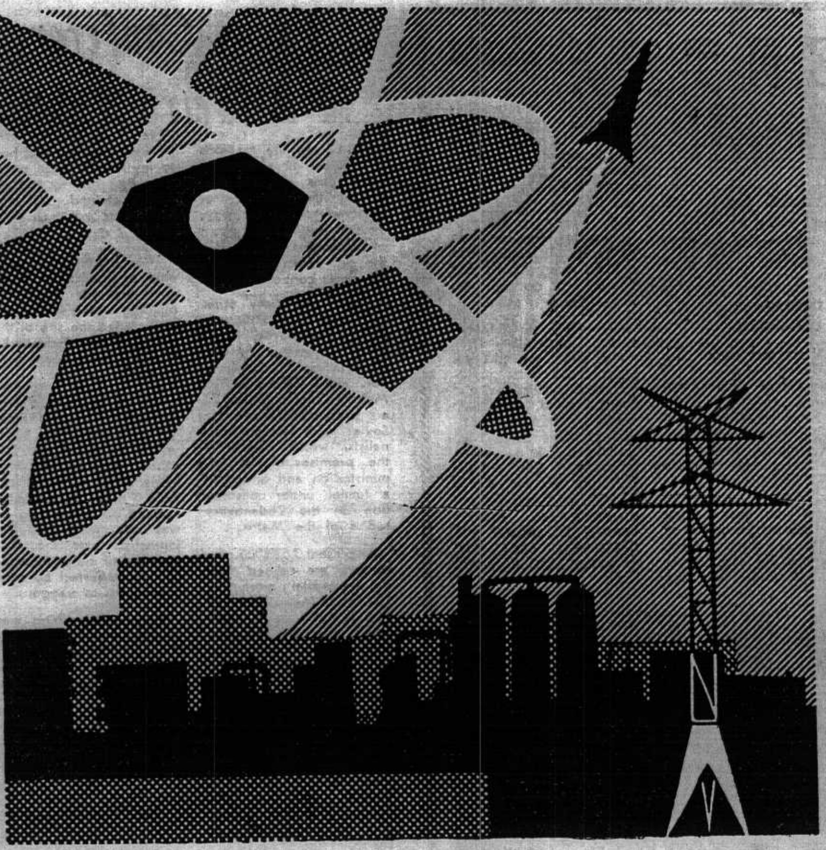

Atoms for Peace—

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By Oleg PISARZHEVSKY,
Our Science Commentator

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● INAUGURATION OF ATOMIC AGE

THE time gap between a scientific discovery and its commercial development is shrinking rapidly in our days. The main problem is to see to it that the increasing beneficial potentialities of science really do enter our lives as a force for good and that the combined efforts of the peaceloving peoples create an insurmountable barrier to their application for war.

One of the greatest victories of science is the unravelling of the atomic mystery. With this discovery the outlines of the atomic age have emerged in all clarity.

We date the beginning of the atomic age not from the tragic flash of uncontrolled nuclear reaction in the atomic bomb exploding over Hiroshima, as a result of which the survivors of this crime are still lingering on in Japanese hospitals, but with the commissioning of the first commercial power station in the world fed by atomic power. Atoms for peace emerged into this world on June 27, 1954.

Soviet people are accustomed to electrification on a vast scale. Compared with the power of the hydroelectric stations on the Volga, which runs into millions of kilowatts, the capacity of the first atomic power station—5,000 kilowatts—seems insignificant. However, the important thing is not the number of kilowatt-hours generated but that it demonstrated for the first time that the artificial fission of an atomic nucleus could be used for the generation of electricity. Besides being a victory for our scientific and technical thought this was a triumph of lofty and humane social ideals.

Soviet scientists have made no secret of their experience in the construction and maintenance of the atomic station. The first atomic station was open for inspection and shortly after it went into operation Soviet scientists delivered a series of lectures on the principles of its design at an international conference in Geneva.

Following the Geneva Conference the construction of atomic power stations gained momentum in the USSR and in other countries, including the USA, Britain and France. However, there is always a beginning to everything and grateful generations will always remember the event which even today is viewed as an epoch-making development.

● THE FIRST PLANT

THE atomic power station of the Academy of Sciences of the USSR stands in an enchanting Russian forest, and there is a general air of peace and tranquillity. There is no black smoke to pollute the fragrance of the surrounding greenery, no trains bringing in fuel supplies. Neither the trees surrounding the building nor their remote ancestors which have now become coal are in danger of disappearing into the insatiable maw of a steam boiler.

The station building is as neat and clean as a school. No supplies seem to be delivered there but there is a continuous stream of electricity coming from the plant, going out to local consumers at enterprises and collective farms.

The deductions and experiments which led to the discovery of atomic energy are breath-takingly complex but the final conclusions are as simple as the culmination of any great cause of mankind. Man's genius has the ability to find simple solutions, simple keys to the most intricate locks barring the way to the mysteries of nature.

If we are not surprised at the miraculous fact that fire may be induced by such primitive means as rubbing two pieces of wood together and that the miracle of electricity may be produced by such a simple manipulation as waving a magnet over a coil of wire, there is no need to be surprised that the great miracle of atomic energy is also wrought by basically simple operations.

In order to obtain atomic energy one has to place bricks of uranium spaced by graphite to form a very accurately calculated edifice. If the sizes and the proportions are chosen correctly the uranium bricks will begin to be spontaneously heated and myriads of atomic micro-explosions will occur within them, producing an immense quantity of energy.

Among the fragments produced in this process new neutrons will be born—new "charges". This is the start of the chain reaction of uranium fission—the simplest process of obtaining atomic energy. As a result we have an atomic furnace, an atomic reactor, an atomic source of heat. This is a miraculously economic furnace: it takes only a few grammes of fuel to generate tens of thousands of kilowatt-hours of energy.

Only 30 grammes of fuel are needed to keep the station going for 24 hours. A coal-fed station would consume more than seven railway trucks of coal in the same period.

A powerful atomic furnace, however, needs even more careful tending than a match burning in the wind. Telemechanics stretches out its steel hands to control this process which has to be kept out of the way of all living matter.

All technological units of the station are viewed from a control post. On it is an electrified mnemonic diagram. The diagram is remarkably simple: the steam heated by the atomic pile rotates a steam turbine and the turbine rotates a 5,000 kilowatt generator.

● WHAT NEXT?

FULL use has been made by Soviet specialists of the experience gained in the operation of the first atomic electrical station for the development of more powerful stations at Voronezh and Beloyarsk. The first sections of the Novovoronezh and Beloyarsk stations have been built (210,000 and 100,000 kilowatts). Quite recently, towards the end of April this year, a powerful reactor was successfully put into commission at the Igor Kurchatov Beloyarsk Atomic Station. The atom, one of the symbols of our age, started its constructive work in the Urals forest, too.

A new pattern of operation has been developed for the Beloyarsk station—it was decided for the first time to have the steam superheated in the pile itself. As it passes through the ducts of the reactor, the steam of the secondary circuit is superheated and sent to a 100,000-kilowatt turbo-generator. This is a Soviet innovation in atomic engineering—a new branch of engineering has made its appearance, just as electrical engineering, thermal engineering, radio engineering, etc., appeared in their time.

Some time ago Academician Anatoly Alexandrov, director of the Kurchatov Institute of Atomic Power, reported that the second sections of the Novovoronezh and Beloyarsk atomic stations would have capacities of 365,000 and 200,000 kilowatts respectively, though the construction costs would be practically the same as for the first sections, and this would slash substantially the cost of electricity.

Estimates indicate that with greater capacity the cost of electricity generated by atomic stations drops far more quickly than is the case at thermal stations using conventional fuel. This is understandable because cost of radiation protection, system of control and operation are almost totally unrelated to reactor capacity.

Academician Alexandrov believes that given stations of about one million kilowatts and reactors of about 500,000 kilowatts or more, the electricity generated by atomic power stations will be cheaper than that produced by thermal stations in the northern and western areas of the USSR. Thus the development of atomic electric stations is becoming a commercial proposition.

"It can be said," the Academician stated, "that the stage of exploration in this field is practically over. Furthermore, there are no obstacles keeping us from making the next step—starting the development of a system of atomic power generation consisting of atomic power stations, the production of 'fuel' elements and of plants that will process nuclear 'fuel' waste by radiation and chemical means."

● YOUNGER GENERATION

SHORTLY before that, towards the end of last year, small transportable atomic power stations of about 750 kilowatts successfully underwent trials. A big advantage of this type of station is that it can be dismantled into units weighing from 10 to 16 tons. These units can be delivered to the construction site by various means, even by aircraft. Such stations are planned for construction in the north and the east of our country—wherever local fuel is lacking and its delivery involves many difficulties. Whenever the Arctic Circle is in question there is always the danger of the fuel not being delivered on time. Meanwhile a transportable atomic station, according to estimates, can operate reliably without recharging for two years.

Last year the first surface ship in the world with an atomic engine —the icebreaker *Lenin*—completed its fourth navigation season. Construction work on the vessel began in Leningrad in August 1956 and the ship was launched on December 5, 1957. Last summer the ship's atomic reactor was closely examined and it was found to be in perfect condition. The ship could have operated without recharging for another navigation season but one has to exercise caution in the severe Arctic conditions, and so the heat elements were replaced last year.

We are entering a new decade of the peaceful uses of atomic energy enriched by a wealth of scientific and technical experience. So, we shall be building even more highly perfected atomic stations and ships in the future.

● DREAMING OF A MINIATURE SUN

COULD this be the end of our searchings for new power sources? A categorical answer in words and in actual deeds has been supplied by Soviet scientist Academician Lev Artsimovich. "By no means!" he wrote several years ago. "No new source of energy will be superfluous in future and from this point of view, there are particularly interesting possibilities of using not fission but fusion of the lightest nuclei belonging to the initial elements of Mendeleyev's system of chemical elements. It is worth noting that stocks of light elements are inexhaustible to all intents and purposes."

If we learned to build thermonuclear power stations it would mean that we would no longer need to use any organic fuel for power generation. Coal, oil, peat,

Facts of Interest

● The first atomic power station is housed in three buildings: the atomic reactor and the steam generators (heat-exchangers) where steam is generated are in one of them; another building is for the steam turbine and the electricity generator; the third is for the removal of the small quantities of radioactive gases.

● There are at present about 10 types of installations and reactors for obtaining nuclear energy.

● At present the main source of nuclear energy for peaceful purposes is uranium and not even all natural uranium but only 1/140th part of it—the so-called light uranium (or uranium-235). The main pa or uranium-238) has so far fou generation.

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● The atomic icebreaker ' ing for 4 navigation seasons, a convoys of ships through the

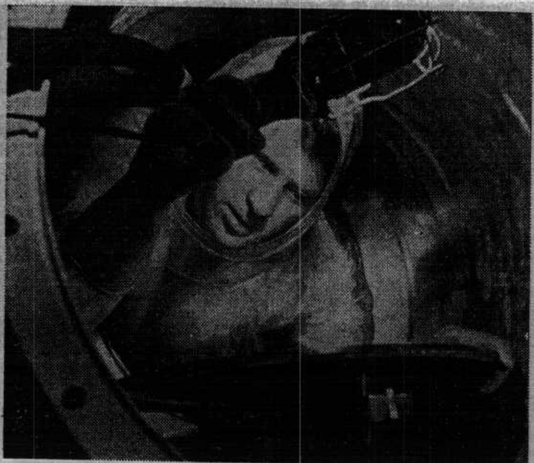
● More than 3,000 indus institutions in our country use clear radiation.

irewood, gas and shale would be ompletely at the disposal of the hemists, who would make much etter use of them than the power ngineers. As for power, it would e delivered in any quantity by a nere stream, by any small lake or iver. Naturally, no harm is done o the water in this process. Freed rom heavy hydrogen—the future tomic "fuel"—it will hardly change t all. There is only one atom of eavy hydrogen in every 6,000 rdinary hydrogen atoms. A number f effective means have been de- eloped for its extraction.

It is also natural that the tem- erature at which ignition of the elf-sustaining continuous thermo- uclear reaction takes place in eavy hydrogen is extremely high. t has been estimated: 300 million- 00 million degrees Centigrade. In- omprehensible heat! This tempera- ure is 25 times as great as in the epths of the sun! True the thermo- uclear ignition of two equal parts f heavy and superheavy hydrogen difficult to obtain), calls for a emperature of about 40 million- 0 million degrees. It is less but ot small either.

We are still far from resolving e problem of nuclear fusion but, s Academician Artsimovich noted, e first necessary step was to de- elop stable plasma in a magnetic eld.

Research along these lines, he aid, had been going on for a ecade at least in the United States, Britain and in our country. owever, only last year did it prove ossible, at least in a physical xperiment, to achieve stable plasma t a temperature of tens of mil- ons of degrees for hundredths of second. In terms of human life is is an infinitely small value but terms of atomic processes it is very great period of time. This ew method of obtaining stable lasma has been developed at the urchatov Institute of Atomic ower.



Vacuum chamber in the laboratory of the "Ogra" thermonuclear experimental plant of the Kurchatov Institute of Atomic Power.

SPLENDID FATE OF PRECIOUS FRAGMENTS

BESIDES being a source of thermal energy a nuclear reactor can be regarded as an "alchemist's furnace" of modern science within which the transmutation of elements takes place. It is in the nuclear reactor that isotopes are born. These isotopes are artificial radioactive versions of atoms—the basis of nuclear engineering other than power generation which is destined to accomplish revolutionary developments in all fields of science and production: in industry, agriculture, public health, and in all natural sciences.

When added to non-active atoms radioactive isotopes "label" them and so make it possible to follow diverse processes in which these atoms are involved. Since in ordinary chemical processes the different isotopes of a particular element behave in a similar fashion, the behaviour of atoms of radioactive isotopes will not differ from that of non-radioactive atoms. With special instruments, however, the movements of these radioactive scouts can be followed. The method of labelled atoms is an extremely sensitive one.

It has made possible important practical findings in relation to the migration of insects, and the carrying by insects of various pathogens like fungi, bacteria, viruses. It has been found that the majority of common flies—vectors of such diseases as dysentery—have a flying range of from two to ten kilometres. Tagged phosphorus has been used to study the transfer of bee diseases from one hive to another.

Soviet scientists A. Kursanov, A. Kuzin, N. Kryukov have used radioactive carbon to discover new functions of the root system: the absorption of carbon dioxide by the roots from the soil and the way it travels to the green parts of a plant.

Using isotopes of phosphorus and radioactive carbon it has been possible to corroborate a hypothesis of Soviet scientists that the main place of sugar synthesis is the leaves of the sugar-beet and that it is only deposited in the roots as a storage. This means that phosphate feeding is important as a means of increasing sugar content.

The method of labelled atoms has helped to establish that cotton, maize, and clover assimilate phosphorus better when the latter is introduced locally than when the fertilizer is scattered.

The method of radioactive tracers has also been instrumental in the study of the role of microelements in the development of farm crops. The method has determined the selective ability of many plants in relation to microelements. Thus cobalt-60 was used to establish the necessity of adding cobalt to animal fodder since cobalt plays an important part in animal organisms for the development of vitamin B-12.

Exposure to radiation is finding a variety of uses in medicine. Thus iodine-131 is being used for thyroid diagnosis and for the treatment of thyroid disorders. Phosphorus-32 is used for the treatment of diseases of the bone marrow. The ability of phosphorus-32 to accumulate in brain tissue tumours has been used in neurosurgery.

Many powerful antibiotics: penicillin, streptomycin, aureomycin, tetracycline are still produced by a biosynthetic method through the cultivation of mould and ray fungi. By exposing these fungi to powerful radiation it was possible to slash production costs of penicillin to one hundredth of their former figure, while the strain yield and overall production increased 1,000-fold. Selection work in this field in our country is conducted by Professor S. Alikhanian and his associates.

Radiation may be beneficial for yields of farm crops. Small doses of radiation, unlike big doses, accelerate germination, shorten the vegetation period, and stimulate growth and yield.

STORMING THE UNKNOWN

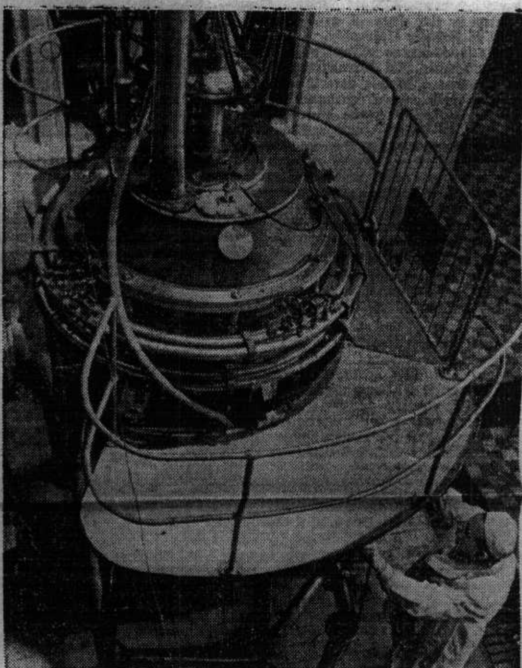
MEANWHILE physicists are developing the gains which have been achieved and are looking forward to storming new regions of the unknown. They are continually attracted to problems of the nature of the forces of interaction between the particles of an atomic nucleus.

How many fundamental particles are there and what is the explanation of their extraordinary and diversified properties?

The main instrument of research into the physics of fundamental particles is powerful accelerators. Now a number of countries are developing superpowerful accelerators. The technical problems involved in the development of these machines which are to be several tens of kilometres long and the expense, which is more than small states can afford, are extremely great. Therefore the search for a new principle of acceleration and for new trends in physics and the technology of developing accelerators is particularly important. Academician Vladimir Veksler, one of the founders of this branch of experimental technology, said at the general meeting of the USSR Academy of Sciences in February this year that the method of "colliding beams" was particularly promising in this respect. The Nuclear Physics Institute of the Siberian Branch of the Academy of Sciences has recently achieved big successes in this field. The Institute accomplished the storage of currents of high energy necessary for the solution of this problem.

Work is underway for the development of new accelerators and for the modification of existing ones. The Physicotechnical Institute of the Ukrainian Academy of Sciences, in conjunction with the State Committee for Atomic Energy of the USSR, is now adjusting a linear accelerator of electrons which is designed to obtain beams with energies of 2 Bev. The Institute of Physics of the Committee for Atomic Energy is building in Yerevan a 6 Bev. electronics synchrotron, while the biggest protonsynchrotron in the world (70 Bev.) with strong focussing is being built near Serpukhov.

New ideas are appearing continually and each new day differs from the previous one. Research is going on to find new ways of developing nuclear reactors and we may say that atomic engineering is making both quantitative and qualitative changes in the world power pattern.



The "Doughnut" installation at the Plasma Research Department of the Kurchatov Institute of Atomic Power.

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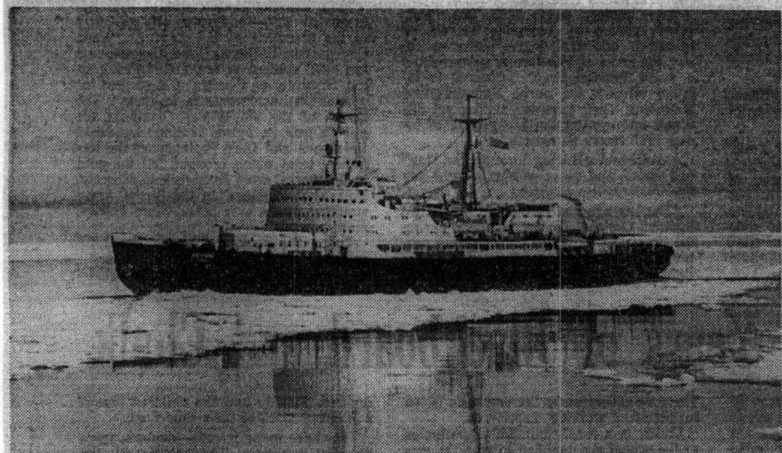

The atomic icebreaker, *Lenin*.

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nin" has now been operat- is in its fifth year of taking im Arctic ice.

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● Our industry now produces about 700 chemical compounds "labelled" with radioactive isotopes, about 400 compounds with stable isotopes, 500 types of sources of nuclear radiation, etc.

● The city of Dubna in the Moscow Region is a world-famous research centre for the peaceful uses of nuclear energy, where scientists from socialist countries work in the Joint Nuclear Research Institute. A new Research Institute of Atomic Reactors has been opened in the town of Melekess on the Volga, and all kinds of atomic reactors for the economy are being built and tested there.