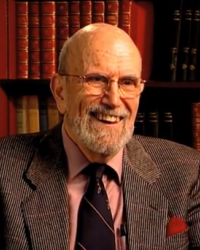
Rockwell on Calutrons

[*Theodore Rockwell*](http://www.atomicheritage.org/profile/theodore-rockwell)*was a doctoral student at Princeton when he was recruited to work as an engineer on the Manhattan Project in*[*Oak Ridge*](http://www.atomicheritage.org/location/oak-ridge-tn)*. In this interview, Rockwell describes the practical problems of working around the giant magnets inside the cyclotrons at the Y-12 Plant in Oak Ridge.*

[Manhattan Project History](https://www.atomicheritage.org/key-document-subjects/manhattan-project-history), [Nuclear Science](https://www.atomicheritage.org/key-document-subjects/nuclear-science)

[](https://www.atomicheritage.org/sites/default/files/Theodore%20Rockwell.png)

**From "Voices of the Manhattan Project,"**[**2002 interview with Theodore Rockwell**](http://manhattanprojectvoices.org/oral-histories/theodore-rockwells-interview)

At its peak, the plants at Y-12 had 22,000 workers who ran the “calutrons,” machines designed after the cyclotron or “atom smasher” invented by Ernest O. Lawrence at the University of California. The Y-12 “calutrons” were used to separate the two nearly identical isotopes of uranium. The heavier isotope, U-238, is very stable and makes up most of the uranium found in nature. The other isotope, U-235, which can be used to fuel an atomic bomb is less than one percent of naturally occurring uranium.

The process involved heating up uranium salts with electric heaters and vaporizing them. The vapor would rise, go though an ionizing path with electron‑producing filament. And as each atom became ionized by giving it an electrical charge, it would take off, attracted to the opposite, negative or positive, charge.

The atoms would be pulled by a strong magnetic force that caused them to accelerate around the D-shaped tank following a semicircular path. The heavier isotopes (U-238) would be flung a little further out because they were heavier and end up falling into one receiver while the lighter atoms (U-235) would fall just short, ending up in a different receiver, just a little closer. Of course in real life, the isotopes would get scattered and the separation into the two receivers was very incomplete. But in theory you could get 100 percent separation this way.

Individually, the separation units look like a capital D. The units were lined up in big ellipses that were called “racetracks,” which they resembled. Facing out were the faceplates or the straight part of the D. The curved part of the D formed the inner part of the racetrack. The material was fed into the bottom part of the D, accelerated up to the top and then collected in receivers.

The control panels for the process were located on the floor above the racetracks.  At each panel an operator controlled one of these D’s, adjusting various knobs to maximize the output. To do this well was quite a feat as it was a very complicated, tricky process. Only Ph.D.’s were allowed to run the cyclotrons at Berkeley. With the shortage of labor, however, the calutrons at Oak Ridge had to rely on young women, many of which had just graduated from high school.

To the surprise of the scientists, the women operators did extraordinarily well, especially considering that were not told that they were separating isotopes of uranium but merely that they were making some sort of catalyst that would be very important in the war. An analogy is the country kid who has an old Model T who doesn’t know anything about engineering but can really tune up the engine with his fingertips and make it run just right. And these women were really incredible. While they had no idea what they were doing, they understood how to optimize this mechanism and make it sing.

And sometimes one of the Ph.D.’s would come along and say “I think we could do this a little bit better.” And he’d start trying to tune that thing but instead of improving the performance, he would cause it to deteriorate. Pretty soon the operator would have to take over and readjust the controls to get it back on track. The women just had a feel for it that the more highly trained men did not.

\*\*\*

The calutrons involved high voltage electricity and the huge magnets. If you walked along the wooden catwalk over the magnet you could feel the tug of the magnetic field on the nails in your shoes. It was like walking through glue. People who worked on the calutrons would take their watch into the watch-maker and discover that it was all smashed inside. The magnetic field had grabbed the steel parts and yanked them out by the roots.

You weren’t supposed to bring any magnetic material, any steel, anywhere near the magnet. If it got anywhere near the magnetic field then “Wham-o!” it would slam up against the calutron. One time they were bringing a big steel plate in and got too close to the magnetic field. The plate pinned some poor guy like a butterfly against the magnetic field. So the guys ran over to the boss and said, “Shut down the magnet! Shut down the magnet! We got to get that guy off.” And the boss replied, “I’ve been told the war is killing 300 people an hour. If we shut down the magnet, it will take days to get re‑stabilized and get production back up again, and that’s hundreds of lives. I’m not going to do that. You’re going to have to pry him off with two-by-fours.” Which is what they did. Luckily he wasn’t badly hurt, but that showed what our priorities were.

<https://www.atomicheritage.org/key-documents/rockwell-calutrons>

