BILL OF RIGHTS ENCASED—Document will be protected permanently from future damage or deterioration in a helium-filled glass case. Here Louis Gilles of Toledo, Ohio, seals the official parchment copy of the original, readying it for permanent exhibit with the originals of the Declaration of Independence and the Constitution on Dec. 15 at the National Archives Building, also preserved by helium. The protection method was developed at the National Bureau of Standards.

prize in 1945) and F. Strassmann, proved that an isotope of barium was produced by neutron bombardment of uranium. The neutron is a fundamental particle of matter without electrical charge and with a mass about equal to that of the proton or nucleus of the hydrogen atom.

Two refugees from Germany, O. R. Frisch and Lise Meitner, suggested that the absorption of a neutron by a uranium nucleus sometimes caused that nucleus to split into approximately equal parts, with the conversion of some of the mass, by Einstein's 1905 formulation, into enormous quantities of energy, a process called fission.

Experimental confirmation of uranium fission in several laboratories followed. The suggested likelihood of emission of neutrons in the process was demonstrated. This indicated the possibility of a chain reaction releasing energy explosively, the neutrons produced splitting asunder other uranium atoms and producing more neutrons as well as energy.

The world's common sources of power, other than sunlight and water power, are chemical reactions, such as the combustion of oil and coal. They release energy as the result of rearrangements in the outer electronic structures of the atoms. This is the same kind of process that supplies energy to the living body.

Combustion is self-propagating. A match releases enough heat to ignite the neighboring fuel, which in turn releases more heat which ignites more fuel. Similarly, nuclear reactions may emit particles of the same sort that initiate them, and they may be sufficient in number to propagate the reaction in neighboring nuclei. This is called a chain reaction, and it is this sort of reaction accompanied by release of energy that occurs in the atomic bomb.

By June, 1940, it was known that slow neutrons caused fission in one isotope, uranium 235, but not in the other, uranium 238. It was known that the average number of neutrons emitted per fission was between one and three. A chain reaction had not been achieved but its possibility was clear.

It was found necessary to separate uranium 235 (less than ½% in any uranium sample) from the more abundant isotope 238 (more than 99%). An enormous isotope separation plant, using gaseous diffusion methods, was erected at Oak Ridge, Tenn.

Two new elements, heavier than uranium 92, both of which were "made to order," played an important part in the atomic bomb researches and manufacture. These were elements 93 and 94.

Element 94 is formed from uranium 238 by neutron capture. This element undergoes slow neutron fission like uranium 235.

Plutonium was obtained from uranium 238 by way of the intermediate shortlived element 93, named neptunium.

Manufacture of plutonium from uranium 238 allowed utilization of the inert uranium isotope for atomic power purposes. It allowed the advantage of sharp chemical separation of different elements instead of the tedious diffusion methods of isotope separation. Plutonium is probably the A-bomb material of today.

Thus transmutation, for centuries the alchemists' goal, became the method of choice of the group of scientists who worked out the chemistry of the atomic bomb.

The great nuclear reactors at Hanford, Wash., manufacture plutonium from uranium by this process.

Fusion for H-Bomb Reaction

The reaction of the hydrogen bomb is different from that of the fission bomb. The thermonuclear reaction involves the conversion of hydrogen into helium with a release of energy due to loss of mass. This is called fusion. This may be the kind of reaction that keeps the sun stoked.

The most likely kind of hydrogen for use in the H-bomb is the triple weight variety or isotope, tritium. It can be produced in a nuclear reactor such as those at Hanford by neutron bombardment of lithium metal. Deuterium, or double-weight or heavy hydrogen, possibly may fuse also.

The starting trigger of the H-bomb would be a plutonium bomb, the A-bomb, whose sun-like high heat brings about the fusion.

Nuclear reactors are thus prime instruments of the atomic age. The original one, called CP-1, has long since been removed from its athletic field cradle. The AEC admits it has 23 reactors, aside from the power ones being built for military purposes and the unrevealed ones at Hanford, where the official count is four, and at the new Savannah River H-bomb plant now building.

Out of the reactors come the stuff of bombs, exploding atoms that cure, and new knowledge about the way the universe is put together. If men can refrain from destroying the world with the atoms they have harnessed, Dec. 2, 1942, will be a great day in history.

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