As for the content of the reforms, the committee, still unanimous, recommended the creation of an International Centre for scientific information, the efforts of which would have two main objectives: first, a continuous recording of the progress of science; and, secondly, the mobilization, as need and demand arise, of information on any scientific point of current interest. The material produced would, in principle, take the form of data, leaving the elaboration and the linguistic form to the journalist, the speaker, the film producer, the organizer of exhibitions, etc.

For its full achievement, therefore, a more satisfactory presentation of science to a general public will require the co-operation of three agents: the scientific specialist working to perfect his branch of knowledge and using the symbols peculiar to it, mostly mathematical; the intermediary man of science competent to grasp the symbolisms of a number of sciences and to assess the value of theorems and proofs offered by the specialists; and finally, the popularizer. Now and again, a specialist, and somewhat more often, the intermediary scientific worker, may also be a good popularizer; but the committee was unanimous in emphasizing that the great and urgent need of our time in this domain is for the development of a class of intermediary scientific worker having a very definite role in the life of science, a role important for science and for society alike.

A draft organization for the proposed International Centre was worked out. Besides the central secretariat, which might be reduced to modest dimensions to start with, there would be regional representatives of the Centre, and in each country, the academy of science or association for the advancement of science or corresponding body would appoint individual men of science or groups to carry on collaboration and correspondence with the Centre and its regional representatives and take initiatives. Otherwise, the initiatives would, to a great extent, come from the interested popular agencies themselves—Press, radio, film, theatres, etc.—as well as from the national bodies and authorities engaged in the work of spreading throughout the nation the knowledge and spirit embodied in organized science. Neither the central organization nor its regional or local subdivisions should constitute a barrier between the Press, the radio and other popular agencies and their direct access to scientific men. The news, comments and publications of the new organization should, on the contrary, be an additional help to them. The new organization being conceived as part of the house of science itself, there is no danger that it would develop intolerance and try to exercise a sort of birth-control of scientific ideas.

In 1938, the Rockefeller Foundation had instituted an investigation into the same problems in the United States. Conditions there differ to some extent from those in Europe; for example, greater efforts have been made to spread 'science news' in the Press, and to organize the production of documentary films. On the other hand, peculiarities of the broadcasting service react unfavourably on the attitude of the public to the news about science presented there. The first Rockefeller conference on Science and the Citizen in 1938 was followed by a second one in the summer of 1939. At that time, efforts were being made to formulate a practical programme that might be put before the leading scientific bodies of the world. The War interrupted these efforts. But in the light of recent experience, our aims of those days seem to me now to carry a more urgent appeal than ever.

To prepare for a lasting peace is to believe that we can have a new spiritual world. But there is no new spiritual world making for peace and progress unless it be centred in a greater proportion of willingness, and even habit, in high and low, to submit one's own judgment to the control of facts and to respect, in others, the supreme freedom to ascertain and assess facts. This submission to the control of measurement, and this respect for the truth of any assertion, constitute, if I am not mistaken, the spirit of science. When organizing the world, the United Nations have no more fundamental task, and no more urgent one, than to implement properly international co-operation for an adequate presentation to every people of the results and methods of science. In this co-operation, I do not propose to include nations subordinating scientific research to racial or other prejudices. Under the proposals put forward by the League of Nations Committee, international co-operation is automatically limited to such nations as respect the freedom of scientific thought and expression; and I believe it is best so.

I know that in Great Britain the better dissemination of scientific news by the Press and other popular agencies, and the establishment of a central organization to deal with the numerous international questions which inevitably arise, have frequently been discussed. Now that the United Nations are taking stock of their opportunities and their obligations, the opportunity should be grasped to make the realization of these purposes part and parcel of a remodelled and strengthened international co-operation.

SCIENCE IN INDIA*

By D. N. WADIA

Minerals in War

A GEOLOGIST'S work during war-time consists largely in mobilizing all mineral resources in his own limited sphere for munitions purposes. Free international movement of minerals having ceased, every country has to produce the full quota from its domestic mineral resources. Far-reaching questions will arise in the near future, if indeed some have not already arisen, as to how long minerals from accessible depths of the earth will be able to sustain man's wars.

Man's advancement to civilization from the hunter and peasant stage is due to his mastery over metals and minerals, but this advance has caused serious inroads on the world's stock of minerals and especially of metals. During the century and a quarter between the Napoleonic wars and the present War, the consumption of minerals has been more than a hundredfold of that consumed during the entire history of man on earth, and, so far as metals are concerned, man has used up between 1914 and to-day, between the two German wars, more metals than during any previous period of history. Metals such as tin have almost reached depletion stage, silver is being made to stand substitute for tin, while the extractable stocks of platinum, silver and gold left within manageable depth for the future needs of the world will be very meagre. The consumption of fossil fuels, coal and petroleum, has been at a far more serious

* General presidential address to the thirtieth Indian Science Congress meeting at Calcutta during January 2–4.

rate, so serious that the world's known reserves of mineral oil at the present rate of production will be exhausted in a few decades. The total world coal reserves are larger, but they will last only a few decades longer, if the present acceleration of production and consumption of coal and its use for the ever-lengthening catalogue of by-products continues in the future at the same rate.

So far no checks have been devised for this alarming depletion of the world's underground wealth and this robbing of the earth by the living generation at the expense of future generations. Metals and minerals are a rapidly wasting asset of a country, for which there is no renewal or replacement. Agricultural and forest resources of a land can be rejuvenated by suitable measures and manures, but no fertilizer can revive one exhausted mine, for geological processes require hundreds of thousands of years to form a vein of metallic ore or a bed of coal.

There are some 1,500 distinct species of minerals known; of these about two hundred find application in commerce and industry and are considered economic minerals. Among these again there is a rapidly mounting list of metals and minerals which are of vital use in the manufacture of munitions of war and of highly specialized commodities of strategic use. In the defence programme of a nation under present-day conditions of totalitarian warfare, the metallurgical industry and its ancillary mining of minerals yielding the ferrous and alloy metals, fluxes, refractories and accessory minerals are of essential importance. A significant feature of the distribution of these minerals is the concentration of their production and manufacture in a comparatively few countries in the world, happily nearly three fourths of these being centred in, or controlled by, the United Nations as against the Axis group. Of the total annual mineral production of the world in pre-war years, so much as 85 per cent came from North America and Western Europe; of these the United States, Great Britain and Germany, and latterly the U.S.S.R., contributed more than 75 per cent.

This, however, does not mean that Nature has endowed these countries to this unequal extent with valuable minerals; it is rather an index of the country's industrial and technical development and the energy of the people. The three successive five-year plans of the U.S.S.R. are an example of this. Industrial progress of other parts of the world may materially change this condition. For example, China's vast reserves of coal, hitherto untapped for lack of economic employment, may, in the not distant future, be put to use in metallurgy, or in the production of heat energy or other profitable channels. India's resources in iron ore are of a magnitude quite out of proportion to the two million tons of pig iron per year it has only recently begun to produce. Only in a few districts of Bihar and the Eastern States Agency, the high-grade iron-ore reserves are calculated to be of the order of 4,000 million tons. Large reserves of aluminium ore are still only potential assets. The minerals of South America and Africa are yet in an early stage of development, while Australia's store of mineral wealth is yet unknown over wide tracts of that region. When these untouched reserves enter production stage, the apparent inequalities will diminish and the countries bordering the North Atlantic basin will not occupy the dominating position in strategic minerals they do at present.

But even so, when the whole world's mineral resources are fully known and mobilized, the stock will not last many generations, if it is made to feed the waste of recurring wars on the scale of magnitude and frequency of the last two world wars. If the supply and free movement of a few ferro-alloys and a few strategic key minerals for non-industrial uses is controlled by some central world organization, the demon of totalitarian war can be banished and other wars shorn of the insane waste involved in military as well as non-military devastations. Then the wreckage of tanks and armour plate can be beaten back into ploughshares and its superior steel released for beneficent uses in peace.

It is no exaggeration to say that half the later wars of history have been directly or indirectly motivated through the desire of gaining access to stores of strategic mineral products, ores, fuels, salts, alloy metals and essential industrial minerals. The international mineral situation during pre-war years was in a chaotic state. While the United Nations were in a state of 'vacuous unawareness' about it, the Axis powers grabbed as much of the indispensable munitions minerals as they wanted, and the War has been waged by them on the stores of hoarded minerals and metals.

Only the adoption of a wise and justly planned international mineral policy framed by an international directorate can preserve peace and goodwill among countries unequally endowed by Nature with mineral wealth. No country in the world, however well supplied it be, is self-sufficient in mineral requirements, nor is any so situated that it can regard its mineral resources as purely domestic or national. Embargoes, tariffs, patent rights and transport controls imposed for political reasons do not offer a solution, but by hindering free movement of minerals become powerful contributive factors in precipitating world wars. Unequal geographical distribution of minerals being an unalterable fact, planned international economy should devise means not only to eliminate this cause of inter-country friction but also to increase the interdependence of nations on each other for their vital trades and industrial needs, and so make minerals a rallying point for international co-operation and goodwill.

The preliminary recommendations of the Conference on "Mineral Resources and the Atlantic Charter", convened by the British Association's Division for the Social and International Relations of Science last July, appear to be on the right lines, but they will not go far enough if their implications are meant to safeguard the interests of the British Empire only, or even of the whole United Nations' group. They should embrace all the free countries and should call for sacrifice from all participating nations of part of their national and natural advantages for the ultimate benefit of all and the future security of the peoples of the world. The main resolution of this Conference reads as follows:

"This Conference, having specifically dealt with mineral resources, submits that, as a first step, the Council [of the Association] should initiate forthwith consultations with appropriate scientific and technical organizations, to secure an understanding on the principles involved. The Conference would further urge that a scientific review of mineral resources, using and supplementing all existing data, should be among the first tasks of any international organization for the social applications of science, such as was envisaged at the recent Conference on Science and World Order. To this end, the Conference recom.

mends that the Council should consider how it might help to promote the establishment of an International Resources Organization, as a fact-finding and advisory body for Governments, as a contribution to world stability, and in the spirit of the Atlantic Charter."

The fourth article of the Atlantic Charter postulates access for all States on equal terms to the raw materials of the world. But if the Atlantic Charter does not unreservedly provide for all peace-loving nations of the earth, whatever oceans bound them, its fulfilment in a partial degree will not achieve the goal of post-war mineral allocation, nor succeed in removing a focal infection point in the body politic of the world.

The position of mineral affairs to-day being what it is, it behoves us as non-Utopian science workers to ask: What is India's place in the world's mineral map? The mineral outlook of the Indian region is on the whole satisfactory both for war- and peace-time requirements. India's resources in minerals of strategic importance, minerals for munitions and defence armaments, base metals, alloys, fluxes, refractories and accessory minerals can be regarded as adequate, in several but not all of them. India is deficient in tin, tungsten, lead, zinc, nickel, graphite and liquid fuels. But in the basic metals, iron, manganese, aluminium and chromium, the country is well supplied, in the case of the former three, in large excess. Our neighbour, Burma, has abundant stocks of the munition metals of which India is in defect, while her oil resources must yet be regarded as considerable. Ceylon has reserves of the world's finest graphite, a mineral indispensable in metallurgy, and of a magnitude sufficient to last a long period. Ancillary minerals such as asbestos, cement, fertilizers, clays, mica, sulphur, various salts, ores and other minerals of industrial utility are available in quantities sufficient for the country's needs, while some are in exportable surpluses.

The experience of the last three years war effort in the production in India of a wide range of munitions, without any previous apprenticeship, is satisfactory proof of the country's adequacy in some respects, though still unequipped in a number of essentials, such as specialized steels, machine tools, manufacture of aircraft, high explosives, automobile engines, big ship construction, etc., on a scale commensurate with her internal requirements.

Social Obligations and Relations of Science in India

Last year, while dealing with the progress of the exact sciences in India during the last thirty years, I stated that the retrospect was satisfying and held out promise of further developments. The time, however, has come, and the events of the last few years forcibly remind us of the fact, that science, as pursued in the laboratory and the field, is becoming more and more a specialist's job and is becoming divorced from the life of the people. Science, as applied to the problem of daily living and the social needs of the common man, is the great necessity of the day. The advent of the motor-bus, the radio and railway engine in the villages of India is not the same thing as bringing science to the homes of our villagers. The impact of science on the Indian masses has come in the form of a rather rude intrusion of machines and mechanics into the essentially simple rural economy of the country, and it is not surprising that this meeting has not been a particularly happy one. It has disturbed the economic structure and created, if not some aversion, an indifference to the cult of science in the popular mind.

But we all know that science is not all mechanics, nor are its practical uses to man the greatest thing about science. The greatest thing about science is the scientific method—the most effective thing man has for discovering truth and the ways of Nature. It can bring solid benefits by releasing life from stagnation and the bonds of ignorance wherever these prevail, whether in cities or in the countryside, among the labouring masses or among the governing class. The awakening to the social obligations of science is of recent date, and even in Europe and America, this aspect of the cultivation of science was for long not realized and left to sporadic individual efforts. With this awakening, a two-fold problem faces science all over the world to-day—to press the newest discoveries and inventions of applied science into the service of agriculture, manufactures, hospitals, homes and schools, and with it so to control the impact of these on man's private life that his mechanized work-a-day life may not be totally divested of all higher spiritual values.

Our future national life and its material well-being largely depend on a wholesome balance being maintained between these two—the impulse to harness science to increase physical comforts of life and a restraining desire to preserve the old-world spiritual calm and simplicity of living. Happily for India, this balancing is somewhat of a natural hereditary trait and does not need much emphasis. While in the European countries the evolving of a true synthesis, a *via media*, demands much searching and learned arguing, our age-old traditions have made this work easier. India's late start in the application of science to industry also gives it an opportunity of planning along right lines. The significance of this problem has been realized both by our political leaders and by scientific men, and some progress is being made in this direction. I refer to the inauguration in 1939 of the National Planning Committee under the chairmanship of Pandit Jawaharlal Nehru, with the specific object of co-ordinating science with industry in all its phases, and to the establishment by the Indian Science Congress at its Lahore session in January 1939 of a Sub-committee on Science and Social Relations, mainly with the object of studying the influence of science on India and collecting data relating to the effects of science on society in India.

The National Planning Committee, through its twenty-nine sub-committees, has set out to formulate a programme covering many phases of the future life and activities of India, material, productive, educational, artistic. Their work, unfortunately, is in a great measure suspended to-day, though some of the sub-committees have furnished more or less complete, well-documented reports, while others have submitted interim fact-finding reports. Their conclusions, doubtless, will be subjected to thorough revision and deliberation by the main body, which comprises some two hundred of the leading industrialists, publicists and scientific men of the country, before they are offered to the public, but a great deal of spade work has been accomplished, a valuable mass of ascertained classified details collected and many blue-prints prepared. A planned reconstruction in a greater or less measure of India's commerce, industry, finance, land, labour, mining, transport, power-generation, technology alongside educational, cultural and social re-organization is expected to emerge from the labours of this body.

Proposed Academy of Social Science for India

The executive committee of the Indian Science Congress has before it a proposal for the institution of a National Academy of Social Sciences, drawn up by the Sub-committee on Science and Social Relations. It is interesting to trace the origin of this sub-committee, which goes back to the Blackpool meeting of the British Association for the Advancement of Science in 1936, where there was much discussion of the social relations of science. In the following year, a few leading science associations took cognizance of this subject. The International Council of Scientific Unions, with its headquarters at Delft, Holland, at its meeting held in April 1937 in London, established a committee on Science and Social Relations, with Prof. F. J. M. Stratton, of Cambridge, as president. This action of European men of science was followed by a resolution passed by the American Association for the Advancement of Science at its meeting in 1937 urging the various scientific organizations of the world to re-undertake examination of the profound changes brought about by science in human society, and thus be in a position to promote "peace among nations and intellectual freedom in order that science may continue to advance and spread more abundantly its benefits to all mankind". In 1938 the British Association at its meeting held at Cambridge brought into being a special Division for the Social and International Relations of Science, with Sir Richard Gregory as its chairman. This division organized a conference on "Science and the New World Order" in London during September 1941. In conjunction with these sister organizations of Europe and America, the Indian Science Congress instituted a Sub-committee on Science and Social Relations at its annual session held in Lahore in January 1939. This Sub-committee has been working for the last three years and its labours have fructified in the above proposal, which in due course will come before the Indian men of science.

The proposed Academy should be a body of high academic standing and professional knowledge, which can take up long-range problems of social well-being of the people of India with which the older societies and associations established along familiar but too general lines in some cases and rather over-specialized lines in others cannot deal without suspicion of religious or political bias. Socio-medical and political subjects, human relations, anthropology, political science, vital statistics, social biology, population problems, sociological research in particular bearing on various Indian communities, are the subjects on which such an Academy can work in collaboration with the Indian Science Congress and half a dozen other institutions already existing in India for some of the above-named specific objects. It can be a living organ in the body politic of India for voicing the collective opinion and focusing the specialized points of view of numerous isolated working bodies on the one problem—how to promote the well-being of the common man.

The Sub-committee has begun a survey of the status of sociological studies in all the Indian universities. Vice-chancellors of many Indian universities have endorsed the proposal about the Academy favourably, and the secretaries of those learned societies that have been approached have announced their readiness to co-operate. Dr. K. Motwani, secretary of the Sub-committee, placed the scheme before Pandit Nehru last July and, in accordance with Pandit Nehru's wishes, the executive committee proposes to appoint a committee of experts to suggest ways and means of bringing this Academy of Social Sciences into being. The matter rests here.

It is too early to outline the exact tasks to which the Academy will address itself. Its chief function will be to explore those avenues through which the contributions of science may be adapted to the life of the individual and the nation without allowing anti-social applications of science, such as have made a shambles of so many countries, ever raising their heads in our midst. Secondly, the Academy should emphasize an integrated, synthetic approach to every problem, pressing into service the contributions of various basic social sciences such as human geography, anthropology, psychology, economics, political science, philosophy and sociology. The bringing into being of a National Academy so constituted may well become a crowning achievement of the Indian Science Congress.

IMMUNITY TO VIRUSES

IN opening a discussion on immunity to viruses in the Section of Comparative Medicine of the Royal Society of Medicine on April 21, Sir John Ledingham said that notwithstanding the immense amount of attention paid in the last twenty years to immunization against virus diseases, Jenner's discovery still remains the touchstone by comparison with which all subsequent efforts in this field must be judged. All attempts at immunization against viruses present the same problem—the preservation in the vaccinating agent of the maximum antigenicity compatible with safety from both immediate and remote sequelæ. The solution of this problem has proved no easy matter and there is still a large field to explore in the exploitation of natural variants of pathogenic viruses of man and animals.

Three fairly general methods were available: (1) the use of the cognate living virus (as in cow pox); (2) the use of completely or partially inactivated living virus; (3) the exploitation of the 'interference phenomenon'. Unfortunately, each virus has to be investigated as a problem in itself, and success with one by a particular method is no guarantee of similar success with others. Cultivation in an unusual host (for example, cow pox in the chick embryo or in tissue culture, rabies in rabbits, yellow fever in tissue culture) may give good antigenic variants; but in the case of vaccinia, there is considerable evidence of loss of antigenicity after prolonged cultivation in eggs. Poliomyelitis virus transferred to the cotton rat, thence to the mouse, and so to the hamster, is so far modified that rhesus monkeys may survive infection with it; such survivors are immune to virulent monkey virus. The value of rabies vaccines is very difficult to assess owing to our ignorance of the probable mortality in untreated cases; according to Webster, the average mortality from rabies among persons bitten by proved rabid dogs, no matter with what vaccine they are treated, is about 0·2 per cent; in man, who is probably relatively insusceptible to rabies, all vaccines appear equally good or equally bad. Webster has therefore devised an improved method of testing rabies vaccines, and has elaborated what he considers an improved vaccine inactivated by ultra-violet light.