Y-12

A HISTORICAL PERSPECTIVE

A PROMISING FUTURE – A WINDOW TO THE PAST

Even though the beta calutrons have been placed on standby, they remain the sole U.S. source of separation technology for many of the most important isotopes used in research, health-related studies and treatment, and for unique industrial applications.

For most people who live in Oak Ridge, or came here to work during the war, the Y-12 calutron remains a symbol of the city's heritage of innovation and creativity as well as the strong commitment to excellence that began with the secret effort of the Manhattan Project.

Y-12 is an unparalleled national resource, whose goal today is similar to that in 1945: ***Protecting America's Future****.*

NNSA National Nuclear Security Administration

Y-12 National Security Complex

For more information visit *www.y12.doe.gov*

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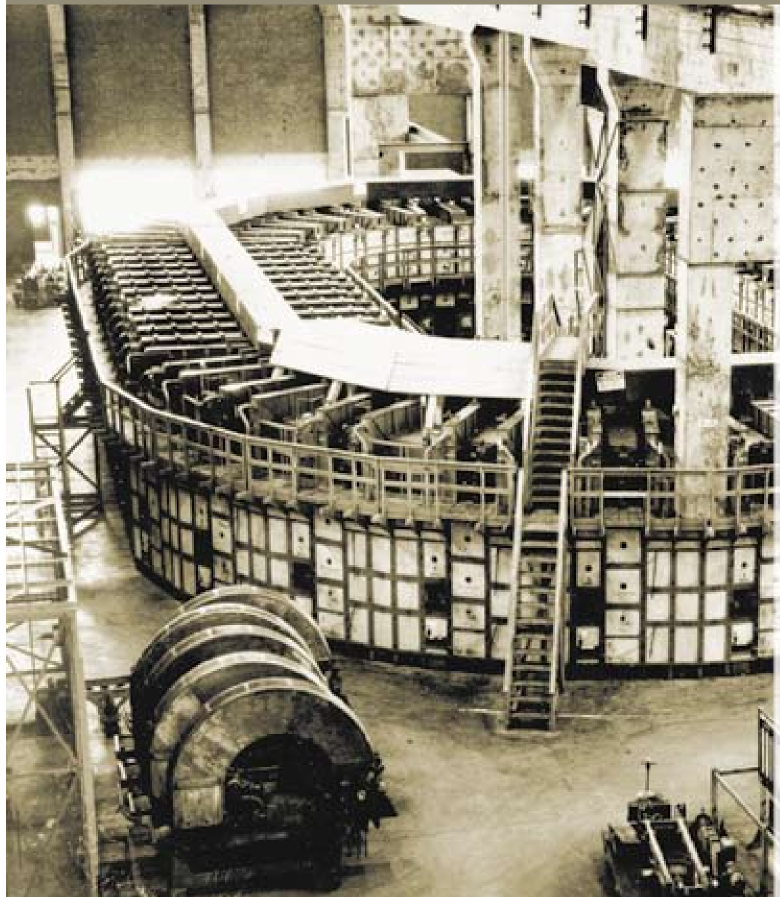
A HISTORICAL PERSPECTIVE

THE POWER TO END A WAR

THE HISTORY OF THE CALUTRON



WHAT IS A CALUTRON?

Calutron: Designed by Ernest Orlando (E.O.) Lawrence to separate the isotopes of Uranium 235 (U-235) from naturally occurring uranium, where the majority is Uranium 238 (U-238). U-235 is the only naturally occurring nuclear fission fuel; therefore, it was vital to develop a successful separation process using this element.

Y-12: Facility built in Oak Ridge, Tennessee, to house the 1,152 calutrons during World War II. Y-12 was a key part of the effort to make the bomb dropped on Hiroshima, Japan, on Aug. 6, 1945. The facility produced 50 kg of U-235 within a year of its construction.

D-Coils: Sections of the Beta 3 calutron magnet, recognizable by their unique "D" shape. The vacuum "tanks" for inserting the uranium mixture ion stream and collecting the U-235 were placed between the D-Coils and thus in the path of the magnetic force – leaving the ions bent in a predetermined arc according to their relative mass.

Alpha: First stage of uranium enrichment at Y-12. These calutrons enriched material to about 15 percent enrichment.

Beta: Second stage of uranium enrichment at Y-12. These calutrons increased the enrichment from the Alpha calutron to weapons-grade material.

MAKING HISTORY

" ***It's hard to imagine*** *…*

…an entire city existing in secret.

…60,000 acres set aside for one, top-secret purpose.

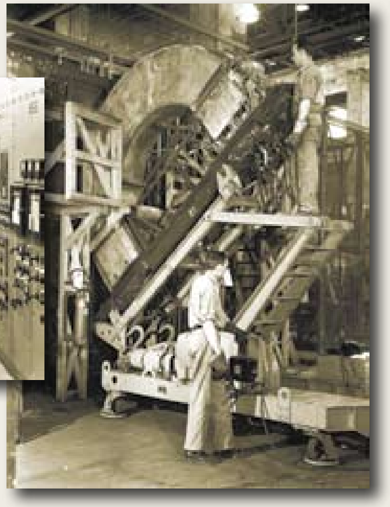
…a discovery so huge it could end a World War.

It's hard to imagine – ***but it's true.*** "

RAY SMITH • Y-12 PROJECTS DIVISION; HISTORIAN • OAK RIDGE, TENNESSEE

At the peak of production during the war, Y-12 had 22,000 workers.

The women working the calutrons were known as the "calutron girls."



Source, liner, and receiver assembly

Beta calutron "racetrack"

PERFECTION TAKES TIME…

The first production system, known as an Alpha "race-track," held 96 calutron alpha tanks. In order to minimize magnetic losses and steel consumption, the assembly was curved into an oval 122 feet long and 77 feet wide. To produce the electromagnets required for this task, a large amount of copper was needed. The Army did something that could only be done in wartime – they borrowed nearly 14,000 tons of pure silver from the U. S. Treasury. This silver was fabricated into strips and wound onto coils as a substitute for copper. In the summer of 1943, the "racetracks" were cleared for full-scale runs.

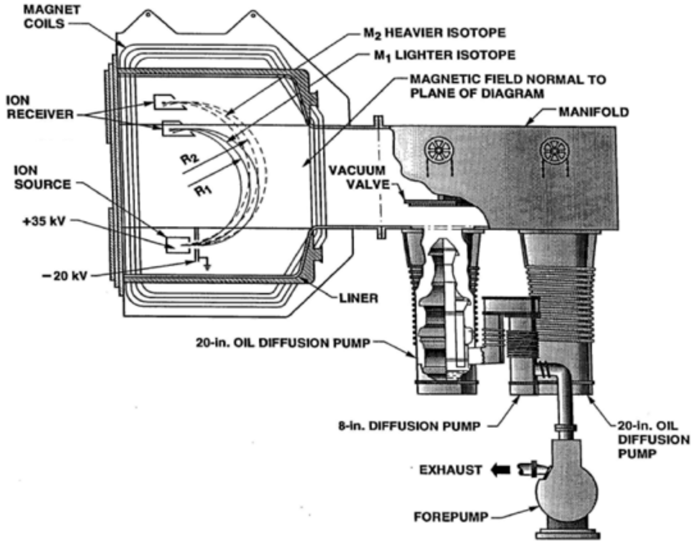
Facing several difficulties during the first months of production, and with only 200 grams of uranium enriched to 12 percent U-235 in February 1944, it was clear that additional stages of the process were needed. The beta calutrons were created to serve as the final process stage. The beta would use the enriched product of the alpha processes as feed material, requiring these machines to be half the size of the alpha calutrons.

In the critical period – the first few months of 1945 – the six betas of 36 tanks each produced weapons-grade U-235 using feed from the modified alpha calutrons. Nearly all of the U-235 to produce the bomb sent to Los Alamos, the final processing and testing site for the Manhattan Project, had passed through the beta calutrons.

HOW A CALUTRON WORKS

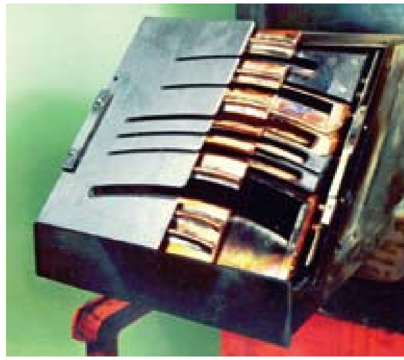
Natural uranium (U-238) is combined with chlorine to form uranium tetrachloride, which is ionized and injected into a vacuum chamber. The ions then pass through slots and are accelerated into an evacuated chamber and through a very strong magnetic field. This field forces the ions into a radial path in the chamber; the heavier U-238 isotope travels on a larger radius than the lighter U-235 isotope, creating the desired separation. These separated isotopes are captured within unique packets as flakes of metal.

When the process was complete, and the required amount of enriched uranium was gathered, it needed to be transferred to Los Alamos. After all the months of secrecy surrounding the project, the enriched uranium used to make the bomb was taken by one man in a business suit, on a train, through Chicago, to New Mexico.



THE WAR IS OVER. NOW WHAT?

In December 1946, all of the Y-12 calutrons, with the exception of those in the Beta 3 building and the pilot units, were shut down and eventually removed. The silver borrowed from the U.S. Treasury was reclaimed and returned.



Isotope receiver

This wasn't the end of the beta calutrons. Between 1945 and 1958, more than 400 different separation runs were performed, demonstrating the importance of separating most elements with stable isotopes. In 1958, the Beta 3 building became available, and the remaining calutrons were modified for use to separate other isotopes. The largest use for calutrons after the war was to produce stable isotopes for the preparation of radioactive tracers used for medical tests. The calutrons at Y-12 were the beginnings of what is now a huge application of medical isotopes for research and treatment.

In 1998, the Beta 3 calutrons were placed on standby as the demand for U.S.-produced isotopes diminished due to the cheaper products provided by other suppliers in the world.

> *"The calutron played a crucial role in **ending World War II**. When the war was over, the calutrons continued to make history by creating the stable isotopes used to make **radioactive material** for medical, industrial, and research applications."*

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