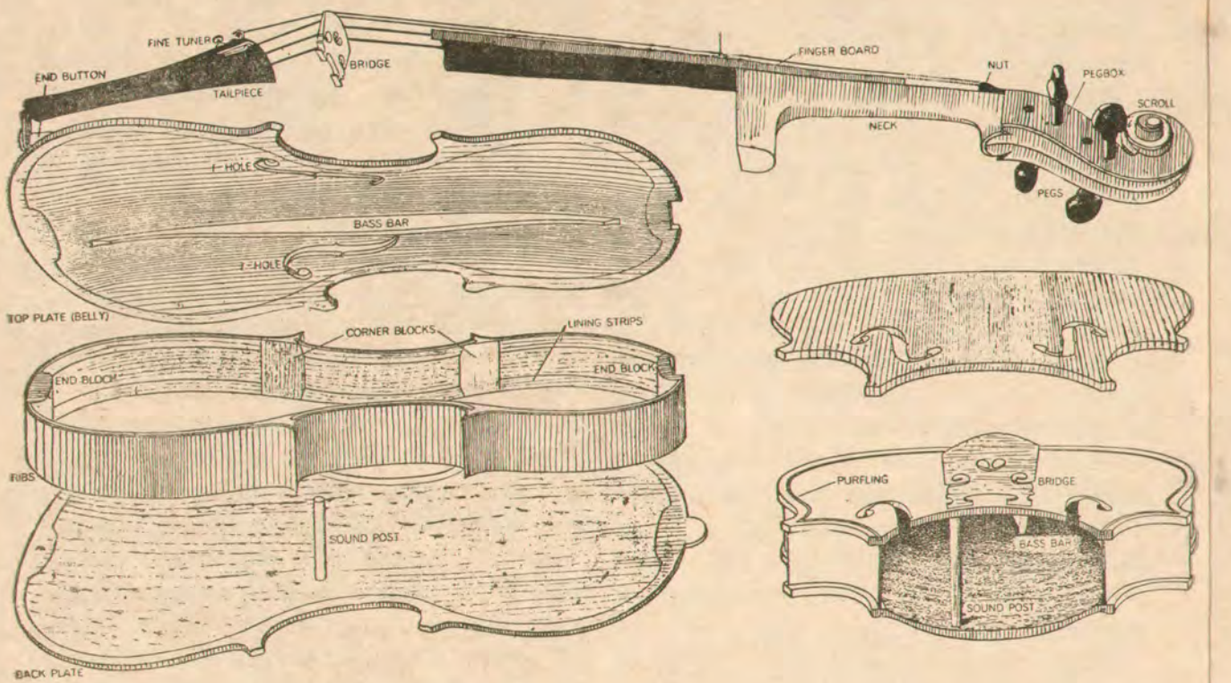
in the centre of the top, making the grain bilaterally symmetrical. The thickness of the top plate ranges from two to three millimeters and a pair of beautifully shaped "f-holes" are cut into each side of the plate. All around the outside part of each plate near the edge is cut a shallow groove in which is inlaid the "purfling" consisting usually of two strips



of black-dyed pear wood and a strip of white poplar.

The outside of the instrument is treated with filler and varnish. Filler, varnish and glue dictate the over-all characteristics of the violin. The Catgut Acoustical society is working to discover new substance that may be even more effective than the old. But it is a slow painstaking search. Whether there is a mysteriously unique virtue in any of the wood or finishes or whether some other types might not do as well for various purposes, is an open question.

A point may be mentioned here that illustrates the subtlety of some of the problems in understanding the violin.

Does the purfling serve any purpose other than decoration ?

It happens that the wood of the plates underneath the purfling is extremely thin. After years of playing, the glue that holds the strips in their grooves begin to crack, in effect creating a vibrating plate with very thin edge. Frederick' A. Saunders, professor emeritus of physics at Harvard university suggested that this may be a factor in the improved tone of an instrument that has been played for a long time.

The combined tension of the four string of a properly tuned violin comes to around

50 pounds. As a result about 20 pounds is directed straight down through the bridge and against the delicate eggshell like sounding box. To distribute the load and help the top plate to withstand the downward component of string tension, the maker glued to it a strip of wood running lengthwise down the middle. One of the earlier violin makers moved the bar to one side so that one foot of the bridge rested above it. The strip, made of spruce, is now called the bass bar, since it is under the foot of the bridge on the side of the string of the lowest tunning. To support the other foot of the bridge there is placed approximately underneath it a vertical post, also made of spruce called the sound post. It is carefully fitted and held in place between the front and back plates by friction. The acoustical function of the sound post has been a matter of debate for many years. The tone of a violin can be so greatly altered by small changes in the position, tightness and the wood-quality of the sound post that the French call it the soul of the instrument. Removing it altogether makes the violin sound rather like a guitar.

Although the modes of vibration of plates exhibit great diversity throughout the frequency range, the bridge must always have some rocking motion to receive power from the string. In the important lower half of the range the sound post and the adjacent foot of the bridge have relatively little motion, thus providing in a sense a fulcrum that serves to transfer maximum travel to the bridge foot standing over the bass bar.

Vibrating strings have been studied since the time of Pythagoras. In early 19th Century Felix Savart, a French Physicist showed that the bowed string has a multitude of harmonics, then the great German Physicist Hermann Vou Helmholtz elucidated the types of vibration that distinguish the bowed string from the plucked string. In this Century the Indian scientist Sir C. V. Raman made an exhaustive investigation of the vibration of bowed violin and cello string.

In spite of the vigorous vibration of the moving string, the sound from the string alone would be all but inaudible. It has too little surface area to set an appreciable amount of air in motion. What happens is that some portion of the energy supplied by the player to the bow – 5 to 10 percent—is communicated to the wooden body of the violin through the complex motions of the bridge. 1 or 2 percent of the total feed energy emerges as sound and rest goes off as heat.

The vibration of the bowed string at any instant includes dozens of energetic harmonics with amplitudes falling off as frequency increases. Each of the frequencies present slakes the wooden box, forces it to vibrate at its particular rate. Obviously the amplitude of vibration depends on the strength or amplitude of forcing vibration.

It is well known that the physical system has scores of frequencies known as natural frequencies at which the system experiences an excessive vibration without further external interference and this phenomena is known as Resonance. The coincidence of such a frequency of resonance in the wood with the frequency of string harmonic will result in an enhanced transfer of energy from string to box and correspondingly greater amplification of that particular tone. Therefore, actual response of violin to the playing of various notes is an enormously complex affair, but a good violinist must unconsciously and automatically deal with it and compensate for it every time he plays.

The resonance of lowest frequency is considered as a guidence for scientific violin makers.

This is called the main wood resonance which is within a whole note of 440 cycles per second for a good violin. Attention is also drawn to the lowest frequency of resonance of the enclosed air space, called the main air resonance. Inside the box of the violin is the air chamber or resonating cavity which communicates directly to the outside by means of a 'f' shape hole known as f-hole, situated in the top of the instrument. The frequency of the air tone depends upon the volume of enclosed air and the area of f-hole openings. Hutchins reported that approximately twenty percent reduction in air volume or fifty nine percent increase in f-hole area is required to raise the resonance of the enclosed air a whole tone.

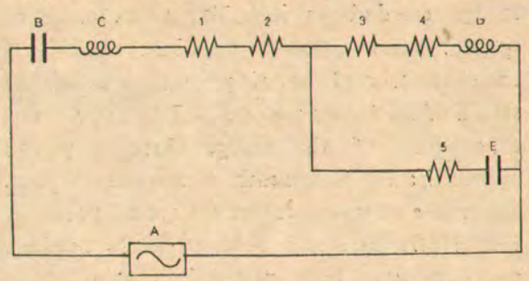
A number of workers—particularly Saunders, the late Hermann Backhaus of the Technische Hochschule in Karlsruhe, Hermann Meinel of Berlin, Gioacchino Pasqualini of Rome etc.—have developed methods of studying the resonance of violins. One of the most useful is the "loudness curve" originated by Saunders.

Traditional violin maker holds the plates (back & top) near the end by his thumb and fore finger during the final thinning and graduating, and he taps it at various points with a knuckle and he tries to listen carefully the pitch of the sounds which are known as taptones. It is very difficult to judge the frequencies of these tones particularly in the case of top plate where the complicated structure with f-holes and bar creates at least two and sometimes as many as five strong natural resonances below 600 cycles/sec. But the detection of taptone plays an important role for of violin making.

Hutchins and Saunders togethere with Alvin Hopping have developed a method of determining the taptone frequencies in a free plate with considerable accuracy.

J. C. schelleng formerly of Bell Tellephone developed an electrical circuit to simulate the study of violin.

By the given circuit the two main resonances can be studyed. The current of constant amplitude from alternating current generator



(A) is analogus to the force applied by a given string to the bridge and force is proportional to the string tension and amplitude of string vibration. The capacitor (B) analogus to a stiffness associated with the elasticity and dimensions wood. The inductance coil (C) is analogus to a mass moving with the velocity of the bridge-string contact and having a kinetic energy equal to that in the wood. In instruments of violin family the stiffness and mass of the wood largely determine its over all response and the frequency of the main wood resonance. The main air resonance is determined largely by the opposition of air to compression when the f-holes are closed (E) and the mass of air near the f-holes (D). The five resistances (i. e. 1, 2, 3, 4, 5) represent the mechanical and acoustical resistance.

Ref: The Physics of violin by Carleen Maley Hutchins: Scientific American, Nov, 1962, Vol—207. No.—5, pp—78—93

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