

PEACEFUL USES OF FUSION

by

Edward Teller*

The problem of how to release fusion energy in an explosion process has been solved several years ago. How to release this energy in a slow and controlled manner has proved to be a much harder question. This situation is in sharp contrast with the history of energy release from fission. One year of intensive work had sufficed to produce the first nuclear reactor in the early winter of 1942, while several more years were needed to perform the first successful nuclear detonation.

Among the reasons for this difference I should like to mention two which are simple and important:

FUSION AND FISSION

Fission energy is released by the mechanism of a chain reaction. The chain-carrying neutrons can be slowed easily. This facilitates a controlled reaction not only because the time that the process takes becomes longer but also because slow neutrons are more easily controlled by specific absorbers and other means. On the other hand, release of fusion energy is accomplished by a heat explosion, or to use the technical term, a thermonuclear reaction. The particles carrying that explosion will necessarily move with high velocity.

The second and more important difference is the following: The fission chain reaction is regulated by assembling the correct amounts of active materials and absorbers. If the correct amount is exceeded the energy release rises in a rather slow manner due to the role of delayed neutrons. In contrast, the main regulating feature in a fusion reaction is the temperature. When a certain ignition temperature has been exceeded, the reaction itself raises the temperature and leads to an exceedingly rapid acceleration of further energy release.

Slow energy release is possible only at low densities; but this raises further problems.

HISTORY

The problem of controlled fusion is difficult but not necessarily insoluble. Some of us have discussed it in a rather detailed manner during the war, in Los Alamos. This group included Enrico Fermi, John von Neumann, James Tuck, and Luis Alvarez.

* University of California Radiation Laboratory, Livermore, California.