= Frank Spedding =

Frank Harold Spedding (October 22 , 1902 ? December 15 , 1984) was a Canadian American chemist . He was a renowned expert on rare earth elements , and on extraction of metals from minerals . The uranium extraction process helped make it possible for the Manhattan Project to build the first atomic bombs .

A graduate of the University of Michigan and University of California , Berkeley , Spedding became an assistant professor and head of the department of physical chemistry at Iowa State College in 1937 . His efforts at building up the school were so successful that he would spend the rest of his career there , becoming a professor of chemistry in 1941 , a professor of physics in 1950 , a professor of metallurgy in 1962 , and ultimately professor emeritus in 1973 . He co @-@ founded , along with Dr. Harley Wilhelm , the Institute for Atomic Research and the Ames Laboratory of the Atomic Energy Commission , and directed the Ames Laboratory from its founding in 1947 until 1968 .

Spedding developed an ion exchange method of separating and purifying rare earth elements using ion exchange resins , and later used ion exchange to separate isotopes of individual elements , including hundreds of grams of almost pure nitrogen @-@ 15 . He published over 250 peer @-@ reviewed papers , and held 22 patents in his own name and jointly with others . Some 88 students received their Ph.D. degree under his supervision .

= = Early life and education = =

Spedding was born on October 22 , 1902 , in Hamilton , Ontario , Canada , the son of Howard Leslie Spedding and Mary Ann Elizabeth (Marshall) Spedding . Soon after he was born , the family moved to Michigan , and then Chicago . He became a naturalized U.S. citizen through his father . The family moved to Ann Arbor , Michigan , where his father worked as a photographer , in 1918 . He entered the University of Michigan in 1920 , receiving a Bachelor of Science (B.S.) degree in chemical engineering in 1925 and a Master of Science (M.S.) in analytical chemistry the following year .

As an undergraduate , Spedding took issue with the prevailing explanation by Friedrich August Kekulé of how the six carbon atoms in benzene hold together and proposed an alternate explanation . His professor , Moses Gomberg , recognised this as being the same as the (incorrect) model advanced by Albert Ladenburg in 1869 . At Gomberg 's suggestion , Spedding applied to the University of California , Berkeley , to study for his doctorate under Gilbert N. Lewis . Gomberg wrote a recommendation so that Spedding was not only accepted , but given a teaching fellowship as well . Under Lewis 's supervision , Spedding earned his Doctor of Philosophy (Ph.D.) in 1929 , writing his thesis on " Line absorption spectra in solids at low temperatures in the visible and ultraviolet regions of the spectrum " . It was published that year in the Physical Review .

= = Early career = =

Spedding 's graduation coincided with the onset of the Great Depression , and jobs became hard to find . Spedding received a National Research Fellowship from 1930 to 1932 , enabling him to stay at Berkeley and continue his research into the spectra of solids . While hiking in northern California , he met Ethel Annie MacFarlane , who shared his passion for camping , hiking and mountain climbing . Born in Winnipeg , Manitoba , she was a graduate of the University of Saskatchewan and the University of Toronto , where she had earned a master 's degree in history . When they met , she was teaching at Victoria High School in Victoria , British Columbia . They were married on June 21 , 1931 . They had a daughter , Mary Anne Elizabeth , who was born in 1939 .

From 1932 to 1934 , Spedding worked for Lewis as a chemistry instructor . Around this time , he became interested in the chemistry of the rare earths . These were expensive and hard to find , and generally available only in minute amounts . In 1933 he won the Irving Langmuir Award for most outstanding young chemist . The award came with a cash prize of $ 1 @,@ 000 . He borrowed

money to travel to Chicago to collect it . While he was there , he was approached by a man offering several pounds of Europium and Samarium . His benefactor was Herbert Newby McCoy , a retired chemistry professor from the University of Chicago , who had obtained a supply of these elements from the Lindsey Light and Chemical Company , where they were a byproduct of thorium production . A few weeks later , Spedding received a package in the mail containing jars of the metals .

In 1934 , Spedding was awarded a Guggenheim Fellowship , allowing him to study in Europe . To save money , Spedding and his wife travelled to Europe by heading westward across the Pacific . His intention was to study in Germany under James Franck and Francis Simon , but they fled Germany after Adolf Hitler came to power in March 1933 . Instead he went to the Cavendish Laboratory at the University of Cambridge in England , where he was welcomed by Ralph H. Fowler . Spedding worked with John Lennard @-@ Jones , and attended lectures given by Max Born . He paid a visit to Niels Bohr in Copenhagen , and gave a lecture in Leningrad .

When Spedding returned to the United States in 1935 , the country was still in the grip of the Great Depression , and the job market had not improved . He was George Fisher Baker assistant professor at Cornell University from 1935 to 1937 . It was another temporary position , but it did allow him to work with Hans Bethe . At one point he drove out to Ohio State University hoping to find a tenure track position . The position had already been filled , but the professor of chemistry there , W. L. Evans , knew that Winfred F. (Buck) Coover at Iowa State College in Ames , Iowa , had a position . " I wouldn 't normally have chosen the place , " Spedding later recalled , " but I was desperate . I thought : I can go there and build up physical chemistry and when jobs really open up I can go to another school . "

Spedding took up the position as assistant professor and head of the department of physical chemistry at Iowa State College in 1937 . His efforts at building up the school were so successful that he would spend the rest of his career there , becoming a professor of chemistry in 1941 , a professor of physics in 1950 , a professor of metallurgy in 1962 , and ultimately professor emeritus in 1973 .

= = Manhattan Project = =

By February 1942 , the United States had entered World War II , and the Manhattan Project was building up . At the University of Chicago , Arthur H. Compton established its Metallurgical Laboratory . Its mission was to build nuclear reactors to create plutonium that would be used in atomic bombs . For advice on assembling the laboratory 's Chemistry Division , Compton , a physicist , turned to Herbert McCoy , who had considerable experience with isotopes and radioactive elements . McCoy recommended Spedding as an expert on the rare earth elements , which were chemically similar to the actinide series that included uranium and plutonium . Compton asked Spedding to become the head of the Metallurgical Laboratory 's Chemistry Division .

Due to lack of space at the University of Chicago , Spedding proposed to organise part of the Chemistry Division at Iowa State College in Ames , where he had colleagues who were willing to help . It was agreed that Spedding would spend half of each week in Ames , and half in Chicago . The first problem on the agenda was to find uranium for the nuclear reactor that Enrico Fermi was proposing to build . The only uranium metal available commercially was produced by the Westinghouse Electric and Manufacturing Company , using a photochemical process that produced ingots the size of a quarter that were sold for around $ 20 per gram . Edward Creutz , the head of the group responsible for fabricating the uranium , wanted a metal sphere the size of an orange for his experiments . With Westinghouse 's process , it would have cost $ 200 @,@ 000 and taken a year to produce .

The other major problem was the purity of the uranium . Impurities could act as neutron poisons and prevent a nuclear reactor from working , but the uranium oxide that Fermi wanted for his experimental reactor contained unacceptably large amounts of impurities . As a result , references published before 1942 typically listed its melting point at around 1 @,@ 800 ° C (3 @,@ 270 ° F) when pure uranium metal actually melts at 1 @,@ 132 ° C (2 @,@ 070 ° F) . The most effective way to purify uranium oxide in the laboratory was to take advantage of the fact that uranium nitrate

is soluble in ether . Scaling this process up for industrial production was a dangerous proposition ; ether was explosive , and a factory using large quantities was likely to blow up or burn down . Compton and Spedding turned to Mallinckrodt in Saint Louis , Missouri , which had experience with ether . Spedding went over the details with Mallinckrodt 's chemical engineers , Henry V. Farr and John R. Ruhoff , on 17 April 1942 . Within a few months , sixty tons of highly pure uranium oxide was produced .

Spedding recruited two chemistry professors at Ames for his group there , Harley Wilhelm and I. B. Johns . Spedding and Wilhelm began looking for ways to create the uranium metal . At the time , it was produced in the form of a powder , and was highly pyrophoric . It could be pressed and sintered and stored in cans , but to be useful , it needed to be melted and cast . The Ames team found that molten uranium could be cast in a graphite container . Although graphite was known to react with uranium , this could be managed because the carbide formed only where the two touched .

To produce uranium metal , they tried reducing uranium oxide with hydrogen , but this did not work . They then investigated a process (now known as the Ames process) originally developed by J. C. Goggins and others at the University of New Hampshire in 1926 . This involved mixing uranium tetrachloride and calcium metal in a calcium oxide @-@ lined steel pressure vessel (known as a " bomb ") and heating it . They were able to reproduce Goggin 's results in August 1942 , and by September , the Ames Project had produced a 4 @.@ 980 @-@ kilogram (10 @.@ 98 lb) ingot . Starting in July 1943 , Mallinckrodt , Union Carbide , and DuPont began producing uranium by the Ames process , and Ames phased out its own production by early 1945 . As a result , the Ames Laboratory never moved to Chicago , but Spedding was present at the University of Chicago on 2 December 1942 , to witness the first controlled nuclear chain reaction in Fermi 's Chicago Pile @-@ 1 .

Throughout the war , the laboratory held regular information sessions known as " Speddinars " . In addition to its work with uranium , the Ames Laboratory produced 437 pounds (198 kg) of extremely pure cerium for the cerium sulphide crucibles used by the plutonium metallurgists . Fears that world supplies of uranium were limited led to experiments with thorium , which could be irradiated to produce fissile uranium @-@ 233 . A calcium reduction process was developed for thorium , and some 4 @,@ 500 pounds (2 @,@ 000 kg) was produced .

= = Later life = =

After World War II , Spedding founded the Institute for Atomic Research and the Ames Laboratory of the Atomic Energy Commission . He directed the Ames Laboratory from its founding in 1947 until 1968 . It was initially established on the grounds of Iowa State College . Permanent buildings were constructed that were opened in 1948 and 1950 , and subsequently named Wilhelm Hall and Spedding Hall . Spedding was " universally acknowledged as one of the world ? s foremost experts on the identification and separation of rare earths " . He developed an ion exchange method of separating and purifying rare earth elements using ion exchange resins . He later used ion exchange to separate isotopes of individual elements , including hundreds of grams of almost pure nitrogen @-@ 15 .

During his career , Spedding published over 260 peer @-@ reviewed papers , and held 22 patents in his own name and jointly with others . Some 88 students received their Ph.D. degree under his supervision . After his retirement in 1972 , he authored 60 books . He received the William H. Nichols Award from the American Chemical Society in 1952 , the James Douglas Gold Medal from the American Institute of Mining , Metallurgical , and Petroleum Engineers in 1961 and the Francis J. Clamer Medal from the Franklin Institute in 1969 . He was nominated several times for the Nobel Prize in chemistry , but never won . An award called the Frank H. Spedding Award is presented at the annual Rare Earth Research Conference .

Spedding suffered a stroke in November 1984 , and was hospitalised , but sent home . He died suddenly on December 15 , 1984 , and was buried in the cemetery at Iowa State University . He was survived by his wife , daughter , and three grandchildren . His papers are housed in the Special Collections Department of Iowa State University .