HARNESSING NUCLEAR FUSION

IN replying on November 11 to a question in the House of Commons, the Paymaster-General, speaking for the Government, said that the experimental apparatus known as ZETA at the Atomic Energy Research Establishment, Harwell, was operating successfully, and discharges through heavy hydrogen were giving very high temperatures, accompanied by discharges of neutrons, believed to be due to thermonuclear reactions. It is appropriate that the first detailed account of this work should appear in *Nature*, where it will be read by scientists all over the world (see p. 217 of this issue).

Ever since the possibility of nuclear fission was realized, it was understood that a converse process of fusion of atomic nuclei was possible and would yield a vast amount of energy. This possibility became a fact with the invention of the hydrogen bomb. All the time, however, scientists in many countries were endeavouring to learn more about the mechanism of the reaction with the view of controlling this immense explosive force. A carefully considered account, by one of the Harwell scientists, of the theory involved was published in *Nature* of May 4, 1957, p. 886; this demonstrated the very stringent physical conditions which control of such processes must entail. Although it is generally recognized that we are continually witnessing the results of thermonuclear reactions—for they are believed to be the source of the heat and light given out by the Sun—their production and control in the laboratory present problems hitherto unparalleled.

The communications from British and American scientists appearing in this issue of *Nature* demonstrate that the first steps in this great task have been successfully taken. Teams of scientists at Harwell and Aldermaston have obtained results which led to the brief announcement made in the House of Commons on November 11. American scientists, working on slightly different lines, have also contributed their results, and it is heartening to read the tribute they pay to the Harwell scientists.

Bearing in mind the scientific importance and wide interest of the work already done, the lag between the Government's brief statement and the present publication of British and American results suggests that difficulties other than those of the laboratory have been met. The work was being done, perhaps inevitably in view of its complexity, under government auspices, in the two countries, and was subject to security restrictions. There seems to have been considerable exchange of information between the scientists directly concerned; but it is regrettable that security measures should have been invoked in such a quest, the significance of which for military purposes would not appear to be greater than that of innumerable scientific investigations in progress in various laboratories in both countries. Only those with full knowledge of the situation can give a final answer to this question.

However, the announcement of the successful control of the thermonuclear reaction has now been made, and all the scientists and others concerned are to be congratulated on their magnificent achievement.

Under the stress of military needs during the Second World War, great efforts were concentrated on the production of the atom bomb, leading to the preparation of fissile material of various kinds; the problem of converting this weapon to the production of energy for peaceful purposes was, for the time being, in the background. But with the end of open warfare, its utilization for the production of useful power became an urgent problem. The culmination of this effort was seen in the opening by H.M. The Queen in 1956 of Calder Hall power station, the first in the world to be solely dependent on atomic energy as a source of power. But the use of fissile material for this purpose, though a triumph of scientific and engineering skill, brought its own difficulties in the economic and other fields, for the initial cost of atomic fuel is high and it is a scarce commodity. Atomic energy power stations and the conventional power stations were seen to be complementary rather than competitive. Now we have the possibility of utilizing another 'atomic' fuel, of wonderful potentiality and world-wide occurrence, though whether it becomes the basis of the generation of electrical power, or means are found of making direct use of it as a source of energy, only the future will show. Meanwhile the control of nuclear fusion will be welcomed both as a great advance in science and as a factor of tremendous importance for the future, bringing vast stores of energy into the service of man for his use in the amelioration of his conditions.

In 1831, Michael Faraday discovered electromagnetic induction. His apparatus was of the simplest kind, consisting of a ring of iron on which two coils of wire insulated with "twine and calico" were wound, and a compass needle as detector. The experiment was not a chance affair, for his thoughts had turned repeatedly to the subject, and he had tried some experiments, but without success. Then he hit upon the correct sequence of events, and the experiment succeeded. Electricity had been generated in one simple circuit by making and breaking another simple circuit. From that experiment the electrical industry was born—the electrical age was initiated; and although its growth was at first slow, it now dominates the industrial world.

The new work on thermonuclear reactions is at present a laboratory experiment, albeit with most complex and costly equipment and even the risk of dangerous irradiation; it is clearly a first step, even as Faraday's experiment was. Life on the Earth has always depended on nuclear reactions in the Sun, and now it seems that man is learning to reproduce those reactions in the laboratory. Are we witnessing the birth of a new age—that of the utilization of man-made thermonuclear reactions?