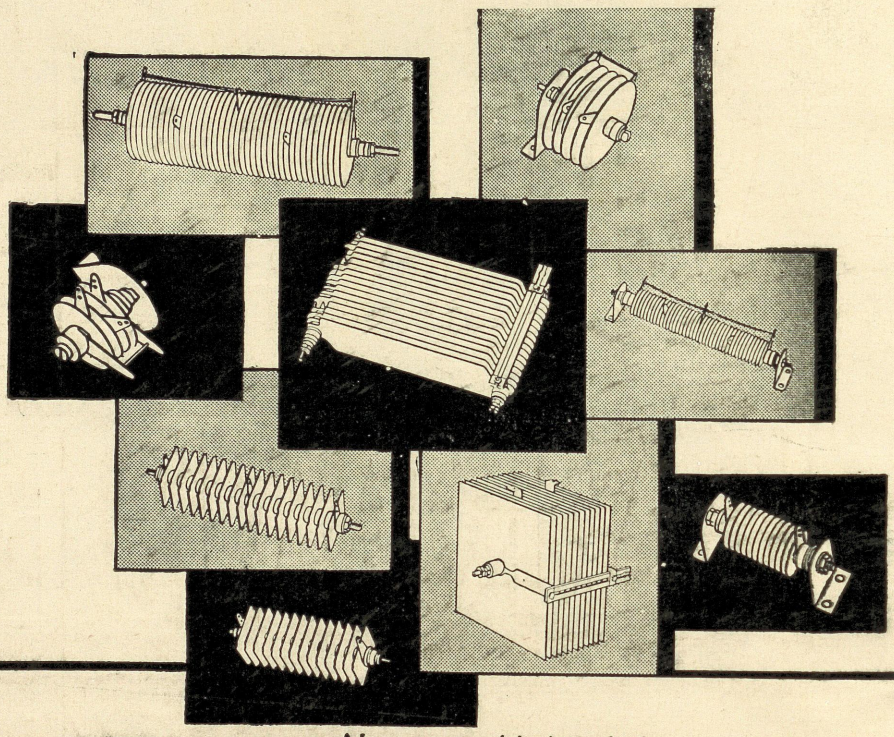
VIJNAN KARMEE

journal of the association of scientific workers of India

Vol. XII

MAY, 1960

No. 5



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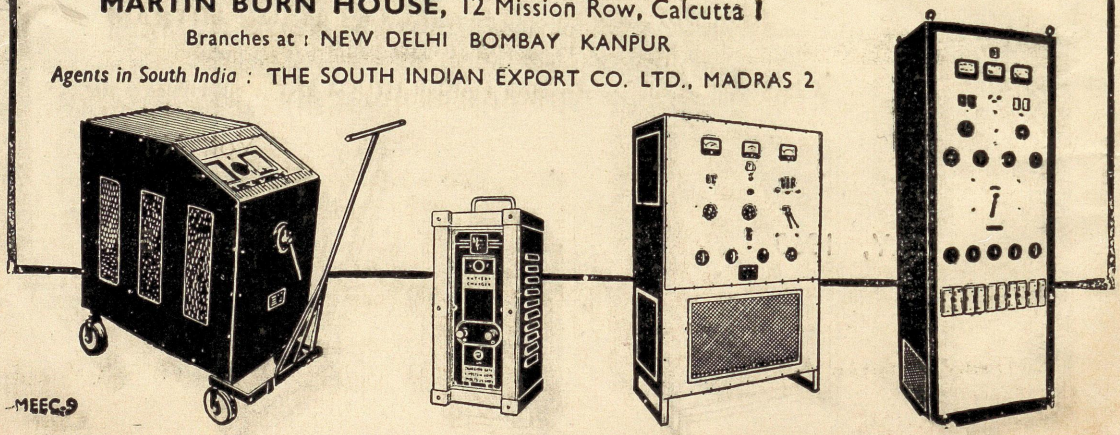

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VIJNAN KARMEE

Journal of the Association of Scientific Workers of India

(Founder-President : Shri Jawaharlal Nehru)

Vol. XII | MAY, 1960 | No. 5

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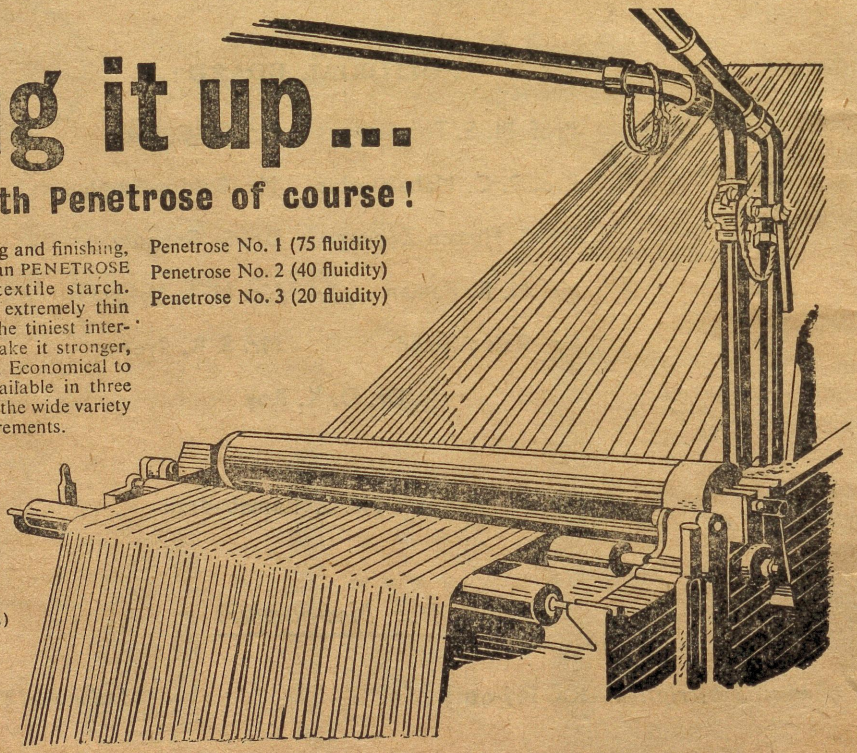

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EDITORIAL

Trade Union Or Association?

In the column of 'workers forum' for the month of April, 1960 V. K. has already published a problem for our members to think over and give their opinions. The Association at this moment has come up to a delicate stage when a decision has to be taken for strengthening and proper functioning in the coming years. The general impression of the Govt. of India, and leading Scientists and Technologists of this country seems to be prejudiced against the Association of Scientific Workers as constituted today as it is a Trade Union. It is felt at some quarters that if the Assocn. can be reconstituted as society only which could also 'deliver the goods' to the members by way of collective bargaining for the improvement in status and dignity of scientists and technologists, such a step would possibly result in the strengthening of the Association. The membership of the Association at present stands at 1300 while the available number of scientists and technologists in the country is nearly 30,000. Making the ASWI an association now is expected to bring in the strength in membership. Fundamentally, the more the number of members in the Assocn. the greater the strength of the association for settling matters of dispute and right based on the principles of bargaining power. This Assocn. has, however, always maintained the value of reciprocity in any such bargaining. The two-way-traffic is, therefore, a collective bargaining and the Assocn. has strived to maintain the professional standards and integrity of the members from within while protecting their rights from without. The opinion expressed in the column already mentioned above is that whether the ASWI is a Trade Union or an Association its usefulness will depend entirely on the strength of members and their honesty of purpose. Time and again, we have stressed the necessity of the scientists to be true to their profession viz: that science is a mover for understanding of the secrets of nature or in other words establishing knowledge of the various processes of nature. When the objectivity of science is for advancement of knowledge for its own sake, those of the people who take up science and technology as a profession should have the really proper objective spirit to raise the standard of knowledge. One should not be taking cover under the same tribal instinct to project one particular species. It is true that science is different from Arts, History or Geography but basically all of them are united under the banner i. e. for increase of knowledge.

This point should be carefully considered by one and all and no difference should exist between pure scientist, applied scientist and scientific workers.

It is hoped that an early decision will be taken by our members on the question of converting the ASWI to an Association status or to maintain the status quo of being a Trade Union. Whatever decision is taken our ideal should be to make the Association a really useful one as it is the one and only Organization meant for the furtherance of the cause of science and for its torch bearers the 'Scientists and Technologists'.

EDITORIAL NEWS

A LINK WITH THE REMOTE PAST

To the students of pre-history late Professor V. Gordon Childe is not an obscure name. In his death a few years back the world of Archaeology and ancient history lost a celebrity whose interests took him from Sydney, Australia, where he was born in 1892 to places as remote as Oxford where he was educated, and to cradles of most ancient civilisations in Syria, Turkey and India where he carried out his brilliant studies. It was the genius of this ardent advocate of humanism in history which gave us such delightful reading as *'The most Ancient East'*, *'Man Makes himself'*, *'What happened in History* and *'Social Evolution'*.

Some of the most fascinating chapters which Professor Childe wrote, present an overwhelming interest for the students of history of science and all those who would like to look to science as something inevitable in the cultural evolution of our species ; instead of viewing it as a sporadic cult which rose only a few centuries back. To overlook this link with the past is to say the least, unscientific, and to deny its influence over the latter pace of scientific progress is fraught with ignorance.

While the very ancient history of man comes, properly speaking, in the domain of paleo-anthropology, which within recent years has been making startling discoveries, the cultural history of human types zoologically not remote from their present day progeny reveals interesting phases in which analytical sociology could distinguish trends which were bound to lead to modern era of science.

The Biologists and the paleo-anthropologists call our kind as wisemen, the *Homo sapiens*. It is difficult to single out the causes which lead to evolution of the sapienta from the closely related types, the *Pithecanthropus*, & *Sinanthropus*, or blood relations auch as *Homo heidelbergensis* and Homo *neandertalansis*. Generally speaking, the student of evolutionary biology looks to environmental causes which make the selection of the favoured type most probable. The evolutionary process within this premiss not only leads to origin of new types but stabilises them. Several causes are suggested. The rigours of ice age which drove the contemporary mammals through half the hemisphere would have certainly eliminated the lesser intelligent human types. Nor can we overlook such factors as salt eating habit of humans which has been presented in a fairly convincing form recently as a necessary stimulus for evolution of human intellect to its present heights !

Several years back in his college days, the writer of these columns read about a bird which used observation and experience for its existence. The bird existed largely on nuts several of which had a hard exterior. To open the nut a curious technique was adopted by the bird, it would carry the nut aloft and drop it from considerable height

on a hard piece of rock. The nut broke open and the bird would detour the soft seed which came out. It struck him as a marvellous property of life, of knowing the properties of external world and utilising the knowledge for living.

As a lone instance, the activity is amusing. It becomes vital for the species only if other members can utilise it. Obviously some form of communication between the members of the species becomes a pre-requisite before observation and experience become at all useful. The hominid of the pre-history was supposedly quite a versatile being. He discovered fire and if the famous 'dissertation on roast pig' is a correct guess, he discovered the flavour of roast pig also. What it meant to evolution of humanity is left to the conjecture of the reader. The greatest obvious advantage of this culinary research is in boundless extension of the dietary menu. Today the most important items of human diet are seeds from wild grasses that have been cultivated since ages, viz : rice and wheat, and legumes such as pulses. In their natural form, uncured by cooking, they are just unfit for human consumption. It would provide moments of purely imaginary pleasure if one were to picture a kitchen without fire. Even digestible animal proteins would provide hardly half the food that they do at present. Yet the discovery of fire is lost in the pages of pre-history, between 140,000 - 10,000 years B. C. Perhaps, it was an accidental discovery, but the very vital factor which made it so important for human beings we tend to forget. This factor is origin of communication. Experiences of our types are little use to us unless we know them. That is true for other living animals also. In this regard tradition by imitation limits the dissemination of knowledge to a seriously handicapped condition. With the invention of words, word-images, and description of events prehistoric experience became significant to human race.

The rise and fall of these ancient civilisations are instructive to scientists. What these people lacked was scientific methodology, viz : the systematic and logical analysis of observation, the inference of inherent mechanism through experimentation and thereby building up a logistics behind environmental manipulations. The ancient civilisations did in no way lack the faculty of technology, that is to say applications of the principles of observed facts for immediate necessities of life. For instance, scarcity of food no doubt lead to highly intricate technology of cultivation of wild grasses, agriculture, domestication of animals, use of fertilisers and manures, and attempts to preservation of food, both processed and unprocessed, during temporary and prolonged storage.

Several linked discoveries appear to be as ancient. For instance, processing seed grains by mortar grinding or pounding to convert to flour, paste and cakes by cooking was comparatively easy and was prevalent in several neolithic cultures. But making bread necessarily involved knowledge of rudiments of microbiology and biochemistry as would be needed in bringing about the desired type of fermentations. That would necessitate preservation and use of suitable inocula, and creating optimum conditions. On the technological side it is very interesting to note that enzymes have been handled by our ancestors of such remote days who are responsible for advancing bakery, dairy technology and brewery all of which

attained a remarkable specialisation in their hands. While food has been an important motivating factor forcing human intelligence to seek complicated means like those enumerated above, purely aesthetical and other mundane urges too evolved almost contemporarily. The neolithics had learnt to utilise fibres for cladding them, and mastered the applied physics of spinning and weaving, together with applied biochemistry of retting of flex to obtain fibre and developed the complex chemistry of clay which lead to the art of ceramics and highly developed form of pottery. In fact, for a prehistorian, amongst the very few manifestations of barbarian culture which still remain preserved for his studies, the remnants of pottery are the important evidence for indexing the level of the culture to which these fragments of man—modified clay are due.

Through successive ages humanity has discovered the processes underlying manipulation of metals like copper and the next prehistoric advancement of man after neolithic age has been connected with metallurgy of these metals. Intensified efforts to increase the stock of applied sciences resulting through such socio-dynamic factors as increase in human population and consequential inefficacy of the existing social order to support them, became inevitable. Raw materials which sustained the neolithic cultures viz: bone and stone became inadequate and had to be supplemented by newly discovered substances like copper and its alloys. While on one hand the societies of metal ages have seen the emergence of specialists who though not at all connected with production of food and yet have to be maintained out of bare necessity, on the other hand they are marked for organising for the first time power other than that of man. Harnessing the domesticated ox and horse, use of wheel and lever are indications of an era of technocracy.

Origin of pure sciences like mathematics and astronomy are similarly woven in this intricate fabric of pre-historic past. While these accounts, even the fringe of which is not touched here, provide amusing indulgence, the analysis of prehistoric trends throws some light on the type of animal that man proved to be. With the power of bare observation and inductive logic he has manipulated his environment in the past. What he has done purely as a mastery of technique is in no way inferior to what he does today. The difference is in methods. Lest technology and technocracy tend to form the type of barbarian cults of these pre-historic people, the scientist of today has to learn lessons from prehistory and be on his guard constantly. The most valuable heritage that we have today is in scientific methodology, not in the mastery of techniqe. To keep the venues of survival and evolution of human intellect constantly open, this method of enquiry, based on observation, experimentation and logistics has got to be kept alive. The alternative is over specialisation of technology, and chapters of prehistory do rudely remind us of the inevitable.

SCIENCE NEWS

THE TREASURES OF SUBTERRANEAN SEAS OF THE KAZAKH SSR

Over 70 percent of Kazakhstan territory which stretches from the Rudny Altai to the shores of the Caspian Sea and from the peaks of the Tian-Shan mountain range to the southern boundaries of the great Western-Siberian Low-land, i.e. an area almost equal in size to Western Europe, is completely devoid of any appreciable fresh water courses or natural reservoirs.

At the same time this territory contains the richest deposits of ferrous and non-ferrous metals and fuels. Millions of hectares of this boundless tract of fertile land could be turned into a vast grazing ground for as many as 80 million head of livestock of all kinds.

Until recently many scientists and specialists looked upon this dry portion of Kazakhstan as a waterless area. It has been proved however in the course of regular investigations for the last 20-25 years that far from being poor in water resources the territory of Kazakhstan possesses considerable reserves of ground water.

Many ground water reservoirs have already been explored by the Ministry of Geology and Protection of Mineral wealth of the Kazakh SSR and their utilisation for the needs of the national economy found economically feasible. They can give discharges upto 20 cu m per sec. It means that industry and agriculture can receive every second 20 thousand litres of water from underground sources. Some underground reservoirs whose economic feasibility has not yet been substantiated are estimated to have a discharge of 125 cu m per sec. or 125 thousand litres i.e. considerably more than the discharge of such water course as the Ili River.

This wealth which spells fertility for the fields and pastures and life for barren deserts and semi-deserts is laid open alongside of research institutes by hydrogeological stations.

The Alma-Ata hydrogeological station carries on its observations on an area of about 7 thousand sq. km. It makes a comprehensive study of the Ili Depression lying between mountain ranges and presenting a huge basin of fresh pressureless artesian waters. The prolonged investigations have revealed the possibility of switching the municipal supply of Alma-Ata and all adjoining towns from surface to subterranean waters and irrigating dozens of thousands of hectares by them. This is not only economically feasible but also allows water supply, and that is no less important, to be prevented from pollution and possible contamination, which improves the quality of water.

The Turkestan hydrogeological station carries observations in the south-western foothills of the Karatau mountain range. It concentrates its activity on the study of underground waters of the Syr-Darya Depression. Many-year investigations have

made this station an important centre of irrigation and water supply.

Large-scale observations are carried out by the Muyun-Kum station established in the vast Muyun-Kum desert. Its role in transforming sands into thriving pastures is difficult to over estimate. The station runs three hydrogeological posts with the total of 29 observation wells on an area of 16 thousand sq. km. The station watches the formation of ground water reserves and determines the available supply for settlements and watering of pastures.

The most important section, the Central Kazakhstan, has been entrusted to the Karaganda hydrogeological station. It carries on its observations on the territory the Karaganda industrial region.

Hydrogeological stations have been also organised in the central part of the virgin soil tract—in the Kokchetav and the Kustanai Regions, in the west of the republic where a number of large artisian basins were discovered not long ago.

At the present time there are 9 hydrogeological stations in Kazakhstan with the total of 760 so-called observation points watching the behaviour of ground waters.

A new state in hydrogeological research is linked to the expansion of the net-work of existing stations and the establishment of new stations predominantly in those areas where such observations have not been carried so far. By 1965, i.e., the last year of the seven-year period, the number of observation points in the republic will reach 1500.

It has been also proposed to expand the network of those meteorological stations and hydrogeological posts which are studying the relationships between the surface and ground waters. This study is necessary for the determination of the ground-water run-off of individual water courses and basins. The observations will help to study the regimen of major water courses of the republic and to predict their run-off.

The question of subterranean waters and engineering geology of the Geological Council of Experts of the Ministry of Geology and Protection of Mineral Wealth of the USSR met recently in session in Alma-Ata. Represented at the session were the hydrogeological establishments of the Russian Federation, the Ukraine, Byelorussia, Azerbaijan, Armenia, Georgia, Uzbekistan, Kirghizia, Turkmenia and other republics. The main item on the agenda was the elaboration of improved methods of studying the regimen of subterranean waters and the laws of their formation.

On Longer Life

Is human life expectancy increasing? Weaved in the network of the answer to this question are several interesting social factors like "will the governments of the world be headed by old or youger men?". Answer to some of these may be sought in discussions that took place in a colloqium on ageing organised by Ciba Foundations in 1959. One of the participants pointed out that in some of the Western countries people reach somewhat greater ages than they did 100 years back.

Dr. H. S. Simms put forth his thesis that longevity depends on the age of onset of lesions of the major diseases. Diets seem to affect onset of lesions on experimental animals. For example, improved diets fortified with vitamins lengthened the life span of female flies. Different processes may be concerned in ageing of males and females.

Egg laying accelerates ageing of female flies. In nature small and fast breeding birds and mammals have smaller life spans than slow breeding ones.

Atherosclerosis has not been studied in some animals such as fish. Exercise seemed to retard or prevent atherosclerosis in birds.

Mr. G.A. Sacher related life span to brain weight and body weight in mammals. His analyses imply that an increase in the relative size of the nervous system is associated with an increase in the attainable length of life, when the rate of energy expenditure is constant.

Females of most species live longer ; the effect may be genetic and sex-linked. It could be summarised that for the present ageing could, hardly if at all, be avoided.

(*Discovery, Aug.* 1959).



USE OF ISOTOPES IN MEDICINE

Use of radioisotopes in medical research and for diagnosis and treatment of disease has increased 150 percent within the last 3 years in the United States. More than 12,000 hospitals and physicians utilize radiation for the benefit of more than 1,000,000 patients per year. The results are new techniques, instruments, and medical discoveries that have improved diagnosis, cured some diseases, and have brought longer, life with freedom from suffering for many incurable patients.

ARTICLES

ORIGIN OF ELEMENTS IN THE UNIVERSE

BY S. RAMABHADRAN

From times immemorial the efforts of man have been directed towards understanding his surroundings — both the material and the phenomena. The attempts to know the properties of all matter has led to the development of Chemistry, Physics, Astronomy and many other sciences. The chemists contribution towards understanding of all the 'elements' that constitute matter, the physicists contribution on the structure of all matter and the astronomers contribution towards how and what way matter behaves or exists in the entire universe, has led to the fundamental question today of understanding how the elements—which constitute all matter—have themselves been built up. A satisfactory theory of origin of elements should stand the valid facts of physics and chemistry and at the same time also satisfy cosmogenesis of stellar matter as observable directly by astronomers instruments.

Everyone of us know something about the periodic classification of elements by Mendeleef, the Russian Chemist. The first element in the Periodic Table is Hydrogen (H) and the last element is Uranium with an atomic No. 92. It is worthwhile to think about the processes by which the series of elements with atomic Nos. from 1 to 92 have been built up, in the matter that occurs in the universe. For this fascinating study, the contributions by chemists, physicists and the astronomers have no parallel in the recent history of scientific development over the last two or three centuries.

It has been known in the study of Astronomy that the energy of the sun and stars in the various galaxies, is entirely due to the reaction of hydrogen being converted to helium. When, even for this conversion of Hydrogen to Helium, a temperature of 1 million degrees of centigrade are required, the causes for occurence of other heavier elements should be of a magnitude in terms of power and energy, which will be quite stupendous and unimaginable. At the same time, it is more or less definite that it is the thermonuclear reactions rather than chemical reactions, which are playing the vital role in the occurence of elements in the stars and the sun. In fact, the conversion of an active element like helium, which is classified as an inert element under the conditions of temperature prevailing on the earth, to lighter elements of the periodic table has been the poser facing scientists in the recent past.

A leading Russian scientist has spent his thoughts on the various possibilities by which heavier elements can be built up from Hydrogen. A number of other workers have also been able to show the types of reactions by which heavier elements could have been built up from Hydrogen.

In the whole of universe, the matter is supposed to be present in the form of interstellar gas which is mainly hydrogen.

Some of the scientists have suggested that the fundamental matter is present in the form of neutrons only as the beta decay of the neutron will produce hydrogen. The birth of stars is supposed to happen by the heating of the interstellar gas by existing blue super giant stars. Due to temperature and high pressure, the gas condenses into stars wherein the energy produced is due to the burning of hydrogen into helium. As the age of the star advances most of the hydrogen contained in the stars is converted into helium. In this particular case, the carbon nitrogen cycle of reactions play a very important part as the whole set of reactions is catalytic for the conversion of hydrogen into helium. When sufficient helium has been built up, the temperature of the star increases and reaches 5 million degrees centigrade. Subsequent reactions cause the 'burning' helium to be converted through carbon and oxygen to neon. When the star further increases in age, this neon burns and produces magnesium. During this particular stage, they can take up two different forms of evolution. One way is because of the very high temperature and pressure, it can break up and what is known as supernovae explosion takes place. By this, scattering of quite a lot of matter, and radiation, a number of elements are produced in the universal atmosphere. However, in the majority of cases, the stars do not explode but subsequently go for the production of other heavier elements from magnesium to zinc. In the case of supernovae explosions, the neon core present in the star can react with neutrons and be able to convert itself into zinc, arsenic, strontium, silver, tin, barium, gold, platinum, rubidium and uranium.

During further ageing, the temperature of the star is as high as two thousand million degrees centigrade. At this temperature, particles from inside the atoms are also thrown off and the elements are scattered throughout universe. However, when this happens, the stripped off atoms can build up further elements by capture of available neutrons in the universal atmosphere. It is believed that magnesium, aluminium, iron, cobalt, nickel, copper and zinc are formed this way. The inside of stars continues to burn the magnesium core and subsequently produces a core of iron group of elements which is the nuclear reactions at the maximum age of the star. When this stage is reached, a very interesting fundamental reaction takes place inside the star. This is known as stellar refrigeration. The star starts cooling down and the inner core of the iron group of elements burning for the production of the necessary energy starts a complete breakdown of these elements again to helium.

From the above, it can be seen that elements with atomic numbers from 12 to 66 can be built up during the growth of the star but the subsequent heavier elements like titanium, vanadium, chromium, manganese and uranium can be built up only by the case explained such as a supernovae explosion or by the scattering of stripped off nuclei from the inside of the star when the temperature of the star is as high as five thousand million degrees centigrade. Though the origin of the lighter and heavier elements can be more or less explained by the theory of the growth of a star there is one peculiarity which is actually to be still accounted for. The birth of lithium, beryllium and boron cannot be explained by the various nuclear processes outlined above.

Mendeleef's contribution to chemistry in the periodic table, has not only stimulated a systematic study of the behaviour of all elements but has also enabled the chemists and metallurgists to obtain these elements from the crust of the earth for utilisation by various industries. While the chemist has been able to characterise and study the properties of elements and elementary particles, the contribution of physics over the last 100 years or so lead to an understanding of the structure of the basic unit viz: the 'atom' which characterises the 'element'. The recent developments in physics over the last 3 decades, has enabled us to know what makes up the atom and has lead to an understanding of how the particles that contribute to the atom are bound together and what part they play in the behaviour of the atom.

As available today on earth the 92 elements do not interconvert into each other. Some of the heaviour elements like uranium and radium do undergo radioactive decay leading to lighter atoms like lead, helium. Conversion of hydrogen or other lighter atoms to heavier elements was an improbability till recently in thermonuclear fusion reactions where under extremely high temperatures hydrogen could be induced to condenseto form helium. That the simplest atom viz: hydrogen, may have been the primordial element was first suggested by Prout. He suggested that other elements may have formed by condensation of hydrogen atom. For over a century chemists have ridiculed this idea, based on the arguments which pointed to impracticability of such a reaction. The study of steller chemistry has proved validity of Prouts idea although in a modified form. The greatest value of this generalisation is that a unified figure of cosmogeny of elements has arisen, consonant with the laws of evolution.

The development of our study on the atom by the advanced countries has shown that the fission of the heavier elements into medium heavy elements gives sufficient quantity of energy. It has also been found possible that by fusion (thermonuclear), such as conversion of Hydrogen to helium, a large quantity of energy can be released. Though this reaction has been successfully utilised by USA & USSR, for production of hydrogen bombs, the thermo-nuclear process is yet to be successfully harnessed for the production of energy.

The release of the energy from atom splitting and thermonuclear reaction has placed in the hands of the scientists the source of energy and the tools, which could enable him to undertake the fascinating study of the destruction, conversion and synthesis of atoms of the various 92 elements and then to simulate the thermonuclear reactions processes that are taking place in the galazies of stars in the universe.

An understanding of the proper reactions and processes leading to the origin of elements from hydrogen will alone solve the mysteries of cosmic evolution.

STRUGGLE AGAINST DEATH

By Professor Pladimir Negovsky

Chief, Laboratory of Experimental Physiology, USSR Academy of Medical Science

Contrary to popular belief, death is not an instantaneous phenomenon, Science has established the fact that it is a gradual process in which the organism's vital functions are successively arrested. In this process of dying the cerebral cortex first stops functioning.

The cortex is that part of the brain which controls the higher divisions of the central nervous system and regulates the adaptation an organism makes to changes in the environment. Ivan Pavlov, the famous Russian physiologist, proved that it was the locus for the conditioned reflex centres.

In the course of human evolution, the cerebral cortex was the last to arrive. The youngest and most sensitive, it is particularly vulnerable to adverse conditions and, in this process of dying, the first to stop functioning. The expiration of its activity is indicated by loss of consciousness and the absence of those special electric currents known as brain waves which record on the oscillograph during the death process.

After the cortex, the lower divisions of the central nervous system stop functioning; next the spinal cord gose out of action; and last of all the medulla oblongata dies—the lungs and the heart then stop working, and somatic or clinical death, as it is called, sets in.

But in spite of the external signs of death—the termination of cardiac activity and respiration—the vital activity of the organism has not yet ended completely. If death has taken place with the important organs undamaged — as a result of shock, loss of blood or electric trauma, for example — than, in a number of cases, the man's vital functions can be revived through special methods of treatment.

This condition of clinical—one might call it suspended—death lasts for about five or six minutes, not longer at present. The duration is determined by the extreme sensitivity of the brain cortex to any disturbance of the blood circulation, and hence, to oxygen starvation. After that, irreversible processes develop in the cells of the central nervous system which cause death of the tissues known as biological death. An organism in this condition cannot be revived.

Reviving Organisms

The Russian scientist Fyodor Andreyev is acknowledged as the founder of the scientific theory of resuscitation of organisms. His method is based on the injection of a nutrient adrenalin solution into the arteries after clinical death. Subsequently, this method was further developed in our Laboratory of Experimental Physiology for Resuscitation of Organisms of the USSR Academy of Medical Sciences.

For the last twenty years our laboratory has been doing experimental and clinical studies of the process of dying with the aim to work out reliable methods of combating untimely death. Resuscitation treatment used by our researchers is quite complex and varies from caes to case. The most general are the following steps: blood and adrenalin are pumped into the arteries; artificial respiration is induced by use of special instruments; uncoordinated contractions of cardiac muscle fibres are stopped; the physician then starts massaging rhythmically with his hand

extract uranium from wash water of processing plants even with a uranium content of thousandths of one per cent. He spoke of the development of such industries which require extremely pure rare elements as the manufacture of semiconductors where admixtures of no more than one millionth of a per cent are permitted, i. e. not more than one gram per ton of finished product. Rare elements are dispersed in nature in minute quantities, and uptil recently they were hardly produced pure. Furthermore, some of them form pairs of metals with very similar chemical properties, such as zirconium and hafnium, niobium and tantalum, molybdenum and rhenium. The highly selective properties of ionites have made it possible to separate these metals in pure form.

Many valuable metals are lost irretrievably in waste waters. Take silver, for example, Film copying studios, electrolysis shops, X-ray rooms and numerous laboratories lose large quantities of silver in wash waters. It has been estimated that annual losses of silver amount to 10 per cent of the total consumption by the Soviet economy. These losses will soon be reduced to practically nil by the processing of drainage water.

Other Valuable Uses

Ionites are active catalysts in many organic reactions and are finding increasing application at chemical plants. The ionites themselves do not take part in the chemical process and are easily extracted subsequently. After extraction, the ion-exchange resin does not require purification and can be used repeatedly, while the reaction products are much purer.

The use of ionites in the sugar industry has already resulted in a 10 to 12 per cent increase in output. This is the equivalent of a ten per cent increase in beet crops. The waste products of the sugar, wine and canning industries are separated with the aid of ionites and yield such valuable products as citric, tartaric and ascorbic acid. They are also used to purify antibiotics, vitamins and various drugs.

Every year more and more new ion-exchange resins are produced. The task now is to introduce them into industry as widely as possible. The Plastics Research Institute and the Mendeleyev Institute of Chemical Technology have recently produced ionite membranes which are used to make extremely polluted water suitable for drinking and, produce highly concentrated solutions of valuable metals from very weak solutions.

There is hardly an industry where ionites could not find application. The time is not far off when ion-exchange resins will be as common place as conventional metals, rubber or plastics. Soviet engineers and scientists are working for this.

An Inexhaustible Source of Energy

CONTROLLED THERMONUCLEAR FUSION

By V. Shatunov, Eng. & O. Kozlov, Eng.

Thermonuclear fusion of helium and other light hydrogen elements goes on incessantly in the sun, producing a colossal amount of energy which reaches the earth through a stream of light and all kinds of nuclear particles. The same process goes in the other stars. The bowels of the stars of this universe are giant thermonuclear furnaces with hydrogen "burning" in them.

The reserves of coal, oil, gas and other conventional fuels on the earth are great, but limited. If power consumption on the earth continues to rise at the present rate, the world's known resources of coal and oil may well run out within some 100-150 years. Limited also are the reserves of uranium used as fuel by the nuclear power stations.

It is the hydrogen isotopes—deuterium and tritium—that are therefore the fuels of the future. The energy obtainable from a tiny amount of deuterium contained in a litre of ordinary water is equivalent to the heat produced by the burning of 300 litres of petrol. Hence, the reserves of basic thermonuclear fuel — deuterium and tritium—locked up in the seas and oceans, will last mankind for millions of years. But to use it, man has to learn to control thermonuclear reactions and to develop special structures—reactors—in which power could be generated by thermo-nuclear fusion.

Thermonuclear Fusion

What is thermonuclear fusion ? It is a reaction in which the nuclei of light elements, such as deuterium and tritium, fuse together at extremely high temperatures. To overcome the electric repulsive forces of the positively charged nuclei in order to cause them to join together, the nuclei of light elements—must be accelerated to very great speeds and made to collide with one another. To speed them up means to heat them to high temperatures. A fusion of two deuterium nuclei produces apart from excess energy, a nucleus of helium. The excess energy comes possible due to the slight difference between the mass of helium — the fusion product — and the combined mass of the nuclei involved in the reaction. According to the principle of mass energy equivalence, a very slight decrease of mass involved the release of a great amount of energy. It is due to these reactions, for instance, that the hydrogen bomb explodes. In the case of a blast, however, these processes are uncontrolled. They cannot, therefore, do mankind any good.

Soviet scientists have carried out a great amount of work in exploring the ways of creating a controlled thermonuclear reactor. In such a reactor deuterium (or its mixture with tritium), in gaseous form, must be heated to hundreds of millions of degrees. At so high a temperature, the deuterium atoms will shed their electrons. The result will be a mixture of positively charged deuterium nuclei and electrons. This form of matter is what the physicists call plasma.

Properties of Plasma

By its properties the plasma is very much like an ordinary liquid. But the presence of free electric charges makes it more conductive for electricity than metals. None of the

known materials can be used for a vessel to contain the hot plasma for it will be cooled by the walls, while the wall material will melt.

Soviet scientists A.D. Sakharov and I.E. Tamm suggested the use of a magnetic field as a means of thermal isolation of the plasma. This field is analogous to that of the earth which causes the compass needle to gyrate. But in a thermonuclear reactor it will be hundreds of thousands of times as intense.

The discharge chamber is a straight ceramic tube with two electrodes to which a high-voltage pulse is passed from a large condenser bank. This current produces an electric discharge, a kind of artificial lightning in the gaseous deuterium, at a very low pressure, which fills the chamber. The electric current, flowing through the gas between the electrodes, sets up around itself an intense concentric magnetic field which squeezes the originating plasma into a "strip", heats it up and keeps it away from the walls. A temperature of several million degrees has been obtained on such equipment. The entire process occurs within a few millionths of a second and is, therefore, called a fast process.

Plasma Clot

A high-temperature plasma can be produced by the same rapid constriction in another form of the apparatus. The plasma column in it takes the form of a turn which arises from an electric discharge in a transverse magnetic field within a hollow ring. The turn is, then, pinched towards the centre of the tube, thus being converted into a plasma clot at a very high temperature.

While by the pulse processes the plasma is heated up by its rapid constriction, in the quasi-stationary or slow processes it is heated by the electric current passing through it. This is similar to the heating of a metal conductor by the electric current flowing through it. These processes take longer time in the first form of apparatus. It is in the apparatus called torodal tubes that such an electrodeless discharge takes place. The toroidal chamber looks like a hollow "doughnut" or a ring-shaped tube. One of them is called "alpha" and represents a big transformer with a 150-ton iron core. The secondary winding of the transformer is a toroidal tube filled with the working—gas—deuterium. A jolt of electricity passed through the primary winding from a powerful condenser bank induces electric current in the gas which produces a plasma ring isolated from the walls.

Magnetic Trap

The third piece of equiqment is called a magnetic trap. It permits the plasma particles to be entrapped within a limited space by magnetic fields set up by solenoids—coils of wire with electric current passed through them. What sets them apart is the method used for obtaining a high temperature plasma. In one of them the plasma is produced by the injection of fast charged particles — deuterium molecules — into the magnetic field. This is the operating principles of "Ogra" - the world's largest magnetic trap. In another magnetic trap the charged plasma particles are withdrawn from an arc discharge set up in the trap itself.

Research into controlled thermonuclear reactions is still in its infancy. But it may well be not long before man will bend this new powerful source of energy to his will by learning to tame thermonuclear fusion.

IONITES IN INDUSTRY

By A. Englin, Engineer

Who has not read of the sufferings of shipwreck survivors without a drop to drink amid boundless wastes of water? For hundreds of years people have been seeking a means of making seawater drinkable.

Today this is achieved very simply: ordinary seawater is poured into a bottle containing a pinch of a coarse-grained powder. In a few minutes you have a bottle of fresh water: the salts which make for the bitterness of seawater have been absorbed by the wonder powder.

This powder is known as ionite or ion-exchange resin and is a variety of plastics with the characteristic big molecules built up of many elements.

Ever-Widening Range of Uses

In recent years ionite resins have penetrated into virtually every branch of Soviet science and technology. Here are a few examples of the wide range of uses they have found.

Water always contains a certain amount of salts which settle on the walls of boilers. In order to ensure the uninterrupted work of high-pressure boilers, complicated "desalting" installations are needed. That is why the problem of soft water is of major importance to heat and power plants.

Moscow's heat and power stations No. 9 and 20 have now done away with their cumbersome desalination installations, and yet they are working without a hitch. The most thorough analysis of water which has passed through ionite filters fails to reveal the slightest traces of sodium, calcium or magnesium salts.

The ability of ionites to catch various specific substances is being employed extensively in hydrometallurgy, an industry which deals with the extraction of metals from ores and factory waste by means of aqueous solutions of acids and other chemicals. Thus, for example, in processing gold-bearing ores a certain amount of gold is inevitably washed away with the water, and it is recovered only by a lengthy and complicated chemical process. Soviet engineers have now applied filters with ion-exchange resins which have simplified the process tremendously and prevented the wastage of even the slightest quantities of gold.

For obtaining Uranium and Other Rare Metals

We live in an age of developing atomic industry. This, naturally, calls for the intensive mining of uranium, the basic raw material for atomic energy. But not many countries can boast ores with a content of 20 to 30 percent of uranium, like Canada or the Belgian Congo. Uranium ore occurs fairly frequently, but the metal content usually does not rise above decimal fractions of one per cent. It is considered worthwhile even to work fields with a content of one-hundredth of one per cent. This has been made worthwhile, thanks to ionites which make it possible to extract the valuable metal from mountains of practically barren rook.

In 1955, Prof. Dmitri Ryabchikov, D. Sc., (Chemistry), Director of the ionite laboratory of the USSR Academy of Sciences, explained at the Geneva Atoms for Peace Conference how ionites make it possible to

the heart that had stopped beating, thus pumping the blood from the heart into the blood vessels.

The all-round scientific study of death processes and restoration of vital functions, however, has barely begun. The most immediate problem is to prolong the period of clinical death. The five or six minutes before the irreversible changes in the cells of the cerebral cortex manifest themselves and biological death sets are much too short for the necessary steps for resuscitation.

But even if it were possible to restore the vital functions of a human being after a longer period, this would still be a defective, "brainless" being, without intellect. To prevent that, measures must be taken to retard the speedy degeneration of the cortex cells and thus prolong the period of clinical death.

Artificial Cooling

As long ago as the beginning of the century the Russian scientist Porfiry Bakhmetyev proved that by artificially cooling the organism of a warm-blooded animal a state of retarded vital activity could be induced. The rate of metabolism is lowered, less energy is used up and the organism's nutrition requirements are diminished. Hence, decay of the cells which require a constant supply of nutritional substances and oxygen is retarded,

Artificial cooling— hypothermy—is now used in cardiac surgery in the Soviet union and other countries. Highly complicated and lengthy heart operations, which the patient could not survive at normal body temperature, are now performed successfuly under hypothermy. Artificial cooling is also being employed in Soviet research to prolong the period of clinical death.

In experiments with animals, whose death resulted from loss of blood, the period of clinical death has been prolonged from the usual five or six minutes to a half hour and even an hour by use of anaesthesia and hypothermy.

After a clinical death lasting for nearly an hour, Soviet scientist were able to restore all the vital functions, including those of the cerebral cortex. This is a notable step forward in the solution of the universally significant research problem—how to prolong human life.

SCIENTIFIC INSTITUTIONS

CENTRAL DRUG RESEARCH INSTITUTE, LUCKNOW

History

The Central Drug Research Institute is one of the chain of National Laboratories under the Council of Scientific & Industrial Research, which came into being in August 1947. The Planning Committee of the Board of Scientific & Industrial Research approved the plan prepared by Dr. B. Mukerji in 1947 and through the generous offer of the historic Chattar Manzil Palace by U. P. Government, it was possible to establish this organisation in Lucknow. The Institute was formally declared open by Sri Jawaharlal Nehru on February 17, 1951.

Organisation

Since 'Creative Drug Research' is essentially a collaborative enterprise, it was felt that the achievement of the ultimate object —the control and treatment of disease though rationalistic investigations for the discovery of diagnostic, preventive and therapeutic agents--depended on a well-unit organisation of different scientific disciplines which could tackle the problem in its manifold aspects.

The Institute, a composite of such disciplines has at present the divisions of Medicinal Chemistry, Biochemistry, Microbiology, Pharmacology, Chemotherapy, Endrocinology Experimental Medicine, Biophysics and Botany cum Pharmacognosy. In addition to these the Institute has an Analytical Section which undertakes the analysis of samples referred to by individuals, industrial concerns and Government agencies ; an animal house which maintains a stock of over ten thousand animals ranging from mice to monkey ; an information section ; a workshop and other anciliary sections. A pilot plant is being currently put up to develop the drug processes on commercial scale.

Work & activities

The Institute since its inception has taken up the study of different diseases and tried to evolve a rational treatment either from indigenous sources or by synthetic methods. The ancient indian systems of medicine describes more than two thousand plants growing in different parts of the country and some of these plants, through careful and systematic scientific researches have been established in the modern system of medicine. An intensive programme of work starting from the pharmacognosy chemistry, pharmacology and clinical trials is required and has yielded, in the past, in an impressive range of remedies e. g. cardioactive glycosides from digitalis and hypotensive and sedatives from rauwolfia, first indicated by the pharmacodynamic studies of Chopra & Mukerji. Recent studies at the Institute on a Himalayan drug plant *Cissempelos pareira* (Zakhme-Hyat) has resulted in the isolation of an alkaloid which can be converted into a powerful muscle-relaxant. The physiological action of this new product is similar to the imported drug, d-tubocurarine, and the studies indicate that it can advantageously displace the foreign product. An active programme on other plants is in progress.

Investigations have revealed that *Psoralea*

cordifolia (Hindi-Babchi) contains furocoumarins—psoralin and Isopsoralin—which can be used as a remedy for leucoderma. This fraction is being tried clinically in a large number of patients on 'out door' basis and has given encouraging results. Attempts are also being made to find out the utliity of *Aegle marmelos* (Hindi-Bael) since this also contains a product closely related to the one isolated from *P. coryifolia*.

The position at present with regard to diabetes is that there is no medicine which can be considered as a radical cure for it. Investigations on a few indigenous drugs like *Coccinia indica* (Hindi - Kundru) and *Syzigium cuminii* (Jaman) have shown to lower the blood sugar to the near normal in alloxan diabetes of rabbits. Fresh seeds are found to be much superior to the older ones. The clinical trials with both drugs are in progress. Studies with sulphonyl ureas and their analogous compounds are also in progress in animals and selected group of diabetic patients.

In man there is evidence purely of a circumstantial kind to suggest that a combination of high dietary cholestrol with obesity may produce aetherosclerosis. Experimental atherosclerosis has been produced in rabbits and chicks at the Institute and the role of vitamins and hormones in this condition is being studied.

New agents effective as oral contraceptives, amoebecides and filaricides are being investigated. Hundreds of compounds have been synthesised keeping in view the structure activity relationship of the well known drugs and screened for biological activity. From the numerous compounds made on the model of DDS (diamiodiphenyl sulphone), S. N. 87 (p-methylamino-p'-aminodiphenyl sulphoxide) have been found to be better than DDS in lepramatous cases on clinical trials. Pharmacological investigations on two glycosides, pervoside and ruvoside, present in *Thevetia neriifolia* exhibit strong cardioactive actions comparable to those of digitalis glycosides. As a result of soil screening programme, a new antibiotic, X-340, has been obtained from a local soil and found to belong to the tetracycline family.

Pharmaceutical Preparations

Preparation of a cheap protein hydrolysate of vegetable origin which could be used in the nutritional disorders was very much needed. As a result, a suitable palatable preparation from oil cakes of mustard and til has been developed on a pilot plant stage and found to be as good as any other preparation in the market. Another food supplement, yeast hydrolysate, has been prepared on a laboratory scale from distillery sludge. Similarly synthetic feed for animals from waste materials like rice bran, oil cakes etc. has been prepared.

A new economic process has been developed at the Institute for the isolation of cardioactive glycosides from the digitalis leaves. The country's annual requirement is of the order of 150 kg. worth about rupees 20 lakhs. This method is expected to be commercially exploited in the near future.

This well furnished laboratory which has so many important discoveries to its credit in a short span of about ten years would surely become a seat of outstanding repute in biological research in the near future.

SCIENTIFIC PERSONNEL

A NOTE ON PROBLEMS OF SCIENTIFIC PERSONNEL

By P. C. Mahalanobis

Chairman Scientific Personnel, Committee

Introduction

1. The terms of reference of the Scientific Personnel Committee are comprehensive :—

(i) to consider the problem of demand and supply scientific, technical, and engineering manpower, both in its quantitative and qualitative aspects, in relation to national development plans, in its long range perspective ;

(ii) to consider how best training and educational programmes existing and planned, could be integrated with (i) above;

(iii) to consider generally conditions of employment of scientific and technical personnel ;

(iv) to consider and recommend on the terms and conditions of service of such personnel in Government and their placement in administrative and technical cadres; and

(v) to consider and recommend the details of constitution of a Scientific Service under the Government of India.

2. It would be remembered that a similar Committee had been set up in 1947 to review the demand and supply of scientific and technical manpower which led to the initiation of the National Register of Scientific Personnel. In the absence of clear ideas on national planning it was not possible, at that time, to adopt any long-large programme regarding scientific and technical manpower.

This note in its original form had been considered by the Scientific Personnel Committee on 1 September 1959. The present note was placed before the Committee on 24 March 1960, and its was decided to release it for wider circulation.

3. It is comparatively easy to estimate the supply of scientific manpower. The demand however would depend on the rate of progress of the national economy in future. Extrapolation is possible only if it can be assumed that the future trend would be a continuation of past conditions. This assumption would have implied ten years ago, in the case of India, a stagnant economy or one with a very slow rate of progress; and would not have been valid in a planned economy. In India the aim of national planning must be to achieve a rapid rate of economic development; and the future demand for scientists must be related to the desired rate of progress in future.

4. The Second Five Year Plan gave special emphasis on the production of energy, metals and machinery. The size of Public Sector plan was roughly doubled, from about

Rs. 2,200 crores during the First Plan to something like Rs. 4,600 crores in the Second Plan. Owing to the backward conditions of the machine building industry, it became necessary to make heavy imports of capital goods; and there was acute shortage of foreign exchange immediately after the initiation of the Second Plan. The total investment contemplated in the Second Plan amounted to only Rs. 6,200 crores inclusive of both the public and private sectors. There was, however, much adverse criticism of the Plan as being 'over-ambitious'; and considerable pressures developed in 1956 and 1957 in favour of a 'small' Third Five Year Plan of perhaps only Rs. 7,000 or 7,500 crores of net investment.

5. This was the position at the time of the fourth meeting of the present Committee in September 1957 when five members agreed to form study groups (in science, engineering, education, medicine, and agriculture). The uncertainty regarding the size of the Third Five Year Plan continued throughout 1958 and even in 1959. It is only recently that opinion within the Congress Party and in Government circles has strengthened in favour of total net investments of about Rs. 10,000 crores (of which about Rs. 6,000 crores together with a non-investment plan outlay of about Rs. 1,100 crores would be in the public sector) in the Third Five Year Plan with the possibility of a further stepping up of investments in the Fourth Plan by 50 or 60 per cent.

6. The importance of perspective planning to supply broad estimates of targets of development over 15 or 20 years began to be appreciated with the initiation of the Second Five Year Plan. However, it is only very recently that tangible progress has been made at a technical level. The Perspective Planning Division of the Planning Commission, in collaboration with the Council of Scientific & Industrial Research and the Indian Statistical Institute, has prepared a number of studies on scientific and technical manpower which gave a good deal of information on the supply side. To prepare realistic estimates of personnel requirements it is necessary to know the total amount of investments (for example, whether it would be Rs. 10,000 crores or something else in the Third Plan with a possibility of its rising to, say Rs. 15,000 crores in the Fourth Plan) as well as the broad pattern of investments, that is, the respective shares of basic and light industries, power, transport, agriculture, education, health services etc. This part of the work will necessarily have to be done in step with the preparation of future plans.

7. Action has been already taken on some of the short-term problems of adjustments of pay-scales and allowances within the Council of Scientific & Industrial Research. The Central Pay Commission has also submitted its recommendations; and decisions for the near future would be made in the Central Government on the basis of these recommendations. It is quite proper to adopt short-range solutions to deal with pressing problems.

8. The planning of scientific manpower, is, however, basically a part of long-range planning; and involves deep seated structural problems of the organisation of science as a whole. Also, policy and programmes relating to scientific manpower will have to be made necessarily within the wider frame of decisions regarding economic and social policy and programmes for the future.

9. Some general observations on the place of science in national development

would be pertinent. Economic progress consists of a steady increase in the amount of national product. This can be achieved only through the transformation, with the help of engineering and technologists, of raw materials into machinery, power, and other capital and consumer goods. Natural resources vary widely from one country to another, and are sometimes highly specific. It is only through technological research that such resources can be properly and fully exploited. It is, therefore, necessary continually to expand technological and applied research by utilising basic scientific knowledge for the solution of practical problems. The success of such research can be assessed by the resulting technological improvement in the exploitation of resources to suit local needs and conditions.

10. The advancement of applied and technological research is determined by the available stock of scientific knowledge. The promotion of pure research (in addition to giving satisfaction arising from an increase of scientific knowledge by itself) would continually expand possibilities of applied and technological research, and hence of economic development. Assessment of such fundamental research must, of course, be made on the basis of world standards, and independently of any immediate aims of solving practical problems. It may, however, be noted that scientists ability engaged in pure research, in any emergency, would be often able to take a wide view and make a fundamental approach to the solution of urgent applied problems. Organisation and promotion of scientific research in its most comprehensive sense is thus an essential requirement for rapid economic development.

11. The United Kingdom (UK) and a little later, the Western European countries and the United States of America (USA), became world powers through industrial developments based on the advancement of science and technology. Much more rapid developments have now occurred in the Union of Socialist Soviet Republics (USSR), also with the help of scientific and technological research. It is being increasingly realised that Soviet economic and industrial progress has been possible only because of a scientific revolution which has taken place in the course of a single generation of about thirty years. The possibility of a rapid transformation of a backward country into a modern industrial economy with the help of science and technology has been demonstrated beyond dispute.

12. In spite of the very high level of seientific and industrial developments in the advanced countries of Europe and America, increasing attention is being given in all these countries to the strengthening and deepening of the teaching of science and scientific research.* A proper appreciation of the need of scientific and technological research for national development is essential in formulating the scientific policy of India.

13. Objective methods for the assessment of scientific work are necessary for the sound organisation of science. This is a difficult task. Proper appraisal and appreciation of scientific work is possible only in a society in which there is an independent frame of scientific values and criticisms. This is the heart of the problem of scientific progress in India.

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* There has been much discussion in this connexion during the last two or three years, for example, in the Rede Lectures delivered by Sir Charles P. Snow at Cambridge in 1959.

14. In UK, West Europe, and America, science and technology had developed independently of Government for centuries, and a great tradition of independent scientific criticism had been built up before the two wars. Scientific societies of a general type (like the Royal Society of London) or in particular subject fields (like the Physical or Chemical Society) had grown up over centuries in UK, Europe and America. Most of the funds for scientific research had come for a long time either from private benefactions, university endowments, or private industries.

15. Scientific research under Government auspices started on an appreciable scale in UK only during and after the first world war. Similar developments occurred still later in USA and other countries. It is only after the second world war that large funds are being made available by Government for scientific research. Because of the enduring tradition of scientific values and criticisms which had been built up earlier, the large inflow of Government funds in recent years has not had, as yet, any serious adverse effect on the progress of science in UK, or in West European and countries and America. Also, Government in these countries, are sensitive to the need of preserving a fabric of independent scientific criticism. In all these countries a most important feature is the high degree of decentralisation in the organisation of science and multiplicity of sources of funds for scientific research.

16. The pattern of development of scientific research in USSR after the revolution has also been highly decentralised and has served as a model to other socialised countries. At the apex is the USSR Academy of Sciences (Akademi Nauk) which has about 120 institutes and field stations with a staff of over 50,000, out of which about 15,000, are professional scientific workers, and 4,000 have the status of professor. The Academy is not under the control of any Ministry but deals directly with Government and in financial matters with the Finance Ministry. There are twenty other academies either of a general type in the different Republics, or of an all-Union character in special subject fields like agriculture, medicine, buildings and architecture etc., which have a research staff of 15,000 professional workers. There are thirty-three universities and eight hundred educational institutions with research facilities in a large variety of subjects. In addition, there are over 1200 research institutions and establishments under the different Ministries and Republic Governments with research units in all important industrial enterprises. The total number of professional scientific workers was 240,000 in 1957 out of which 106,000 were in research institutes, 125,000 in higher educational establishments including universities, and 8,000 in enterprises. It would be seen that USSR has developed a far flung and highly decentralised system for scientific research. It is also worth mentioning that in USSR the accepted policy is to assign only the easier tasks to single teams. The more difficult the problem the greater is the duplication or replication of research groups working on it, the only limit being the involvement of all scientists who have competence to work on the problem.

17. The point to be emphasised is that UK, West European countries and America, on one hand, and USSR and other socialist countries, on the other hand, have in their own way developed a very wide and highly decentralised system of scientific research with multiplicity of sources of funds in the

same subject field. This has given strength and flexibility to the structure of research in all the advanced countries and in all countries which are rapidly advancing in the world. Rapid progress in science has been and is being achieved by promoting a critical evaluation and appreciation of scientific work by scientists themselves working in independent institutions.

18. The value of science to society lies in its unorthodoxy and ability to challenge accepted concepts and theories. The scientist must have freedom to do his work in the way he thinks proper, and the right to express his views in scientific matters. It is characteristic of underdeveloped or pre-industrial societies that the system of administration is highly centralised as all authority tends to be derived from the top. Recent experience has shown that even when democratic forms are set up, these often remain somewhat on the surface ; and the tendency continues to look to the top for guidance in making decisions ; this prevents the growth of the capacity to shoulder responsibility. In this situation there is a tendency to the development of "established" views and of hierarchical levels of authority which inevitably discourage the spirit of independent criticism. Also, if there is only one, or a predominantly single source of research funds in any subject field there would be also an inescapable tendency to conform to established views. Decentralisation is, therefore, essential to preserve the dynamic character of scientific progress. This can be achieved by guaranteeing the right of migration of scientific workers from one institution to another, the freedom of publication and expression of opinion in scientific matters, and a multiplicity of sources of research funds in the same subject field.

19. A multiplicity of sources of research funds is compatible with, and can be made most fruitful through an overall planning of the allocation of resources to different subject fields and different agencies. If an application for funds or facilities is rejected by one agency, a scientist would still have the opportunity of approaching another agency which, being independent, may take a different view of the matter. The planning and coordination of scientific work and research in any particular subject field, at each level of specialisation, would then become primarily the concern of the scientists themselves. The different agencies sanctioning research funds would have the responsibility of reviewing ane assessing the progress achieved in each field from time to time.

20. In India scientific studies and research of the modern type started only very recently in comparison with Europe and America. Pioneering and significant work was done at first by a few individuals usually in some private (non-government) scientific societies such as the Asiatic Society of Bengal and of Bombay, the Indian Association for the Cultivation of Science in Calcutta, the Bombay Natural History Society, and a few other such institutions but their resources were meagre. About fifty years ago specialised scientific societies began to be formed; and quite a large number are now in existence; but excluding Government grants, they have very little income except membership subscriptions. The Indian Science Congress Association was started in 1914, and twenty years later the National Institute of Sciences and other science academies; these also have very little funds excluding Government grants. The Indian Institute

of Science, the Bose Institute, the Indian Statistical Institute, the Indian Academy of Sciences, the Tata Institute of Fundamental Research and a few industrial research institutions, such as the Shri Ram Institute in Delhi, the ATIRA at Ahmedabad, etc., have some funds of their own but are being increasingly financed by Government. Also, excluding developmental work, very little research is being done in private industries.

21. The Survey of India, the Geological Survey, the Meteorological Service, the Botanical Survey, the Zoological Survey, the Anthropological Survey, etc., are all Government agencies. The Atomic Energy Commission is a department of the Central Government. The Indian Council of Medical Research, the Indian Council of Agricultural Research, and the Council of Scientific & Industrial Research are in form autonomous but function in practice under a good deal of Government control and under Government audit. The remaining scientific laboratories and institutions mostly belong to the Central Ministries, or in a few cases to State Governments. The Universities have very little funds of their own and depend mostly on Government grants. For historical reasons, rather than by intention, a situation has developed in India in which practically all funds for research flow from Government. Decentralisation of scientific research, therefore, has special significance in India, and has a deep connexion with the terms of reference of the present Committee.

2. Supply And Demand

22. The first term of reference relates to the supply and demand of scientists. (As decided by the Committee, the word scientists would be used in a comprehensive sense and would include engineering, technological, medical, and agricultural personnel). It would be convenient to consider requirements under certain broad heads :

(a) operating scientists (such as production and maintenance engineers, general practitioners, scientists engaged in day to day work in agriculture, irrigation and power, meteorology, minerals prospecting etc.);

(b) science teachers (in universities and higher educational institutions, junior technical institutions, secondary schools, etc.);

(c) research scientists (for both developmental and fundamental research in pure and applied subjects);

(d) supporting and auxiliary junior technical staff; and

(e) personnel required for the diffusion of science as a part of general culture.

23. If Rs. 10,000 crores is accepted as the dimensional size of net investments with a developmental outlay of Rs. 1100 or 1200 crores in the public sector in the Third Five Year Plan (and, possibly, investments of about Rs. 15,000 crores in the Fourth Plan), it would be possible to work out broad patterns of industrial and economic development over the next 10 or 15 years. The solution is not unique and there is an element of choice. The permissible limits of variation are, however, not very wide. For example, industrial and agricultural developments are closely interlocked for both technological and economic reasons. Any rapid increase of agricultural production is not possible without industrial development to provide additional supplies of fertilisers, pes-

tisides, irrigation, agricultural machinery and implements, transport etc. Industrial development, on the other hand, would depend on the progress of agriculture to give additional supplies of food and of raw materials to meet the increasing demand. Expansion of employment, increase of income and improvement of the level of living are merely different aspects of industrial and agricultural progress.

24. There is some greater choice in social services. For example, theoretically, it is possible to have a great deal of advance in education without any progress in health services, or vice-versa. But this also is only a hypothetical possibility. In practice, human nature would demand some kind of a balanced progress of both education and health. Once certain social aims are accepted (such as a continuing increase of income, getting rid of the fear of unemployment in 10 years, increasing equalisation of opportunities, etc.), and the size and pattern of investments are settled in a broad way, it would be possible to work out, at a technical level, aggregate targets of production and of targets of social services at the end of the Third and Fourth Plan periods.

Operating scientists

25. On the basis of such targets of production and of expansion of social services during the next 10 or 15 years it would be possible to make realistic estimates of the requirements of operating scientists. Such estimates need not be highly refined or extremely precise. There is some margin of transferability from one specialised field to another; and training programmes can be adjusted according to changing needs. Also, it is usually possible to increase the output of operating scientists by 40 or 50 per cent at comparatively short notice. This has been already the experience in India. The admission to degree level courses in engineering and technology have increased from 6600 per year in 1955-56 to 9800 in 1957-58, and are expected to rise to 13,000 in 1960-61.

Science teachers

26. Once the requirements of operating scientists are dimensionally known, it is possible to estimate how many teachers would be required to train the required number of operating scientists. Also, if the provision for teachers and teaching facilities can be made in a "comfortable" way, then a margin would be left to increase the training capacity at short notice.

27. A very large number of teachers would be, however, required to extend the base of science teaching. Important policy decisions would, therefore, have to be made regarding the coverage and intensity of programmes of science teaching during the next 10 or 15 years. The spread and consolidation of science education is a difficult and complicated task. A superficial knowledge of some scientific facts is not enough. Science is an integral part of the culture of the present day, and enduring foundations can be built only by making the scientific outlook and way of thinking a part of general education. This, however, will take time. Also, with available resources (which are extremely meagre in competent personnel) it is not possible to cover adequately all stages of education in the immediate future.

28. The school stage cannot, however, be neglected. Without a broad base of science education in schools it will never be possible to build a sound superstructure at the top. To have an impact at the school

stage, it is necessary to have competent science teachers in very large numbers. To produce such large numbers of science teachers, it would be logical to strengthen science education at higher levels in the first instance. This would, in time, provide an increasing supply of science teachers for schools.

29. What should be the proper phasing of the different levels of science teaching requires careful study. Once policy decisions have been reached, in a general way, regarding the scope and coverage of the teaching of science at different stages (schools, technical institutions, college, university etc.) over the next 10 or 15 years, it would be possible to formulate the requirements of science teachers by broad subject groups at different levels.

Research scientists : applied research

30. It may be convenient to consider requirements of research scientists under two heads. One is "applied research" in which the main task would be to utilise existing knowledge for the solution of technical and technological problems. This is quite different from what has been called operating work in science and technology but is closely related to it. The number of scientists required for applied research is likely to be broadly proportional to the number of operating scientists. The use of an overall ratio (or specific ratios for particular subject fields) should supply fairly realistic estimates of future requirements.

31. Training in applied research can possibly be best organised through research units attached to technological institutions and big enterprises or groups of small and medium enterprises. It would not be difficult to prepare some rough estimates and programmes at a concrete level, once the pattern of industrial development (in its broad sense) is formulated.

Research scientists : fundamental research

32. The position is entirely different in fundamental research. The number of persons who have competence and aptitude for fundamental research in either pure or applied science is very small in every country. Neither demand nor requirements have any meaning. It is only the supply which matters.

33. The only wise policy is to give necessary facilities for work to as many scientists as are found fit to undertake fundamental research. The number would be very small in the near future. The cost per reserach worker would not be large in most subjects; and total funds required would be comparatively small and may not be prohibitive in relation to the size of the Third Five Year Plan. The really difficult tasks are to select suitable men, to create a congenial atmosphere for work, and to make a proper appraisal of performance. This question has been considered in somewhat greater detail in another section.

34. Experience of the more advanced countries of the world tend to show that about three or four auxiliary and supporting staff is required, on an average, for each professional scientist. The ratio varies widely in different subject fields. The use of an overall ratio, or of specific ratios in particular subjects, would enable realistic estimates being made of future requirements.

35. It is also necessary to have scientific and technical personnel for the diffusion of science as a part of general culture. Requirements would depend on the total effort at the popularisation of science. This is likely

to be small for some time to come; and the required personnel would probably be available as bye-product of the general expansion of science teaching. Separate estimates for this purpose may not be necessary at present.

Summary

36. To sum up, in the case of operating scientists, science teachers, personnel for applied research, and auxiliary technical staff, the task of estimating the demand would be fairly straightforward and can be taken up as soon as certain broad policy decisions have been reached regarding the size and shape of the Third Plan. This would also necessarily have to be a continuing task. The Committee may indicate what steps should be taken in this connexion. The case of research scientists is discussed later.

3. Educational and Training Programmes

Training in relation to service and employment

37. The educational and training programme in science must be suited to the needs of the patttern of scientific employment in the country. The educational policy and programme, therefore, in principle, can be formulated in the most effective way only after policy decisions have been made regarding recruitment, appraisal, and promotion of scientists. Some of the general problems may, however, be considered at this stage. Also, much can be learnt from the experience of the more advanced countries. Some information on recruitment, promotion, and structure of scientific employment in UK and Western European countries, USA and USSR is given in Appendix (1).

Experience of advanced countries

38. In the United Kingdom (and to some extent in West Europe) the basic concept is a "service" which scientists would join at a comparatively young age and which would offer a career for life. There is great security, and "service rights" are carefully safeguarded. Promotion is vertical within the service, usually by seniority, and would be possible only when a vacancy occurs higher up. The greatest emphasis is placed on the initial qualifications, and recruitment is usually through competitive examinations at the time of entering the service. This is facilitated by the structure of education in UK and Europe where a comparatively small number of persons have university education, and the higher services are recruited from among this small group. There is stringent selection in admissions to universities which helps in maintaining a high standard. This system is well suited to administrative work in which emphasis is usually laid on the conservation of the established order, and in which experience is generally transferable.

39. The Scientific Civil Service as well as the Administrative Civil Service in UK have a class structure which is closely related to the structure of education in the country. Promotion from one class to another is extremely difficult and rare. Owing to pressing requirements of scientific and technical manpower in increasing numbers, significant changes, however, are being made in the British service system to permit greater flexibility in recruitment and promotion scientists.

40. The American and the Soviet systems are more flexible; and make it possible for young scientists of ability to work their way up from the bottom. In USA the emphasis is on the qualifications required for each particular post; and, although there

is something like a service system, each post has to be filled, principle, by the best available candidates either from within or outside the service. In USSR there is no concept of a service system in science and technology, and each post must be filled, in principle, by the most highly qualified candidate available. In consequence there is no great emphasis on initial qualifications or competitive examinations in these two countries; and there are incentives to acquire additional qualifications to improve one's prospects of securing more attractive posts.

41. In UK and Western Europe (and, to a smaller extent, in USA) opportunities for higher education used to be and still are somewhat associated with the income level of parents. In UK, there is still a good deal of class stratification in education. The tendency in all Western countries has been, however, to broaden opportunities for higher education through the liberal provision of scholarships.

42. In USSR education is free at all levels. Admissions are on the basis of the results of qulifying examinations. Also, the general rule is for students at the university level to receive a stipend which would pay for his expenses during the period of study. Some mistakes, no doubt, would occur in making assessments through examinations and other tests. Some differences in opportunities would also arise indirectly from disparities in income of parents. But by and large the Soviet system is believed to be attracting most of the qualified cadidates into the educational system. A great deal of thought is being now given to this matter in the Western countries. It is possible that the American and the other Western countries would tend to adopt more and more the Soviet model by widening educational opportunities.

43. In the Soviet system great importance is attached to technical training at all levels. Day and evening courses in a very large number of subjects at different levels are organised not only by educational institutions but by government agencies and industrial enterprises. The social and cultural prestige of an institution, or an office, or an enterprise depends to some extent on the number and variety of training courses offered and on the number of students attending such courses. There are qualifying tests for admissions to such courses. Sometimes a candidate attending and passing an examination at the end of the course receives a special allowance which acts as an incentive. In all cases, the candidate would receive a certificate which would serve either as an obligatory or as an additional qualification for certain posts.

The position in India

44. The "service" system was established in India on the British model for historical reasons, but has continued in more or less the same form after independence. The experience of both USA and USSR and the general trend even in UK, would seem to indicate that the "service" system is too rigid for scientific posts. It is doubtful whether it would be wise to establish in India a "scientific service" on the model of the administrative services; and then modify it as is being done in UK. It may be desirable to develop a more flexible system for scientific personnel suited to the needs of a planned economy. This has been considered in greater detail in another section.

45. It is necessary at this stage to point out some of the educational consequences

of the "service system" in India. Before independence the Indian Civil Service and other administrative services with high pay and great social prestige used to offer the most attractive career for youngmen of ability. Entry was almost always on the basis of competitive examinations. This placed a great premium on passing such examinations. This emphasis on examinations inescapably pervaded the whole educational system. The position has remained unchanged, or has perhaps worsened, since independence. Academic success is still interpreted as success in passing examinations.

46. The emphasis on examinations is particularly harmful in science. Examinations at any given moment would be largely an assessment of the amount of knowledge which the candidate has succeeded in acquiring; such success may in some cases even indicate a refusal to get interested in a particular branch of a subject. Also, it is the very nature of science to go beyond the limits of current knowledge. The capacity of help in this process and not merely to acquire knowledge is the true measure of scientific ability. A system of recruitment through competitive examinations is likely to lead to a wrong selection of candidates for a scientific career. In research the only reliable criterion is performance.

Need of a long range programme

47. The system of employment and the system of education and training are closely interlocked. It is difficult to change one without changing the other. In India a strongly or almost exclusively examination-oriented system of education has become established because of the dominance of the service system based on success in competitive examinations. If it is decided to develop a more flexible system of employment in science the educational system would also have to be changed to suit the new needs.

48. It is particularly important to give education and training in science and technology to a very large number of the people of India as quickly as possible. This would be the most effective way of strengthening the forces in favour of social and economic progress. This would call for an effective organisation of science teaching, at all levels, from schools to universities and technological institutions and post-graduate research. Unfortunately, it is not possible to undertake this task on a large scale because of the lack of competent teachers. The only way to turn out teachers in adequate numbers at all levels is to give the highest priority, in the first instance, to the strengthening of science teaching at the university level.

49. It is not possible, however, to build a broad superstructure without a sound and widespread system of science teaching in the schools. The Indian educational system is weakest at this stage. It would be desirable, therefore, to start experiments in science teaching on proper lines at the school stage. Such experimentation would necessarily have to be on a small scale for lack of teachers of ability. The first task must be, therefore, to offer attractive terms and create a congenial atmosphere for work for science teachers in selected schools. The fullest advantage must be taken of local resources to develop the capacity of the students for observation, measurement, and experimentation. An imaginative approach may eliminate much unnecessary expenditure on appliances and paraphernalia. The Committee may consider making some recommendations in this regard.

Preferential treatment for science

50. Because of the urgent need of rapid advance in science and technology it is desirable to give preferential treatment to science. Special incentives are given to the natural sciences in USSR by awarding scholarships of higher value. Pay and prospects are also higher in natural sciences. The same policy may be adopted in India with great benefit to the country.

51. It is now being increasingly appreciated that the successful implementation of the big developmental plans would depend entirely on the availability of the required number of scientists and technologists at the right time. Greater attention is also being given to expanding the facilities for scientific and technological education. The greatest need at this stage is to ensure that quality is not sacrificed to numbers.

Maintenance of standards of teaching and examinations

52. The maintenance of desired standards in teaching and examinations is a difficult problem during a period of rapid expansion of training programmes. Facilities for higher education had grown more or less gradually in UK and the West European countries; and standards of education and examinations have been maintained in these countries through a generally high level of scientific and cultural traditions. In UK, Europe, and USA, a larger number of scientific societies and professional institutes also play an important part in the maintenance of standards. Professional membership of such institutions provide recognised and country-wide standards of qualifications. In USA there is collaboration, for example, between professional institutes of engineering, for the evaluation of courses of instruction showing equivalence between different institutions. The American Medical Association also has some similar functions. These represent (non-government, but) definitely professional grading of higher educational and training courses.

53. In India, owing particularly to the speed of educational expansion, the problem of maintaining standards of teaching and examinations has become quite serious. In engineering and medicine the professional associations are looking after the question of standards to some extent. The scientific societies, however, are not generally active in this field. The whole question calls for urgent consideration.

Admissions on merit

54. The questions of admissions to technical and higher educational institutions is of fundamental importance. In principle, there cannot be any dispute that all admissions should be on merit. Also, no candidate should get any advantage because of a higher income level of his family. The desirable system then must be to admit candidate strictly on merit; and, secondly, to make education free and give adequate stipends to the admitted candidates to cover their living expenses. This single step would go a long way in the equalisation of opportunities, and would strengthen the social and educational structure of the country. There is a strong case to introduce this system in scientific and technical subjects because of the urgent requirements of trained personnel for national development.

55. Methods of selection of students for admission to universities and higher scientific institutions require careful study. Here the question arises of setting up of standards of examinations on a country

wide basis. The use of objective tests (which may include performance exercises, and written and oral examinations) deserve consideration in this connexion. Such objective tests can be constructed and administered with greater validity and uniformity than the conventional type of examinations. With the help of such tests it should be therefore possible, in principle, to set up objective standards on a country-wide basis.

56. It would be useful if the present Committee can make, for example, a review of possibilities of introducing, in the course of the Third Five Year Plan, a system of admission on merit and provision of stipends to meet educational and living expenses in selected scientific and technical subjects. The questions for decision would be subject fields, level of instruction (post-graduate, degree level, junior technical, school, etc.), institutions where tenable, number of scholarships, and broad principles of awarding the same. For example, it may be decided that a beginning should be made at the research and university level; and a certain number of scholarships of the valve of say, Rs. 1000 per year may be offered to all or a selected number of science students of outstanding ability, assessed on the basis of all-India standards, for the whole period of the study at the degree or post-graduate level. In the same way, it may be possible to offer, say, scholarships of Rs. 500] per year to a limited number of school students of outstanding ability for two or three year for the study of science in selected secondary schools. Action on these lines would be in accordance with a basic policy which is unexceptionable and would also supply valuable experience for wider applications.

Standard text books of science

57. The question of providing standard text books of science for the whole country is important. Such text books are used extensively in USSR, and Soviet experience seems to have been entirely satisfactory. This need not necessarily lead to a stereotyped pattern of teaching. The text books would supply basic material; and every teacher would be free to supplement them by additional readings in any way he likes.

Evening and correspondence courses

58. Expansion of evening courses and double-shift work in laboratories would lead to large economies in laboratory buildings and equipment. The teaching in evening courses can be done eithe by whole-time teachers, or by teachers of day courses or by persons engaged in research or other work during the day. The experience of the advanced countries has been entirely satisfactory. In India also there are some evening courses. It is necessary to consider possibilities, at a concrete leval, of better organisation and expansion of such facilities in India.

59. Organised courses through correspondence would have great advantages in a big country like India. Opportunities for education and training can be made available very widely at a comparatively low cost. It is of interest to note that more than a million persons receive instruction through correspondence courses at the junior technical and higher educational level in USSR. In USA also between one million and a million and a half undertake home study courses through correspondence. In scientific subjects, miniature laboratory sets are used in both USA and USSR. Also, short intensive courses of practical work are arranged in laboratories in educational institutions during vacations or in the evening. Students trained through

correspondence courses, on passing prescribed examinations, receive regular degrees and diplomas in USSR. This is comparable to the system of "private students" appearing in university examinations in India. This has obvious advantages and the possibility of strengthening and extending this system deserves serious consideration.

Indian students abroad

60. There is a special problem of Indian students who go abroad for education and research. About five or six thousand Indians are believed to be studying or working in the field of science and technology outside the country. It is a serious loss that some of the most competent men are staying abroad ; but they are earning their own living. A very large number of students depend on remittances from India which involve a continuing expenditnre of foreign exchange.

61. There are two separate issues. One is the problem of persuading Indian scientists working abroad to come back to India ; this has been considered in the next section. The other is sending students abroad for education and training. It must be recognised that there are many subjects in which adequate training facilities are not available in India. It would be necessary to send scientists and technologists abroad to acquire technical knowledge and wider experience. Some broad principles should be followed in this regard. The general rule, for example, may be to send students abroad for training in specified subjects or fields in which they would work on their return to India ; this would ensure the proper utilisation of the knowledge and experience acquired. In all cases it should be a condition that the trainees should have received education and training up to the highest level available in India. It would be more profitable, whenever possible, to send persons who already got a good deal of experience in their own line of research or work within the country as this would enable them to identify what would be most useful in India. Studying for examinations and foreign degrees should be discouraged. A rapid expansion of research and training facilities in India must also, of course, proceed all the time.

62. I have mentioned a number of problems. There are many others. What is now necessary is to select some of the important problems of high priority for detailed and critical examination. As regard standards, for example, enquiries may be made in one or two selected subjects, in the first instance, at one or two selected level. Some experiments may be started on developing objective tests. Ways and means of improving and maintaining more uniform all-India standards can also be examined at the same time. Or, in a technical subject, an enquiry can be made of the adequacy of available courses of instruction. Or, a beginning can be made in the preparation of standard text books in selected subjects, for example, different branches of mathematics which are of special importance in the teaching of science. A first task should be the preparation of a programme of technical studies for the improvement of educational and training programmes in science and technology.

4. Terms and Conditions of Employments of Scientists

Social appreciation of science

63. The scientific revolution which has taken place during the last twenty-five or thirty years has given the scientists an indispensable and leading role in the economic

and social developments of the future. Terms and conditions of employment, therefore, require to be considered in the new context. The scientist cannot replace political and social leaders or administrators but he must take the initiative in the advancement of knowledge and in the utilisation of this knowledge for the advancement of social and human welfare. It has, therefore, become necessary to attract to science as many men of ability as possible and to give them adequate facilities for their work.

64. The only way to do this is to make the scientist feel that he has the appreciation of society. It is necessary that a scientist should be given as attractive terms as men of comparable ability in administration and other occupations. But this is not enough, He must also have adequate facilities and a congenial atmosphere for work; encouragement for initiative in his professional activities; evaluation of his work by fellow scientists; freedom of expression of scientific views; opportunities of exchange of experience and scientific discussions with colleagues at a national and international level; also, when of senior status, facilities to offer opportunities and encouragement to junior colleagues and pupils.

The need of flexible system

65. The first basis question is whether the "service" system which was established in India during the British period, and is continuing in the same form since independence, is really suited to scientists. The service system was originally developed for government administrators. The higher administrative posts are organised forms of all-India services such as the Indian Administrative Service, the Indian Foreign Service, the Indian Police Service, Central Services (Audit and Accounts, Revenue, Posts and Telegraphs) etc., and also different State services, all broadly on the British model. On the scientific side, there are organised services in the Geological Survey, the Meteorological Services, the Defence Science Service, etc.; and also for engineering works. Otherwise, recruitment is to individual scientific posts. The services generally have a structure of the British type with a clear separation of Class I, Class II and Class III officers. Postings and promotions take place within each service. There is no possibility of movement to a post outside a service or from one post to another except through the usual procedure of recruitment.

66. Recruitment is through either the Union or State Public Service Commissions. The age for recruitment for most of the higher services varies between 22 and 25. Usually several candidates are selected every year for each service on the results of competitive examinations. There is a safety in this method of group selection for the services. In spite of appreciable variations in ability, individuals of the required ability are likely to become available from among each batch of entrants, in time, to fill senior posts of responsibility. Also, as a good deal of the administrative work is broadly of a similar nature in each service, and there are well established norms and precedents, the general efficiency of the service would be maintained if the quality of the fresh recruits every year can be maintained at an average level.

67. The method of group selection by competitive examinations for a life career does not seem to be at all appropriate for research scientists. Ability to do well in a

competitive examination is not a safe criterion of success in research. Each scientist has to make his own contribution. This is true even in team work in science, just as in a football or cricket team. The selection of young scientists for research requires an individual approach. It is desirable to offer facilities in the form of research fellowships to promising young graduates on the basis of their academic and other records. But this is only a first step. The appraisal of the quality of the work done during a probationary period must be done on an individual basis. The pay and prospects and facilities to be offered for further work must also be settled separately for each individual. Only scientists with knowledge and experience of the different subject fields can undertake this responsibility.

68. The inherent tendency in any system of administration must be to preserve the established order and to take action in conformity with past precedents. Promotion on grounds of seniority and conformity to established norms is inescapable and even desirable. Scientists, on the other hand, must be temperamentally unorthodox, and would be necessarily vulnerable because of their tendency to deviate from established norms. Secondly, in administrative (or defence) services there may be need of a structure of successive levels of powers and responsibilities. In the case of scientists, there must be, in principle, complete equality of status in discussions in scientific matters because decisions cannot be made on the basis of authority but must have the sanction of reason. Also, evaluation by scientists themselves would be the only suitable method for the selection and promotion of scientific workers.

69. The American and Soviet systems of scientific employment are more flexible, offer greater equality of opportunities and are more suited to the needs of scientists than the service system. The trend in many countries would seem to be towards the more flexible system in USA and USSR.

A universal system for India

70. For the most fruitful utilisation of scientific talent in India it would seem desirable to build up a universal system which would cover, in time, all scientific personnel in the Central Government, the State Governments, and non-government (but public) institutions like universities and scientific institutes. Selection, appraisal of performance and promotion would have to be by competent scientists. There should have to be parity with persons of comparable ability in the administrative services in respect of salary, leave, retirement rights, medical care, housing and other benefits. The pay structure and propects should be uniform for the whole country with however special allowances, when necessary, to compensate for regional differences in the cost of living. There should be guaranteed rights of freedom of expression of scientific views and of freedom of movement from one post to another, with transferability of leave, retirement rights and other benefits so that the requirements of particular posts can be satisfied by the most suitable candidates available. Also, there should be no discrimination on grounds of political views.

A phased programme

71. It may, however, be argued that even if this be the ideal, it is not possible immediately to have one single, comprehensive scheme for the whole of India. It would be proper then to have a phased programme and to adopt short-term measures which

would facilitate the transition to the desired system. It would be useful to consider to what extent unified schemes can be developed, step by step, for the Central Government, quasi-Government agencies, State Government, local authorities and non-Government (but public) agencies like universities and scientific institutions. A start may be made with the Council of Scientific & Industrial Research (CSIR) and the Ministries and agencies in the Central Government.

72. It may be desirable, for example, to create for scientific workers a number of grades or categories, perhaps four or five in number, each with a short time scale, and provide for promotion from one grade to another on merit as assessed by panels or commissions of scientists. Also, it would be desirable to permit entry from outside the system in each grade.

Pay and prospects

73. A fundamental issue of special significance in an underdeveloped country like India with a highly developed system of administrative services is the question of parity of the terms and conditions of service for scientists and administrators. Remuneration and prospects in the administrative services are much higher and are generally considered much more attractive than those in scientific services or posts. Pay and prospects of scientists and teachers in universities and non-government agencies are, again, even lower than those enjoyed by scientists working in Government agencies. Disparities of pay and prospects between scientific workers in non-Government agencies and officials in the administrative services are thus extremely high. For persons of comparable qualifications, the pay of officers in the higher services may be three or four times higher than that received by scientific workers in universities and non-government institutions. These disparities must be reduced or eliminated.

74. Some information on scales of pay in the advanced countries is given in Appendix (2). It would be seen from this Appendix that in the Western countries scientists and administrators have basically similar pay. In USSR and socialist countries scientists get much higher pay than administrators.

75. Another important question is whether the terms and conditions of service should be the same or similar for (a) operating scientists, (b) science teachers, and (c) research scientists. In principle, there is a good case in favour of uniformity of terms and conditions. This would promote free mobility from one group to another, depending on individual aptitudes and abilities, and thus ensure most effective utilisation of available resources. Special incentives and promotions should be provided for persons of outstanding ability on the basis of their performance in each sector (operating, teaching, and research). Research would attract a large number of persons of outstanding ability. In practice, a larger proportion of research scientists are likely to be found deserving of special rewards and promotions. This should be, of course, encouraged; and generous provision should be made for rewards for success in research. This would not be discriminating as the rewards would be awarded not on the basis of the occupation but on individual merit.

Leave, retirement rights, and other benefits

76. Besides pay-scales, there are benefits and amenities such as leave, provident fund, retirement rights, medical care, housing etc. Making these benefits uniform would be equitable and would facilitate mobility. Each

scientist would then have his own leave and retirement rights and also be entitled to other amenities on the same standards. On transfer from one post or agency to another the scientists would carry his leave and retirement rights and other benefits with him which would be a simple and automatic procedure.

77. If complete uniformity cannot be achieved immediately it should still be possible to arrange transfer of benefits from one agency to another. A scientist having earned leave or provident fund or retirement benefits etc., on transfer from one agency, would carry his credit which would be accepted by the agency he joins. This could be easily arranged by introducing a system of clearance of credit and debit between different agencies, possibly through a central clearing house as in the case of banks. Individual investment of provident fund contributions in the form of life insurance would automatically facilitate the transfer of such benefits. The existing differences would have to be, however, accepted in the case of current benefits like housing and medical care until a more universal system is established.

78. The age of retirement is usually 60 or 65 in all the advanced countries. Research scientists in West European countries, after retirement from their official posts, may continue their scientific work as long as they are active. In some countries, they continue to draw the same or almost the same salary. In USSR they get the old age pension at 60 but also get their salary as long as they are fit to continue their work. In India it seems desirable to introduce a similar system, at least, in the case of research scientists. The appointment of National Professors and the scheme for retired scientists have been first steps. Such facilities require to be provided on a wider scale and at more than one level.

Trade unions of scientific workers

79. In all the advanced countries there are well organised trade unions; or there are excellent channels of communication between Government and legislators on one hand, and scientists on the other, through Congressional and Parlimentary Committees as in USA and UK. This is a sign of maturity of the fabric of science. Some information on trade unions of scientific workers in the advanced countries is given in Appendix (3).

80. In India the position in this respect is weak. The Indian Medical Association is well organised but it is probably much less influential than its counterparts BMA and AMA in UK and USA respectively. Some of the professional engineering societies are occasionally taking up questions of economic interests to their members but have very little activities of a trade union type. As regards scientific workers, the Association of Scientific Workers of India was established in 1947 but its membership is small and it has at present little influence on government policy.

81. The special situation in India requires to be taken into consideration in the present connexion. Opportunities for employment in scientific posts are comparatively small and research posts are very rare in the private sector. Teaching posts are poorly paid. Government is by far the largest employer of scientific workers. Since independence most of the research posts have been created in Government or quasi-Govt. agencies like the ICMR, ICAR, CSIR, AEC etc. In this way a kind of monopolistic

situation has arisen which makes it absolutely necessary for Government to devise ways and means to offer opportunities for expression of opinion about service conditions or specific or general grievances.

82. Taking a long view, it would seem desirable to promote the growth of a trade union movement among scientific workers on the British and European model. In India it may be desirable to make a double approach, somewhat on the Scandinavian model, by strengthening the Association of Scientific Workers on one hand, by persuading the scientific and professional societies to take interest in social and economic concerns of their members. The promotion of educational, training and cultural facilities, on the Soviet model, would also be useful.

83. It would seem desirable for Government to take a view regarding the Association of Scientific Workers of India (ASWI) and give it official recognition. Early action should also be taken to set up machinery for joint discussions between what are usually known as the "staff side" (representing the employees) and the "official side", on the lines of the Whitley Councils. On the financial side, it would be advisable for Government, in the initial stage, to sanction adequate funds (which would not be large) to enable the ASWI to maintain a small but efficient secretariat, a really useful journal, and organise a few meetings and conferences at different places.

Scientists working in private sector

84. The existence of a large private sector competing in some ways with an enlarging public sector in an underdeveloped country like India gives rise to some special problems. It is known that private industry sometimes offers very high pay to individual scientists and technologists. The average salary of scientists in private industries is lower than that in Government agencies. The real competition between the private and the public sectors occurs only at the very top in regard to individuals of outstanding ability. Men of ability are very few in number in an underdeveloped country. The loss of such men, even if few in number, can be serious handicap to the public sector. Also, it is not always a question of pay. Scientists of ability are sensitive regarding their status in relation to other Government officers. They require a congenial atmosphere for their work. The real remedy would be to improve conditions of work in the public sector so that it would be possible to attract and retain scientists and technologists of ability.

Scientists working abroad

85. A considerable number of competent Indian scientists are working abroad. Some of them may prefer to stay abroad for personal reasons. But many are eager to come back to India. Some came back, but have again gone away because they could not adjust themselves to Indian conditions. In many cases there is something lacking on their part. But this is not the whole truth. There is something also lacking in conditions of work in India which young scientists who have never been abroad also find discouraging. This is a deep-seated malady which requires careful diagnosis and courageous remedial measures.

Lack of the spirit of criticism

86. Expenditure on scientific research has increased in India, perhaps by ten times since independence. A large number of laboratories and institutes have been estab-

lished; and the number of scientific workers has increased very considerably. And yet the output of research of high quality does not seem to have been commensurate with the physical volume of expansion of facilities. There are complaints of lack of enthusiasm and frustration among young workers. It is generally agreed that, before independence, resources were meagre and the number of workers was also much smaller but there was great enthusiasm for research, the quality of work was also reasonably high.

87. Professor J. B. S. Haldane has pointed out that Indian scientists are too polite to criticise one another's work; he thinks that is the great weakness of Indian science. Science thrives on criticism. And, conversely, in the absence of criticism, progress of science must be retarded. Although a large number of ditinguished scientists from all over the world visit India every year, they stay for a short time ; and, having come as guests, are probably too polite to give expression to their views bluntly. It is possible that Indian scientific opinion has become somewhat isolated; and the spirit of criticism has not been cultivated in a sufficient measure. It is necessary to examine the reasons for this failure.

"Officialisation" of science

88. I venture to suggest that the basic factor has been progressive "officialisation" of science since independence. The high pay and great prestige and power of the administrative services dominate the thinking of both administrators and scientists. The ambition of a young man is to become a high official. Also, success or failure is decided by a single event, namely, the results of a competitive examination with which an element of luck is always associated.

89. A linear order of ranking and of level of authority is indispensable in administration. The opinion or decision of a superior officer must prevail. This is in complete contrast to decision making in science in which the ideal must be complete equality of status of all scientific workers, as all decisions must be based on reason and not on authority.

90. Before independence, total resources were very small but an appreciable part of the funds for scientific work came from private and non-Government sources. Since independence a great deal more money is available for science but it is coming in an increasing measure from Government sources. Officials are thus having an increasing influence on the sanctioning of funds for scientific work. It is inevitable that, in the present set up of Indian administration, official "control" should also increase. This is not the fault of individual officials. The present system is a legacy of the British period when the prevailing idea was that Government must function as trustees of the whole country. In the British period, grants for science were, however, few in number ; and usually once the grant was sanctioned, there was no further question of control. Due to the great increase of the volume of work in connexion with scientific activities since independence, decisions in scientific matters tend to be made, in effect, at lower levels although, in form, the sanction is given higher up. The desire for control and interference in details, usually in the form of seeking information or clarification, has been continually increasing.

91. It is worth noting in this connexion that the present practice of giving sanctions at a high level of authority is

leading to a continual dilution of real responsibility. It is not possible for any authority at a high level (whether an individual officer, or a Minister, or a committee, or a Governing Body) to examine each case on its merits ; the inevitable tendency must be to accept most of the recommendations which come up from lower levels. The practice of securing formal sanctions at a high level leads to the possibility of recommendations at lower levels being by personal considerations because, once the high level sanction is given, recommendations originating at lower levels cannot be questioned. Unfortunately, this has given rise to a widespread feeling among scientists that "cultivating the officials" is likely to be of advantage. Gradually, confidence is shaken that decisions in scientific affairs rest on reason, and the belief becomes more and more general that such decisions can be and are being influenced by personal considerations.

92. It should be again stressed that it is the system which requires to be changed. Placing scientists in administrative posts is no solution. It may lead to some short term advantages in expediting the flow of funds or some good decisions. It would, however, retard progress in the long run, because scientists also are human beings and would yield and conform to the prevailing practices. The existing administrative pattern, with its vertical ranking of levels of authority and little delegation of powers, is tending to become dominant even in scientific laboratories, universities and research institutions. Scientists are burdened with administrative responsibilities and have to deal with an increasing flow of recommendations for sanction from lower levels. Administrative rank rather than scientific activity becomes more and more important. It is widely believed that many young workers of ability are feeling frustrated by the discouraging influence of their official superiors who hold their position because of their administrative seniority rather than scientific competence. In this situation there is widespread belief in the advantages of "cultivating" the superior officers, and also that those proficient in this art are likely to get promotions and secure special facilities. This leads to the growth of cliques and power groups at different levels. A large number, usually the majority of the scientific workers, develop a feeling of cynicism and of indifference to work. Another group reacts in an opposite way and becomes troublesome. It is only a very few rare individuals of great strength of character who can pursue their scientific work with devotion and undivided attention.

93. There is also a tendeny on the part of the government agencies to extend their directing and controlling functions. This is inevitably leading to a loss of sense of responsibility on the part of scientists, which, in its turn, is leading to government agencies taking over still more and more functions which should have been left to the scientists themselves. I may give some recent cases from the National Institute of Sciences of India as illustrations. There is a system of applications for funds from scientific societies being submitted to Government through the National Institute. In recent years it was found that favourable recommendations of the NISI were not accepted in some cases while in other cases applications not recommended by the NISI were successful in securing grants from Government. The result was that the NISI felt it had no real responsibility and, therefore, started forwarding practically every application like a post office.

There is nothing improper in Government making independent decisions. A saisfactory procedure would be to place a part of the available funds in the hands of the NISI and make it responsible for the distribution. Government can also directly sanction grants out of the balance to be reserved for this purpose.

94. An instance of the increasing desire for secretariat control may also be mentioned. Government had sanctioned some time ago a grant to the NISI for the construction of buildings. After very careful consideration, the NISI approved the plan of the building, submitted a copy to Government, and entered into a contract with a firm of engineers for construction. At this stage, one room originally reserved for guests was changed into a reading room. After construction work had made considerable progress, payment of the Government grant was held up pending explanation why an additional reading room was being provided. The matter was quickly settled on reference to higher authority, but it is significant that a request for explanation did come and also that this had to be settled by an appeal to a higher authority. The practice of personal approach to different levels of authority or power is tending to become general both inside and outside Government. There is widespread belief among young scientists that a personal approach to senior scientists is essential to get elected as a fellow of the NISI.

95. The real task is to promote the growth of a sense of integrity and responsibility among the scientists. Taking over more and more control by Government agencies would not be a solution. It is necessary to eliminate from scientific affairs the form and spirit of the present administrative system with its successive levels of authority. The only way to do this is to hand over specified responsibilities to scientists and hold them accountable for the discharge of such responsibilities. The scientists must be given the initiative in scientific affairs. The concept of supervision, control, and sanction by administrative agencies must be replaced by the concept of holding the scientists accountable for their own decisions and performances. An experimental approach is essential. Assessment would have to be made, not on conditions precedent, but on achievements realised in practice.

96. This is the basic remedy. Once this principle is accepted, grants would be given to scientific laboratories, institutions and societies for specified purposes but otherwise unconditionally so as to fix the entire responsibility directly on the organisations themselves. Each laboratory or institution or society would be judged, not on the routine fulfilment of conditions attached to a grant, but on the successful achievement (or otherwise) of the objects for which the grant was sanctioned. This would immediately throw the entire responsibility on the scientific institutions to make the best use of the available resources. To attract and hold scientific workers of ability would immediately become important factor for success in scientific work. Nothing short of this will be of any real avail.

Private donations for science

97. There is one way of giving the initiative to scientific institutions to raise donations from private sources which is worth mentioning at this stage. In USA and UK there are provisions for examption of income-tax for donations to recognised scientific and educational institutions. In India

such exemption is granted to the extent of only five per cent of the income. There is a strong case in favour of increasing the exemption limit or not having any limit at all. In India great social virtue has been always attached to donations for public benefit. Exemption from income-tax, if given in a large way, is likely to stimulate substantial benefactions for scientific research, health, education, and social services. Abuse can be prevented by allowing such exemption only in the case of scheduled institutions (such as universities, national laboratories, recognised scientific and educational institutions, public hospitals etc.). Also, a limit can be placed on the earmaking of donations for specified institutions preferably in the form of a slab system. This would make a part of the donations available for distribution to other institutions to promote a balanced development.

98. This approach may be used as an indirect way of getting round tax evasion which is believed to be widespread in India. The income from donations would be to some extent counterparts of taxes. In case the donations exceed the amount of tax exemptions, there would be a net increase of available resources for constructive purposes. The greatest beneficial effect would be in strengthening the initiative of the institutions themselves to raise such donations, and in giving them the freedom to decide the best way of utilising the donations in consultation with the donors.

A pool of research scientists

99. To restore initiative to the scientists themselves and make them accountable for their endeavours and achievements is the only way out of the present difficulties. Because of its strategic importance it would be desirable to make a beginning with the organisation of research. The quality of fundamental research must be assessed on world standards, and of applied research on its value in solving practical problems. Research institutions would be then eager to attract scientific workers of ability, give them a congenial atmosphere of work, and promote them on merit. Attention would be focussed on the identification of scientific talent and its most effective utilisation.

100. Research is still a comparatively small sector in India. The total number of scientists engaged in research was about 2,500 in 1955, according to the National Register; and the total number at present may be about 3,000. The expenditure on research (excluding the Atomic Energy Commission and developmental research) is also comparatively small. To initiate some action in this sector would not be very expensive.

101. Consideration may be given, for example, to the creation of a pool of research scientists covering both Government and non-Government agencies (universities, scientific institutes etc.) during the period of the Third Five Year Plan. All scientists engaged in research need not be absorbed in the pool. Admissions should be restricted to persons of proved ability.

102. It is essential that the scheme should be started on an adequate scale. Progress is sometimes impossible without a concentrated attack. In India, although the steel industry was established in 1908, production did not rise above one million tons for nearly half a century. At the end of the Second Five Year Plan or within a year or two, the production would increase to nearly 6 million tons per year; and it is only in this way that the industrial transformation would

start. In the same way, an effective transformation of scientific research in India may become possible only though a rapid expansion within a very short time to create a new atmosphere. This would call for adequate funds. But the amount involved would be comparatively small and should not be considered excessive in the context of a Government outly of perhaps Rs. 7,000 crores during the period of Third Five Year Plan.

103. It should be possible to make experiments on terms and conditions of service in connexion with this pool of research scientists. For example, this pool may be arranged into a number of grades; and selection and promotion to each grade may be done by panels or committees or commissions of scientists on the basis of an object evaluation of the work done. Experiments can also be made in giving defferent rates of increment (regular, above average, or exceptional as in Netherlands)on the quality of research. The members of the pool may be guaranteed complete freedom of movement from one post to another *within the same grade*; and allowed to carry their leave, retirement rights and other benefits with them. They may be permitted or encouraged to undertake part-time teaching or consultation work. The right of publication and freedom of expression of views in scientific matters may be guaranteed subject only to the requirement of keeping secret data which may have to be treated in this way; in practice this restriction should come into operation only on very rare occasions.

Grants to institutions and societies

104. It may be desirable to adopt a new approach to sanctioning grants to scientific institutions and societies on an experimental basis. The objects of the grant would be clearly specified, otherwise no conditions would be attached so that the institutions concerned have complete freedom in making the best use of the funds at their own discretion. Government must, however, assume the responsibility of assessing the success or otherwise of the realised achievements.

Task forces for scientific research

105. In spite of the high degree of decentralisation of scientific research in USSR, it is interesting to note that some of the leading Soviet scientists are showing great sensitivity to regidities which may be developing in some of their institutes and agencies. Academician Kapitza has recently advocated the organisation of research, *not* in a permanent institutes or agencies, but through *ad hoc* temporary "task forces" of scientists which would be formed to solve assigned problems and would be given necessary facilities for their work. These task-forces would remain in existence only for the period required to complete their assigned task, but would never form a permanent organisation and would he dissolved as soon as they have fulfilled their task either by solving the problem or by reaching the conclusion that further work on the same lines would not be worth while. When any task-force is dissolved, the scientists would be free to join other task-forces. Kapitza thinks that the only way to prevent the loss of dynamism in research is to have a system of perpetual task-forces for temporary periods. There would be adequate provision of buildings and scientific equipment which, however, would not belong to any permanent institute or agency and would be placed at the disposal of different task-forces according to needs. It may be desirable to set up one or two such task-forces in India,

on an experimental basis, for the study of assigned problems especially in relation to planning, and thus explore possibilities of this form of research for national development.

Conclusion

106. Some of the issues raised in this note cannot be decided by scientists themselves. They may, however, perform a valuable task by making a scientific analysis of the problems and by recommending to Government suitable lines of action. What can be achived in the near future would depend on how much importance is attached to the advancement of science by persons who make decisions. Progress would also depend on whether the principle of decentralisation is accepted and also to what extent it can be realised in practice. The task is not to try to "control" scientific work through Government machinery which must fail, but to promote seriousness of purpose among scientists so that they can shoulder greater responsibilities. It is only in this way that science can progress in India.

107. It is the long-term problems on which the views of a committee of the present type are likely to be of value. The reorganisation of science and technology to serve the needs of national development is likely to call for structural and institutional changes which can be brought about only through a fuller appreciations of the basic issues by both scientists and administrators. This is not primarily a matter of quick implementation of a number of administrative decisions. It would be necessary, no doubt, to make policy decisions of a far reaching character, But this would have to be preceded by an educative process of serious thinking on basic problems.

APPENDIX I

RECRUITMENT, PROMOTION, AND STRUCTURE OF EMPLOYMENT OF SCIENTIFIC WORKERS IN UK, USA AND USSR

Great Britain

1. The general outlook or philosophy underlying the structure of scientific employment is characteristically different in UK and the Western European countries, USA, and USSR. In UK (and also in many Western European countries) the basic concept is of a "service" or a "cadre" consisting of a group of individuals who have entered the service for life careers. The "service" system offers great security of tenure and prospects of promotion usually on the basis of seniority. Time scales of pay are also characteristic features of the service system in UK and in most of the Western European countries. Every service officer has certain rights regarding his pay, and other benefits and higher posts. Promotions are normally from within each service and, at higher levels, depend on vacancies. Transfers from one service to another are rare, and very few resign or are discharged from the service.

2. The "service" concept logically leads to recruitment at comparatively young ages through a Civil Service Commission. In U. K. in principle, this Commission is completely eentralised. The Civil Service Commission also acts as a referee in various questions relating to the services. Posts are publicly advertised and candidates either sit for special examinations or are selected usually after interviews by selection boards or committees.

3. In UK there have been some significant developments in the case of scientific posts. The need of making special arrangements for scientific posts began to be appreciated during the war; and a new organisation, the Scientific Civil Service, was established in 1945 which led to an improvement of the status and prospects of scientists working in Government agencies. A scientific committee was set up with the responsibility of making a continuing review of the efficiency of the Scientific Civil Service. (The service consists only of scientists and engineers engaged in research, development and design activities. Operating scientists including engineers engaged in production, maintenance etc., structural and other work serve in other branches of the civil service). There is a scientist member of the Civil Service Commission who has special responsibility for scientific appointments ; and a scientific section of the commission works exclusively on recruitment to such posts.

4. The scientific officer class is recruited mainly from first and second class honours graduates from the universities; the experimental officer class mostly from junior technical institutions with about 20 or 25 per cent of graduates from the universities. The scientific assistant class correspond to laboratory mechanics and technicians in the universities and are recruited from among persons with high school education who have had some training in scientific or technical work. Candidates for permanent appointment are elected on the basis of academic records and experience and usually after a personal interview by a selection board with scientists as members.

5. The scientific officer class has six grades; and promotion in the three upper grades depends not only on the ability of the individual but also on the existence of specific vacancies. Promotion usually implies larger supervisory duties. Some special provisions have been made for merit promotion in the British Civil Service; and additional posts can be created in the higher grades to provide from the promotion of individual research scientists of outstanding ability without necessarily expecting them to carry additional administrative responsibilities. Merit promotions are made on the recommendation of an inter-departmental scientific panel which works through subcommittees of which all the members are scientists of established reputation.

6. The stratification into three classes is quite rigid and reflects the social structure and stratification of the educational system. Promotion from one class to another is extremely rare, The maximum age of entry is 31 years for the grade of senior scientific officer (with certain exemptions for officers from Defence Service). In UK, in addition to the Scientific Civil Service, there are also some Defence Science Services.

7. In UK salary scales for top Govt. posts in science are, however, still lower compared to top posts in the administrative class. There is a good deal of feeling within the Scientific Civil Service against the lower

status of scientists compared to the administrative class in the Civil Service. In UK the Atomic Energy Authority, however, has a large scientific organisation which has been separated from the Civil Service in order to secure greater flexibility and greater opportunities for promotion for outstanding scientists. There is also provision for offering higher pay in special cases.

8. The most significant change in the British system has been the recognition of the principle that the accomplishments of scientists can be properly evaluated only by their peers. Panels of scientists are therefore used for recruitment and also for normal and special promotion.

9. In the British Scientific Civil Service opportunities are being provided for advanced training at Government expense at universities and non-government laboratories by the award of fellowships; and there is a system of sabbatical leave on full pay. Attendance at professional meetings is encouraged. There is occasional inter-change of scientists with other parts of the British Commonwealth.

10. In UK the universities and non-Government agencies have separate structures of recruitments, promotion, pay and prospect etc. The system is broadly similar in the different universities; and there is some movement of scientists from one university to another. Leave and retirement benefits are usually transferable without difficulty (and medical care is practically free as in USSR). Scientists working in government agencies or in industrial concerns get somewhat higher pay. Scientific traditions, however, are very strong in the British universities; and many scientists of ability prefer to work in the universities because of the academic freedom and other social and cultural amenities.

11. In the Western European countries the normal system is that of career services to which recruitments are made at a comparatively young age. The class structure is absent or is much less rigid compared to UK. Recruitment is more decentralised and in some countries there are arrangements for contract posts. The status of scientists is generally high and the social prestige of university professors (who are usually members of the Civil Service) is in most Western European countries as high as members of the higher Civil Service. In Switzerland the pay and status of scientists in universities and higher educational institutions is higher than the pay and status of administrative officers of comparable ability and qualifications serving under Government.

USA

12. In USA the system is entirely different and there is nothing which is really comparable to the service system in UK and other Western European countries. In USA the emphasis is on the "post", and in principle it is possible to select for any post the best available candidate from within or outside Government agencies. In U. K. post falls vacant in a Government agency, normally it must be filled by promotion from within the service itself. In the Western European countries also the position is broadly the same but there is greater freedom of movement because the service system is more universal and covers the universities and scientific institutions.

13. In UK recruitment to Government service is completely centralised. In USA, although there is a Federal Civil Service Commission, recruitment is decentralised to

a very large extent. In UK the appointment authority is in fact the Civil Service Commission but in USA the authority for making appointments is vested in the department or agency concerned and not in the Federal Civil Service Commission. In USA the Civil Service Commission prepares standard job classifications and lays down the required qualifications for appointment to particular posts and prescribes rules and procedures for selection. The actual recruitment is delegated to selection boards of a department or an agency or to a board representing a number of such departments in the same fields of activities. In USA the selection boards for scientists consist entirely of scientific members; and the evaluation of candidate's qualifications for appointment or promotion is made by scientists.

14. In USA, Government employees can apply for any post in any Government agency on his own initiative. In UK and Europe the movement of Government employees is kept strictly under official control; and individual employees cannot take the initiative in looking for more attractive posts. Because of the greater initiative in seeking other posts in USA, there is much greater mobility compared to UK and Europe not only between difierent Government agencies but also between Government agencies and non-Government educational and scientific institutions as well as private enterprises.

15. Because of the service concept, promotion in UK and Western European countries is normally possible only when there is a specific vacancy in a higher grade. In UK some flexibility has been introduced through the provision for special merit promotions, but these are very few in number, only about 10 or 12 per year on an average. In USA promotion depends on an individual being selected for a higher post. There is great emphasis on evaluation of posts with a system of classsification and specification of requirements. In the American system which is oriented to the concept of the "post", the ability or achievement of any individual scientist is not relevant except when he is seeking a new post. That is, there is no explicit concept of normal promotion. However, in USA there is an increasing tendency to create additional posts in order to attract or retain scientists of ability. In fact one very important feature in USA is the financial provision for a larger number of posts than are filled at any given time. Government agencies are continually on the look out for man of ability and usually have sanctioned but unfilled vacancies at their disposal to enable the appointments being made very quickly. The American system is highly decentralised and promotes greater mobility depending on individual aptitudes and also on mutual adjustments between the superior and subordinate workers. For persons of comparable ability, promotions are normally much more rapid in USA compared to UK and Western European countries.

16. In USA the universities and non-Government scientific institutions have their own individual systems for recruitment and promotion of scientists. There are also wide variations in scales of pay and prospects from one institution to another. However, in the large universities and institutions the tendency is towards a great deal of uniformity in the pay structure. Retirement benefits are generally similar and transferable; and a person serving in a Government agency can take out his benefits when he accepts a post outside Government and also, if after an

interval, he comes back to a Government agency be can usually bring back his benefits and deposit the same with Government. Leave rules are also basically similar.

17. There is practically no class stratification of the British type in USA, and there are good opportunities for scie ntists to work their way up from the bottom. Compared to UK and Western European countries there is far greater horizontal and vertical mobility.

18. In USA pay scales in Government agencies and in educational and scientific institutions used to be appreciably lower compared to private industries. This has received a great deal of attention in recent years and already there is a good deal of improvement in pay scales in the universities and scientific institutions. Pay scales in Government agencies have also been increased.

19. In America there are also indirect methods of offering high pay for Government work. Large contract projects are given by government to universities and private scientific organisations which enable very high pay being given to scientists of outstanding ability. I have heard that a big research institution (The Rand-Corporation) is in legal form a non-Government non-profit incorporated agency which, however, in actual fact is practically an organisation of the Defence Services. This enables the Rand Corporation to offer terms and conditions to scientists without any of the Civil Service restrictions.

USSR

20. USSR has developed again, still another system which resembles the American system, but is even more flexible. There is no concept of a scientific service in either the British or Indian sense. There is a great deal of emphasis on classification and specification of posts somewhat resembling the practice in USA. But the real emphasis in the Soviet system is on the functional qualifications of individual scientists.

21. The structure of scientific posts is broadly as follows :—(1) Technicians (which correspond broadly to the scientific assistants in the British Civil Service) ; (2) Junior Scientific Worker ; (3) Senior Scientific Worker ; (4) Professors and Directors, and (5) about 500 members of the USSR Academy of Sciences and 1200 members of 20 other Academies of Republics, or of all-union academies in special fields (medicine, agriculture, buildings and construction etc.).

22. There is no concept of any service system on time-scales. There is more or less a fixed pay (with a very small band to provide some flexibility) in each category. The pay is basically uniform for each category of posts (with slightly higer pay by 10 or 15 per cent in some institutions of national importance). Also a personal allowance of the order of 10 per cent or 15 per cent of the pay can be given in special cases. There are certain personal allowances for additional qualifications, for example, for passing prescribed examinations in foreign languages or acquiring special qualifications in particular subjects.

23. Qualifications and eligibility for each category are carefully prescribed. Candidates who have completed their training in junior technical schools are eligible for appointments as technicians in category (1). Graduates from universities and higher educational institutions are eligible for appointment as junior scientific workers in

category (2). Persons with the degree of "Kandidat" (the junior doctorate) are eligible for appointment as senior scientific officers ; and persons with senior doctorate degree for appointment as professors (Exceptions can be made on the basis of actual accomplishments and record of work but are subject to confirmation by a higher authority.

24. The system of recruitment is completely decentralised and the authority for making appointments vests in each agency or institution. There is, however, a well organised system and procedure for this purpose. Each scientific institute and institution has a scientific committee which is appointed by a higher authority and which consists of the Director and some members of the staff with some outsiders. In the case of the research institutes of the USSR Academy of Sciences (to be referred to as Akad. Nauk) the scientific committees are appointed by the presidium (governing body) of the academy. Posts are normally advertised. There are prescribed qualifications for each post with possibility of giving preference to candidates with recognised additional qualifications. Applications are scrutinised by a small committee on which there is a representative of the USSR Trade Union of Scientific and Educational Workers. The task of this scrutiny committee is to examine the qualifications of each candidate and check whether these satisfy the prescribed requirements. This committee simply prepares a report on the eligibility of the candidates without giving any opinion on their merit. This scrutiny prevents any candidate without prescribed qualifications being considered for the post. The applications then go to the Director and the scientific committee.

25. The Director can appoint technicians with the concurrence of the scientific committee. For any appointment in any higher category the selection is made by the scientific committee on the recommendations of selection boards. Evaluation of the candidates including personal interviews are entirely by scientists and the concurrence of the Director is necessary. The scientific committee has the powers of selecting an eligible candidate for any post in the category of junior scientific workers; but appointments which are proposed to be made on grounds of exceptional individual merit require confirmation by a higher authority. Promotion to a post in the category of senior scientific worker is subject to scrutiny and examination by a higher appointments committee, nominated by the presidium of the academy. Such examination, I understand, is real, and cases occur in which the recommendation of the scientific committee is not accepted. Appointment to posts of directors and professors are made by the presidium on the recommendation of scientific committees or selection boards. It is also worth mentioning that no candidate can be appointed to a post, even by the presidium of the academy, except on the recommendation of the scientific committee concerned.

26. The system is basically similar in universities and Government agencies. The initiative comes from the agency concerned but there are higher committees to examine recommendations for promotion to a higher category. In the universities, for example, the appointment of a professor is subject to approval by a special committee of the Ministry of Education. There are similar committees consisting of scientists in other ministries with similar functions.

27. The Soviet educational system is closely related to the methods of recruitment and promotion of scientific and technical man-power. There is a comprehensive system of education convering the whole country which is free up to the highest level. The 10-year shool education up to the normal age of 16 plus is free, compulsory and universal. (A radical change has been, however, recently announced and would be soon introduced by which all school students would start earning their living two years before completing the school course and would finish the last two years of the present school programme by taking evening courses extending over 3 years). After the 10-year school education, admission to all educational institutions (both junior technical and university level) is strictly through entrance examinations. The subjects differ for different types of institution (university, engineering, or medical, agricultural etc.) but for the same type of institution the syllabus and standards of examination are more or less the same for the whole country. A candidate passing the entrance examination for universities becomes eligible, in principle, for admission to any university in USSR. The most important feature is the high degree of uniformity of standards.

28. As a general rule, stipends are given to practically all students who are admitted to technical and higher educational institution which are sufficient to meet their living expenses during the whole period of study. This has ensured the maximum flow of students of ability into science and technology.

29. In addition to day courses, there is a highly organised system of education through evening and correspondence courses. Evening courses are given not only in educational institutions but also in industrial enterprises. Big enterprises individually, or groups of small and medium enterprises in a locality would give training in evening courses not only in general education but also at different levels, in subjects related to their respective type of production. In 1954, during a visit to Erevan (in Armenia, which used to be a very backward area before the Russian revolution) we saw a big enterprise with about 3,000 workers engaged in the production of heavy electrical goods. We found that four types of evening courses were being given in this enterprises. There was a 3-year upper school course for workers who had completed only 7 years of school work but did not have the opportunity of receiving the full 10-year education. There was a junior technical school which admitted workers who had completed 7-year of school education. There were also higher (or university level) course leading to the degree of electrical engineering with specialisation in heavy electricals. Finally, post-graduate courses had also been started a year ago which would enable workers who had completed the higher (university-level) degree course to study for the "Kandidat" (or junior doctorate) degree and later for the senior doctorate degree. Most of the teaching is done by the engineering and scientific staff of the enterprise itself; a number of teachers also come from the local university and higher technical institutions. Teachers participating in the evening courses received additional remuneration which (depending on the amount of work) can go up to 50 percent of the pay for the regular day time occupation. The enterprise had a good research section and possessed a great deal of scientific equipment which was used for

purposes of training in the evening. We learnt that a programme for expansion had been sanctioned which would double the capacity of this factory, and saw that some construction work had already started. It was the responsibility of the enterprise to recruit the additional technical staff, and the manager of the factory told us that they expected to do this mostly by giving training in their own evening courses. This made the training completely suited to the task.

30. The normal period of study in an evening course is usually one year longer compared to the corresponding day course leading to the same degree or diploma. In addition to the courses leading to regular degrees or diplomas a very large number of special courses are provided. These are usually qualifying tests or examinations for admission to their courses. Usually there is also an examination at the end of the course which is not necessarily a written one, but may be a practical exercise or an oral examination. Passing these examinations is considered as obligatory or additional qualifications for appointments to particular types of posts. This acts as a great incentive for undertaking such courses.

31. Every Soviet employees has an absolute right to resignation (except in a limited number of cases where a trainee has accepted an incentive scholarship for training in a specialised field on condition that he would serve for a limited number of years in assigned posts). This right of resignation together with complete decentralisation of recruitment enables young scientists to find opportunities of work to suit their own aptitudes. For changes within the same strata, he would not get any higher pay (or only to a very small extent in the case of a small number of designated institutions of national importance).

32. An importance feature of the Soviet system is that the responsibility is thrown on the Directors and the supervisory staff to attract and retain promising candidates, *not* by offering higher pay, but by providing better facilities and a congenial atmosphere for work. (During my visit to Moscow two months ago I asked a distinguished Academician, who is setting up a new Institute of which he would be the Director, how he would select the professional staff. He answered: "Well, it is mostly with the help of a smiling face and sweet words to point out to the candidates how he would feel happy with us, how he would get a little more space for work or some special equipment. We cannot offer higher pay except in the case of a promotion from one category to another. This is, however, a more difficult procedure and usually appointments are made within the same category").

Comparision between the different systems

33. The American and the Soviet systems are a good deal similar. The American system is naturally restricted to posts in the Federal Government while the Soviet system is universal and covers all posts in the country. In the Soviet system there is much greater emphasis on scientific and technical training and on the acquisition by each candidate of general and academic and specialised training qualifications. There is a high degree of decentralisation of recruitment in both USA and USSR. In USSR it is not possible to offer higher pay for posts of the same category which leads to a great deal of emphasis on creating a congenial atmosphere for work for the scientists.

34. There is, however, one important difference between the American and the Soviet system. In USA posts have to be created in terms of duties and responsibilities without any reference to the qualifications of individual candidates. In USSR there is much greater emphasis on individual qualifications and ability; and normally additional posts would be created to promote suitable candidates. For example, when a scientist working in any institute under the Akad. Nauk receives the Kandidat's degree or the Doctor's degree, a new post in the category of senior scientific worker or in the category of professor would almost automatically be created to give him promotion. This acts as a great incentive for a continuing improvement of individual qualifications. In USA also, in actual fact, government agencies usually have unfilled vacancies in reserve so that appointments can be made very quickly as soon as suitable candidates become available.

35. In contrast the service system in UK or in the Western European countries is far more rigid. In UK (but not generally in the Western European countries) the scientific service is still in a somewhat lower position than the administrative class. The service system also has a sharply defined class structure in UK (but this is not so in Western European countries).

36. For historical reasons the service system with a very rigid class structure was established in India on the British model and has continued (and has become possibly even more rigid) after independence. The basic issue in India is whether it would be wise to continue indifinitely the present system on the British model or whether, at least in the case of scientists, attempts should be made to evolve a more flexible system on the lines of USA and USSR.

APPENDIX 2

PAY SCALES FOR SCIENTISTS IN ADVANCED COUNTRY

United Kingdom

1. In the British Civil Service the standard pay scales (before taxation) are in pound sterling[1] per year: (1) Scientific Officer (£506 to £1055), (2) Senior Scientific Officer (£1135 to £1345), (3) Principal Scientific Officer (£1375 to £1950), (4) Senior Principal Scientific Officer (£2000 to £2300), (5) Deputy Chief Scientific Officer (£2400 to £2700), and (6) Chief Scientific Officer (£3000 to £3250). It is interesting to note that a "broad band" has also been recently established from £3500 to £6000 for scientists of exceptional ability who may be given any suitable pay within the band. This entirely new and unorthodox provision had to be introduced in order to attract and hold outstanding men.

2. There have been also considerable improvements in pay scales in educational institutions in U. K. In grammer school the pay range until recently was from £425 to £900 per year for an assistant teacher, £1250 to £1525 for a deputy headmaster, and

1. One pound is equal to Rs. 13.33.

upto £2200 for a headmaster. Very recently further improvements have been made. A teacher with an honours degree may now go up to £1700 in London and a little less elsewhere. If he is a scientist he is likely to reach this stage in late thirties; most science graduates would reach £1440 to £1500 per year, and the least successful will earn £1200 by the age of forty. The maximum for headmaster in bigger schools has been increased to £3000[2].

3. In British universities the standard pay scales are £550 to £650 for an Assistant Lecturer, who is, in fact, on probation and would go elsewhere unless he is promoted to the post of a Lecturer on £650 to £1350. A Senior Lecturer or Reader would get from £1400 to £1850 and a Professor from £1900 to £2850. In UK the pay in educational institutions (both schools and universities) is somewhat lower than that in the regular civil service posts but the difference is not very great (except for the "broad band" of £3500 to £6000 mentioned above).

4. In UK it is also possible for a scientist in universities and higher educational institutions to undertake outside work on a part-time basis either through his own institution or on his own for which he may receive additional remuneration upto a certain proportion of his regular pay.

Western European Countries

5. In Western European countries pay scales are usually the same for men of comparable ability working in Government agencies and in universities, educational and scientific institutions. It is usual to have a number of overlapping grades with short time scales. Among scientific workers the dispersion or the ratio of the maximum to the minimum pay is usually quite small. In UK and practically all Western European countries there are dearness allowances and also some compensatory allowances in places with a high cost of living. Also, scientists can accept part-time consultation or teaching work for which he can receive suitable remuneration.

6. In France in universities and scientific institutes and laboratories, a Laboratory Assistant would get a monthly salary of about 60,000 francs (one rupee=100 francs), a Junior Scientific Worker from 75,000 to 95,000 (in 15 years), a Senior Scientific Worker from 90,000 to 110,000 (in 10 years), a Reader from 100,000 to 125,000; and a Professor would start at 120,000 and go up to 150,000 or in exceptional cases to 200,000 per month. The top civil service pay would be 250,000. Engineers in France would get from 65,000 to 115,000 francs per month.

7. In Germany there is a large number of overlapping grades A (1) to A (16) with time-scales in each grade and higher posts on fixed pay in grades B (1) to B (11). A scientist or engineer would normally start at A (13) with a scale of from 735 to 1155 (German) Deutsch Marks per month. (One DM=Rs. 1.14). Promotion to the next grade A (14) with a pay scale from 807 to 1335 DM per month would be normal, but after this only a selected few would reach higher grades A(15) and A(16) rising to 1490 and 1735 DM. The director of a large research establishment may be promoted to B (3) with a monthly salary of 1925 DM. There are family and other allowances and pensions which may be as high as 75 per cent of the

2. *The New Scientist*, 18 June 1959, It is also noted that a newly graduated chemist would get more in industry. In late thirties an industrial chemist could expect to earn on an average £1750, and about £2200 in his fifties.

pay, and a widow may receive pension up to 60 per cent of the husband's pay.

8. In Switzerland there are 25 grades, each with a short time-scale. The lowest grade (25th) has a pay scale from about 6000 7,100 Swiss francs per year (one Swiss franc=Rs. 1.11 approximately). Engineers would start at the 8th grade (11000 to 15500) and after a few years reach the 5th grade (13100 to 17700) and may stop there for the rest of his career. The top (1st) grade in civil service has a scale from about 21,000 to 25,700 Swiss francs per year. Professors in universities would often get higher pay, up to about 30000 Sf. The range is small, and the ratio of maximum to minimum of scientific workers would be less than 3.

9. In Sweden also there are 30 grades ranging from the bottom (1st grade) with a monthly salary of about 700 Swedish Kroner to the top (30th grade) with 3000 Skr. per month (One Skr.=Rs. 0.90). A graduate would start in grade 13 on 1257 Skr., and persons with a higher degree in grade 15 on 1400 Skr. and may normally go up to grade 27 or 28 on 2500 or 2600 Skr. per month. In universities and higher educational institutions a junior part-time teacher may start on 1000 Skr. per month, and fully qualified research workers on about 2000 Skr. Professors get from 3200 to 3500 Skr. which may be compared with the pay of Cabinet Ministers of about 4500 Skr. per month, which is the highest pay in Government.

10. In Norway, in educational and scientific institutions a Scientific Assistant has a salary of about 16,800 Norwegian Kroner per year, Research Fellow 17600, Lecturer 24900; Associate Professor 26100, and Professor 33000 Nor. Kr. per year (One Nor. Kr.=Rs. 0.67).

11. In Denmark engineers start at about 13,400 Danish Kroner per year (inclusive of cost of living bonus) and rise in 15 years to about 27000 Dkr. per year (One Danish Kr.=Rs. 0.71). The ratio of maximum to minimum pay for qualified professional personnel in the Scandinavian countries is about 2½ or 3.

12. In Netherlands there are short time-scale in different grades. An Assistant Engineer has a scale of about 6000 to 7100 Dutch Guilders[1] per year (in 3 years), Engineer 7100 to 9900 (8 years), 1st Class Engineer 9500 to 11400 (5 years), Chief Engineer 11000 to 13200 (6 years) and 1st Class Chief Engineer 12000 to 14100 (6years). Head Engineers may go up to 18400 Duch Guilders. The ratio of maximum to minimum pay is again about 2. Salaries for research scientists have three rates of promotion for "average", "above average", and "outstanding" persons; these rates and promotions are reviewed every year.

United States of America

13. In USA there are great variations in pay scales in different universities and institutions. In the bigger institutions, the pay scales are broadly similar for men of comparable ability in Government agencies. In universities and scientific institutions the teaching staff can undertake part-time consultation work in industry or Government. In fact, in M. I. T. and similar institutions such part-time work is encouraged as a mark of competence. Men of comparable ability would get higher pay in private industry. However, many scientists prefer to work in universities and educational and scientific institutions because of greater academic free-

1. One Dutch Guilder = Rs. 1.24.

dom. In USA it is usual for scientists working in universities and educational institutions to accept additional paid work during vacations.

14. Because of wide variations it is somewhat difficult to quote figures for USA. The scale in Government increases from $2400 to about $12000 or $ 14,000 per year. (But sometimes very high pay is offered to scientists in an indirect way through "contract project" for Government work). In the larger universities and higher technical institutions the pay would increase from perhaps $4,000 or $5,000 for junior instructors to $ 10,000 or $ 12,000 (and $15,000 in exceptional cases) for full professors. There are also earnings for part-time consultation work or for lectures given (usually in other institutions) during vacations. In industry, men of comparable ability may get from 25 per cent to 50 per cent more but conditions of service are sometimes considered less congenial. There are also outtanding prizes (beyond the reach of scientists in government or educational institutions) but greater risks in industry. There has been a great deal of complaint that industry has been taking a large number of men from the universities and higher educational institutions; and it has been also stated that about ten per cent of science posts have remained permanently vacant at university level in recent years. Serious attention is being given to this problem at the national level; and pay scales in universities are being steadily increased.

Union of Soviot Socialist Republics

15. Scientists have the highest pay scales and other incentives in USSR. This policy was initiated long ago with the object of attracting persons of ability to a scientific career. It is now agreed that this policy has achieved its purpose in the spectacular development of science and technology in USSR in recent years. During the last two or three years there has been, however, a general reduction in salaries at higher levels, as an egalitarian measure, but even now scientists recieve the highest salaries.

16. There are no time-scales and all appointments are for five years, subject to review at the end of each five year period. For persons working in the same post for five years there may be a slight increase in pay, of the order of 10 per cent, and another similar increase after 10 years of service but such increase is not given in every case. There may also be special allowances on the basis of additional qualifications (for example, for having passed an examination in a foreign language or having attended a post-graduate course in medicine). On the research side, the institutes are now placed in two categories, namely, (a) "leading" institutions and (b) ordinary institutions. The Tarde Union authorities have an effective hand in this classification. Pay scales in "leading" institutions would be from 10 per cent to 15 per cent higher. Pay scales in natural sciences are also generally somewhat higher.

17. Most of the institutes in the USSR Academy of Sciences (which will be briefly referred to as Akad. Nauk) belong to the "leading" class. Typical pay scales in natural sciences in Akad. Nauk are given below. The Laboratory Assistant in the lowest category of scientific worker would start at about 900 roubles* per month if with training from junior technical schools, and at about 1000 roubles (which in special cases may go up to 1200 roubles) if with a univer-

* One US dollor is 4 roubles at official rate and 10 roubles at the tourist rate; and one rouble is about Rs. 1.19 at official and Rs. 0.48 at tourist rates.

sity level degree. The next higher eategory is the Junior Scientific Worker (for which the minimum qualification is the university level degree), who would get about 1200 roubles (fixed pay) which would be increased to 1800 or 2000 roubles if he gets the "Kandidates" (junior doctorate) degree. The next category is the Senior Scientific Worker (for which the minimum qualification is now a Kandidates' degree) who would get from 2500 to 3000 roubles, which would be increased to 4000 roubles, when he gets a senior doctorate degree, which is also the pay of a Professor. Thus a Senior Research Worker with a doctor's degree and a Professor have practically the same status. An Associate Professor would get about 3500 roubles and would be normally a Senior Research Worker of experience with a Kandidats' degree. The head of a "chair" (which would imply some supervisory responsibilities, such as the guidance of some research workers) would get about 5000 roubles. A Director of a laboratory or institute may get 5000 or 6000 roubles per month, depending on the importance of the institute. The ratio of maximum to minimum salary is thus about 6.

18. In Akad. Nauk, a "Corresponding" (or associate) member gets 3000 roubles as life pension; there are about 320 such members. An Academician, or full member, would get a life pension of 5000 roubles (and a surviving widow would get a life pension of 2500 roubles), a country house and a car. As he would be almost certainly a professor or a director, his income would be at least 10,000 or 11,000 roubles per month. There are about 170 Academicians or full members of Akad. Nauk. Members of the presidium (governing body) of Akad. Nauk get about 13,000, Vice Presidents 15,000 and the President 19,000 roubles per month which is the highest salary received in USSR (and is higher than the salary of the Prime Minister and the President of USSR).

19. Pay scales in other All-Union Academies (for Medicine, Agriculture etc.), the Academies of Sciences of the different Republics, and in the universities and higher educational institutions are similar but somewhat lower than the pay scales in Acad. Nauk. It may be noted that pay scales for research scientists and teachers in university level institutions compare very favourably with pay scales in Government service. For example, in the Foreign Service, junior officers get 1200 roubles (about the same as Junior Scientific Workers), Officers of the standing of Vice-Consuls and Second Secretaries about 1800, Consul-Generals and First Scretaries, 2,000 to 2,200, Counsellors 2,200 to 2,500 and Ambassadors 2,500 to 3,000 per month as basic pay when working in USSR, that is, exclusive of special allowances when serving abroad.

20. Pay scales are lower in industry, but the staff may earn substantial bonuses on the fulfilment or over-fulfilment of the plan. The general view is that on the whole there is a good balance between industry, education, and research depending on individual aptitudes; and there is no appreciable drain from any particular sector.

21. There is wide-spread practice of scintific workers in research institutes giving lectures in the universities and educational institutions for which they get additional pay which may be of the order of 500 to 1000 or 2000 roubles per month depending on the number of lectures. (A. N. Nesmeyanov, the president of Akad. Nauk, gives regularly two or three lectures in

undergraduate classes in the Moscow University. Other Academicians also participate in university teaching. This, of course, is a cultural gesture). It is also usual for the teaching staff of universities and educational institution to participate in the evening courses or to do some work in research institutes for which they would get additional allowances. Scientists in all institutions are encouraged to do part-time consultation work in industry; and scientists in industry participate in evening courses or sometimes in research work in institutes or universities for which they receive additional allowances. In fact additional part-time work is a strong feature of the Soviet system; the additional earnings may amount to half the salary of the regular full-time post. Many scientific workers have a good income from books and articles, as in USSR all scientific articles are paid for. It may also be noted that in USSR income-tax is very low and for top salaries would be of the order of about 12 or 13 per cent.

22. There is a system of awards of medals and money prize for distinguished work in science and technology, the highest award being the Lenin Prize of 50,000 roubles. There is still a great shortage of housing in USSR and residential accommodation is very strictly rationed on the basis of the size of the family. Scientist with a Kandidats' or Doctor's degree are entitled by law to have an additional room (in principle, for use as his study); this privilege is highly prized.

23. Great encouragement is given to attend special training courses for which there are prescribed requirements which may include passing a qualifying examination. Fellowships (which would not be less than the regular pay) are awarded for full-time study, also grants for books and equipment, travel expenses, and additional paid holiday of one month after completing the courses. Incentives are offered for part-time training in the way of supplementary paid holiday or special leave to prepare for examinations.

24. The pattern is broadly similar in all socialist countries. Scientists receive very high pay, professors are practically at the same level as the top administrators in government; and academicians enjoy still higher pay and have a higher status.

APPENDIX 3
TRADE UNIONS OF SCIENTISTS

1. In UK and Western European countries there are well established channels of communication between scientific workers and Government and the legislators for the representation of the personal, social and economic needs of scientists and for collective negotiations.

2. In UK there is a highly developed staff association, the Institution of Professional Civil Servants, with over 500,000 members from all scientific and technical grades in public services. This Institution functions as a trade union and represents the "staff side" in the National Whitley Council Organisation in negotiations with the "official side" in staff matters. It is generally

agreed that the Institution is working quite effectively. There is also a Civil Service Arbitration Tribunal which consists of a Chairman and one person from the 'official side" and one person from the "staff side" to consider cases which could not be otherwise resolved.

3. The British Medical Association is a powerful professional organisation which functions in some ways as a trade union and represents the whole profession in negotiations with Government. In UK, there are also large trade unions of engineering and technical workers and an Association of Scientific Workers which look after the wider interests of scientific and engineering workers of the country in both Government and non-Government employment.

4. In UK the Parliamentary Scientific Committee is a voluntary organisation with members elected from among Members of Parliament on one side and scientist members elected by a large number of professional organisations and societies on the other side. this Committee is quite active and maintains effective contact between the legislators and scientists.

5. In Germany there is a German Federation of Civil Servants (Deutscher Beamtnbunden) with a memberships of over 400,000 and also a much bigger General Federation of Trade Unions (Deutscher Gewerkschaftsbund) with about 600,0000 members. These two trade unions represent the staff side and are able to exercise a good deal of influence on Government policy.

6. In France employee participation in joint consultations with Government is provided by legislation. There are Technical Committees in each department consisting of an equal number of members appointed by Government and staff representatives appointed by trade unions of employees. There is also a Higher Council of the Public Service with a Chairman and 12 members each nominated by Government and by employee unions. In addition there are Administrative Committees for each occupational group consisting of four members, of which two are appointed by the ministry and two by the employees.

7. In Sweden there is a Central Organisation of Academics (Sveriges Akademikers Central Organisation), representing all university graduates and also non-degree holding professional employees, which includes thirty-one member organisations representing 45,000 members. The SACO looks after the economic and social interests, tries to improve the training and career prospects of its members, and represents its affiliated associations or helps such associations in negotiations with Government.

8. In both Norway and Denmark there is federated association of unions of graduates and government scientists which function as counterparts of SACO in Sweden. In both countries there are also Engineering Societies which, in addition to their professional activities, represent the economic interests of these members.

9. In USA there are, as yet, no trade unions of scientists of the European type. The American Medical Association functions in the same way as the BMA in UK and probably exercises an even greater influence. The professional engineering institutions to some extent look after social and economic interests of their members.

10. In USA there are, however, good contacts with legislators. Several important committees of Congress are concerned with

science and technology and have a highly daveloped system of studies and investigations by their own staff which are some-times published in the form of reports. A good deal ofdiscussion on science and technology also takes place at the time of budget hearings before various Appropriation Committees. In addition, the scientific societies and various committees of scientists look after scientific interests in a general way.

11. In UK and Western European countries there are thus well organised trade unions of scientific workers which function broadly in the same way as trade unions of industrial workers. In addition, the professional societies and institutions of science and engineering take up from time to time questions of social and economic interests of their members. In USA, although there are no trade unions of scientific workers, there are good contacts between scientists and legislators.

12. In USSR there is a federation of trade unions of all workers in scientific & educational institutions with over four million members in about 115,000 local committees or associations in individual institutions. In addition to negotiations regarding terms and conditions of service, the Soviet trade unions play an active role in promoting education and training and cultural amenities for its members.

13. It is worth noting that in USSR until two or three years ago there used to be separate trade unions for the scientific workers of professional standing and for other workers in scientific and educational institutions. Although these have been now amalgamated in a big federation, usually there are separate functional committees to look after the interest of the professional scientists and of other workers. This is necessary as the terms and conditions of service are in many respects dissimilar for the two groups.

14. Other socialist countries have Associations of Scientific Workers with membership broadly from among the professional workers. These function generally on Soviet model and have large educational and cultural activities. In Yugoslavia the trade union of scientific workers is broadly of the Soviet pattern with some minor variations. In addition, there are workers. councils in all enterprises which participate in management decisions.

15. There is a World Federation of Scientific Workers to which the Association of Scientific Workers of a large number of countries are affiliated. The Association of Scientific Workers of India is also affiliated to this World Federation.

ENROLMENT IN THE NATIONAL REGISTER

The total number of scientific and technical personnel enrolled in the National Register by March 1, 1960 was about 57,000 This includes about 4000 persons in the *Indians Abroad* section, where technical personnel currently under study, training or employment abroad (as also those who returned to India recently) are registered. About 300 persons with qualifications in business administration from abroad are also included as a special measure.

The broad distribution among the various fields of registration is given in Table 1

Table 1

Gategory	Registered in	
	General Register	Indians Abroad Register
Scientists	17,209	1,056
Technologists	3,837	359
Engineers	28,792	1,901
Medical personnel	3,228	332
Business administrators	—	309
Total	53,066	3,957

The details of the countries of training or employment of Indian personnel abroad are given in Table 2.

Table 2

Countries	Scientists	Engineers	Technologists	Medical personnel	B & A	Total
USA	504	478	86	84	84	1236
Canada	132	43	17	40	5	237
UK	192	765	126	155	167	1405
Germany	55	374	58	12	12	511
Other European countries	58	104	26	14	4	206
Australia & New Zealand	12	10	12	2	—	36
African countries	24	29	10	12	19	94
Burma & Ceylon	27	38	8	9	11	93
Other countries	52	60	16	4	7	139
Total	1056	1901	359	332	309	3957

B & A — Business administrators and accountants

(*Tehnical Manpower Bulletin, March* 1960)

SCIENCE & INDUSTRY

GLYCERINE INDUSTRY IN INDIA

Occurence

Glycerine occurs in all vegetable oils and fats and is usually present as a triglyceride combined with such fatty acids as stearic, oleic, palmitic, lauric etc. The fats are generally mixtures or combinations of glycerides of defferent fatty acids. Such oils as cocoanut, and palm kernal yield larger amounts of glycerine than fats like tallow.

Industrial Importance

Although Glycerine is primarily a by-product commodity, its production is, in general a fairly good indication of industrial activity because it enters into a large number of industrial processes. The industrial uses of glycerine number in thousands. Several grades of glycerine such as high gravity, dynamite, yellow distilled and BP/USP grades are marketted. The largest amount of glycerine go into the manufacture of synthetic resins, ester gums, dynamite, nitro glycerine, tobacco processing, manufacture of cellulose films and meeting casings; glycerol is also used in emollients, demulcents and as solvent in a number of other products. It is used in foods, medicines, cosmetics and as ingredients in syrup, where non-toxiciry is a major requirement. It is also used in lubricant because of its ability to remain fluid at law temperature. Thus, it would be seen that glycerine is virtually used in every industry. It is estimated that the world production of glycerine is of the order of 500 million pounds. In India, the industry produces about 7,000 tons of glycerine per year.

Source of Production

The major portion of glycerine produced in the world is obtained as a by-product in the manufacture of soap and fatty acids by saponification and hydrolysis (fat splitting) respectively of fats and oils. The glycerine crude (by-product) obtained directly from the above processes is of impure quality. Elaborate methods of refining are resorted to for producing satisfactory grades of glycerine to meet different end uses.

Processing for extraction

In the process of saponification, when fat is treated with caustic soda and salt, the fatty acids form soap, while the glycerine from the fat remains in solution. The glycerine containing liquid known as 'Spent Lye', is the most important source of glycerine. The spent lye is drained off from the soap for treatment, concentration and refining.

In other commercial method known as fat splitting, the dilute glycerine is obtained as 'Sweet Water'.

Recovery

In technologically advanced countries, 'spent lye' resulting from the saponification of fats contains on an average 10 to 15% of glycerine, while the sweet water from the hydrolysis of fats contains upto 20% glycerine. Generally the spent lye is boiled with fatty acids or high fatty acid stock to

reduce the amount of free caustic soda content and is allowed to cool; the solid soap is skimmed off and lye then subjected to a double treatment. This essentially consists of (a) addition of an acid and a coagulant, followed by filtration to remove the bulk of the impurities and (b) addition of caustic soda to the filtrate to remove the balance of coagulant in solution by precipitation and to regulate the pH of the lye to a point which is least corrosive to equipment used for subsequent processing.

The treatment of 'sweet water' differs from that of spent lye, but the equipment needed is essentially the same. The sweet water is neutralised with CaO (an excess to the extent of 0.23% of CaO being added where Twitchell process is used) and filtered through filter press; the clean filtrate is concentrated to 20° Be gravity of "half crude glycerine". The 'half crude' is then treated with soda ash or with sulphuric acid to remove excess of lime as carbonate or sulphate. The precipitate is separated by settling and decantation or by filtration. In the case of sweet water from continuous and batch autoclaves, the dirt and insoluble fatty material are skimmed off after settling; this is followed by a light treatment with lime to precipitate the dissolved fatty acids and neutralise the liquor to phenolphthalein end point. The alkaline liquor is filtered and evaporated to about 90% crude glycerine.

Concentration

The dilute glycerine liquor, after the purification treatment, is concentrated to crude glycerine by evaporation; that is usually carried out in conventional, natural-circulation evaporator under low pressure and with low pressure steam as the heating medium. At the bottom of the evaporator, means are provided for the recovery of salt which collects as the lye is concentrated. In normal operation, glycerine liquor is first concentrated to a half crude stage (about 40% glycerine content) and discharged from the evaporator to the holding tank for accumulation until the quantity is sufficient to return to the evaporator for subsequent finishing to crude. When the required concentration is reached, the vacuum is broken on the system and the finshed crude glycerine is drained into settling tank, settled, and the clear crude is ready for distilation.

Concentration of sweet water is carried out with the similar equipment and the method of operation is the same as that described for spent lye evaporation with the exception that no provision is made for salt handling; half crude need not be produced in handling 'sweet water'.

Refining

The refining of glycerine is accomplished by distillation of the crude under high vacuum to separate glycerine from non-volatile impurities. The extent to which refining or purification is carried out to meet the specifications for high purity grade necessary for use in foods, drugs, cosmetics or for technical uses such as the manufacture of explosives and resins, is determined largely by the use for which the finished product is intended. In order to meet the requirements of pharmacopoeia and extra pure quality grade, it is usually necessary to specially treat the glycerine to remove the last traces of colour and odour.

Yield

When we consider overall yields of glycerine, there are many points at which minor losses can occur. The combined effect of all

the losses may form a very substantial amount and materially reduce the overall yield. For instance, in kettle practice, an overall yield of 90 percent from the fat is an average figure and in many well-managed plants it ranges from 85 to 90 percent. For glycerine refining an overall average of 95 percent from the crude to the refined is good practice, but 95 to 96 percent is not unusual. Keeping in mind that all these figures represent reasonably cereful operation under good conditions, it may be seen that the miscellaneous losses form a considerable portion of the total in normal operation.

Effective control of these sources of loss requires more than a periodic check-up. The glycerine plant should be provided with weight tanks at the points where the heavier liquors and glycerine are handled, and with holding tanks for the measuring of the lighter liquors. All incoming and outgoing glycerine bearing materials to and from the glycerine plant should be weighed, sampled and analysed. A system of records should be set up to cover these movements of glycerine, not only in and out of the plant but during processing, that is from the lye to crude and from crude to refined. Only in this manner can figures be obtained for accounting which will represent actual results and be of use in tracing losses. With even the best control, constant care must be exercised or the net recovery of glycerine will fall below the yield possible by good operating practice.

In addition, there must be strict chemical control of incoming materials and supervision of standards of processing to insure quality of production.

Glycerol Production in India

The major portion of the glycerine produced in the country comes from the soap manufacturing units. Hardly 5% is processed by the fat splitting methods. About 80,000 tons of oils and fats are utilised in the country for the manufacture of soap. Of this more than 90% is utilised by the organised Soap Industry who also have the facilities for recovery and refining units for glycerol manufacture. About 4,500 tons of oils/fats is used by smaller units, who, however, do not have the necessary equipments for the recovery of the glycerol. Further, about 2500 tons of oils and fats are saponified by the cold processes where the glycerine goes completely waste. So effectively only 7000 tons (approx.) of glycerine

Quantity of oils and fats saponified by large scale Industry		80,000 tons approx.
Estimated quantity of oils/fats saponified on Cottage Industry scale		80,000 tons approx.
Recoverable glycerine	— 14 to 15000 tons	,,
Quantity of 80% crude produced	— 7000 tons	,,
Quantity of distilled/refined glycerine produced	— 3800 tons	,,
Existing capacity for evaporation	— 1 lakh tons	,,
Existing capacity for distillation	— 11000 tons	,,

is recovered from a total glycerine potential of 8000 tons.

In addition to the above, it is also estimated that quite a good quantity of oils and fats are utilised by the Cottage Industry and the house-hold for production of crude soaps. The order of oils and fats saponified in this crude manner is about 80,000 tons from which about 6000 tons of glycerine can be recovered which is going waste today. It would thus be evident that the potential for glycerine oil production in the country today is of the order of 14 to 15,000 tons of which only 50% is produced today. Therefore, there is a definite need not only to improve the yield of recoverable glycerine but also in finding out the requirements of the industry for suitable and specific designs of equipments and machinery, with a view to bring about the maximum utilisation of the existing capacity of the industrial equipment available. Further, a greater emphasis has to be laid on the fat and splitting process whereby the quantity of fats/oils consumed by the Cottage Industry could be provided in the form of fatty acid stocks and the glycerine recovered in an economic manner.

Efficiency of the recovery process

Normally a yield of 90 to 95% of the recoverable glycerine, from the fat to the lye in the saponification process and a higher yield of the order of 98% by the hydrolytic process are considered as good. Under Indian conditions, the glycerine recovered is only about 85 to 90% at the lye stage. Therefore, the yield of glycerine at the lye stage has to be increased.

The total loss in the recovery from lye to crude glycerine can only amount to about 3% of the glycerine content in the spent lye. In poorly equipped badly operated plants, the losses can be as high as 5%. The recovery under Indian conditions is generally of the order of 60 to 90%. There is a definite case for examining whether the losses are due to use of poor equipment or bad operations.

The quantity of refined glycerine produced in the country is about 66 to 70% of the total quantity of the glycerine crudes produced. Apparently, a large quantity of crude glycerine is exported/marketed or utilised as such. With the expansion of the industries, it would be desirable to block such leaks particularly when the demand of the industry is for better quality glycerine.

Equipment/Machinery

The largest soap manufacturing units have at their disposal sufficient equipment/machinery for evaporation of lye. In the case of the smaller units who are economically viable, there is a need for designing smaller evaporation plants with a evaporating capacity of 500 tons of lye per annum. In such a case smaller soap manufacturing units can recover glycerine going waste at present.

In respect of distillation capacity, it would appear that the distillation plant, both single and double type, available with the larger units have sufficient capacity for undertaking the refining of glycerine produced by all the existing manufacturing units in the country. It will not, however, be economical for smaller units to set up refining-plant of their own.

Conclusion

Though glycerine is one of the important chemicals for industrial developments, a sufficient emphasis does not appear to be laid

on its production in our country today. It is surprising that the order of production of high grade glycerine in the country is only about 4000 tons whereas about 7000 tons glycerine is recovered in the country. Compared to the world production which is of the order of 500 million pounds, the amount of glycerine produced in our country is negligible.

There is a definite need for improving the recovery of glycerine. Whereas the efficiency should be of the order of 90 to 92%, we are hardly attaining 80% efficiency of the overall recovery at the crude stage. Not only have we to examine whether this poor efficiency is due to bad equipments but also whether it can be due to bad operation.

Further, sufficient quantity of fats should also be provided for hydrolysis of fats by the hydrolytic processes. This will lead to a more economic recovery and increased output of glycerine. The extra-production of fat acids can be suitably absorbed in the form of fatty acid stock of desired blending for use by the Cottage Industry for production of soaps. This will avoid the collosal waste of glycerine when crude soaps are produced on the Cottage Industry scale.

ASSOCIATION NEWS

ASSOCIATION OF SCIENTIFIC WORKERS OF INDIA
HYDERABAD BRANCH

A General Body meeting of the branch was held on 23rd April, 1960, at the Regional Research Laboratory premises. The General Body of the Branch approved the annual report for the year 1959-60 presented by the Secretary and the pre-audit statement of accounts presented by the Treasurer.

The General Body also approved the proposal of the Joint Executive for Hyderabad Branch and RRL Unit, and the following office bearers and members of the Executive for the year 1960-61 were elected unanimously :

President	Shri Baldev Singh
Vice-President	Dr. E. R. Saxena
Secretary	Shri H. Gopalkrishnan
Jt. Secretary	" K. M. Ghouse
Treasurer	Dr. R. Vaidyeswaran.

Members

Dr. M. G. Krishna, Dr. P. M. Bhargava, Shri S. M. Mohsin, Shri G. M. Sastri, Shri K. Seshagiri Rao, Shri Khurshid Hussain, Shri M.M. Hasan, Kumari Safia Mehdi.

The meeting came to a close with a vote of thanks to the Chair.

Report of the Hyderabad Branch of the ASWI for the year 1959

The activities of the Branch may broadly be divided as (1) Organisational activities, (2) Trade Union activities and (3) Activities for popularisation of science and (4) Other activities. The Branch consisted of one unit, i.e. RRL Unit with (76) members and seven outside members.

1. Organisational activities

The paid membership for the year is 83 till 1st April 1960. 11 members have left the Branch for different reasons. Twentyone new members have been enrolled and subscription is yet to be received from ten old members. Shri M. Sampat Kumaran one of the Joint Secretaries had to take up a new assignment at Oil Technological Institute at Anantapur. He is making efforts to form a unit there. Necessary information and materials were supplied from this Branch.

2. Trade Union activities

The Regional Research Laboratory unit met and discussed the pending problems that arose out of taking over of the laboratories by the C.S.I.R. Further negotiations by the Unit with respective authorities are under progress. The unit also set up a Committee to go into the medical rules of CSIR and explain them the members of the association so that maximum benefit is derived.

3. Activities for popularisation of Science

A. Lectures on scientific topics : The Branch arranged discussions and lectures as detailed below :

	Subject	*Name of Speaker*	*Place*	*Month*
1.	Some impressions of the "All India Rice Research Workers Conference" held at Cuttack.	Shri M. S. Pawar	Y.M.I.S. Hall	March
2.	Planned Parenthood	Dr. Taher Qureshi	R.R.L.	April
3.	A discussion on "the ideas on present day research expressed by late Prof. Joliot Curie at the Noble Laureates Conference in 1958"	The discusssion was initiated by Shri Baldev Singh	,,	June
4.	Viruses and Bacteria their uses and abuses	Dr. K.B. Deshpande	Madrasa-i-Aliya High School	August
5.	Insects & Insecticides	Dr. M.B. Naidu	Mahboob College High School	October
*6.	Power development programme of Government of Andhra Pradesh	Shri S. A Qadar	R.R.L.	November
7.	Pigments of the Body	Prof. K. Ranganath Rao	YMCA Secunderabad	September

*Collaboration with Colloquim, R.R.Lab.

B. Excursions to places of scientific importance: The Branch arranged a two-day excursion to Nagarjuna Sagar Project and Nagarjuna Konda excavations during first week of December, 1959. The Branch also made preliminary arrangements for holding a symposium on "Integration of Science Teaching at University Level". The Symposium was not held.

4. Other activities: 1. The RRL Unit has collected a sum of Rs. 438.09 towards donation to the widow of late Shri Mohd. Yousuf of Paper Section of RRL who died in an accident.

2. The Branch Executive Committee passed a condolence resolution on the sad demise of Shri S. Neelakanta Rao on 3rd March '60 who is one of the members of the executive.

3. The RRL Unit of Hyd. Branch of ASWI, passed a resolution, in connection with the tragic conditions under which Dr. T.M. Joseph of IARI committed suicide. The resolution was forwarded to Central Executive for further action.

Programme of work for the year 1960-61

The Chairman invited each member present to offer suggestions on the various activities that could be taken up by the Association. The following suggestions were made:

(i) Revival of Assembly and Sceintific Committee.

(ii) Acquainting the research staff about the role, function and importance of the Association and what it stands for.

(iii) A study of the CSIR medical attendance rules and interpreting the same to the staff.

(iv) A study of the occupational hazards confronting the research workers and measures to remedy them.

(v) Accident insurance for the research workers and other employees (Dr. Vaidyeswaran and Dr. Bhargava cited the example from other countries).

(vi) Study of the service conditions of the employees of the RRL CSIR, and their implication with particular reference to (a) confirmation and (b) promotion (c) salary & grades.

(vii) Popularisation of science through Lectures & film shows.

(viii) Cultural activities.

(ix) Collection of subscription and enrolment of members.

(x) Issues which have been discussed at the previous Unit meetings and on which action has not been taken.

U. P. P. W. D. Research Institute, S. W. A., Lucknow
(Affiliated to ASWI)

The Annual General Meeting of the Association was held on the 6th May, 1960, under the Presidentship of Sri Manohar Lal.

The first year of the Association had been a year of constant struggle, a struggle marked by the non-attainment of any visible results. In the very beginning, precisely speaking on the 27-5-59, the General Body expressed their discontentment against the prevailing conditions and passed a number of resolutions for the betterment of their service conditions and requested the Chief Engineer to move the Government to withdraw the G. O. restricting the services of the scientific staff.

While the department and the Govt. paid no heed to the Assocn. the Assocn. of Scientific Workers of India were very sympathetic and friendly to our newly born Association. Our request for affiliation was promptly acceded to. A strong resolution for removal of restriction on our services was passed at their Bombay Meeting,

The following were elected office-bearers for the next years :—

President	—Sri Manohar Lal
Vice-President	— ,, J. P. Bhatnagar
Hony. Secy.	—Dr. T. N. Chojer
Asstt. Secy.	—Sri U. C. Gupta
Treasurer	— ,, C. M. Nagar
Members	— Saravshri BL. Dhawan, Sayeed Zair Husain and R. D. Khare.

Southern Railway Chemists And Metallurgists Staff Association
Organisation
Number of members: Twenty One Only (21)

Number of meetings of the Executive held — Two

Science Activities :
Four lecturers were arranged.
Issues Pertaining To Economic/ Professional Interests :
Some problems are being pursued.

W. F. S. W. NEWS

A SCIENCE GROUP IN THE CAMPAIGN FOR NUCLEAR DISARMAMENT

(The following statement is contained in the first issue of a new bulletin, issued in Great Britain, called C. N. D. Scientists.)

Modern weapons are the products of an advanced scientific technology, requiring considerable technical training for their operation and maintenance. But, apart from nuclear weapons and biological or chemical warfare devices, no special scientific background is needed to envisage their effects. Nuclear weapons are rather different. The huge extent of their immediate destructive effects due to heat and blast are only hard to grasp in the sense that any very large number presents difficulties to the human mind. However, the implications of early effects of radiation, and the later effects of radioactive fall out, require for their understanding a degree of specialised scientific knowledge which most of the population, including our political representatives, do not possess. The help of scientists is needed to seek out and interpret the information available. Although decisions about the manufacture and use of nuclear weapon must ultimately be made on political and, ideally, moral grounds, they cannot properly be made unless the facts or uncertainties are understood as fully as possible. Many scientists realize this, and it is why scientists throughout the world were the first to express in public their uneasiness and dismay at the prospect of the Great Powers coming to rely more and more on nuclear armaments, which might one day be used to achieve political ends.

The C.N.D. has from the beginning had the advice of scientisis, but only five months ago did the Executiue Committee decide that there was room for a special scientists' group in order to draw more scientists into the Campaign and to provide a channel for them to give their specialist advice to the Campaign. At an invited meeting last September addressed by Earl Russell, a Working Group was formed, of which the provisional officers are Professor N. Kemmer, F.R.S., (Chairman), and Dr. A. Pirie (Secretary). The Group intends to provide regular advice to the Campaign in the light of scientific information, as it becomes available, on such subjects as fall out, civil defence, control of tests, effects of nuclear war, relevant aspects of general disarmament, and civilian uses of nuclear energy. The more important information will be abstracted in the Campaign bulletin or in special supplements. It is also hoped that local Scientific Groups will be formed whose functions might be to discuss problems of nuclear weapons among themselves and to train speakers; to study special aspects of the subject and to exchange information or to write up material for the Working Group. As experience is gained, other functions will doubtless suggest themselves.

New Canadian on the Cessation of Nuclear Tests

(The following report is taken from the New York Herald Tribune, Sunday, 21 February, 1960)

OTTAWA, February 20—The Canadian Government appeared today to have broken with its American and British allies on the question of ending nuclear test explosions, and to have taken a new position closer to that of the Soviet Union.

In yet another shift in foreign policy, the government here gave notice, through External Affairs Secretary Howard C. Green, that Canada is finished with the "honest broker" role in international relationships. Instead, Mr. Green told the House of commons during an external affairs debate which ended this week, "the time has come to take an independent approach".

Prime Minister John Diefenbaker's speech in the debate listed ten "concepts" as being basic to the Canadian government's approach to the problem of disarmament. Canada is a member of the ten-nation disarmament commission which is scheduled to meet next month at Geneva.

Mr. Diefenbaker listed "ending of nuclear tests" as the first of his government's ten concepts. He said nothing about adequate controls and safeguards as a necessary prerequisite to a ban on such tests.

When Mr. Green rose to conclude the debate, the liberal opposition leader and former External Affairs Secretary, Lester B. Pearson, asked whether the government has changed its policy since last autumn. He pointed out that at the United Nations last November Mr. Green's parliamentary secretary, Wallace Nesbitt, made a speech which treated the question of controls as inseparable from the question of a test ban.

In reply, Mr. Green stated: "The Canadian Government is opposed to further nuclear test, period". Pressed further by Mr. Pearson, Mr. Green elaborated by explaining: "My parliamentary secretary (Mr. Nesbitt) recognised the need for working out, in the three-member (U.N.) committee now dealing with this question of nuclear tests, some method of control. That is one thing. The other thing is that Canada believes there should be no more nuclear tests of any kind".

Liberals questioned whether Mr. Diefenbaker's concepts of disarmament were an independent approach. They include: controlled disarmament by stages, beginning with missiles; prohibition of nuclear weapons, gas and germ warfare, space weapons, manufacturing of fissile material for military use and national jurisdiction in space or on celestial bodies; establishment of an international police force with capability to deter aggression; and universal acceptance of compulsory arbitration of international disputes by the International Court of Justice (the World Court) at The Hague.

Statements from India on the Sahara Test

Statement by Mr. Sanjiva Reddy, the President, Indian National Congress

[*Times of India*, February 17, 1960 (7)]

The atomic test carried out by France is definitely injurious to the cause of world peace and hurting to the people of Africa and the Arab Countries. It has also caused disappointment to the whole peace loving world. Whatever the motives behind the French action, it appeared to be wholly out of time with the prevailing atmosphere of peace in the highest international spheres. With the

way being paved for a successful summit meet the French world have been well advised to stay their hands. The Algerian people, in whose territory the test had taken place, are bound to feel rebbled in the extreme at what the French have done and more so at the prospects of a repetition of the same.

The people of India could not approve of any act that tended to accentuate international tension, and hoped that the French "will see the wisdom of not repeating the performance".

* * *

Statement by Shri Jawaharlal Nehru, the Prime Minister of India, in Parliament on February 17, 1960 [*Times of India*, February 18, 1960 (1)].

The rise in the atomic radiation level in the Indian atmosphere had been found to be 'far below the danger level' by the monitoring stations following American and Soviet nuclear tests. Most of the African countries had protested against the French test and there was an appeal in the United Nations that it should not be done. It was a matter of great regreat that the test had taken place, not so much because of its immediate effects—"it is difficult to measure those effects, and possibly the effects may not be immediately dangerous to anybody"—but because the process of atomic tests had started again after their suspension and when there was hope that they would be totally stopped.

* * *

Dr. Homi J. Bhabha's, Chairman of the Atomic Energy Commission, India, note on French Atom Blast presented to Mr. Nehru, Prime Minister of India [*Times of India*, February 20, 1960 (1)].

The radioactive clouds from the Sahara would possibly take some three or four days to pass over India and were expected to rise to a maximum of 50,000 to 60,000 feet in the troposphere. There might be a small increase in radioactivity for a few days. However, the magnitude of the activity was not expected to be of any great significance in comparison with the radio-active fall-out that India was still rechiving from past tests elsewhere. The U.S.S.R., the U.K., and the U.S.A., had exploded 50 hydrogen bombs and 200 atom bombs. The Atomic Energy Commission was regularly analysing milk supplies sent by about 30 sampling stations in India to keep a close watch on the radioactive contamination of air, water, foodstuffs and soil. The measurements so far made have definitely proved that the contamination is increasing gradually compared to the normal background levels.

* * *

Resolution on ending nuclear weapon tests passed by the Soviet Public Disarmament Conference, Moscow, 15 and 16 February

We, the participants in the Conference of the Soviet Public on disarmament, have discussed the question which today agitates the whole of mankind—that of achieving agreement on ending nuclear weapon tests.

The Soviet people, in common with peaceloving people in all countries, experience a feeling of satisfaction that for a considerable time now no nuclear explosions have been conducted by the United States, the USSR or Great Britain. The whole world knows of the statement of the Soviet government to the effect that it will not resume nuclear tests if the western powers do not do so.

However, all people of good will are disturbed by the fact that the powers possessing nuclear weapons have still not concluded an agreement on banning all nu-

clear weapon tests for all time. This alarm has been increased recently in connection with statements made in the United States indicating that there is a danger of nuclear tests being resumed.

Public circles in the Soviet Union share the justified indignation of the world public at the atomic weapon test conducted by the French government in the Sahara, in defiance of the appeal of the United Nations General Assembly. This, Geneva negotiations of the three powers, which have been going on since 1958, on an agreement for ending nuclear weapon tests. It also plays into the hands of all opponents of disarmament, of all advocates of the atomic arms race.

The powers have already agreed on many important questions, and the road to an agreement is in effect open. The obstacle to agreement is the unwillingness of the United States to ban underground nuclear tests, under the pretext of explosions, although it is common knowledge that the meeting of experts, held in Geneva in 1958, recommended sufficiently effective methods of control over all underground nuclear explosions.

Neither the Soviet public nor the public of other countries can recognise this as sufficient reason for refusing to come to terms on ending all nuclear weapon tests. When such an agreement is signed it will impose on its signatories great responsibility for its strict observance.

It can hardly be expected that, once an agreement on ending nuclear weapon tests has been concluded and the control machinery has been set up, any country would undertake secret underground explosions at the risk of being exposed and branded with infamy in the eyes of the peoples of the world. As a result of several meetings of technical experts, the absolute and full feasibility of detecting various kinds of explosions has been established and the basic control machinery required for this has been outlined. Modern science offers sufficient opportunity for tackling any unsolved technical details.

The only correct course in present conditions would be to conclude an international agreement on ending nuclear tests as quickly as possible and to set up control machinery in accordance with the recommendations of the experts. The rapid progress of science and technology, and also the practical experience gained in the course of the work of this control machinery, would make it possible to introduce subsequent improvements in the control system.

The Soviet public express their sincere hope that the Geneva conference will reach agreement on ending nuclear weapon tests universally and for all time. This is awaited by peace loving people all over the world and by the world public.

SYMPOSIA & SEMINARS

ENERGY IN THE SERVICE OF MAN

BY DR. SAMPURNANAND,
Chief Minister, U. P.

The bringing together and dissemination of knowledge on a very important subject will itself serve a useful purpose. It will also help to direct attention to what, besides being a matter of great topical interest, makes a great aesthetic appeal to those who care to approach Nature with that sense of awe and reverence which is so rightfully her due.

The destructive uses to which nuclear energy can be put hardly need recapitulation. It is indeed a tragedy that man very often fails to appreciate the inherent value of a great scientific discovery or invention unless he can immediately put it to the purpose of war. The history of science is full of examples of this. To give only one example, the rocket which is today our only means of exploring space was invented in China about a thousand years ago and was promptly used as an engine of war by the then Chinese Emperor in a war which he was waging against his neighbours in Manchuria. It then fell into desuetude except as a piece of fireworks. Much later, Europe took notice of it when Hyder Ali's army used it with deadly effect in his wars against the British. Had it not been for the discovery of powerful explosives near about that time, the world would probably not have had to wait so long for space travel. Not even the United States of America would have been willing to finance the experiments that led to the atomic bomb if the second World War had not been in progress at the time and no one would have cared to find the money for researches in atomic fusion or fission if the world were not haunted by the spectre of a prospective third World War. It is clear that at present one is hardly aware of any harmful effects of nuclear energy other than those manifested in the physical destruction of material objects, the human body included. It is suspected that there may also be grave effects of a biological nature. The genes may undergo powerful metamorphosis resulting in unpredictable morphological changes. All this may sound like a wild nightmare of a science fiction writer but at present science is merely on the fringe or the periphery of knowledge in this field and cannot write off the potentialities of the forces with which it is playing.

Unfortunately, people's attention has naturally been directed to the destructive uses of nuclear energy with the result that it is being seriously suggested that all research in this field should be given up. Scientists are being blamed, and not without reason, for allowing their genius to be prostituted for purposes of destruction not only of the human body but of all those finer attributes and feelings which make man truly human.

Fortunately, all is not yet lost. It is possible to rectify the mistakes of the immediate past and apply nuclear energy to innumerable purposes of a beneficent nature.

As President Eisenhower observed to the General Assembly of the United Nations on Dec. 8, 1953.

"The United States knows that peaceful power from atomic energy is no dream of the future. That capability, already proved, is here-now-today. Who can doubt, if the entire body of the world's scientists and engineers had adequate amounts of fissionable material with which to test and develop their ideas, that this capability would rapidly be transformed into universal, efficient and economic usage?" What is true of the United States is equally true of every other country which is interested in scientific research. As for the condition which President Eisenhower postulates, it may be said that scientists and engineers can hardly devote their energies to the task of peace so long as men's mind are influenced by the forces of competition, jealousy, hatred and envy.

Before one considers the peaceful uses of nuclear energy, the aesthetic aspect of the matter may be discussed. A beautiful book by Charles-Noel Martin named, "The Thirteen Steps To The Atom"-A Photographic Exploration is in the market. It has been rightly observed that this book deals with the fantastic world which one cannot see with the naked eye. The author hastried to show, in the words of the Publisher, that 'in science is to be found the inexhaustible source of an art which dwarfs our own, in which Nature seems determined to overwhelm us with the spectacle of her riches and the profusion of her beauty'. The 118 photographs in the book reveal patterns which can be adopted with advantage by a number of handicrafts men as well as architects and even town planners. It is not all about the atom, but deals with a world which increases in minuteness of size and beauty of design till it reaches the atom and even here as the author has pointed out, men are at the end of the journey.

The first peaceful use of nuclear energy which comes to mind is as "fuel". One field in which atomic energy would be of immense use and incalculable is for space exploration benefit. Man has begun to make his first attempts in Space Travel. Apart from all other difficulties, he is handicapped by the lack of a suitable 'fuel'. The chemical 'fuels' which are available today and may become available in future will all possess bulk and volume and in this way influence the ballistics of the space-ship. In addition to this is the fact that the amount of energy which can be released by any conceivable chemical reaction is not of a very high order. Such source of energy will not allow a space-ship to travel very fast and a journey even to some of the members of our own family of planets will be a life-time job. If somehow speed approaching something like one-half the velocity of light could be achieved, space travel might become more attractive and more useful. This, again, looks like a wild dream of a science fiction writer. But as one such writer has put it rather bluntly' it is only now that science has begun to catch up with science fiction'. The supply of energy in our own planet from is literally unlimited. Down in the bowels of the earth, in the star-dust and gaseous clouds that span interestellar and probably intergalatic space, in the cosmic rays that are without any break bombarding the earth from the depth of outer-space, nature provides us with an inexhaustible fund of material which can yield nuclear energy.

Consider our own estimate of fuel requirements. In the address given at the Geneva Conference, Dr. Bhabha had estima-

ted that in the 18½ centuries after Christ, not more than 9 Q of energy were consumed, (a Q, roughly equal to one lakh million British thermal units). But the use of energy by mankind has been steadily rising since then. At present, it is roughly speaking, a little more than 10 Q per century. The total world reserves of coal, oil, gas and oil shals which are economically workable are estimated to be between 40 and 100 Q. This means that, at the present rate, the fuel reserve would be exhausted in about 7 centuries. But in saying this, no account is being made for the rate at which fuel consumption is rising. According to a paper read at the same Conference on behalf of the Statistical Office of the United Nations, it is increasing at the rate of 4½% per year. It may also be remembered that world population is increasing roughly at the rate of 11.5% per year. This would mean that before the end of the present century, it will be more than twice the requirement of energy. By the year 2000 it would be in the neighbourhood of. 5 Q per year. This would mean the exhaustion of all available sources of fuel supply within a maximum period of 200 years. Of course, there are some other sources from which energy can be obtained such as wood, hydroclonic machinery and vegetable oils. In India Cow dung is burnt as a fuel and experiments have shown that it is possible to extract a gas from it which can be utilised in the kitchen. and as an illuminant. But all these sources put together do not really amount to much and would hardly meet the needs of a advanced economy even for a month.

The situation is, therefore, serious. Either humanity completely reverses its steps, scraps industrialization completely except what can be ligitimately called manual craftsmanship, limit power requirements as far as possible to muscle power about 10,000 years ago or it adopts nuclear fuel. Man was not less happy then than he is now. It will be an arduous journey and an unpleasant one. Also it will be an unnecessary one. The fuel situation does not imply that mankind should turn primitive. One should try to tap a source of energy which has hitherto been left untouched and that is nuclear energy.

It should be clearly understood that nuclear energy includes the term Thermonuclear power, the energy derived from fusion. Researches in this field have been on for sometime, but the whole thing is covered with a veil of secrecy. It was Dr. Bhabha who through, what has been called, an 'act of calculated indiscretion' forced into the open some of the knowledge gained through these experiments. It is true that the production of nuclear energy is, at present, very costly, but one can only hope that technological advance will be able to master this problem in the not very distant future. In any case, when the problem before humanity is almost total extinction of civilization, the only alternative being the use of nuclear energy, no pains will be spared and no expenditure considered too great for the purpose.

Another peaceful use of this source of power which easily suggests itself is in the sphere of medicine. What might be called, peripheral use, has been known to medical science for a fairly long time. The use of the X-ray in diagonsis is too will known to need recapitulation. During recent years the radium treatment of Cancer has almost completely surpassed other methods. Earlier, reference was made to the possible biological effects of exposure to radiation, but the converse can also be conceivably true. Gene-

tic changes of a desirable nature might, perhaps, be induced in the parents and any desired type of progeny might be produced by this means. This is not to say that this revolution in eugenics is just beyond the corner. It may also be a debatable question whether it is morally right to induce mutations in accordance with a *priori* notions.

It is highly probable that other applications of nuclear power in the field of medicine will be discovered as time goes by. An artificial satellite station in space, well beyond the earth's gravitational pull and secluded from those bacteriological and other influences which are native to the earth, may prove to be not only an ideal research station in medicine, but also an ideal sanatorium. The potentialities of nuclear power for the destruction of harmful bacteria in the atmosphere, in water and in various kinds of food are under study.

Nuclear energy can be also put to use in industrial and even in agricultural processes. Wherever power from any other source can be used, one may safely assume that nuclear power can be used; one may safely assume that nuclear power can be substituted for it and will prove, under proper safeguards, cheaper and less injurious. Apart from the uses to which it lends itself in various directions in the domain of applied science, the study of radiology and nucleonics is beginning to prove more and more useful in the field of pure science. Examples easily come to the mind from astronomy and geo-chronology and the light thrown on palaeo-botany palaeo-zoology and anthropology.

SEMINAR ON ANTIBIOTICS

A seminar on Antibiotics will be organised by the Scientific Workers' Association (Ministry of Defence) at DRL(S), Kanpur in August, 1960. The scope of the seminar will be broadly as under:

History of antibiotics ; Methods of production & assaying antibiotics ; Antibiotic actions on tissues ; Antibiotic actions on microbes & viruses including mechanism of action ; Drug resistance ; Clinical aspects ; Hazards of antibiotic therapy ; Stability of antibiotics ; Nutritional and other non-medical aspects of antibiotics.

Those, desirous of participating in the seminar, should send their papers with abstracts (30 to 50 lines) to the Convener Dr. J. N. Tayal, Post Box No. 173, 12-A, Napier Road, Kanpur.

RADIOACTIVITY IN MEDICINE

BY DR. M. M. SINGH,
Deptt. of Medicines, Lucknow Medical College, Lucknow.

Radioactivity has become an all embracing subject. There are few topics to equal it in its breath and depth.

The medical uses of radioactivity cover 3 broad areas. It has been used in the diagnosis of a few conditions but the diagnostic uses todate are limited. Less limited is the use of radioactivity in therapy but the results, by and large, have not been spectacular or earth-shaking. The most productive use of radioactivity is in the study of the intermediary metabolism of the body; and the knowledge gained in the past decade by the use of tracer technique has been phenomenal. The diagnostic uses of radioactivity in clinical medicine may be taken.

In countries where radioactive material is available in plenty, the interest in its biological uses can be gleaned from certain statistics. A recent bibliography issued by the Atomic Energy Commission covering only the 3½ years period from June 1951 to Feb. 1955 lists about 5000 publications in the open literature wherein radioisotupes were used in the life-science fields. Some indication of the popularity of radioactive isotopes can also be gained from the fact that the Oak Ridge National Laboratory has dispensed over 100,000 curies of isotopes—which is the equivalent of 200 pounds of radium (less than 3 lbs. of actual radium is available in the world today).

Like any other diagnostic procedure, the one employing radioactive material must satisfy 4 well established criteria. It should furnish useful information when a diagnosis is questionable; it should be simple to perform; it should provide an answer in a reasonably short time and it should do no harm. In addition to these simple rules, radioactive isotopes used clinically must satisfy certain additional criteria. The isotopic element and its atomic mass and number must be known — with certainty. The atomic decay scheme must be known. The physical, biological and effective half life must be of proper duration. The emitted radiations (α, β, γ, and so forth) should be suitable. The biological effects of the emitted radiation should be understood. Radiation protection should be feasible and easily accomplished. Availability of isotope should be no problem. Chemical and metallic processes must be well understood. Chemical or physical toxicity of the isotope and its offspring must be absent. Quantity of isotope should be minute so that untoward radiation effects are avoided.

The potential diagnostic uses of radioactivity isotopes are many and the next few years, no doubt, will see great activity in this field of isotopic endeavor. At present, however, in practical clinical medicine, radio-active isotopes have a limited diagnostic use applicable to only a few clinical conditions. The principle involved are simple and few.

The most commonly used test utilise of *selective localisation.* If a certain element is selectively localised in a given tissue and if disease processes affect its concentration in that tissue, then the isotope of the stable element may be used and from changes in the radioactivity of the localising tissue, diagnostic information

may be gained. This principle is the basis of the isotopic diagnosis of the thyroid disorders and for tumour localisation. It is this use of isotopes that has been found diagnostically most useful in clinical medicine.

A second principle underlying isotopic technique involves simple isotopic dilution not unlike some of the dye dilution techniques. A pre-determined number of radio-active atoms is injected into a space of unknown size and allowed to mix evenly with the medium in that space. A known quantity of the medium is withdrawn, and the number of radioactive atoms counted; from this the size of the unknown space may be computed. This principle has been utilised in the determination of plasma volume, blood volume, various other body fluid volumes, potassium space, sodium space, chloride space etc. in various medical and surgical conditions.

A third principle underlying the diagnostic use of the isotopes involves cytological tagging with the isotope. Thus, the tagging of red cells with isotopes may be used to study the behaviour of the red cell itself and much diagnostic information about the red cell volume and homolytic anemia can be obtained.

Fourthly, the most straight-forward use of radio-isotope is to give a tracer dose in its element form and know its concentration as judged by radio-activity in various tissues. Thus bone marrow counts after the injection of Fe^{59} provides diagnostic clues as to the nature of the anemia. Further examples of the application of this principle are in determining the effectiveness of vascular shunts and vascular grafts, revascularisation of pedicle skin graft, venous stasis, circulation time and cardiac output. A variant of this tracer use is the substitution of the radio-active isotope of an element for its stable element in molecules of biological importance. Thus by substituting $Cobalt^{60}$ in Vitamin B_{12} molecules, useful diagnostic information about pernicious anemia can be obtained.

From the practical clinical stand point, the only test that deserves some detailed consideration is that involving the use of radio-active iodine in thyroid disorders. The radio iodine test owes its popularity to the very remarkable and unique ability of thyroid gland to concentrate iodine. The gland avidly picks up iodine from the plasma, the concentration in the gland being 50-100 times greater than that in plasma.

Although, there are at least 10 isotopes of iodine, the one most suitable for use is I^{131} with a half life of 8 days. In western countries I^{131} became abundantly available as a fission bye product when the atomic pile was built. Tracer dose of I^{131} is now almost always less than 50 u curies and commonly 10 u curies. This dose is given orally on a fasting stomach as a simple solution of radio-active sodium iodide. Although, there are many ways of assaying the thyroid function, the most widely used test still remains the simple 24 hour uptake expressed as the percentage of the administered dose found in the thyroid 24 hour after the ingestion of I^{131}.

The usual range of 24 hour uptake for euthyroid patient is 15 to 40% for hyperthyroid patients more than 45% and for hypothyroid patients less than 15%.

Pit falls are many and one must never pronounce or exclude a diagnosis on the basis of the laboratory figures alone. It is

very important to evaluate the finding in the light of previous exposure to iodine and other drugs. If stands to reason that if the patient has taken iodine in the immediate past, the gland will become saturated and the uptake of I^{131} will be depressed. Many thyrotoxic patients have been unisdiagnosed as being euthyroid because a careful history was not taken. Before proforming the test, the standard procedure must be to enquire about exposure to excessive iodine. Thus external application of iodine in tinctures and gauze, sea-food diet rich in iodine, vitamin preparations containing iodine compounds, lugol's solution, potassium iodide, sodium iodide and cough and asthama medication containing iodine, almost all X-ray contrast midiums which contain organic iodide compounds and are used in cholecystography, cholangiography, urography, bronchography, angiography and myelography and such iodine containing drugs as vioform, di-iodoquin, fluroquin etc. depress I^{131} uptake and as such give misleading results. The depressing effect of iodides may last upto 6 weeks and tracer studies must, therefore, be repeated after 8 weeks. Iodinated vials, as used in contrast radiography may affect I^{131} uptake for months after its use.

Thyroid preparations will also depress I^{131} uptake. The mechanism of this phenomenon is believed to be through the suppression of TSH. Thyroid medication should be discontinued for 8 weeks before the test is performed.

Other drugs that decrease I^{131} uptake are the thio-urea derivatives, thiocyanates, perchlorates, PAS, ACTH, Cortisons etc.

The other difficulty with interpreting I^{131} uptake results is due to the overlapping of the results obtained in the differing function states of the thyroid. There is an equivocal zone between each of the ranges where the diagnosis ordinarily is in doubt. Thus if a patient has an uptake of 65%, there will be little doubt about the diagnosis of thyrotoxicosis. What about the patient in the range of 45%—60%? Is he euthyroid or hyperthyroid? To settle this point a modification of the standard test has been devised. It has been reported that the administration of 2 grains a day of thyroid extract for a period of 10 days will depress the I^{131} uptake of enthyroid patients to values below 20%, whereas in thyrotoxic patients the uptake is little affected.

Likewise, if a patient has an uptake of say 5%, diagnosis of myxedema is unequivocal. What about the patient in the 10-20% range? Is he euthyroid or hypothyroid? To clearify the diagnosis in these patients, a modification using TSH has beed used. If the patient has primary hypothyroidism, I^{131} uptake will not increase in response to TSH; in euthyroid patients it will.

The TSH test is also an excellent way to distinguish between primary and pituitary myxedema. In pituitary myxedema, TSH administration will lead to an increase in the radioactive iodine uptake; in primary myxedema with morphologically damaged gland, TSH will not lead to increased I^{131} uptake.

Tumor diagnosis or localisation, or both, by isotopic techniques is not feasible across the whole spectrum of tumor. Most methods involve the injection or ingestion of an isotope followed by counting over the suspicious area. From practical point of view, the tracer studies have offered little by way of diagnosis.

A clinical situation arises in which a patient with non-toxic goiter has nodules in the thyroid and one wants to know if the nodules are neoplastic. Scanning of the nodule after I^{131} ingestion has shown that if the nodule is functioning more actively than the adjacent thyroid tissue, malignaney can be ruled out with reasonable certainty. On the other hand, if the nodules concentrate the same amount of I^{131} as the surrounding normal thyroid tissue then the nodule may or may not be malignant. You cannot tell.

Total body scanning may be performed in a search for metastatic thyroid tissue. In the absence of scintillation scanning apparatus, one may obtain a total body profile by moving a Geiger counter or other radiation detector down the length of the body. Again I^{131} has little to offer, since in the majority of cases, metastases will not pick up iodine in the presence of the intact thyroid.

Radioactive isotopes have been of some value in the localisation and delineation of brain tumors. Almost any isotope will cross the malfunctioning blood brain barrier in the presence of a tumor and thus there will be a somewhat higher concentration of the isotope in the tumor tissue. However, the concentration gradient is not high enough and there are other difficulties. K^{42}, Cu^{64}, Mn^{52}, As^{72} and As^{74} have all been tried with equivocal results. P^{32} gives more reliable results but since P^{32} is a beta emitter, this procedure requires counting after an open operation on the tissue. Recently, a new method has been reported using isotopes which emit positrons. Brownell and Sweet have administered tracer doses of the positron emitter arsenic^{74} and using two Scintillaton counters, one on each side of the head and facing each other, have plotted the distribution of the arsenic within the skull by coincidence counting of the annihilation radiation. They found this method superior to the older ones in giving better resolution, and therefore, more precise localisation of the tumor. Thc binding of chromium by hemoglobin of circulating R. b. c.'s has provided methods for the determination of a. b. c. mass and of red cell survival. The procedure has been of value in the diagnosis of hemolytic anemias and in the quantitation of blood loss in gastrointestinal bleeding.

Measurement of fecal radio-activity after oral administration of radio iron^{59} provides useful information regarding the absorption of iron in patients with hemochromatosis and iron deficiency anemia. Bone marrow uptake studies throw light on the nature of the anemia.

One final illustration is the use of Cabalt^{60} labelled Vitamin B_{12} in the diagnosis of Pernicious anemia. In the absence of the intrinsic factor. Vitamin B_{12} will not be absorbed into the blood stream; urinary excretion will then be lower and fecal excretion higher than normal. Now the normal urinary excretion of Vitamin B_{12} is taken as 10 to 20%. If the excretion is less, Pernicious anemis or some other g. i. disease is suggested. The test is then repeated in 2-3 days and intrinsic factor with the Cobalt^{60}, labelled Vitamin B_{12} is administered. If pernicious anemia is present, urinary excretion should increase 2-8 times. The normal patient and the patient with steatorrhoea and most other g. i. diseases will not show an increase.

In conclusion, as with any other diagnostic procedure, it must be recognised that when one is dealing with biological organisms there will not always be a black or white, yes or no answer; inevitably there will be "gray" patient whose value is borderline. Clinical judgement should always be used in full measure in the evaluation of isotopic procedures.

RADIATION HAZARDS & PROTECTION

BY DR. S. K. AGARWAL

Within about six month of the discovery of X-rays experimenters began to notice the harmful effects of these rays on the skin. In the years that followed and before the dangers were fully realised cases of X-ray burn and dermatitis were all too common among Physicists and Radiologists. Similarly it was not long after the isolation of radium that it was realised that exposure to skin of the radiations from this could lead to painful results. The danger of over exposure to X-rays or to the radiations from radioactive bodies were consequently well known during the first decade of the present century. But there was no or little organised effort to establish suitable procedures to insure adequate protection until the early 120's when radiologists in the United States and in Great Britain gave consideration to the matter, and recommended measures for use in the manipulations of X-rays and radium. This led to the formation of an International Commission on Radiological Protection and thus the nucleus of Health Physics was laid down.

It is now well known that exposure of human beings to ionising radiation always involves some potential hazard both somatic and genetic regardless of designed beneficial purposes. To understand the cause of damage, it is necessary to go briefly into the biological effects of radiation. When radiation falls upon living matter, it products changes which be more or less profound, depending upon the radiosensitivity of the system, and the quality of radiation. The immediate effect of the radiation is the production of ion pairs while the irradiation is going on. The ionization results in the production of abnormal atomic or molecular fragments. This condition is however very transient, positive and negative ions quickly recombining to form natural atoms or molecules. Yet during the brief instant of ionization, physico-chemical changes can be initiated in the living matter which may ultimately lead to detectable radiation changes. Once initiated, the chain of biological events is apparently irreversible except under very special conditions.

There are other factors besides the does which affect the degree of final reaction produced :

(1) The rate at which the does is administered.
(2) The age of the individual.
(3) The extent of the body irradiated and the type of radiation used.
(4) The part of the body irradiated.
(5) The variation among the individual.

It is noteworthy that, except for fantastically high doses, no immediate result irradiation is observable. There is always a longer or a shorter latent period, whose duration depends on the effect to be observed and the magnitude of the dose. With moderately large doses, radiation sickness may appear within a few hours, skin erythema and blood changes in few days and epilation in a week.

The late manifestations associated with the exposure of ionizing radiation are as follows :—

1. Cataracts in the eye.
2. Carcinogenesis-Skin and bone cancer, leukemia etc.

3. Shortening of life span.

4. Genetic effects-sterility.

It is only an assumption that the life span of the individual will be shortened if the cumulative roentgen dose exceeds a certain limit. There is no evidence of it. It is also an assumption though a permissible one that there is doubling of mutation rate if the germ plasm receives a certain radiation dose. As regards the carcinogenetic effects of radiation, it has been experimentally found that low level radiation over a long period is sometimes more effective in producing cancer than is short period instense radiation. Leukemia due to exposure of high doses of ionizing radiation, bone sarcoma due to retention of appreciable amounts of tadioactive material in the skeleton over long periods and lung cancer because of inhalation of natural radioactive dust by uranium miners are almost certain outcome of over exposure. The problem becomes manifold when we come to the recorded case in which latent period is over forty years. As regards the genetic effects of radiation the following points should be remembered.

1. There is no radiation exposure threshold for genetic hazard. 500-700γ given within a short time is apt to produce sterility, usually oermanent in case of females.

2. Damage to genetic material is cumulative and irreparable and is carried on from generation to generation.

3. There should be no confusion between sterility and impotence. It is a fact that impotence is not caused by ionizing radiation and if so one is past the reproductive age, there is of course no effect.

4. Radiation of pelvis of any considerable degree during early pregnancy has been considered as a possible cause of microcephalic idiocy.

5. We must realise that medical use of radiation is increasing and may well be approaching a point where its hazards become a population problem rather than an individual one.

In view of the harmful nature of radiation from radioactive substances and from particle accelerators and nuclear reactors, and the lack of any adequate method of treating the resulting injuries the obvious procedure is to take all precautions necessary to avoid overexposure. It is evident that a restricted exposure to radiation is not injurious, but what needs to be known is the limit below which there will be no harmful consequences. The revised recommendations of International Commission on Radiological Protection are that the maximum permissible weekly dose remain 0.3 r. Therefore precautions should be designed for a weekly dose not to exceed 0.1 r. in controlled areas. It is further recommended that the figure be reduced by a factor of 10 when a large population is exposed.

With the above knowledge about radiation hazards, we recognize the extreme importance of radiation protection service. The one who associates himself with the various projects of health physics and devotes every effort to making a study of the behaviour of radiation and to the other development of the methods, procedures and instruments to minimise radiation damage is a Health Physicist. One of his most important part of the work is to check on the radiation exposure of the individual.

The monitoring of the personnel is both physical and biological. For the latter regular blood examination of the personnel is necessary while for the former use is made of ionization chambers and the photographic film, both of which measure essentially the ionizing power of radiation. The photographic film may be worn as a badge, or on the wrist, or it may be in the form of a ring. The film badge consists of a pieee of film wrapped in a thin opaque paper and is placed in a frame. It will not be out of the way to mention that the Radiology Department of G. M. A. & Hospitals is shortly going to start its own film badge service.

To reduce the exposure of the individual following points should be noted.

1. Education of physician first and the public second in the science of radiation hazards and protection.
2. Good and properly installed equipment.
3. Regular Monitoring.
4. Attention to details of procedure. In this we should know that radiation exposure at a particular position from a certain source of ionizing radiation will vary according to the time of exposure, the distance from the source and the thickness of the intervening material i. e. shielding.

In the end in our country not much attention has been paid to this and almost none in the state. In most of the places where X-ray machines are fitted technicians are provided with no safety measure. Besides they are always in the dark as to how much they expose themselves as there are no monitoring facilities available. This deplorable state of affairs prevails not only in the districts but also in upto-date laboratories and leading institutions who are expected to know better.

BOOK REVIEW

Secrets of Soviet Science by Lucien Barnier translated by Alan Neame

Publisher M/s Rupa & Co., Calcutta, Allahabad and Bombay

The author has attempted to give a full picture of the enterprise of the budding scientists and technologists of Soviet Russia in different fields of science. The reader is impressed by the planning and regimentation of science in Soviet Russia. No wonder that Russia has been able to build up science and technology to standard of already advanced western countries in a short span of 30 years. An interesting book which should be read by the scientists of all countries for forming an idea about Soviet Science.

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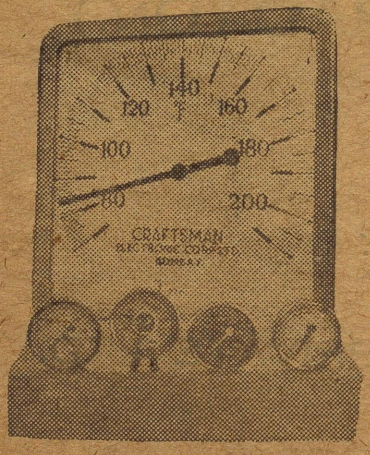

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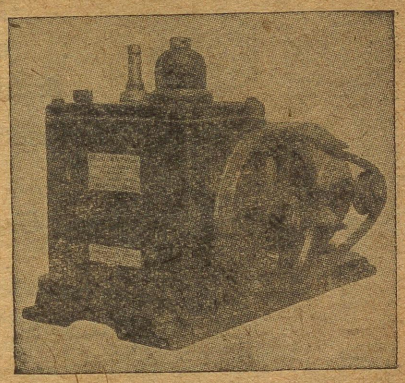

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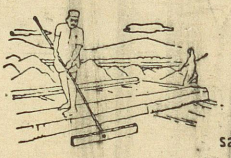

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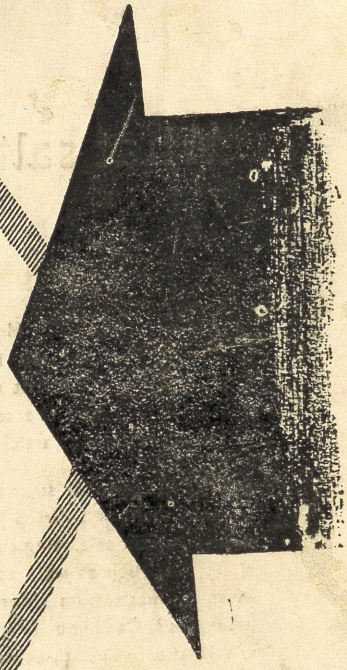

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VIJNAN KARMEE

journal of the association of scientific workers of India

OCTOBER, 1960

Vol. XII

No. 10

VIJNAN KARMEE

Journal of the Association of Scientific Workers of India

(Founder-President : Shri Jawaharlal Nehru)

Vol. XII } OCTOBER, 1960 { No. 10

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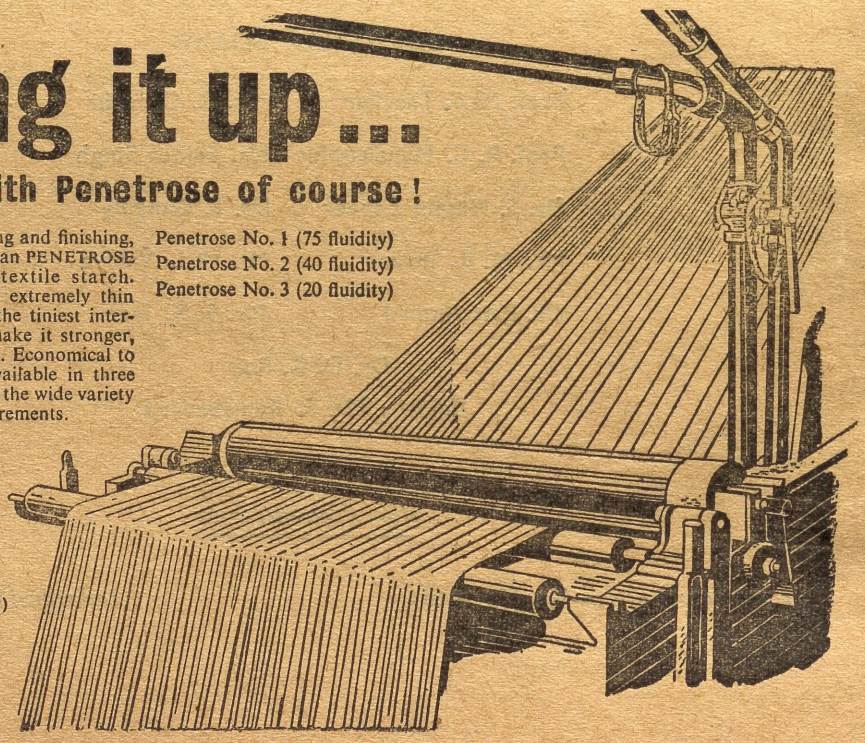

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EDITORIAL

Scientific Reserach

During the growth of scientific knowledge during the past 300 years, it might be noted that scientific research has been a sparodic effort by a few men who were interested in understanding the laws of nature. From the first World War and the second World War scientific research in almost in all the countries of the world has been planned and more or less regimented to achieve both offensive and defensive needs of one's armed forces. Thus, in fact, the Defence science has contributed to a rapid planned system of scientific research.

The scientific research conducted by any country can be rationally classified into three groups:—

(a) fundamental and basic research

(b) technological and scientific research &

(c) Pseudo research.

The first two are productive and at the same time contribute to comforts of humanity, while the third is fast developing and bringing a set of followers into a path of science which is not at all conducive to the development of science.

The fundamental and basic research is generally carried out in Universities and Academic Institutions. Leading scientists and Professors in the Universities and Institutions are able to have their projected planning of science and bands of workers are devoting their time and energy in carrying out such tasks. It is true, that a discovery worth a name can be made possibly once in 10 years but even then the cumulative efforts put by these scientists is productive if one views it critically. The work done by them for example—in a university, a band of workers is engaged in the study and preparation of properties of silicon compounds. Though it is known today and enumerated in text books that silicon has specific physical & chemical properties such a study might not give a new discovery to the existing knowledge but the study, preparation and properties of some of the compounds might elucidate the way in which the silicon as an element can form a compound. Anyway, therefore, this study can add on to the productive efforts and to the fundamental and basic research. However, even in the Universities there is a necessity for an integrated course of research. It could be seen that the band of workers are not put on the same lines of thoughts but distributed freely in studying the different aspects so that the study can be completed in a comprehensive manner. A higher coordinating group can sift the data collected by these bands of workers to increase *knowledge* as a growth process.

Technological research is mainly confined to scientific laboratories under Government or in various industries of the country. The basic and fundamental research scientists discover some new properties of elements and these properties are then translated into a productive material for the benefit of human kind. For example, the study of semiconductors by a set of physicists proved that semi-conductors can be used for different purposes. Everybody earlier knew about insulators and conductors of electricity. One always meets the rubber sheets on a flexible wire which is the insulator and inside the rubber there is a copper wire which is the conductor of electricity. Peo-

ple also knew about the properties of some conductors such as selenium. The semiconductors do not conduct electricity at ordinary temperatures but if they are thermally heated, then, there is a flow of electricity. This property has been utilised by the technologists in the preparation of transistors. A man in the street today knows that Radios and Refrigerators can be made from transistors which can give a long life. It may be seen from the above that technological research conducted by a band of scientists and technologists is again a productive one in that efforts are made available to make the properties of basic research applicable to industry.

The last form of research which is being conducted in any country is the Pseudo Research. It becomes more or less a fashion for this group to call themselves scientists and they have a tendency to justify their career and their profession by copying or making repetitive results on problems which have already been tackled elsewhere. In fact, there is a particular group in this Pseudo Research group which even go to the extent of cooking up results as these days the real scientists do not question papers and publications which come out in Journals. Further, the specialists in the field have no time to critically analyse such cooked up results. The poor boys of this group (Pseude Research workers) generally do not understand that the scientists of the country are able to realise their worth straight by looking at their papers. It has also been generally seen that this band of workers go scotfree in getting a good career in their lives. We do not know how this Pseudo Research can be stopped. We would only request the real men interested in scientific concepts to think over this problem and see to it that this form of research is never encouraged.

EDITORIAL NEWS

A PLEA FOR ATTITUDE

Through these columns from time to time we have been trying to initiate the awareness of a scientific outlook as distinct from applications of science or intricacies within the world of science. Our objective has been the scientist, call him the scientific worker if you will, and his placement in the society as one of its own individuals. There has been a growing tendency amongst the populations of underdeveloped countries of late to utilise science as a tool for accelerated economic advancement. As a result today it is amongst these countries that state-awareness towards science has reached, apparently atleast, a significant level. For instance, a full fledged Ministry was entrusted the portfolio of science along with culture and education in India well over a decade ago. In U. K. it is interesting to note, the cabinet status for such a ministry has been given only very recently. Again a study of executive and legislative functioning of contemporary governments reveals that the distribution of science portfolio in the cabinet ranks has been influenced very much not only by political history of the country concerned but also on the pressing needs of a particular industry in that country. Whereas Ministries such as Iron and Steel, Non-ferrous metals, Food & Agriculture, Forests, Coal-Mines or Petroleum are politico-economic indicators of State-involvement in these enterprises, their functioning is very much dependent upon scientific and technological advancements in their respective fields. Only within that premises, ofcourse, they are evolved with the word *Science* (with a capital ***S*** if you please and with all that it implies). But their very functioning has got a tremendous bearing on advancement of selected disciplines in science. The very fact indicates that the State takes it for granted that the scientific disciplines with the endeavour and fruit of which they are concerned will themselves take care of *Science* as a mode of thought, as an outlook and as purely a social phenomenon.

These broad aspects of science are left to the mode of science teaching. The statement of case for science, as presented here, perhaps, seems to have become involved. Compared to the growth of science in Western countries, the situation in underdeveloped countries is different. Purely as a working hypothesis let us consider the statement that *science has evolved in some countries of West whereas in the countries where planned economy is being pursued with science as a tool, the emphasis is purely on what science can deliver*. Within the premises of this statement as a corollary it follows that in our country the applied aspects of science training and utilisation only have attained importance. As an example, we are producing good engineers, doctors, polymer-chemists, analysts, glass technologists etc., men who are good jobbers. In their field they can live up to what is expected of them, but are they also contributing to advancement of science in this country ? Again this question appears

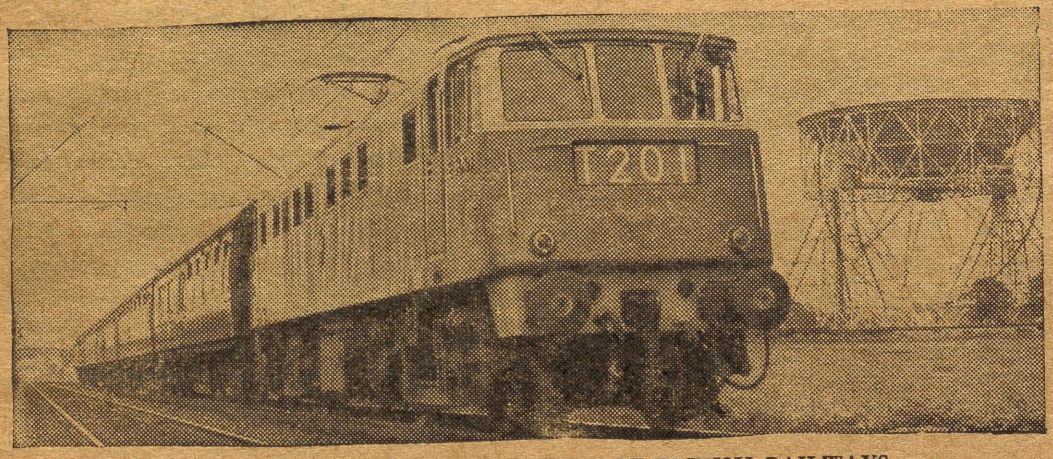
to be superfluous. But we have to consider all the implications of the term science before we should proceed to answer it. Science implies an outlook as well as the know-how. It is best stated that way. We can vouch for the latter but in the opinion of the writer of these columus, the former aspect of science is hopelessly muddled up in this country. For the fear of encroachment on printing space, we request the readers to turn back to some of the aspects that we earnestly believe are part of science not only as a social activity but as a social force also.

It is a good augury that the Ministry of Scientific Research is linked with culture in our country. This twin link howsoever cumbersome from the view point of the legislators and administrators inspires a hope of balancing the turnover of trained scientific jobbers (in the absence of a fitting term we have taken resort to this crude expression) with a true evolution of science in this country. Obviously the task is difficult. Some of the difficulties are certainly very much due to cultural history and outlook of our masses. There also does not seem to be all well with the method of science education whether in the schools or in universities except in the institutions where technological education is imparted. Part of this problem is related with extreme scarcity of really good science teachers. The glamour of profession in industrial and administrative field saps up the stream of scientific intelligentia, a part of which has to be directed to the teaching profession. The problem is not peculiar to this country, its rather epidemic nature has prompted the UNESCO to divert its attention to this problem, specially to that of science teaching in the country. Again the social aspect of science has received less attention in this country then elsewhere. This as we have pointed out earlier, is a problem for which the working scientist is as much responsible as the state machinery and scientific organisations. All these factors contribute towards a development of a scientific outlook and hence cannot be ignored.

As an illustration to the above line of argument we have presented some specific cases earlier in these columns. These involved social responsibility of scientists by large. That such evils may well be ***within*** instead of being outside the field of science bears our contention that the development of *scientist* is ignored here, or atleast lesser stressed upon in this country. For instance, the scientific educator is least concerned in our country to impart the education of scientific attitude to his pupil. As a result, the professional scientist may be confronted with the choice of experimental versus *observational* approach to a specific problem. The problem may be of some social consequence such as effect of a certain drug or dietary item on human beings. The mere involvement of the opinion of an authority, is taken as a sufficient guarantee of science behind it. That it may not be so is beautifully analysed in a recent leading article in the British Magazine *Discovery*, July, 1960, pp, 279.

The case in point is of the argument advanced by Sir Ronald Fisher in his book *Smoking : The cancer controversy* (Oliver & Boyd, London). Professor Ficher's approach is based on theoretical framework of statistical genetics. His contention, again theoretical, is that smoking and cancer may have a common genetical cause. He finds the evidence but not necessarily for the phenomenon. A very valid line of approach exists as pointed out in the article under reference,

and that is of experimental approach. How many times this scientific perspective has been applied in legislation made in this country over similar controversies in the past? The advisers as well as lay public could have raised strong voice that equally convincing view points were completely ignored in framing the legislation on matters which got legislative stand if only science would have attained, its natural status as an outlook. We hope that we could as well be equally aware of science involvement here in this country and that the Ministry of Scientific Research & Cultural Affairs will take stock of it. *Interalia* it will not be out of place to suggest that History of Science may be introduced in the curricula at degree standard of both technological and pure science courses in the institutions of our country.



NEW STAGE IN ELECTRIFICATION OF BRITISH RAILWAYS

One of British Railways' new 3,300 horse power electric locomotives hauling a train past Britain's giant Jodrell Bank Radio telescope on the 31-mile Manchester-Crew electrified line, which was officially opened recently. Thirty-five of these locomotives are being supplied by a British company to the London Midland Region of British Railways. They are capable of hauling a 475-ton passenger train at 90 miles an hour or a 950-ton mineral train at 55 miles an hour. The locomotive is of the Bo-Bo type equipped with four series-wound traction motors mounted on two fabricated bogies, and the nominal weight is 80 tons. The driving compartments at each end are connected by a corridor.

SCIENCE NEWS

ULTRASONIC CLEANING

A unique scouring apparatus, in which the cleaning is done by ultrasonic methods, is being produced by a very well—known Dutch firm at Eindhoven. The actual cleaning liquid in a container is vibrated at a frequency of 40,000 cycles a second, which produces bubbles on the bottom which develop so rapidly that they susequently burst with such violence as to produce a scrubbing effect on the objects to be cleaned in the liquid. This system, it is maintained, not only cleans much more quickly and efficiently than mechanical scouring but also ensures that the articles are not scratched. It is therefore especially useful in laboratories and precision equipment works.

Drinking Sea Water

Several years' intensive research on the part of the Netherlands Organisation for Applied Scientific Research has resulted in a start being made with the manufacture of a machine which can effectively solve the problem of obtaining fresh water from survivors of shipwrecks. The machine, which is neither large nor complicated, can produce 90 gallons of fresh water from sea water for 60 consecutive days. It uses a process by which the salt components are eliminated by electric currents and the water thus obtained can be drunk immediately without being mixed with any chemicals.

Protactinuim

From 60 tons of waste material from the production of uranium from its ores, chemists at Windscale have with some difficulty extracted 100 grammes of protactinium. This is the extremely rare element No. 91., formed chiefly by the radioactive decay of uranium—235. It was discovered by O. Hahn and L. Meither in 1917.

Plastics From Cashew Nuts

Most of East Africa's cashew nut yield is shipped to India in the shell: to reduce freight costs, shelling machinery is currently being devised. Now the East African Industrial Research Organisation reports that 80 percent of the cashew nut shell liquid (CNSL) can be recovered by shell grinding and subsequent countercurrent solvent extraction.

The shells contain some 30 percent CNSL. A vesicant toxic substance, it is used in the manufacture of certain thermosetting resins and in the production of some car brake linings. The new extraction process provides an economic answer to the problem of disposing of what would otherwise become waste material if mechanical shelling is introduced.

The Artificial Kidney

The first practical artificial kidney—the first artificial kidney applied to a patient—was invented by a Dutchman in Holland during the occuption by the German troops. This Dutch doctor came to London and demonstrated his machine, and indeed, he built a second machine in this particular hospital. And moreover, used it in the treatment of patients. This happened in 1947,

and in those days the materials available to us now—the palstic materials—were not at hand. The result of the early attempts at use of the artifical kidney were not very happy because clotting occurred, leakage occurred during the circulation through the machine, and although some patients recovered it was decided that the method was too hazardous to recommend as a routine.

The modern artificial kidney works by taking blood from the patient and passing it through a transparent plastic tubing, rather like the plastic material you use for cigarette packaging. This plastic material is permeable to these toxic substances and holds back the solid constitutents of the blood. After the blood has passed through the tubing, it is returned to the patient by a system similar to the pumping system which takes the blood from the patient to the machine. We take the blood from a superficial vein in a leg, and return it to a superficial vein in an arm. This is simple, and we find that we can use these veins time and time again.

There may be improvements in the future by the application of new methods meaning the direct filtration of the blood through substances which we call exchange resins and which are complicated organic materials rather like the materials used in water softeners. If we can circulate the patient's blood through packs of iron exchange resins, we might be able to remove all the substances which, left in the body, produce illness and death.

(—Dr. R. Shackman)

Electrocuted Cotton

Weak electric currents are being used in attempts to render cotton seed and fibre more water-absorbent and to make cotton yarn stronger. The experiments, in the US Department of Agriculture, place seed and fibre in a partially evacuated tube and pass a current of 10—50 milliamps through the tube.

Seed treated in this way was found to take up more water than usual and it is thought that this increased absorption may have a bearing on seed germination, survival, growth and yield of cotton. Thus corn seeds exposed to the electrical radiation germinated somewhat faster and more uniformal than untreated seed. The researchers do not yet fully understand how the current acts on the plant material and a three-year test has been initiated in three states to evaluate the electric treatment.

When cotton fibre is subjected to the glow discharge, its surface becomes roughened and the wax coating is found to be pierced in many places. The roughened surface affects the yarn's breaking strength which is stated to be 20 per cent better than that of untreated yarn.

As materials differ in their radiation tolerance, the process is also expected to prove useful in getting rid of weed seeds mixed with cotton seeds.

Electronic Machines In Surgery

Wanted: Experienced operators of electronic computing machines for the A. V. Vishnevsky Surgical Institute of the U. S. S. R. Academy of Medical Sciences.

An announcement of this kind has recently appeared in one of the Moscow newspapers. What has surgery to do with mathematical machines? We put this question to prof. Alexander Vishnevsky, Director of the Surgical Institute, and received the following answer:

"Up till now technology in medicine served, as it were, to extend the possibilities of our hands and sense organs, but very soon it will help the surgeon to think. It is particularly important to introduce such machines in surgery,

Just try to imagine an operation whose successful outcome is decided not by hours and minutes but by a few seconds. Uninterrupted information on the condition of the organism—pulse, blood pressure, breathing, temperature — is indispensable. Such information is obtained with the help of diverse complex apparatus to be found in every modren operating room. And yet the data obtained often prove insufficient, their analysis is difficult, and, above all, at times belated, whereas certain information, as, for instance, electrocardiographic control, can prove effective only if the data are received immediately.

It is enactly in such cases that electronic computing machines must help the surgeon. They will be able not only to receive and rapidly process all the necessary data but also to make definite conclusions. These machines will soon appear in the cybernetics laboratory of our institute."

We enter the new laboratory. A few computing-analytical machines have already been installed here. They will process and systamatise the data contained in the clinical records of each patient. The information obtained will serve as the basis for electronic machines, the first of which is already being installed.

"What is the principle of its operation?" we ask engineer M. D. Lerner.

"Its memory is filled with symptoms of certain diseases, notably cardio-vascular. It remains for the doctor to introduce additional data—the patient's age, blood pressure, temperature. The machine will decipher these data and make a correct diagnosis. However, this is only the beginning. In the near future the diagnostic possibilities of electronic machines will increase considerably. Recorders will be attached to a patient's heart and lungs, and the machines will register the condition of the organism, determine the outcome of an operation and prognosticate the progress of a disease.

"The cybernetics laborator will soon become an integral part of the institute's complex organism. Its scientific personnel will be required to possess extensive knowledge not only in the field of machine but also in physics, statistics and higher mathematics. The engineers will supervise the operation of electronic machines, the doctors will study the history of diseases and the mathematicians will generalise their experience and work out a programme . . ."

A few years ago all this would have looked fantastic. Today it is the tangible future of medicine in general and of surgery in particular.

(—S. Yarmdyak)

ARTICLES

SCIENCE AND GOD

By
Julin Huxley
&
Rev. Mascall

Some Christian writers maintain that there is not necessarily a conflict between science and theology. I cannot agree. There is not necessarily a conflict between science and religion. For an evolutionary humanist like myself, religion is a natural phenomenon that can be scientifically investigated. But science and theology—that is another matter.

By theology I mean Christian theology. And this implies a system of thought deriving from belief in a personal God, in the human soul as immortal, and in the incarnation of the Son of God as the saviour of man kind from the effects of the Fall. By science I mean the knowledge gained by the scientific method of publicity recorded observation, hypothesis and checking by further observation and, where possible, experiment.

Between science and Christian theology there is a very real conflict. This is an important part of the larger conflict between two vast systems of thought that are competing for the mind of man — dualistic supernaturalism and unitary naturalism.

These two radically different systems of thought are competitive; one is destined to replace the other.

In the first system the phenomenal universe and its evolution are secondary to a central and eternal god, and are assumed to be products of or dependent on divine operation. In the second, gods are peripherial phenomena produced by evolution. In modern god-centred systems, human beings are supposed to possess a unitary and immortal spritual entity or soul, capable of existence apart from the body; in the evolutionary system, man's spiritual capacities are taken to be part of the mental aspect or inner face of the human organism.

A Hypothesis

Christian theology has a highly organised theoretical structure, based on a combination of an elaborate god-theory with a subsidiary but equally elaborate soul-theory. It can develop only within certain limits: the fixed postulates of its basic god-theory set limits to its range of applicability, while its reliance on the authority of divine intervention and revelation limits its powers of self-correction. Humanism, on the other hand, is acquiring a well-organised theoretical basis in the form of a comprehensive theory of evolution as a whole. It is an open system, capable of ultimated development: its only postulate is a thorough going naturalism, so that all phenomena are grist to its mill. Its reliance on scientific method makes it automatically self-correcting.

The Huxley-Wilberforce duel a century

ago symbolized the defeat of the idea of special creation by that of biological transformation. Today the entire god-theory is in competition with the extended evolution theory, and its picture of the world and man's destiny is in process of being superseded by the evolutionary vision.

In what fellows, I shall try to justify this statement.

First of all let us remember that god is a hypothesis: This comes as a shock to many, but it is true. The god-hypothesis seeks to account for a number of phenomena by postulating the existence of an essentially personal supernatural being or beings capable of influencing nature and human life. In the course of millennia, it has evolved into a number of elaborate and often competing theories, of which Christian theology constitute one family.

Evolution was also originally a hypothesis. But in the course of a century it has not only developed into a single comprehensive framework of theory, but has become established as a fact.

The soul, too, is a hypothesis and so is the atom. But whereas the atomic hypothesis has now become modern atomic theory, with high predictive value and practical applicability, the soul-hypothesis, after being promoted by the scholastic theologians to the dignity of high theory, is now increasingly falling to account for psychological and neurological facts: the soul as an entity is disappearing.

Now I must give the briefest possible outline of the findings of extended evolutionism as they impinge on theology.

First of all *creation*. Over and over again the scientist is told that the world must originally have been created, and that this implies the existence of God as creator. This quite fallacious. It is hundred years since the famous clash about Darwin's theories between T. H. Huxley and the Bishop of Oxford brought to a head the conflict between science and religion. The argument is restaged in this article between Huxley's grandson, the eminent biologist Sir Julian Huxley, and one of the leading theologians of the Church of England, the Rev. Dr. L E. Mascall, of Christ Church, Oxford.

Shorn of theology, the debate boils down to the conflict between science and religion. Before conceding that much can be said on either side it is best to understand and appreciate the points made by a man of science and a man of religion. Sir Julian, to begin with, states, the case for science—eternal existence is just as probable (or improbable!) as once-and-for-all creation.

It is true that some astronomers are suggesting that the universe as we know it began its development—they sometimes even say was created—at a definite period in the past. The catch is in the words "as the universe may have been undergoing a reverse development" we can just as well think of an alternation of expansion and contraction as of the creation of an expanding universe at a particular moment.

According to Dr. Mascall in his book Christian Theology and Natural Science, Christian theology identifies creation "not with an act in the past by which the world was originated, but with an incessant activity (of God) by which it is conserved in existence.... Preservation and creation are really identical". This, I must confess, seems to me mere double-talk. The whole range of physico-chemical and biological phenomena

can now be accounted for in principle in naturalistic terms: to invoke the operation of God in the process is not only unnecessary but intellectually dubious.

As regards the evolution of the universe as we know it, the physicists and the astromomers have now given us a firm picture of the process. Together with geneticists and geophysicists, they are providing a first outline of how "life" could have arisen naturally from non-life, without any need for supernatural intervention.

Living Matter

For the two and a half billion years of biological evolution, scientists have provided a highly satisfactory picture. The self-multiplying and self-varying properties of living matter lead automatically to a struggle for existence among the array of variations. The result is natural selection—the diffentrial survival and reproduction of genetic variants. And this, far from being a matter of chance, as is often unthinkingly asserted, is an orderly process. As Darwin himself point-out, it inevitably leads to the improvement of organisms in relation to the conditions of life. It is an automatic regulating and directive agency, certainly the main and probably the sole mechanism of bio-evolutionary change.

With the acceptance of this, Paley's old argument from design drops dead. Adaptation is no proof of conscious design (if it were, its finger would sometimes point to a stupid, a Rabelasian, or a cruel designer). The same holds for the gradual evolution of higher types with immensely enlarged capacities, This, too, is the result of natural selection on the large scale, the differential survival of groups instead of individual variants, It leads to the replacement of one dominant type by another with improved general organisation.

Moreover, it holds for the most important of all major biological improvements—of the improvement mind. Just as all physiological activity is accompanied by minute electrical activities, which in a few fish have been intensified and turned to biological use in specially evolved electrical organs, so we cannot avoid the conclusion that minute mind-like activities accompany all the processes of living matter, and have been intnsified and turned to biological use in the specially evolved mental organs constituted by brains and their attendant sense-organs. If I may extend a suggestion of Dr. Mascall's, the final only mystery is the mystery of the existence of an evolving world-stuff containing the potentialities of mind. But the god-theory does not render it any less mysterious.

Each improvement of mental awareness affects the further course of evolution. The development of colour-vision led to the evolution of visual warning signals, recognition marks and courtship displays: that of learning capacity led to play and primitive education and put a premium on experience.

Eventually we come to man. The mainlines of his evolution are now clear. The passage from a non-human ancestor on the tailless anthropoid level to a definitely human type took place very late in the evolutionary process. It involved a number of separate steps, in hands and teeth, in posture and habits, and, most decisively, in the improvement of the brain. This proved the basis for speech and thought; and these in turn made it possible for man to hand on the fruits of experience, thereby enabling him to become the latest dominant type of organism.

This was a critical point in the evolutionary process, comparable in importance with the critical passage from non-living to living systems,, In both cases, a new mechanism of change came into action, working at a much faster tempo and producing quite novel results. At the first critical point, material organisations became self-producing, and evolution became subject to natural selection; at the second, mental organisations became self-reproducing, and evolution became subject to what we may call psychological selection.

The evolutionary passage from anthropoid to man can perfectly well be accounted for in naturalistic terms. So can the development of a mindless ovum into a thinking human being. The assertion of Roman Catholic Theology that all mankind is descended from a single couple, instead of from a slowly evolving population, is certainly untrue; and its claim that, though natural evolution can only account for man's body. God is needed to account for his soul, is quite unjustified.

So is the claim that embryonic development cannot be understood except by invoking a mysterious entelechy or an equally mysterious divine intervention; while the assertion that human souls are individually created by God, whether the *animation* of the human individual is supposed to occur at the third month of pregnancy, as affirmed by Catholic theology, or at the moment of fertilisation as suggested by Dr. Mascall, is not only superfluous, but fails to take account of the continuity of living substance involved in reproduction. If fertilised ova have souls, even in potential form why not the hundreds of unfertilised ova and the hundreds of millions of unsuccessful spermatozoa ?

Man has just begun for the first time to obtain a coherent outline of his own history from Upper Paleolithic times to the present. His evolution has been predominantly and increasingly cultural, not genetic. It can be accounted for by the operation of natural processes—natural in terms of human nature—such as cultural diffusion, invention, myth-making, moral valuation and symbolic expression.

There is no need for recourse to spiritual guidance and intervention by gods. On the contrary, gods appear as a product of what we may call psychometabolism. Every type and species of organism has its own particular chemometobolism, metabolism in the usual physiological sense—a set of persistent systems of chemical organisation which have the capacity to take in, assimilate, and work-up the raw material of matter into their own dynamic and self—reproducting pattern. Similarly, every type of human culture has its own particular psychometabolism—metabolism in the psychological sense--a set of systems of mental organisation which have the capacity to take in, assimilate and work up the raw material of experience in a similar way.

There psychometabolic systems include myths, abstract concepts, modes of artistic expression, scientific theories, beliefs, moral principles—and goods. They bend man's experience into their patterns, and impose themselves on his cultural life.

Thus for centuries, the idea of the Four Elements bent man's experiences into an erroneous pattern. Today, in communist countries, political, social and economic experience is metabolised into the powerful pattern of Marxist doctrine.

So with gods. Once the god-concept was accepted, every kind of experience was grist to its transforming mill. Disasters and epidemics became a god's wrath, the natural world a god's creation, morality a god's edict. The intellectual history of the West during the last three centuries has largely consisted in removing more and more phenomena from its orbit, and utilising them in a naturalistic system.

Final Reality

The science of comparative religion shows that religions are just as much natural products of psycho-social evolution as are plants and animals natural products of biological evolution. Dr. Mascall claims that the universality of religion among men testifies to the existence of an ultimate supernatural reality "behind and beyond the fragile and transient world of sense-phenomena". On the contrary, I would say that it is an inevitable result of man's capacity for abstract thought and moral judgement. The reality to which it testifies is what Pere Teilhard de Chardin has christened the noosphere—the new environment of ideas and values, of duties and purpose, which man has created from his experiences and in which he lives half his life.

In any case, the existence of religion is no proof of the existence of God. Pure Buddism lacks a god, and so do modern secularist religions like Nazism and Marxist Communism.

The truth seems to be that the simplest and most natural way of accounting for the bewildering phenomena of existence, such as earthquakes and winds, madness and dreams, and eventually for the fact of existence itself, was by ascribing them to the actions of personal but supernatural beings. Some of these crystallised into gods. Man's craving for unity eventually fused them all into one God; and then pure reason and logic got to work untrammelled by scientific method, and evolved the elaborate god—theories of theology.

Unfortunately for the theologians, this proved to be an evolutionary impasse. The god—theory, as well as often turning out to be unnecessary, is ultimately self-contradictory. The single absolute god of Christian theology is omniscient, omnipotent and omnibenevolent: yet he permits suffering and waste of all life, and evil in human life. Christian theology seeks to escape from this impasse by putting much of the blame on the Fall (a mythical event for which, may I remind my readers, there is no real evidence whatever), and by the gratuitous assertion that god permits human wickedness and stupidity because he wishes to preserve human freedom.

Such a god is a burden to the human spirit, a cloud heavy with frightening incomprehensibility, overshadowing the landscape of human destiny. To me—and I am sure to many others—it is an immense relief to shed this burden, to escape from this dark cul-de-sac of thought.

Real Values

Canon E. L. Mascall has this to say for religion:

When a theologian looks back over the century which separates us today from the famous and acrimonious encounter between Huxley and Wilberfore in 1860, he must frankly admit that most of his predecessors at the time failed almost entirely to see what were the real points at issue.

What should have concerned them as theologians was the bearing which the new

evolutionary theory, if accepted, would have upon the basic Christian beliefs about the nature and destiny of man, his fall and his redemption. However, theology in the true sense of the world—that is to say, the study of God, and other beings in their relation to him—was at a very low ebb, and the main reaction of religious thinkers at the time was concerned with the *prima facie* incompatibility of Darwin's teaching with the literal interpretation of the opening chapters of the Bible. Today we can look back on the matter with a calmer mind and see it is a truer perspective.

Two striking conclusions seem to have been reached on the biological side which are of the greatest theological interest ; both of these have received strong emphasis in the writings of Sir Julian Huxley, though he has, I think, strangely failed to see their real significance.

The first is that, at any rate, so far as this planet is concerned, man, as an intelligent and reasoning being, unique. So far from it being the case, as many people have supposed, that intelligent beings might emerge in any branch of the animal, or even of the vegetable, kingdom—the giant ants or oysters or fungi with superhuman minds dear to some types of science-fiction-there are cogent physical and biological grounds for holding that intelligence could appear only in a ground-dwelling descendant of the Primate (or ape-like) stock. All other branches of the evolutionary tree come to dead ends, the organisms are either too specialised to survive changes of environment, or too settled and sheltered to develop any further.

The second conclusion is that, with the appearance of an intelligent being, evolution as generally understood—that is, a process operating by natural selection upon the raw material of genetic mutations—has virtually come to an end, or, to state the position in a different way, an entirely new mode of evolution has come into being. For an intelligent being can both decide what he wants his future and that of other living beings to be, and take steps to modify the environment and genetic material in order to attain it.

On the Frontier

These conclusions are obviously of great interest, to the theologian and the non-theologian alike. It would, however, be both foolish and unscrupulous to acclaim them as providing direct support for the Christian faith ; they do no-things of the sort. They do, nevertheless, state a position which is congenial to a Christian interpretation (this is where I part company with Sir Julian) ; and they pose a question to which the Christian religion is concerned to give a very definite answer.

The uniqueness of man which biology can establish is, of course, only a biological uniqueness, the uniqueness of an intelligent species inhabiting this planet. The uniqueness of man which Christian theology asserts is something more than this ; it is the uniqueness of earthly beings with an eternal destiny and of the earthly species in which God has become incarnate. Nevertheless. Christian theology has seen a very close connection between the fact that man is an intelligent being and the fact that he is, as it believes, made for eternal life with God in the beatific vision of the Holy Trinity.

For it is precisely man's intelligence which makes him able to envisage an order of being above that of his merely biological functioning. Man thus lives on the frontier between the natural and the supernatural

world ; and, although he cannot life himself above the natural level, he can be lifted above it by the power God or, to use the technical theological term, by divine grace. While he can never cease to depend upon God for his existence and his endownments, he can nevertheless become, in the words of one of the New Testment books, a partaker of the divine nature.

Believing as he does that man has a unique supernatural destiny the theologian welcomes the reflection of this uniqueness which the biologist is able to discern on the natural level. And he welcomes this all the more in view of the fact that in the early days of the evolutionary theory most biologists were unwilling to admit that man was unique in any way at all.

Christian theology thus endorses the uniqueness that contemporary biologists such as Sir Julian Huxley and Sir Wilfrid Le Gros Clark attribute to man, but it goes very far beyond them. For the Christian, the primacy of man is indicated not simply by the fact his brain is two or three times as heavy as that of the gorilla or even that he is able to release nuclear energy and devise electronic computers, but the fact that he is made for the vision of God and that in his nature God has become incornate. (If in some distant region of the universe there are other rational species and if God has become incarnate in their nature too, that will affect man's uniqueness but will not impair his dignity.) However, more is involved in this than the fact man's dignity, namely the question which is raised by man's power to influence the course of his own future evolution. What in fact do we want man to be ?

Recalling that God has become man, the Christian man only reply that he wants man to be man. This does not in the least imply that he wants man to remain as he is. Christianity does not believe that God became man in order to bring human history to an end and to reduce man to the status of a divinely labelled fossil. With the incarnation a new thing came into the world and a new era of human history began.

The Incarnation

Many people — and unfortunately some Christians are among them — think of the Incarnation as constituting a kind of temporary episode in the life of God, as if for thirty years the Second Person of the Holy Trinity ceased to be God and became man, then at his Ascension ceased to be man and became God again. Traditional Christianity, however, has always held, in the words of a great theological document, that the Incarnation took place "not by the changing of Godhead into flesh, but the taking up of manhood into God" or, in a more popular phrase, that Christ is "God from everlasting, and man for evermore."

Thus, in Christian belief, the human organism which God the Son took from his mother, and in which he died and rose again, was not destroyed by the event which is called the Ascension; it was transfigured and made universally accessible. By baptism a man or woman is reborn into this glorified human nature of the Incarnate Lord and, being thereby united with others who have undergone the same process, he becomes a member of Christ's body, the Church, a member of the recreated human race whose Head and first member is Christ. His further progress is then not simply progress within the natural order of existence, but progress within the supernatural order of grace and redemption, though within the

supernatural order the natural order itself will be transformed and perfected. And from God's will for the individual there follows his will for the human race; it is the building up of the Body of Christ.

The power which man, as an intelligent being equipped with all the techniques of genetics, neurophysiology, biochemestry and psychology, now possesses over his own future, his power to decide and control his own evolution, while it is not limited, is vast and alarming. What secularised man may do with himself, what monstrous organisms he may produce from human genetic material, what and may be his chances of survival we can only guess; the purveyors of science fiction have here an unrestricted field. But, although science can raise the question "What should man try to become ?" and can even indicate some of the possibilities, it clearly cannot give an answer.

Man's Purpose

When the Christian religion replies that man should try to become man, it is not suggesting that man should try to remain as he is, for it believes that only by incorporation into the human nature of the Incornate Lord can men become fully men. For Christianity, the final term of human evolution and of human history is the Total Christ, composed of Head and members sharing a common supernatural life in that ultimate transfiguration of the created world which theology describes as the resurrection of the body for the life everlasting.

The conflict which Sir Julian claims to discern between biology and Christian theology reduces, as I see it, to just this — that theology is not needed to account for the purely biological aspects of man. Man is, however, more than his biological aspects; and I believe we are today, as our forebears of 1860 were not, in a position to see that, when biology has said all that it can about man and his potentialities, theology has even more important things to say. This was clearly seen by the remarkable palaeontologist Pere Teilhard de Chardin, whom Sir Julian has so enthusiastically introduced to the English public; it is strange that Sir Julian has not seen it himself.

In my judgement, therefore, the most urgent task for Christians thinkers today—and by Chsistian thinkers I do not mean simply Christian theologians—is to work out the lines along with the tremendous techniques which science has now placed at the disposal of man can be brought to subserve the purpose and destiny for which God has made him.

(*By Courtesy* —**Observer**)

THE ROAD TO THE STARS

[Mankind will not remain for ever on earth, but in its quest for light and space will first timidly penetrate beyond the atmosphere and then conquer the whole of pre-solar space.]

—Tsiolkovsky

Introduction

Could we dream when we went to bed on October 3, 1957 that the next day would go down in history as heralding man's conquest of space? For, the next day the world's first artificial earth satellite was launched in the Soviet Union, opening a new chapter in the history of mankind. Man had carried out his cherished dream and embarked on the road leading to distant stellar worlds. But this road began much earlier, and the first to take to it was Konstantin Tsiolkovsky, a teacher of physics in the small Russian town of Kaluga.

By
V. Azernikov

Principle of Jet Propulsion

The principle of jet propulsion was known three thousand years ago. It was used in ancient China for rocket flares. But thirty centuries had to pass before man ventured to employ it to escape the earth's gravitational sphere into the expanses of the Universe.

But for this a theory of jet propulsion was needed, and Tsiolkovsky supplied it. He studied all the basic problems of jet propulsion, including the fundamental question of rocket flight. He made a mathematical study of rocket flight as the flight of a body with a diminishing mass (a rocket's mass falls as the fuel burns out), and evolved a corresponding formula. Today the trajectory traced by a rocket's fiery train is depicted in the precise language of a mathematical formula, which justly bears the name of Tsiolkovsky.

To Tsiolkovsky belongs the idea of the solution of one of the main problems of rocket flight, that of fuel. Originally powder was the only known rocket fuel. He proved that liquid fuel was more effective and put forward the idea of a liquid-fuel rocket motor. It was a brilliant forecast indeed, for liquid fuel is being widely used in rocketry today.

Multi-Stage Rocket

His ideas have been implemented in all modern rockets. It is to Tsiolkovsky that one of the basic principles of modern rocket design belongs—the principle of multi-stage rockets.

There are two ways of achieving the main goal of increasing the flight range of rockets. One is to produce more powerful fuels, the other is to build up "rocket trains." There is a limit to the possibilities of fuel, which cannot give out more energy than it possesses by nature. That is why the second alternative—multi-stage rockets—is the more effective means of increasing the range of rockets.

The multi-stage principle is as follows: Back in the 19th century when rockets were used for fireworks they had above the powder charge a substance which flared up in a colourful burst of sparks. When the basic fuel charge would burn out, the addi-

tional charge would be ignited and there would be a fresh flare. Now, if instead of a varicoloured mixture, the head carries another rocket which is ignited when the fuel of the first one burns out, then the second rocket flies ahead at twice the speed of the first. A rocket is thus made up of several such stages. When the fuel of the first rocket is used up, it fires the motor of the second and falls away, and so on till the last stage, which imparts the required velocity to the payload. That is how the necessary cosmic speeds are obtained in modern rockets.

Internal Rudder

Another design originally suggested by Tsiolkovsky and now used successfully is the internal rudder. Rudders made of a heat-resistant alloy are placed in the stream of gas ejected from the nozzle. The rocket is steered by altering the position of the rudder with regard to the jet of gas.

Fuel burning in a rocket motor develops a temperature of up to 3,000 or 4,000 degrees centigrade. No metal can withstand such heat. That is why the question of cooling the motor walls is of such great importance. But it would be difficult to have a special coolant on rockets, where every kilogram counts. It was proposed to use either the fuel or the oxidizer as a coolant. Before entering the combustion chamber, the fuel passes through a system of pipes enveloping it and takes away the excess heat. This method of cooling, which has eliminated the necessity to have a special liquid coolant on board, is being widely used at present.

Ethereal Islands

But probably one of the boldest and most brilliant ideas of Tsiolkovsky was that of creating "ethereal islands"—artificial earth satellites. It was his idea that they should be used not only as flying laboratories but as refuelling stations for spaceships as well. Today this idea is accepted universally. Most scientists dealing with questions of space flight consider such refuelling stations imperative for the success of interplanetary travel, at least as far as rockets working on liquid chemical fuel are concerned.

Tsiolkovsky, the pioneer of astronautics, was not destined to see his dreams of penetrating into outer space come true. But the brilliant prophesies he made have come true. His original and daring ideas are embodied in the splendid achievements of Soviet scientists and engineers. They are embodied in the first aircraft, which took off from a Soviet aerodrome on May 15, 1942. They are embodied in the first artificial earth satellite. They are embodied in the first interplanetary ship launched from the Soviet Union on January 2, 1959, in the direction of the Moon, which became an artificial planet of the Sun.

And a thankful humanity will for ever remember the great man and scientist who was the first to point out to us the road to the stars.

TOWARDS MAN'S FLIGHT IN SPACE

By
INNA YAVORSKAYA,
Scientific Secretary,
Interplanetary Travel Committee,
U.S.S.R.

The two space rockets launched recently by the Soviet Union—one with a robot launched aboard on May15 and the other with couple of dogs, mice and other living organisms launched on August 19—have brought nearer the day when it will be possible for man to fly into space. The most fantastic dream of mankind has been transformed into a practical aim capable of being realized in the near future.

Much of the research the Soviet scientists have been carrying on with satellites and rockets is directed towards the final solution of the problems concerning space travel, in particular man's safety in space and his safe return to earth. Not until they are solved fully in practice will the Soviet Union send a human being out into space. For to make a flight just to create a sensation, without his safety guaranteed, is an idea essentially alien to the very nature of Soviet Society.

How to ensure the safety of man in space? A large body of scientists, engineers and medical men in the USSR are working together to find a full answer to this question

Problmes of Space-Travel

The human organism is extremely delicate and adapted only to the earth-bound environment. To sustain the functions of man's life-cycle, there must be an atmosphere with a definite amount of oxygen in it, a definite pressure and a proper temperature. This means that the interplanetary medium cannot support human life for even a fraction of a second. The crew of a spaceship will therefore have to be accommodated in a sealed cabin with the interior environment similar to that the earth. It is this kind of sealed cabin that carried the dog Laika, the first living being to have ventured into space, in Sputnik II. The same type of cabin was installed in the two spaceships launched recenily. The cabin contains a system for air reoxidisation and carbon dioxide disposal as well as a system of heat regulation. It is in this sort of cabin that man will set out on his maiden flight into space. It was, therefore, particularly satisfying for scientists to know that in the first spaceship the temperature and pressure of the air was maintained within the prescribed limits for a month. Some thought must however be given to the possibility of a sudden decompression in the event of a meteorite impact, however improbable this may be. For that reason, the astronauts may have to use special space suits designed to make up for any loss of pressure in the vacuum of space in the event of a rupture in the cabin.

To provide an adequate supply of food, water and air for men in flight is a very serious problem, too. It has been calculated that for just a month of travel in space, a crew of 3 to 5 will have to take with them about a ton of food, water and oxygen. This is quite a heavy load, if you bear in mind the amount of other equipment the space travellers will need.

Unexpected Discoveries

The launchings of artificial satellites and

rockets have resulted in quite a few unexpected discoveries. Perhaps, the most significant of these has been the discovery of two gigantic bands of radiation circling the earth symmetrically in the region of the earth's magnetic equator. These radiation belts consist of electrons and protons moving at what is close to the speed of light. These particles, which have a great penetrating power, are a serious danger to human life, and to guard against them is a very complicated problem. Radiation intensity in outer space proper is not great, as a rule. Yet, whenever there is solar prominence, the entire region near it is filled with deadly radiation and with streams of high-energy particles. These discoveries have great bearing on the problem of protecting the astronauts. The discovery of the radiation belts makes it possible for example to select the safest flight paths for manned spaceships.

The terrific acceleration at the time of the spaceship's take-off and landing creates another obstacle to space travel. The spaceship's speed, however great, has no effect on the organism, as the experience with Laika, and with Strelka and Belka recently showed. On the other hand, acceleration creates what is known as an overload—an additional force which, depending on the magnitude of acceleration, may be several times as great as man's own weight. Acceleration however is no insuperable obstacle. The dogs were able to stand it, although they were temporarily upset by it. There is no reason why man can not stand it. Medical experiments show that the best kind of acceleration for man to endure is lateral (chest-back) and the worst is linear, for in the latter case there is a blood shift either towards the head or the feet. Under lateral acceleration, a human being can withstand 10 g. for a time of several minutes. A further increase of acceleration or its longer duration upsets man's functional capacity. This is what makes it very important to check the effects of acceleration in terrestrial conditions and to have the engines operate so as to allow the degree and duration of accelerations to be kept within tolerable limits.

Weightlessness

With the engines off, the spaceship will start coasting along by its own momentum, thus bringing about a state of total weightlessness. In such a state man has been found to lose the ability to control his movement, lose the sensation of up and down, and the capacity of orientation. Yet, with this state repeated over and over again, man adapts himself to it little by little and regains the faculty of controlled movement. The numerous experiments carried out in recent years in laboratory conditions, jet aircraft cabins and with animals sent up in geophysical rockets and finally in the recent space roket have led the scientists to conclude that life in zero-gravity conditions is possible and that the organism will adapt itself to these conditions. Space medicine has much data today on the effects of space factors on the living organism. Yet, this is not enough. Many of the experiments need to be repeated over and over again.

The flights of Soviet artificial earth satellites and space rockets have helped to solve many of the technical problems on which man's safety in space depends. These cover the programming of rocket flight, the placing of rockets in the pre-selected orbit with a great measure of accuracy, the establishment of two-way radio communication over distances of scores and hundreds of thousands of kilometres, the development of

a dependable power supply system, the checking of the spaceship orientation control system and of radio-television transmission back to earth and last but not the least the safe return of the spaceship to earth.

Second Biggest Step

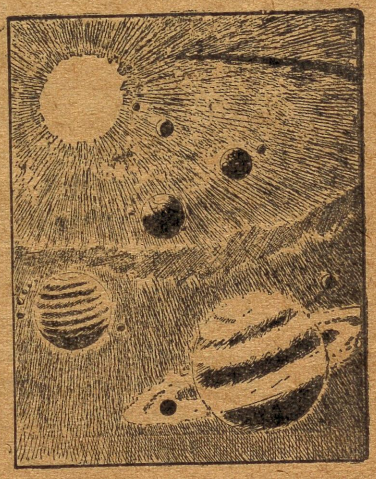
The testing of new ballistic missiles in the Pacific was of great interest from this point of view. The dummy final stages of the rockets had been protected from heating by a special technique and landed intact in the pre-arranged area. The launching of the two spaceships recently was the direct outcome of the Pacific tests. The fact that the second spaceship landed with remarkable accuracy in the pre-determined area, with all the animals in it safe, shows that the Soviet Union has solved the key problem of the re-entry of the spaceship in the earth's atmosphere, and its safe return to the earth. After the launching of the Sputnik I three years back, this is perhaps the second biggest step towards making space travel by man possible. Another step, and man will be flying off into the Cosmos.



An interplanetary space ship must travel at least 24,688 miles an hour to escape the pull of the earth's gravity and atmosphere. Once this has been accomplished its speed drops to between four and five thousand miles per hour. At this speed it would take a space ship 50 hours to reach the moon, 290 days to reach Mars, and 215 days to reach Venus.



Many sceientists feel man may find primitive life form, such as lichen, on Mars and other planets. Some believe intelligent beings may be found. But the first exploration of other planets may be carried on by electronic robots, which would be unaffected by temperature, radiation, atmosphere, etc. Some now possess near-human dexterity.



The Sun's family of planets consist of Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Scientists believe that Venus might be a "friendly" planet for exploration and that Mars may have intelligent life. Only through peace can this marvelous new age of space benefit mankind.

UNRAVELLING THE MYSTERY OF THE VEILED PLANET

BY
ALLA MASEVICH,
Deputy Chairman of the Astronomical Council of the Soviet Academy of Sciences.

Ever since 1877, when Giovanni Sehiaparelli, an Italian astronomer, discovered on Mars a pattern of straight lines which he called canals, this reddish planet has attracted the attention of scientists and fiction writers. The prevailing opinion was that its physical conditions were closest to our own and therefore it was of supreme interest to mankind.

However, this point of view has come under great doubt in the past few years. It was suggested that conditions most resembling those of the Earth should be sought not on Mars, but rather on Venus. The idea came as a result of analysing the latest data obtained about the second planet in order of distance from the Sun.

What do we know of this celestial body ?

At inferior conjunction it is only 40 million km. from the Earth and 13 million km. closer than Mars. And yet for a very long time we knew less about Venus than about any other member of the solar *commonwealth* First of all, precisely when it is at its closest to the Earth, observation is most difficult, for it gets between the Earth and the Sun and shows us its dark side.

When we get a look at the illuminated side of this planet it means that Venus is moving away from us. Secondly, our celetial neighbour is heavily cloud-laden, and the screen is so dense and impenetrable for telescopes that the astronomers cannot get a sight of its surface.

Period of Rotation

Because of the elusive nature of the surface features the character of Venus' rotation is still a mystery.

Schiaparelli put forward the theory that this cloudy planet always keeps one and the same side turned towards the Sun. This would mean that its period of rotation is the same as its orbital revolution, or—in terms of our time units—is equivalent to 224 days 16 hours 48 minutes. Many scientists continue to maintain this point of view.

There have been other theories too. Aristarkh Belopolsky, a Russian astronomer on the basis of his spectrographic studies at Pulkovo in 1903 to 1911, concluded that Venus' period of rotation was 34.5 hours.

As Schiaparelli claims if one hemisphere of the planet always faces the Sun while the other is always dark, it would mean that there was a great temperature difference between the two hemispheres and that hurricanes blew constantly.

The latest astronomical findings, however, do not bear out this hypothesis. Radiometric studies of Venus have shown that the day-side temperature is -40 to 50° and that of the night-side —23° The gap is not too wide. It means that one and the same side of Venus does not remain turned towards the Sun the whole time.

In 1956 astronomer J. Kraus, of the University of Ohio (USA), established that Venus is a source of powerful radiation in the 11-metre waveband.

Radiation intensity varies within a period of 13 days. Considering this phenomenon in conjunction with the Earth's period of rotation it is possible to arrive at the conclusion that Venus' period of rotation is approximately 22 hrs. 17 min. This, however, is almost equivalent to that of the Earth, so in this respect Venus is similar to our planet. What about the other aspects ?

It has long been known that the two planets are very similar in mass and volume. The diameter of Venus is 12,600 km., only 160 km. less than that of the earth. Its mass is 0.82 of the Earth's and its density 0.84 of the Earth's.

Winter And Summer

Dr. G. Kuiper, an American astronomer, succeeded in determining the poles of the planet and hence the inclination of the equator to its orbit. This proved to be 32°.

V. Ezersky, a Kharkov astronomer, has compared the distribution of the bands of brightness on the disc of Venus. It has emerged that there are regular changes and the only explanation of this is seasonal differences. When Ezersky began calculating the inclination of the equator, which could explain the periodicity of the seasons, his final figure coincided precisely with that found by Kuiper—32°. The inclination of the plane of our Earth's equator is 23° 27′.

One of the most interesting problems in the study of Venus is the "marine problem". Are there seas and oceans ? Until recently many astronomers did not believe it possible. The argument for this point of view was the large amount of carbon dioxide in Venus' atmosphere. It was believed that if big open expanses of water existed on the surface of the planet, carbon dioxide would be rapidly dissolved in the water. Then the atmosphere would in a geologically brief time be cleansed of the gas which, however, is still observed there. By the way, the same argument has been advanced against the theory that there is vegetation on Venus.

Based on a photometric study of the planet, Academician N. Barabashev, a Ukrainian astronomer, arrived at the conclusion in 1949 that the greater part of Venus if not its entire surface, is covered by oceans.

He noticed that the planet was sending out sunflashes which is possible only if the flashes are produced by the clouds veiling Venus, let us say, either because of the presence of ice crystals in them, just as in our high cumulus clouds, or because the sunbeams are reflected from a large expanse of water. It is possible that both these reasons operate.

In 1955 American astronomers D. Menzel and F. Whipple also spoke in favour of the idea of an oceanic Venus, though they were led to this conclusion by other considerations.

Atmosphere

Now we come to a very important aspect of the question—the composition of Venus' atmosphere. All deliberations about the physical similarity of the two planets are pointless if it is established that Venus has an atmosphere which cannot support life. Until recently the majority of scientists believed on the strength of spectrographic studies that to all intents and purposes the planet had no oxygen.

At any rate the upper layers of Venus' atmosphere (its stratosphere) consists almost

entirely of carbon dioxide. The oxygen content there is at the most a thousandth of what it is the Earth's atmosphere.

Not long ago Nikolai Kozyrev, a Soviet astronomer, discovered in the spectrum of the atmosphere of our neighbour an absorption band caused by the presence of some unknown organic molecule. It has been established that this molecule exists in the atmosphere of the Earth. Could not this coincidence prove at least some similarity between the atmosphere of Venus and the Earth ?

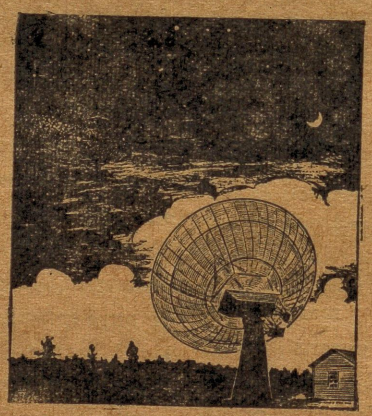
Barabashev thinks it quite possible. "There would be nothing surprising", he states, "in oxygen staying below the cloud layer immediately above Venus' surface. True, carbon dioxide is heavier than oxygen, but even on the Earth this heavier gas rises with the streams of warm air and remains at a higher level than the lighter gases".

As for Venus, the heat of the Sun is felt twice as strongly there and the same tendency might be even more pronounced on that planet. Also conducive to the same result would, it seems, be the fact that Venus has a magnetic field with an intensity approximately five-fold that of the Earth's, and carbon dioxide, which is diamagnetic and would to a certain degree be repulsed by it.

As for the temperature on Venus, last year the theory was advanced that it possesses strong reflecting properties and that the temperature of its surface is on the average approximately $+11°$.

If this is so, then Venus in this respect too is very similar to our planet.

The study of Venus is still going on, and it is premature to draw any final conclusions about the conditions existing on its surface. However, the ideas now being formulated by scientists differ greatly from those that prevailed until recently. And if it should turn out that from the point of view of its conditions, Venus is first cousin to the Earth we shall not be greatly surprised.



Scientists listening to the heavens with radio telescopes report that the sun roars in bursts, while the moon rustles softly. The milky way—the glaxy to which the sun and its planets belong—hisses steadily. All the sounds resemble the rushing "hash" that sometimes irritates radio listeners, but to the scientists it is the music of the spheres.

DUPLICATING SATURN

[Since the beginning of history, progress in science and technology has engendered marvellous projects that have reached out into the far future. But whereas until recently such projects did not get beyond the pages of science-fiction magazines, today overpowering flights of imagination frequent become a basis for the elaboration of realistic, "down-to-the-earth" plans.]

By Valentin Cherenkov

Borrowing Sun's Energy

The established order of things is that spring is followed by summer; autumn by winter and so on. And we are accustomed to thinking that this has been eternally so. But studies of the remote past of the Earth show that millions of years ago it lived a different life. Summer was the one and only season. Even the Arctic seas were warm and their shores were covered by lush vegetation that has come down to us in the form of coal.

Then it became cold. Some scientists attribute this to changes in the Sun's radiation. The climate of the Earth became different, and at first glance there seems nothing that man can do about it. But people have dreamed of altering it and have put forward all manner of projects. Some envisage local jobs, others big-scale projects. And the bigger the scale the greater the quantities of energy required. Here is where the Sun comes in. We can borrow energy from the Sun! In endless stream the energy passes by the Earth into outer space. What is needed is a "reflector" to "turn" the Sun's rays to our planet. This would give us all the heat we wanted.

Naturally, ordinary reflectors cannot be used. The problem is to set up round the Earth a ring, something in the nature of the rings of Saturn. White opaque particles would be just the right material. Being in the path of solar radiation, they would scatter the rays in all directions, sending some to man here on Earth.

The energy of this thermal flux will be enormous. Calculations show that every ton of particles of diameter 0.3 micron and of unity specific weight will take from the Sun more energy than the largest power stations in the world generate. A 300-mile-wide ring 600 to 900 miles distant from the Earth's surface is capable of deflecting earthwards 1,300,000 million kilowatts of power in the form of heat.

Part of the energy will be reflected back into space by the atmosphere and the Earth's surface. But even what is left will be sufficient to make a change in the global climate, which will sort of level out to something in the nature of the spring-summer season in the middle latitudes.

The energy defiected by the ring will affect mainly the polar regions of the globe, the Arctic and Antarctic. The equatorial areas will also get warmer, not as a result of the direct effects of radiation, but rather due to alterations in the climate of the high latitudes.

Eternal Day

In addition to heat, the ring will give

light. Night will practically disappear from the face of our planet. The average illumination along a belt on the Earth embraced by a ring only 60 miles in width would come to 540 luxes. Recall that jewellers work with 200 luxes, and only 30 to 50 are required for reading.

Of course, no one will undertake to build this ring without previous detailed studies of its possible positive and negative effects on all forms of life. Two important questions arise : Won't this eternal day be harmful to animals and plants ? Won't the melting of polar ice lead to inundation of large tracts of land ?

In my opinion, these questions can be resolved as follows:

Yes, life has become adopted to the existing order of things. But we should not forget that organisms always retain their ability to adapt themselves to new conditions. Don't humans and animals fare quite well during the half-year polar day ? Some interesting experiments have been carried out by the Agrophysical Research Institute of the Academy of Agricultural Science of the USSR. It was demonstrated, for example, that beans "get used" to continuous light in seven days, and they grow much better, too. Under "eternal-day" conditions, cotton reaches maturity (from shoots to open balls) in 80 days instead of the usual 110 to 140. Tomatoes bear fruit six times a year !

A more difficult problem is the melting of polar ice. To many, this seems to open up a very real danger of the inundation of vast areas of land. But then we could attempt to make the ring elliptical, thus reducing the radiation over the poles. Another thing to bear in mind is that the rise in temperature would increase the humidity of the atmosphere and the soil, particularly in arid regions, and that this would eat up a considerable portion of the surplus water.

Global Pool

And, finally, the most important problem. Only highly developed rocket techniques can make the construction of a ring a practical undertaking. It would weigh hundreds of thousands, even millions, of tons. Tens of thousands of rockets would be needed to ferry out such loads to a pre-calculated orbit. Where is one to raise the necessary money ? From a global pool ! Yes, the expenses could be shouldered if all countries adopted their arms spending. Just remember that the annual military budget of this planet is roughly equal to 100,000 million dollars. Universal disarmament would, in only a few years, make a practical proposition out of the boldest project for changing the climate of our Earth.

WORKER'S FORUM

SCIENTISTS AND ACRs

The annual confidential reports (ACRs) are measures to provide the employer with an assessment of the ability of the employee and the work carried out by him during the past year. The rating is apparently carried out for purpose of utilisation of the inherent abilities of the employee in the best interests of the State. In a previous article under the same column (April 1960 of Vijnan-Karmee) stress was laid on the essential features which should be considered for purpose of 'assessment of work and the workers' for the purpose of reporting on his capacity and relative merit. It may perhaps be desirable in this context to consider whether the annual report which deals in regard to the salient feature of the individual's ability should be treated as open or confidential.

The prevailing practice varies from country to country. In UK, the annual reports are treated as confidential in respect of the Non-Gazetted staff whereas for Gazetted staff, assessment reports are shown to the individual concerned. In the USA, the practice seems to based on a system of rating of individual merits and demerits, with a provision for the right of appeal by the individual concerned. In the continental countries the trend generally seems to be, to apprise the employee of his drawbacks or merits with a view to enable him to improve and to provide necessary incentives for a better output.

In our country the practice of showing ACRs to individual concerned was prevalent for some time. This privilege was withdrawn towards the close of the last decade. In the Defence Services, ACRs are still shown to the service officers. The modifications introduced by the Government of India, Ministry of Home Affairs, in the recent years, lay a stress on the individual being apprised by the assessment officer during the year and before annual reporting, the intention being to enable better incentives and closer relationship between the assessment officer and the assesse.

The drawbacks in keeping the assessment reports confidential in the case of scientific workers are :—

(a) the assessment is not factual but generally opinionated,

(b) the fear of *confidential* assessment hampers the closer relationship between scientists and creates classifications between the scientist and scientist, though they are expected to work together as a team since scientific work does not recognise strata or classification, and

(c) the worth of individual in terms of scientific efforts in his professional capacity are masked by qualities relating to the personal type viz : leadership, initiative, quality of expression etc. While the personnel qualities may be of particular importance from the administrative point of view and for the purposes of promotions to senior

appointments in the service requiring administrative ability, they have no bearing in regard to scientific efforts whether research, development, design, inspection or production types. A wrong assessment invariably has resulted in stagnation, mutual fear and disregard.

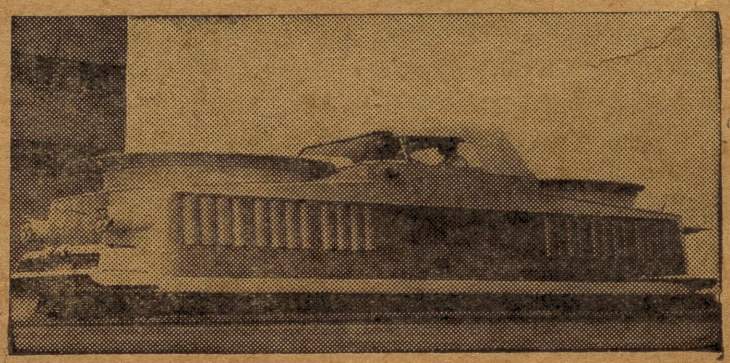
The arguments against showing the ACRs should be :—

(i) the assessing individual will not be in a position to make an unbiased and bold appraisal, for fear of his relationship with the assesse being strained,

(ii) mutual recrimination may occur, which may not be conducive for a harmonious blend of cooperative efforts particularly in the research and production type, and

(iii) treating ACRs as non-confidential may not be conducive for administrative discipline.

It will be evident that most of these reasons can be tenable only for administrative purposes and not for scientific work. The scientist in principle must have complete equality in status and non of the decisions and efforts towards decisions with a technical importance should be dependent on authority but must be purely dependent on logic, reasoning and validity. In other words freedom should be the essential criterion for the scientfic occupations and factors that do not contribute to this freedom, particularly which tends to create mental subordination, will have adverse effect in regard to progressive and procreative scientific efforts. Treating annual assessment reports as confidential, is, therefore, one of the hampering factor in the average scientific worker's efforts in our country. *This practice should cease and ACRs should be shown to the individual concerned.*



AIR-CAR IN PRODUCTION—The Air-Car, which travels over land or water 6 to 12 inches above the surface on a cushion of air, has gone into production at the Curtiss-Wright Corporation factory in South Bend, Indiana. The 300-horsepower vehicle, which carries four passengers and travels at a maximum speed of 60 miles per hour, has no wheels, transmission, or clutches. It is 21 feet long, 8 feet wide, and weights 1,700 pounds.

SCIENCE & INDUSTRY

CHLORINE INDUSTRY

Introduction

Among the heavy chemicals going into a host of process industries chlorine has a really important place. It is a basic material in the manufacture of many organic and inorganic compounds, and or bleaching pulp and paper and textiles. Resins and plastics, selective solvents, special synthetic rubbers, nontoxic detergents, vitamins and drugs, high octane gasoline, delicate dyes are a few of its many and varied products. Insecticides like D. D. T. and gammexane fungicides like 2:4:D and hexochlorophenol and plant hormones also involve its use. The history of the development of the heavy chemical industry may be said to start with the first world war period. The then Industrial Planning Commission stressed the importance of developing a heavy chemical industry in India for a well balanced National economy. Even so, development in the post war era after the first war has been insignificant except for some increase in sulphuric acid manufacture. The period preceding the second world war, as well as the war years and after, gave a real impetus to bring in manufacturing facilities for soda ash, chlorine and caustic soda and for substantial increases in sulphuric acid manufacture. In respect of chlorine, production till 1937 was negligible, being restricted to certain paper or textile mills which operated their own small electrolyser units. Since 1937, however, medium sized units specially for the manufacture of electrolytic chlorine and caustic soda have been set up in different parts of the country. After the war the Government got down foreign experts to report on a plan for the development of the heavy chemical industry, constituted a special planning and development department and set up different panels for the different groups of industries and brought out a report giving a general blue print for the expansion of the industry, It is estimated that at least 60 to 70% of the World's Chlorine production is by the United States, which has a highly developed organic chemical industry.

Production

Present production of chlorine in India is insignificant totalling to about 20 tons chlorine per day only. Reasons for this low production are traceable directly to the very limited fields of application in India.

It is the limitation in the use of cholrine that has been responsible for the strangling of caustic soda production in India. Chlorine disposal has been the bottleneck in increasing caustic soda output.

It is well at this stage to give a very short review of the process of manufacture of chlorine. The basic process operating in India is the electrolysis of sodium chloride solution producing chlorine, hydrogen, and caustic soda.

$$2NaCl + H_2O \xrightarrow{\text{Electrical Energy}} 2NaOH + Cl_2 + H_2$$

Thus the two requirements of chlorine production are only salt and electric power. Approximately 1.8 tons of salt and about 3,500 units of electrical energy are required per ton of chlorine. The units in India employ practically all the well known types : Hooker S. Vorce, Allen Moore and Billiter among diaphragm cells and Nreb's Mercury cell. The modern practice is to effect the liquefaction of chlorine at higher temperatures by employing higher pressure.

Liquid chlorine is transported by road or rail in India at present in steel cylinders of capacity varying from 68 lbs. to 150 lbs. each and steel containers of capacity 16 cwt. and one short ton (2000 lbs.) each.

The limited Indian production of chlorine finds application in sanitation, water purification, textile and paper pulp bleaching. An appreciable percentage is converted to hydrochloric acid and chlorides and into bleaching powder. Some units are also are forced to waste the clorine to keep up a minimum caustic soda production. Development of the uses and applications of chlorine would consist in (a) utilising more and more chlorine directly in water and sewage treatment and in pulp bleaching, (b) widening the manufacture of chlorine inorganics, inclusive of fertilisers, and (c) laying the foundation for the beginning of chlorine organics.

Chlorine Inorganics

The important compounds manufactured in India are bleaching powder, bleach liquors like calcium and sodium hypochlorites and a few metallic chlorides like those of iron, tin, copper, zinc, magnesium and calcium.

Development of chlorine inorganics should proceed on the pattern of development elsewhere. Among solid bleaching agents, calcium hypochlorite preparations possessing more than 70% available chlorine have found favour in view of their superior stability, low sludge volume and easy manner of application due to their good solubility. Even so there is no calcium hypochlorite manufacture in India. The chief factor that has been responsible for the lack of a producing unit for calcium hypochlorite is the fact that the existing practices and processes of manufacture as adopted in other countries are protected by patent rights and trade secrets. In the context of the present sulphur shortage and the greater purity of the synthetic acid by chlorine producers all hydrochloric acid must shortly be from chlorine only. Hydrochloric acid goes into production of bone-glue activated charcoal, in metal cleaning and etching operations, galvanising and in the manufacture of inorganic chlorides like iron and zinc.

In the chlorine inorganics field substantial development is foreseeable through substitution of hydrochloric acid generally whereever sulphuric acid is used to-day. This change over will step up the chlorine production by nearly 25,000 to 30,000 tons per year. This is very substantial and will greatly help a healthy expansion of the chlorine industry.

Chlorine Organics

The need for the development of an organic chemical industry based on chlorine to produce such chemicals as solvents, insecticides, resins and plastics, perfumes, dyestuff intermediates and selective chlorinators cannot be overestimated if it is agreed that to-day India is at a starting point in self sufficiency in essential chemicals.

The basic raw materials available are benzene from the coal tar plants to the extent of 1.5 mil. gals. annually, alcohol to practi-

cally any extent from molasses and a limited supply of phenol, naphthalene and creosote oil. Benzene and alcohol could be straight-away utilised for production of the insecticides—D. D. T. and Gammexane.

India is already developing automobile, airplane and other allied machine industries where machine part cleaning and handling call for large quantities of solvents, and degreasers. Carbon tetrachloride, chloroform, trichlor ethylene and acetylene tetra chloride are among the more widely used and well known solvents. The first step in the manufacture of these is to set up facilites for carbon disulphide and calcium carbide manufacture. There is a demand for these two chemicals from the rayon industry and for gas-welding operations. Chlorine can be consumed in the manufacture of solvent.

It is well known that the textile industry in India which is a very well developed one is fully dependent on imports for all the dyestuff it requires. Such imports have meant a serious drain on the country's financial resources and it is high time a balanced programme and start was made in the manufacture of some of the easier and more needed dyestuffs and intermediates.

Recommendations

Reviewing the chlorine-alkali industry in the U. S. A., R. L. Murray, President of the Hooker Electro-chemical Company concludes "Many well informed persons concluded that chlorine production capacity was over-built during the war. To them the further expansion which occurred after the War must have been a real surprise. Has the ultimate now been reached? This question can now be answered in the negative only, if the tremendous amount of research now going on in this field is continued over the years ahead —and it is certain to be". As with the American industry only intensive and organised research can help the Indian industry.



Wall Street in New York, U. S. stockmarket center, has the world's busiest telephones. More than 5,000,000 calls are made and taken there every business day.



The new transatlantic telephone cable system that went into service recently can carry the voices of 36 persons at once over a wire only 13/100ths of an inch in diameter.

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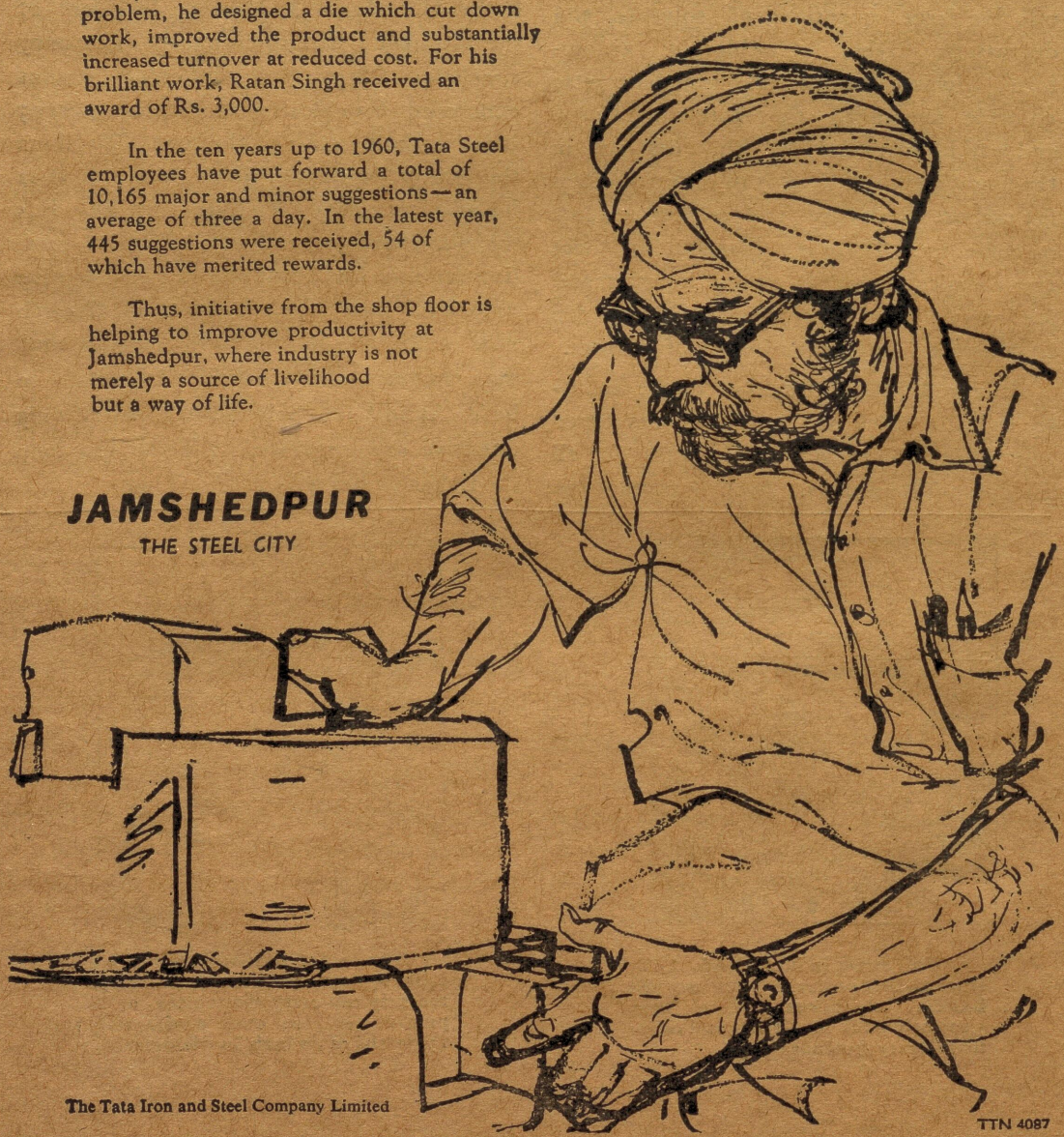
initiative from the shop floor

The manufacture of crowbars in Tata Steel's Agrico factory in Jamshedpur involved a number of time-consuming and uneconomic manual operations. Ratan Singh, a foreman, decided to do something to improve matters. Carefully studying the problem, he designed a die which cut down work, improved the product and substantially increased turnover at reduced cost. For his brilliant work, Ratan Singh received an award of Rs. 3,000.

In the ten years up to 1960, Tata Steel employees have put forward a total of 10,165 major and minor suggestions—an average of three a day. In the latest year, 445 suggestions were received, 54 of which have merited rewards.

Thus, initiative from the shop floor is helping to improve productivity at Jamshedpur, where industry is not merely a source of livelihood but a way of life.

JAMSHEDPUR
THE STEEL CITY



The Tata Iron and Steel Company Limited

TTN 4087

SCIENTIFIC PERSONNEL

TECHNICAL MAN-POWER AND SCIENTIFIC RESEARCH

TRAINING PROGRAMME IN THE PLAN

(ii) Stientific Personnel

The National Register of the Council of Scientific and Industrial Research provides information about the pattern of employment of scientific personnel. In March 1960, the total registration in the National Register stood at 57,000. This includes 53,000 registrants in the 'general' section and 400 in the 'Indian Abroad' section, the broad distribution being as follows :—

	General Register	*Indian Abroad Section*
Scientists ..	17,209	1,556
Technologists ..	3,837	359
Engineers ..	28,792	1,901
Medical personnel ..	3,228	332
Business administration	—	309
Total ..	53,066	3,957

A Scientists' Pool was set up in 1959 for immediate placement of well-qualified Indian scientists and technologists prior to regular employment in positions for which they are fitted.

During the second plan, there was shortage of science teachers in secondary schools and science departments of colleges and universities. For the National Laboratories and other institutions scientists with post-graduate degrees are required in increasing number. To meet these needs the intake of science students in colleges and universities is proposed to be raised. Out of 900,000 students at present about 270,000 take science. It is proposed that out of 1.3 million students in colleges expected by the end of the third plan period over 500,000 should take up science, thus raising the existing percentage of science students from 30 to 40.

(iii) Personnel for Agriculture and Rural Development

The requirements of agricultural graduates during the third plan period are estimated at 16,000 and of veternity graduates at 6,800. The following table indicates the training facilities for graduates in agriculture and veterinary science :

	Year	*No. of institution*	*Annual intake*	*Annual out-turn*
Agricultural graduates.	1951	19	1,060	1,122
	1955	30	1,989	806
	1961	39	4,500	2,231
Veterinary graduates.	1951	8	434	242
	1955	14	1,269	322
	1961	16	1,300	1,100

The training facilities provided by the end of the second plan are expected to meet the requirements of the the third plan. The requirements of the fourth plan are at present estimated at about 27,500 for agricultural graduates and about 7,000 for veterinary graduates, but these are being further examined with a view to working out proposals for expansion of training facilities during the third plan.

Requirements of technical personnel for dairy development during the third plan are estimated at about 3,000. The necessary trained personnel will be available from facilities which have been already established.

Training facilities for providing personnel for the development of fisheries, estimated at around 2,000 are at present inadequate and the requisite facilities are being established at the research stations in Calcutta, Mandapam and Bombay and other institutions.

The requirements of forest personnel during the third plan are estimated at about 400 forest officers and about 1,100 forest rangers. These will be met through training facilities at Dehra Dun and Coimbatore.

The Third Plan envisages considerable expansion in the soil conservation programmes, the requirements for trained personnel being estimated at about 400 officers, 2,000 assistants and 6,000 other personnel. The details of the training programme are under consideration.

As part of the community development programme, training facilities have been arranged for the different categories of personnel needed including Block Development Officers, Social Education Officers and specialised personnel. By the end of the second plan 100 extension training centres for training village level workers will come into existence. The total output of village level workers by October 1963 will be about 50,000. Facilities for training women village level workers exist in 37 extension training centres which are equipped with home science wings; the number of these institutions is proposed to be increased to 69. Among the major training programmes organised under the auspices of the Ministry of Community Development and Cooperation are the arrangements for training non-official workers, including Gram Sahayaks. These are being considerably expanded.

Large scale expansion of training programmes for different grades of cooperative personnel is envisaged during the third plan. This includes increase in the number of senior personnel trained at Poona from about 500 to 1,400. The number of persons trained in specialised fields like marketing, land mortgage, banking etc. is expected to be 8,000 in the third plan compared to 1,700 in the second. For intermediate and block level cooperative personnel the necessary training facilities have been established during the second plan. The number of training centres for junior cooperative personnel is to be increased from 60 to 100, the number of persons training rising from 34,000 to 56,000.

(iv) *Personnel For Education And Other Social Services*

The programme for the expansion of education in the third plan entails a large increase in the requirements of teachers. These are estimated at 420,000 for primary schools, 120,000 for middle schools, 85,000 for secondary schools and 27,000 for colleges. The percentage of trained primary and middle school teachers is to be raised from 65 at the end of the second plan to 80 at the end of the third plan. Arrangements for providing the necessary training facilities are being made.

By the end of the second plan, the annual intake capacity of the 55 medical colleges which have been established will be about 5,000, the out-turn being a little over 3,100. Proposals for the expansion of medical education in the third plan are under consideration.

During the second plan there has been considerable increase in the facilities available for the training of social welfare workers. These include 12 schools of social work with an average annual out-turn of 400 to 450 which offer a two-year course, 5 other schools with an average annual out-turn of 460, and 24 centres maintained by the Kasturba Gandhi National Memorial Trust for training women village level workers. Senior and supervisory personnel required for work among the backward classes, specially scheduled tribes, are trained at the institutes which have been established at Ranchi, Chindhwada and Calcutta. In the field of social welfare one of the most important aspects is to arrange for the training of large numbers of non-official workers at the group and community level. The assistance of voluntary organisations and educational institutions has to be availed of for this purpose.

Personnel for Administration and Statistics

A National Academy of Administration and a Directorate of Training have been set up at Mussoorie offering a combined course of training for the All-India Class I Central Services. The establishment of the Administrative Staff College, Hyderabad and the organisation of the Industrial Management Pool are the other steps which have been taken during the second plan. It is expected that the State Governments will shortly review their requirements during the third plan period of administrative personnel at all levels for the implementation of their plans and work out further proposals. During the second plan courses of business administration and management have been set up at seven institutions, two of which also provide education in industrial and production engineering. Facilities in this field are proposed to be increased during the third plan. A proposal for setting up an All-India Institute of Management is under consideration.

A number of steps have been taken in recent years in developing facilities for the training of statisticians. A series of in-service training courses are provided by the Central Statistical Organisation, the Indian Council of Agricultural Research and the All-India Institute of Hygeine and Public Health. State Statistical Bureaus have arranged for the training of district satistical officers, progress assistants in community development blocks and other personnel. The Indian Statistical Institute, which has been declared by law an institution of national importance, is expected shortly to provide courses for the degrees of Bachelor and Master of Statistics. The institute provides a two-year professional statisticians' course and is also arranging for a number of other training courses, including those at the International Statistical Education Centre, Calcutta and courses in statistical quality control. In the field of demography, training is provided at the Demographic Training and Research Centre, Bombay. The Bureau of Industrial Statistics in Calcutta arranges for training in industrial statistics. Statistical requirements of planned development are increasing rapidly. It is proposed to expand the existing facilities to the extent necessary to secure the requisite personnel.

(*To be continued*)

SCIENTIFIC INSTITUTIONS

NATIONAL SUGAR INSTITUTE, KANPUR

History

The establishment of a Central Research Institute for the proper development of the Sugar Industry in this country was recommended by the Indian Sugar Committee in 1920 and 4th Tariff Board Report of 1930. The Government of India accordingly started the Imperial Institute of Sugar Technology in October, 1936, and housed it in the building of the Harcourt Butler Technological Institute, Kanpur.

Objects

The main functions of the Institute are to:—

(i) undertake research on (a) problems pertaining to sugar technology, sugar and sugarcane chemistry and sugar engineering in general and those of sugar factories in particular and (b) utilisation of the by-products of sugar industry ;

(ii) give technical advice and assistance to sugar factories with a view to improving their efficiency and assist other sections of the industry and the Central and State Governments in matters relating to the sugar and allied industries ;

(iii) collect, collate and issue technical statistics relating to sugar industry ;

(iv) provide technical education in all branches of sugar chemistry and technology and provide training in research ;

(v) prepare and issue the Indian Sugar Standards, and

(vi) survey factory plants and processes to economise fuel consumption and increase overall efficiency.

Organisation

Since its inception, the institute worked under the administrative control of the Imperial Chemical Council of Agricultural Research and later on in 1945 under the administrative control of the Indian Central Sugarcane Committee. Consequent on our country attaining independence, the name of the Institute was changed to Indian Institute of Sugar Technology. Subsequently in 1954, the administrative control of the Institute was transferred to the Ministry of Food and Agriculture, Government of India. In April 1957, the name of the Indian Institute of Sugar Technology was changed to National Sugar Institute.

The work of the Institute is organised into several divisions like Sugar Chemistry, Sugar Engineering, Sugar Technology, Advisory, Survey & Information, Extension Service, Ion Exchange, and Cane price under the administrative and technical control of a Director.

Apart from well-equipped laboratories and a workshop, there is an Experimental Sugar Factory with a capacity of 35 tons cane per day provided with an electrically-driven milling plant and a boiling house for working a continuous sulphitation process; a library containing 5932 volumes of technical

and technological books and about 150 journals; a Scientific Society is also run and managed by students and staff and provides a forum for exchange of the scientific and technical informations among the students themselves and between the eminent Scientists and Technologists and the students through lectures and Society's yearly published journal.

524 acres of land near Kalyanpur (7 miles from the city) have been acquired for the construction of the buildings of the Institute as well as a large sized experimental Sugar Factory.

Work & Activities

The principal activities are (a) research, (b) teaching and (c) giving technical assistance and advice on factory problems and other matters relating to sugar industry.

Research

Research is the main activity of the Institute. Problems relating to sugar technology and on the utilisation of by-products of the sugar industry are taken up for investigation. The results of research are regularly published in different journals of India and abroad. Some of the more important problems that are being tackled at present are :—

(i) Resistance heating of massecuites.

(ii) Application of hand refractometer in forecasting the sugar recovery from the standing canes in the Deccan.

(iii) Further studies on chemical composition and modification of some properties of cane wax.

(iv) Ion Exchange process of Cane Juice Clarification in collaboration with the National Chemical Laboratory of India.

(v) Sugar Factory Effluents.

(vi) Blackening and feathering of containers in the canning of fruits in the Indian Sugars.

(vii) Use of Ethylene diamine tetracetic acid in Sugar Industry.

(viii) Automatic Bagasse weighing equipment.

Teaching

The various courses of instructions are comprehensive, so that the students after completion of their respective courses can straightaway assume positions of responsibility in the industry.

The regular courses are—Ph. D. Degree, Fellowship and Associateship of the Institute (FNSI & ANSI) and Associateship in Sugar Engineering; for the benefit of the factory staff, the Institute have short certificate courses in Sugar Engineering, Sugar Boiling, Industrial Fermentation and Alcohol Technology and principles of Sugar Technology.

Technical Advice and Assistance

Technical officers and staff of the Institute are being deputed to sugar factories whenever called by factories to investigate problems on the spot. Besides,

(i) advice is given to promoters of new factories and for extensions and alterations to existing plants and for improving efficiency,

(ii) assistance in regard to technical matters is being provided to the Central and State Governments,

(iii) consolidated statements of technical data from all factories are being compiled and issued periodically for the benefit of all factories,

(iv) reviews of the working of sugar factories and of the quality of sugar produced in India are being prepared and issued annually,

(v) analysis of samples of sugars and sugar products and various chemicals and materials used in the sugar industry are carried out, and.

(vi) the instruments and apparatus used in the Sugar industry are repaired, overhauled and calibrated.

The Bureau of Sugar Standards prepare and supply Sugar Standards sets every year, publish an annual review of the quality of different grades of Indian Sugars and giving comparative figures for different years, and carry on research regarding grading of Sugar Standards. An Advisory Committee representing sugar manufacturers, sugar merchants and brokers and technologists advises on the modification of the Standards to bring them in conformity with the requirements of various interests.

Schemes

(i) Extension Service Scheme

The scheme has been sanctioned by the Govt. of India for improving the technical efficiency of sugar factories in the year 1957. The Fuel Economy Scheme which has been successfully working for the last nine years has been merged with this scheme.

The main objective of the scheme is to carry out complete survey by two expert teams appointed for the purpose of the participating sugar factories who would contribute the prescribed fees and recommended possible improvements so as to improve the overall efficiency of the factory to the maximum extent possible.

(ii) Cane Price Scheme

The Cane Price Scheme was sanctioned in October, 1956 by the Government of India and was tried in nine sugar factories during the season 1956-57 and 5 sugar factories during the season 1957-58. The main object of the scheme is to study the practicability of introducing the system of payment of cane price on quality basis in order to provide incentive to the growers for improving the quality of sugarcane crop.

(iii) Project for De-Ionization of Cane Juice

The Scheme was initiated by the National Developement Corporation of India (Ministry of Education and Scientific Research) for the pilot plant experiment of Ion-Exchange method of sugarcane juice demineralisation in the year 1956.

Journal

The National Sugar Institute publishes a quarterly bulletin entitled *Sharkara*. The Journal reviews principal events of the Sugar Industry, features original and review articles of applied, fundamental or general importance to the sugar industry, presents industry/Institute collaborative efforts, contains questions and answers on technical aspects, reports on the activities of the Institute and other similar organisations, facts from advisory notes, practical tips etc., publishes review of books, patents, and other materials concerned with sugar production and briefly extracts articles on the latest investigations and inventions or new theories propounded.

ASSOCIATION NEWS

LIBERALISATION OF LEAVE TRAVEL CONCESSION SCHEME

Members may be aware that the question of liberalisation of Leave Travel Concession was represented to the Government. (Item III (6) of the previous General Secy. (Org.)'s report refers). The Pay Commission had also made certain recommendations giving certain concessions to the scheme already prevalent in the case of Government and Quasi-Government servants. An extract of the replies received from the Government of India, Ministry of Home Affairs, is reproduced below for information of the members :

"These issues have been reconsidered in the light of the recommendations made by the Pay Commission and the following decisions are communicated for the information of all concerned :—

(a) Industrial and work-charged staff who are entitled to regular leave will also be eligible to avail of the leave travel concession in the same manner as other Central Government employees. The first block in their case would be 1960-61.

(b) Leave Travel Concession will also be admissible for journeys between places not connected by rail. Such journeys should, however, be performed by the shortest road route/steamer services. The extent of assistance from Government in such cases will be limited to what would have been admissible had the journey been by rail, in the authorised class, or 90 percent of the 'actual expenses' whichever is less.

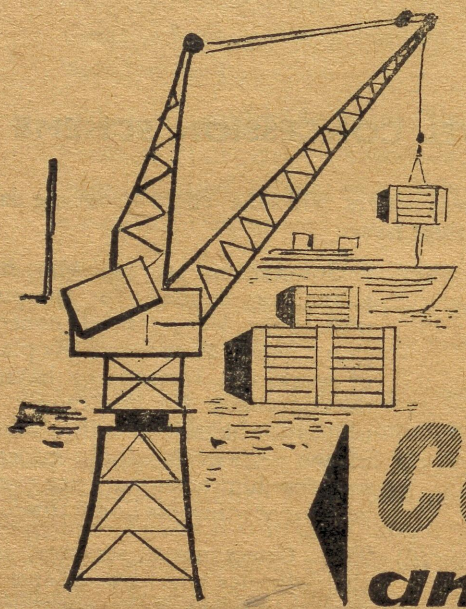
These orders will take effect from the date of their issue.

(c) A Government servant who has a family, as defined for the purpose of the leave travel concession, living away from his place of work, say, instead of having the concession for his family as well as for himself once in a block of two years avail of the concession for himself alone once every year for visiting his home town.

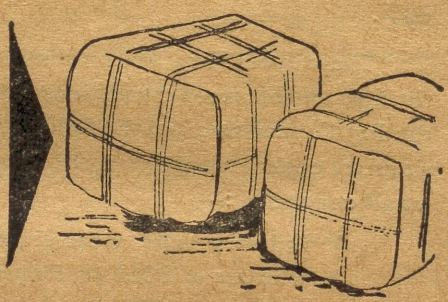
(d) The Government servants and their families who are unable to avail themselves of the concession in a block of two years, may be permitted to count the next block period from the end of the first year. Thus in a case where the Government servant and his family could not avail themselves of the concession in the 1960-61 block, they should be eligible to count the next block with effect from the 1st January 1961. The concession due for the 1960-61 block must, however, be availed of by them before 31st December 1962. In case they fail to avai themselves of the concession before that date their title to concession for that block should be treated as having lapsed.

(e) In respect of places not connected by rail, the Government servant may travel by air where an alternative means of travel is either not available or is more expensive. In such cases, Government will bear the same portion of cost as in the case of rail journeys.

These orders take effect from the 15th June, 1960."



METRIC SYSTEM *in* CUSTOMS *and* CENTRAL EXCISE



The Metric System of Weights and Measures has came into force in Customs and Central Excise from October 1, 1960.

Rates of duties are expressed in terms of metric units.

The rates have been converted to their nearest practicable equivalents in metric units.

METRIC SYSTEM

FOR SIMPLICITY & UNIFORMITY

Issued by Government of India

DA 60/390

What salt means to you!



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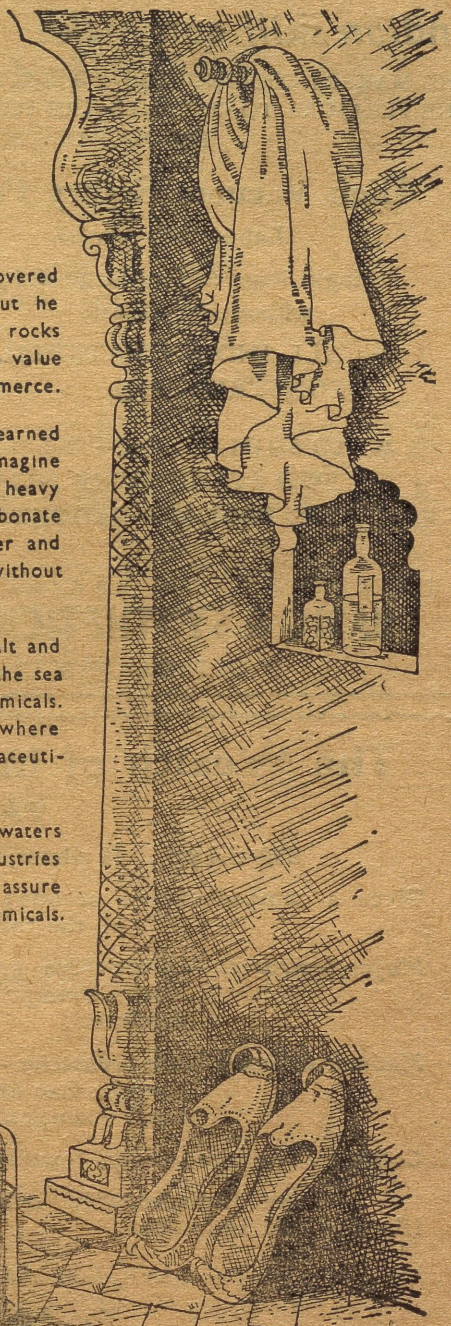

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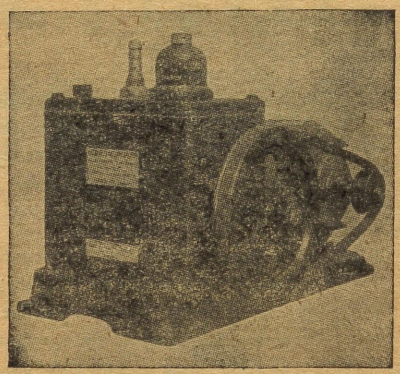

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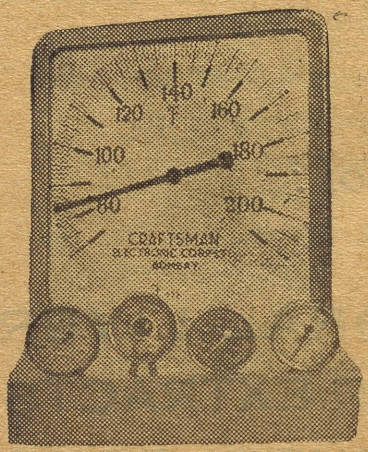

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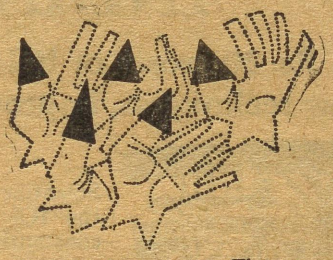

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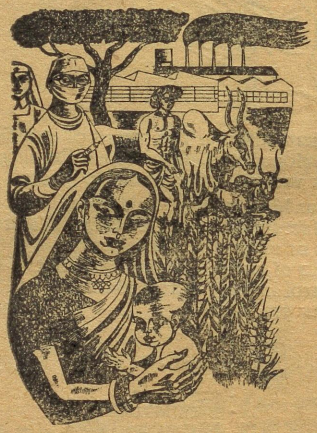

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With the establishment of new Industries, ICI gives a pledge of faith in the future.

ICI has given solid proof of its faith in the future of India. Numerous projects have been investigated and capital has been invested in schemes where local conditions promised sound development. These are mentioned below.

In addition to production, I.C.I. (India) furnishes free technical advice and service on the use of the products it sells. Specialists are available to assist customers in every way. This free service ranges from training their staff to answering technical problems and even to trying to assist in marketing.

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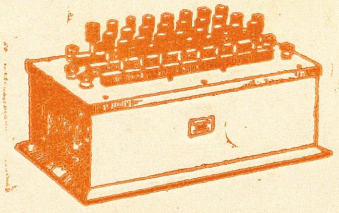

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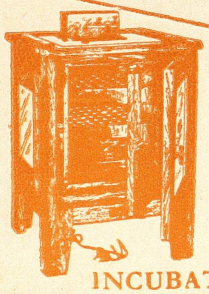

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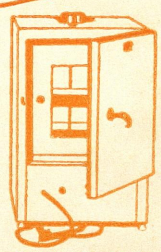

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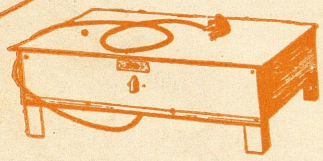

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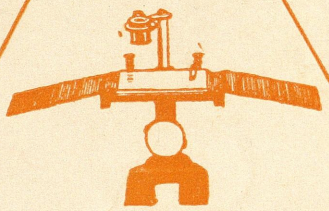

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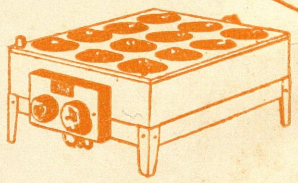

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