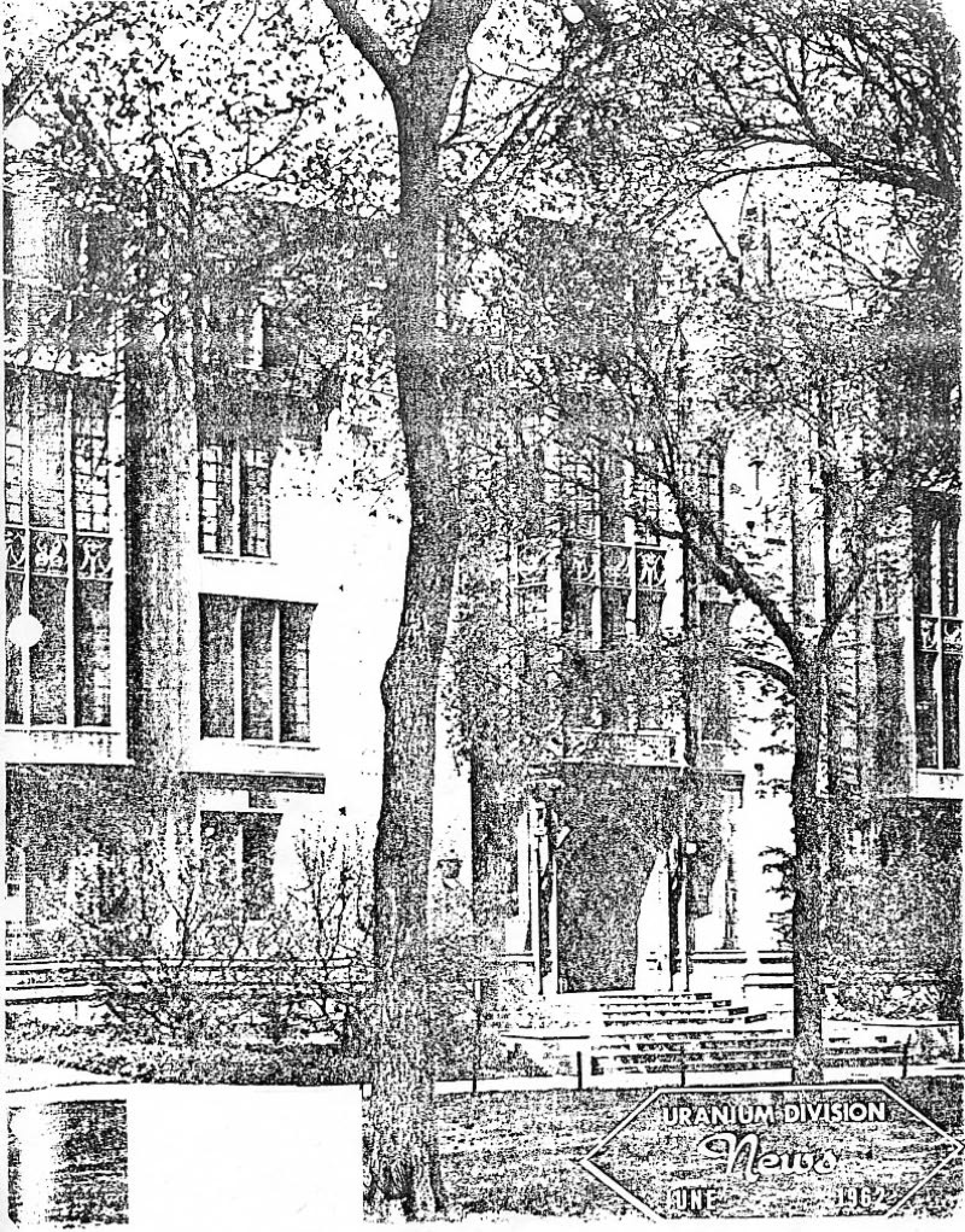

URANIUM DIVISION
News
JUNE 1962

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D.C.

Dear Mr. Thayer:

I am pleased to send you this word of greeting from the Commission on the occasion of the twentieth anniversary of Mallinckrodt's participation in the Nation's atomic energy program. The part that you and the Mallinckrodt people have played in the defense of our country and in the advancement of peaceful uses of the atom has been one of major importance.

Both in weapons development and in putting the atom to work for peaceful purposes, much has happened since the pioneer days of May 1942 when the late Arthur Compton first contacted Edward Mallinckrodt. I personally had the opportunity to visit that early operation in 1942, and I am aware of the significant contribution it made to our country's efforts in those trying times by supplying substantial quantities of high purity uranium.

I congratulate all at Mallinckrodt who over the past 20 eventful years have contributed so much toward progress in the uses of atomic energy. I send you my best wishes.

Sincerely yours,

Glenn T. Seaborg

Chairman

Mr. Harold E. Thayer
President
Mallinckrodt Chemical Works
Second and Mallinckrodt Streets
St. Louis 7, Missouri

2 FOREWORD: "What is Past is Prologue"

3 The First Fifty Critical Days

10 The Importance of People

16 Development and Technology — The Story of Progress

22 Five Who Have Served as Managers

25 The Magic Key: $E = mc^2$

32 "These Things I Remember---"

36 Top-Flight Health Program Pays Off in Healthier People

40 Why We Are Here

44 Uranium Division Plays Major Role in Development of Accountability Techniques

47 That Special Ingredient

54 20 Years of Plant Security Without a Serious Violation

57 Are we a Good Neighbor?

back cover "Mallinckrodt - 20 Years a Pioneer in the Atomic Energy Program"

URANIUM DIVISION

Mallinckrodt

News

Vol. 7 Nos. 3 & 4

ON THE COVER: Twenty years ago, in April 1942, under a tree on the campus at the University of Chicago three men sat talking quietly — A. H. Compton, eminent physicist and Nobel prize-winner and Mallinckrodt chemists Henry V. Farr and John R. Ruhoff.

In front of Eckhart Hall under that very tree in the foreground the three scientists discussed the technical problems of making uranium oxide, decided that Mallinckrodt would undertake the task and agreed on a committment of $15,000 to start the work.

EDITORIAL STAFF: G. W. Lambrecht, managing editor; Bill Williams, illustrations and layout.

EDITORIAL BOARD: F. N. Anderson, G. W. Lambrecht, J. Mituleki, A. E. Ruehle, E. K. Teter, A. J. Windisch, R. O. Zeisler.

CREDITS: Cover photo, p. 7 (top), 8, 10 Argonne National Laboratory; p. 7 (bottom) ©1957 *Chicago Tribune;* pp. 18, 19, 27-31, 35, 40-45, 52 U.S. Atomic Energy Commission; pp. 57, 58 (lower right), 59 (upper left), 60 *Newsweek;* other photos by Mallinckrodt photographers Chas. Grauer, Orval Heflin and Bill Williams.

CONTRIBUTORS: Knowlton Caplan, Pat Fain, John Harris, Jeanelle Hoffert, Dick Kerlin, Matt Kuehn, Alan Lehmann, Perry Morgan, Arch Ruehle, John Ruhoff, Harold Schlueter, Bob Shearer, John Shepardson, Sam Tuthill.

With this special issue of the NEWS we commemorate an anniversary of the uranium division. In terms of time, twenty years can be not very long, yet the efforts of the people who are the uranium division have made it a period of significant contribution to one of the Country's most dynamic technologies.

This, the first twentieth anniversary, measures more than a span of years. It measures growth, change, development and the real test of time — progress. Progress in research, in products, in management, in human relations — and in the total reputation of the organization.

The story that unfolds on the pages that follow is the 1942-1962 story of the uranium division — its growth and progress, but more especially its people and the time and talents they contributed to the success of our past efforts.

We have tried to tell the story faithfully and factually, but not fully, for there is neither time or space enough to cover all of the successes and all of the people. Among the progresses, we have told the story of the early critical days, the major technological breakthroughs, the achievements in analytical control, the history of Oak Ridge, the nostalgia of the first few years, the successes of the security program, the accomplishments of accountability methods, the effectiveness of health measures and the good name of Mallinckrodt as an industrial neighbor.

But, there are others — successes too many to enumerate, people too numerous to mention. People who have left us — for other pursuits: engineer Fred Rauch, custodian Ollie Jordan, technician Jim Renshaw, tool and die maker Earl Hurst, executive Carl Brownfield, operator Jim Scanlon, technologist Dick Edwards, inventor and scientist Wayne Keller. People who have retired: porter Fred Doane, operator Ed Schuenemeyer, guard Noah Myers, supervisor Harold Schlueter, guard lieutenant Gussie Zimmerman, porter Charlie Witthoeft, guard Ed Roberts, porter Myro Meuse. And people who have died — yard operator Dick McNutt, personnel man Everett Bozarth, foreman Charlie Harstick, chemical operator Stan Wasonovitz, health hygienist Gerry Filla, scientist Norton Berry, innovator Fisher Ritchie.

And the union leaders and management representatives — Bob Allen, Norval Bauman, Virgil Belfi, Roy Hachman, Al Seipman, Bob Spencer and Euell Sweeten; Ernest Conte, Joe Dowell and Earl Miller. They may have argued and they may even have disagreed but they always realized the importance of sincere negotiations and the fact that sooner or later a settlement had to be reached.

Then there are whole departments of people that we have not mentioned — personnel, procurement, engineering, maintenance, plant services, and a host of others. And the many crafts and jobs and professions that are not much more than represented by an individual and some of which are not even mentioned by name — designers and engineers, buyers and accountants, recruiters and expediters, stenographers and storekeepers, nurses and analysts, welders and millwrights, operators and mechanics, doctors and metallurgists, planners and decision makers.

Also the many major suppliers, government agencies, research facilities and other operating contractors: Nooter Corporation, Penn Salt, Union Carbide, Dow Chemical, du Pont, the Army Corps of Engineers, the AEC staffs at St. Louis, Oak Ridge and Washington — people and organizations who have provided counsel, direction and guidance, and without whose contribution this anniversay would not have been possible.

To all of these people — past and present — we fondly dedicate this salute. And we quote Shakespeare: "What is past is prologue" with the sincere conviction that this appraisal of the past is but a preface to the future.

The Editor

1942 RESEARCH PROJECTS

		DATE OPENED	APPROVED BY		
42-12	Lead Thiocyanate	3-26-42	H.V.F.		D
42-15	Succinimides	4-17-42	V.H.W.		+
42-16	Cyclopropane Epoxe	4-17-42	V.H.W.		+
42-17	~~Uranium Dioxide S.L.~~ Tube Alloy Dioxide	4-24-42	H.V.F		
42-26	Calcium Chloride S.L	5-14-42	H.V.F		
42-28	Strontium Salts	5-14-42	H.V.F.		D

Page from MCW research department "Research Project Book"; Tube Alloy Dioxide project formally opened on April 24, 1942.

THE FIRST FIFTY CRITICAL DAYS

by John Ruhoff

as told to

Pat Fain

On April 24, 1942 work began on research job number 42-17, designated in secrecy as "Tube Alloy" project. Fifty days later, on June 13, Mallinckrodt accomplished the "remarkable achievement" of producing highly purified uranium oxide on a tonnage scale.

In April of 1942, MCW was engaged in the start-up of a new sodium sulfite plant located in Building 50. Several of us were working in this plant one morning when we received word that some important visitors were in the executive offices; would we please come up to talk with them? Although we didn't know it as we left Building 50, this was the last day of our concern with the sodium sulfite plant.

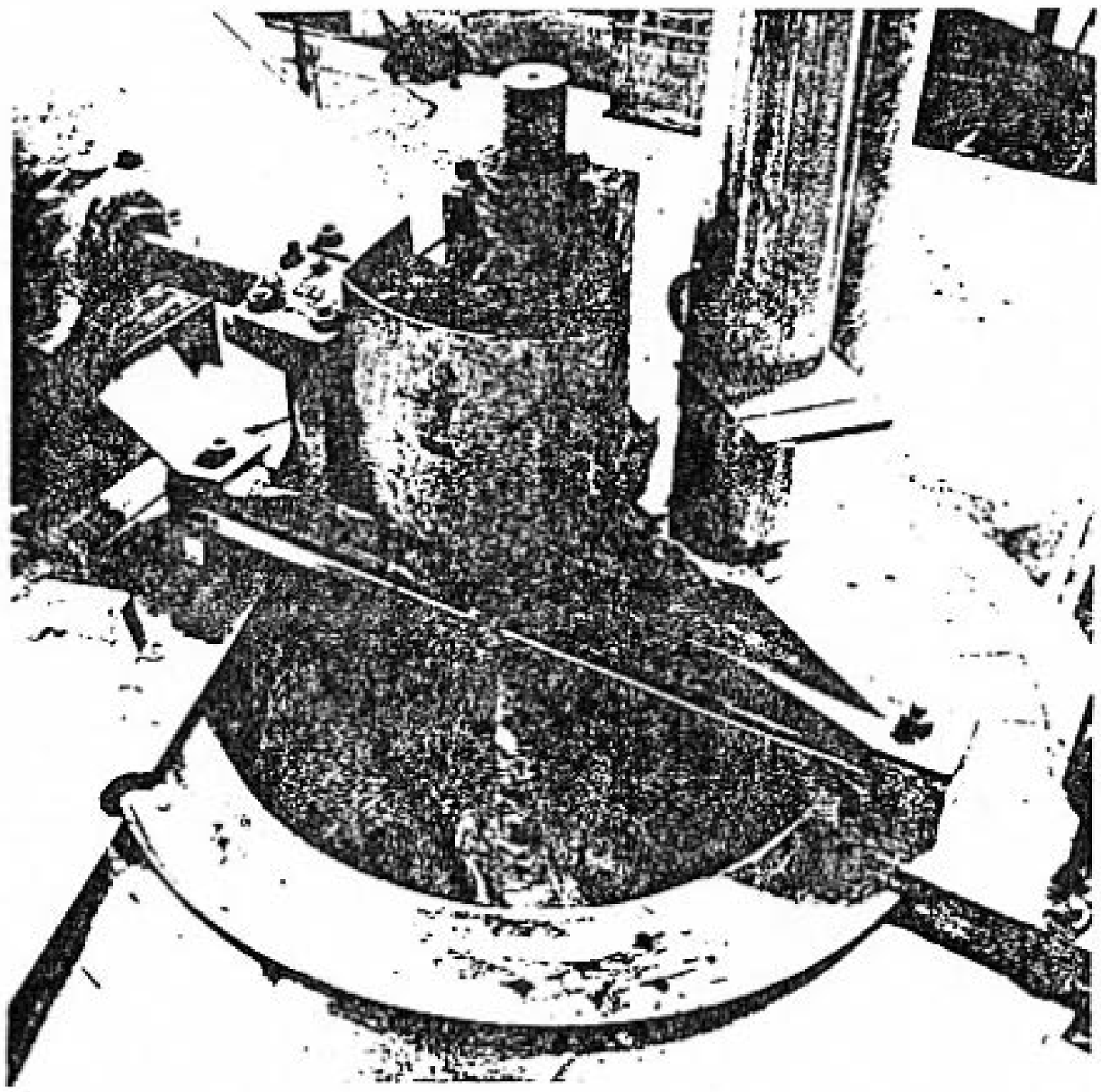
The visitors were Dr. A. H. Compton, Dr. F. N. Spedding, and Dr. Norman Hilberry of the Metallurgical Laboratory of the University of Chicago. They had come to see Dr. Compton's old friend Edward Mallinckrodt, Jr., and to ask whether MCW would prepare some extremely pure uranium compounds urgently needed for a secret project of great importance to the war effort. The degree of purity necessary was not defined, but the visitors emphasized that the best grades of uranium compounds then available had been tried and found to be unsatisfactory for their purpose. They did not tell us why this high-purity material was needed, but they impressed upon us the urgency of the need.

Dr. Compton and his colleagues described a method of purification, the adequacy of which had been demonstrated on a laboratory scale. It involved dissolving uranyl nitrate in ether, washing the resulting solution with water to remove impurities, and then re-extracting the purified uranyl nitrate with water. Would MCW, the visitors asked, undertake the task of utilizing these principles on a large scale with the object of purifying tonnage quantities of certain uranium compounds in a short length of time? After some discussion, in which Mr. Mallinckrodt, Chairman of the Board, and Mr. H. V. Farr, Technical Director, participated, it was agreed that the Company would study the matter further in the hope of assisting in this undertaking.

Shortly after Dr. Compton's visit, MCW personnel visited the University of Chicago for further technical discussions. After a tour of the laboratory, meetings with a number of University of Chicago people, and lunch at the Quadrangle Club, we were about ready to leave for St. Louis when a question of business arrangements was raised. Since we were to have custody of several hundred thousand dollars' worth of uranium and since we would be installing a new plant in which to do the processing, formal arrangements of some sort were necessary.

Dr. Compton said that he had a little money avail-

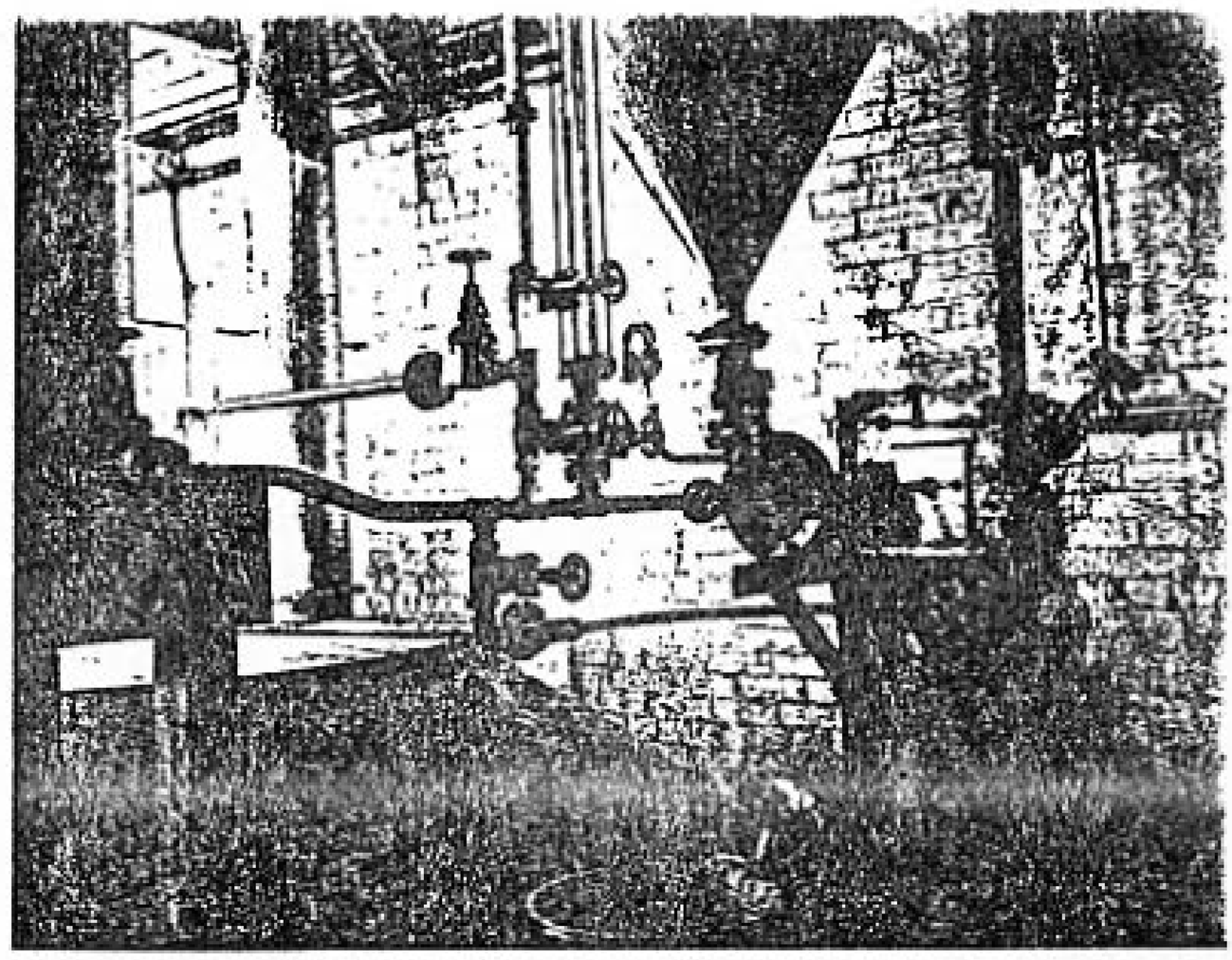
Denitration kettle used in early work. The denitration process was so successful it is still the standard way of making uranium trioxide.



able from the National Defense Research Committe, an amount between $10,000 and $20,000. He suggested '15,000 to begin with, and, on the basis of his verbal assurance that this amount would be forthcoming, we returned to St. Louis and began to work. A letter of intent, pledging the sum of $15,000, was received shortly thereafter.

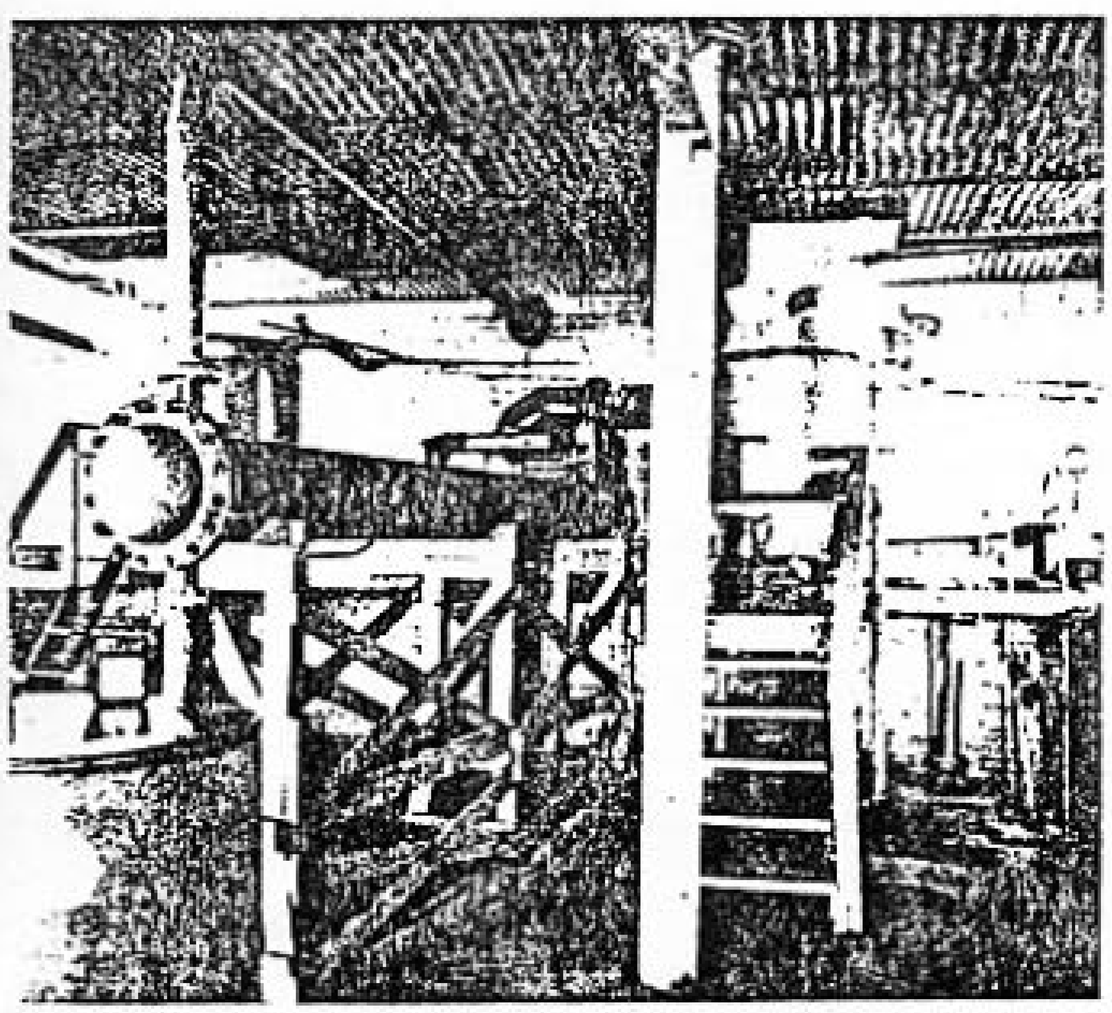
Dr. Compton's account of this in his book, "Atomic Quest," is as follows: "This was in early May 1942. Some months later, Colonel K. D. Nichols dropped in at my office. 'A.H.,' he said, 'you'll be interested to know that we have finally signed the contract with Mallinckrodt for processing the first sixty tons of uranium. It was the most unusual situation that I have ever met. The last of the material was shipped from their plant the day before the terms were agreed upon and the contract signed.'"

Work began in April in the research laboratory in Building 25-2 on the proposed process, including the ether purification step.[1] The process was to include conversion of commercial uranium oxide, the raw material, to uranyl nitrate, separation of the latter from associated impurities by ether extraction, recovery of the uranyl nitrate from the ether, conversion of uranyl nitrate to uranium trioxide, and reduction of the trioxide to uranium dioxide. Initially, efforts were concentrated on two of these operations: the ether extraction of the uranyl nitrate and the conversion of uranyl nitrate to uranium trioxide.



This is a view of the bottom of the extraction unit. Note that the drive shaft of the mixing pump goes through the brick wall. Approved motors for this service were not available in those days. The sight glass to the left of the extractor permitted precise control of the separation of ether and water layers.

Second floor in the extraction room. At the top of the stairs is the tank from which molten uranyl nitrate was fed. The condenser and tank to the left were used to recover ether. The top of the extractor can be seen on the right.



All available Company personnel who could contribute in any way to the project were commandeered. By May 1st, those associated with the research and development effort under the direction of H. V. Farr were Donald Alnutt, James Boyd, Charles Conard, Charles Harrington, Louis Kaplan, Jack Kyger, John Lemp, Gerry Reid, Bill Rosenbaum, Sam Tuthill, and Charles Winters. Marie Prange and June Neff became involved in the project almost immediately in keeping records and helping to maintain the secrecy that surrounded the work.

A formal research project was opened on April 24, 1942, called "Uranium Oxide S.L. 42-17." Although we knew that the uranium work was secret, this name was chosen deliberately for the project to imply that the uranium compound was merely another in our line of S.L. (standard luminescent) chemicals and therefore did not merit any special attention or curiosity. But the use of the term "uranium" in the name was contrary to security regulations. At the request of Government security officials, the name of the project was subsequently changed to "Tube Alloy Dioxide."

While the work on purification of uranyl nitrate was proceeding in the laboratory in St. Louis, a

[1] A complete description of this process was published in 1959 in the book, "Uranium Production Technology," edited by Charles Harrington and Arch Ruehle.

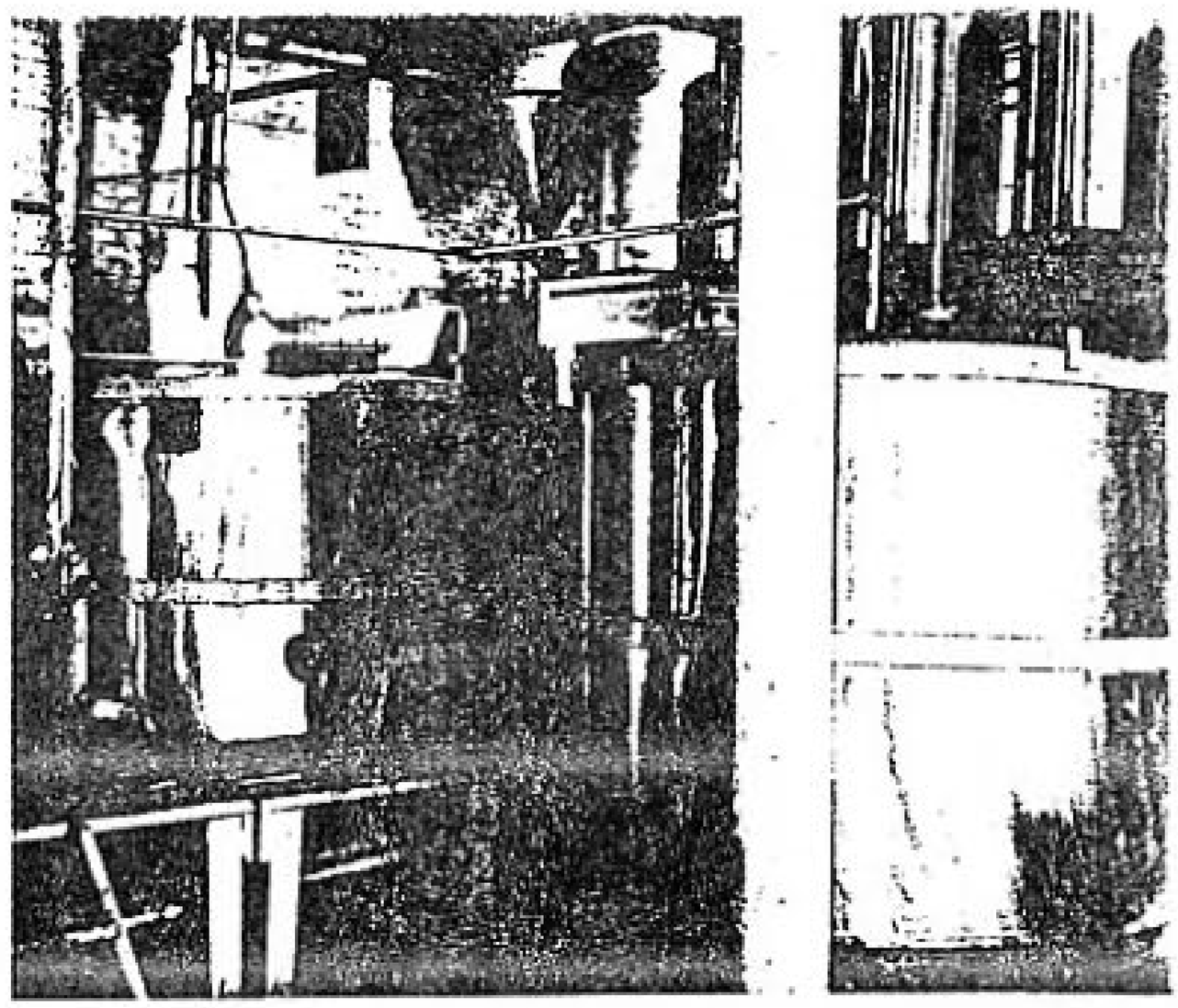
parallel effort on the conversion of uranyl nitrate to uranium trioxide--but on a larger scale--got underway in Jersey City. The Company already had a process in operation there, making red mercuric oxide, that was similar to the proposed process for converting uranyl nitrate to uranium trioxide. In the Jersey City process, an aqueous acidified solution of mercuric nitrate was simultaneously heated and stirred in small, stainless-steel kettles. The liquid was gradually evaporated, and, as the temperature rose, the mercuric nitrate decomposed to form mercuric oxide. The proposed method for making uranium trioxide was similar; that is, thermal decomposition of uranyl nitrate.

The University of Chicago arranged for the delivery to the MCW plant in Jersey City of several thousand pounds of black uranium oxide, the grade which was available at that time from commercial sources. This material came in containers of various shapes and sizes ranging from drums to paint cans. Some of the oxide had been pressed into the form of small cylinders with dimensions of about 2 x 4 inches. We later learned that the cylinders had been used in early experimental exponential uranium piles in attempts to determine whether a pile could be built in which a self-sustaining chain reaction could be carried out.

Before we began a large scale run, Ernest Conte tried the thermal decomposition of uranyl nitrate in the laboratory. When that experiment was successful, we tried it in the plant. The black uranium oxide was dissolved in nitric acid, and the resulting solution was filtered into the kettles. The coal fire, by means of which the kettles were heated, was started, the stirrer was turned on, and the experiment was underway. As the heating continued, water evaporated, the reaction mixture grew thicker, and brown fumes of nitrogen oxides began to come off, indicating that the expected decomposition of uranyl nitrate was occurring. In the last stages of the reaction, the material in the kettle took on the consistency of dough and finally turned into a bright orange powder, uranium trioxide. The operation was repeated twice with similar results. This led us to a conclusion and a question: The process was applicable to the production of uranium trioxide, but how were we to get such equipment in St. Louis?

The answer ultimately lay in Montreal and Jersey City. In the hope of avoiding the installation of coal-fired reaction pots in the St. Louis plant, Burton Brower and I went to Montreal to look at the oil-fired Dutch ovens used to heat the pots in which mercuric oxide was made in MCW's plant there.

Returning to Jersey City with drawings of the Dutch ovens, we met Walter Schmidt, who had come from St. Louis; also we learned that efforts of the Jersey City people to purchase stainless-steel kettles for in-

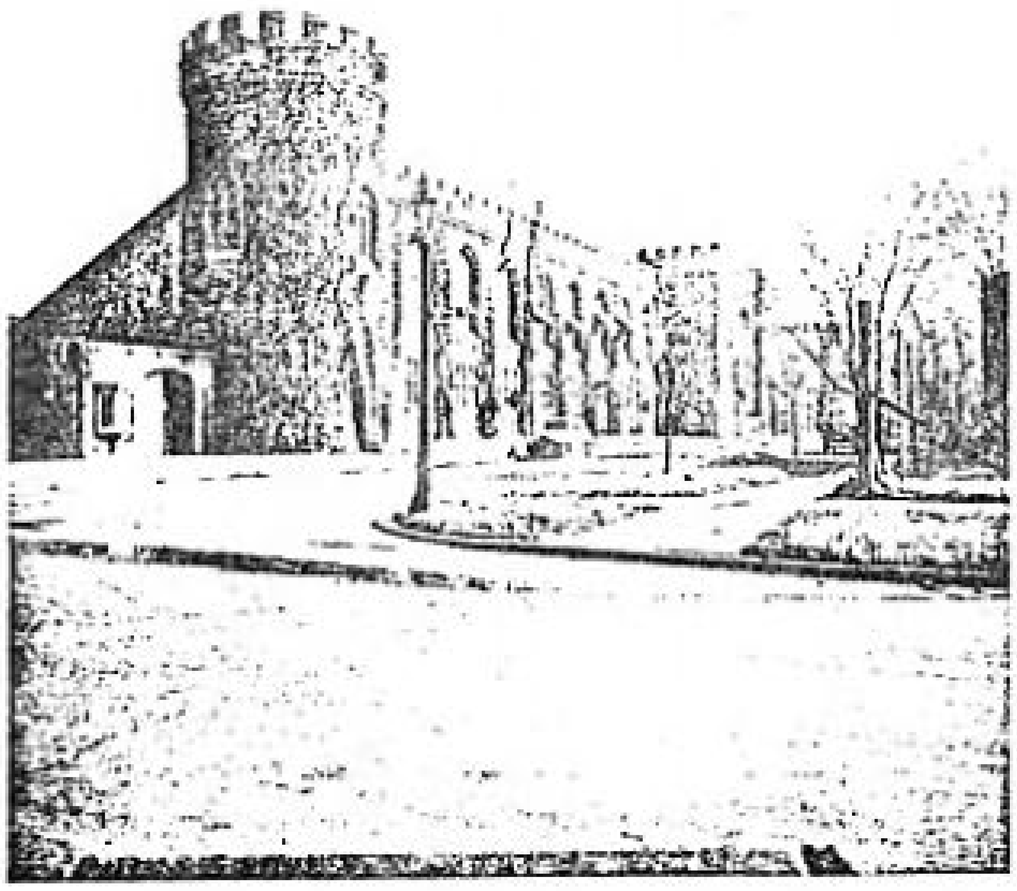


The two larger tanks, 1,000 gallons each, were used to store and de-etherize the aqueous layers. The two products, OK liquor and NG liquor, were stored in separate tanks and then de-etherized separately in tanks like Tank #2 (background). The bottom of the extractor can be seen near the top of photograph. Five of the "seven dwarfs" wash tanks can be seen in the upper right of the photograph.

stallation in St. Louis were fruitless. Stainless steel was in short supply--three to six months delivery, and then only with high priority. On being informed of this situation by telephone, Mr. Farr said, "Why don't we ask the people at Jersey City to dismantle the red oxide plant, spike the equipment onto some flatcars, and ship it out to St. Louis? This is our only chance to get the job done in time." Nat Goodwin, Plant Manager, promptly agreed to this request, and, after making final arrangements Walter, Burton, and I left for St. Louis.

Within a few days, the equipment from Jersey City arrived, including 220-volt, two-phase, gear-head motors for which we had no electrical power in the plant. But Walter, resourceful as always, found some special transformers that converted our three-phase power to two-phase power. The Dutch ovens were built, and the kettles from Jersey City were installed in Building 51. When the time arrived to clean the kettles for the first trial run Ed Ball, Charlie Kinkaid, and Bill McGrath, who were to be shift supervisors in the new plant, undertook this task using sand, water and generous quantities of elbow grease.

By the time the kettles were ready, Bill Fuchs and Steve Lutz had arrived from Jersey City to help us with the first runs in St. Louis. Everything went smoothly at first. The Dutch oven performed satisfactorily, the uranyl nitrate solution boiled vigorously, and the fumes of nitrogen oxides began to evolve. As the reaction mixture thickened in the pots, however,



West Stands at University of Chicago's Stagg Field housed the first reactor.

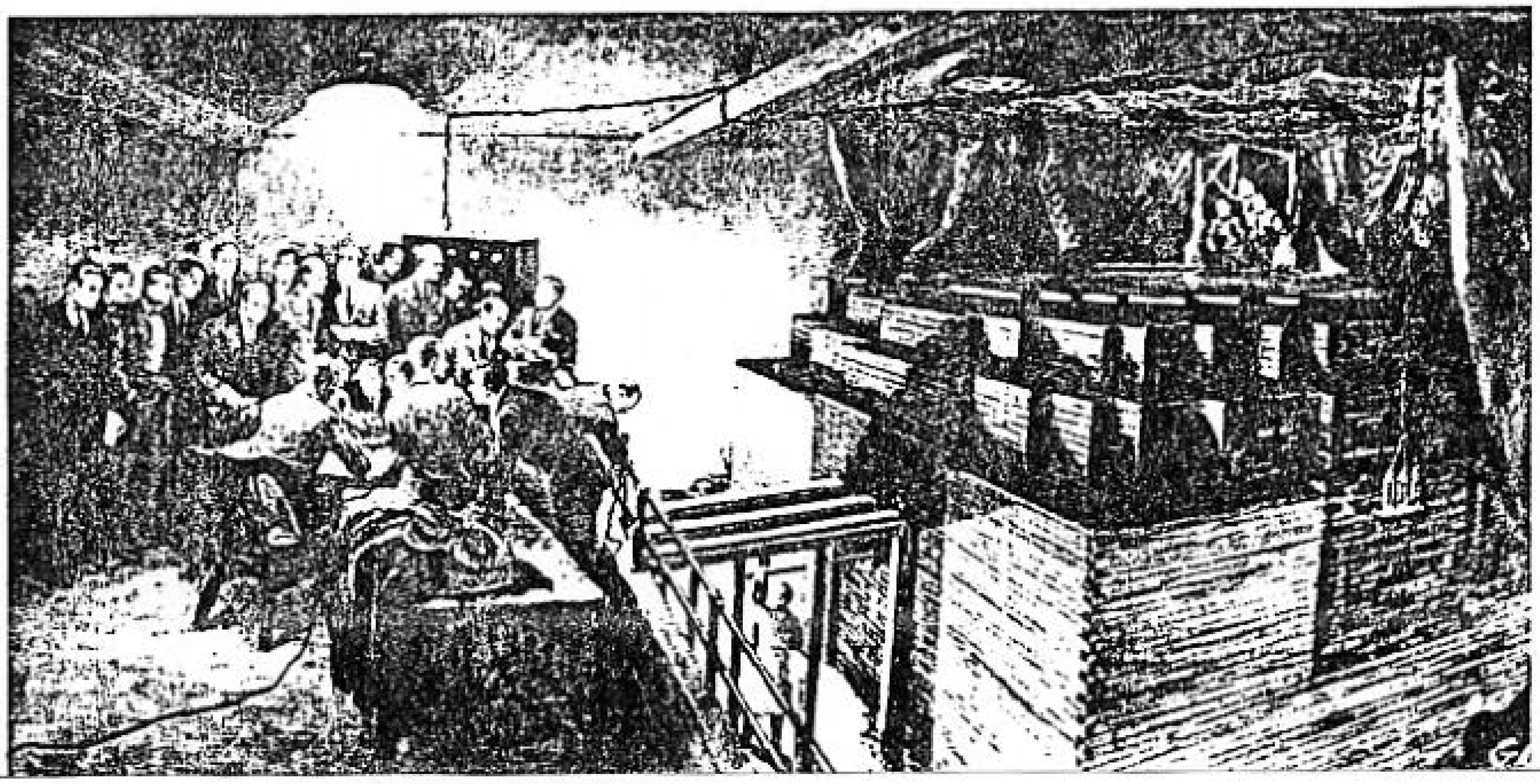
the stirrers began to bind, and this put a heavy load on the motors that drove them. As the binding continued, the load increased and finally became great enough that about 3 a.m. the motors pulled loose and brought with them huge chunks of the concrete floor to which they had been bolted. The damage was subsequently repaired, and, in addition, stronger braces for motors and stirrers were installed, and the blades on the stirrers were changed so that binding could not occur. After these changes were made, the kettles worked well.

Meanwhile, work was proceeding in the laboratory on the ether extraction of uranyl nitrate. Studies by Charles Harrington and a group working with him on the explosive characteristics of ether-uranium nitrate mixtures helped to define the conditions under which ether was to be handled in the plant. The scale of laboratory operations was small, but large enough to demonstrate that a good separation of uranyl nitrate from impurities could be achieved by ether extraction. The next step was to try the extraction on a larger scale. Our "pilot plant" was the alley between Building 25 and K, where we set up an apparatus, which, if it worked, was to serve as the prototype for a large scale extractor.

This prototype, constructed entirely of stainless steel, comprised an 8-foot section of 2-inch-diameter pipe to simulate an extractor and a 3/4-inch pump to circulate and mix the ether and water. Suitable piping and valving arrangements were provided for the unit, the capacity of which was about 1.6 gallons.

Ether, water, and uranyl nitrate were placed in the prototype, the system was closed, and the pump was started. The mixture was circulated through the system for a while, then the pump was stopped, the layers of water and ether were allowed to separate,

Artist's conception of scene in what had been a squash-racquets court under West Stands. Scientists are observing the world's first atomic reactor as it become self-sustaining.



SEUC

and the aqueous phase was drawn off. The pumping operation was repeated several times, each time after an addition of a small amount of water to the system, and laboratory tests indicated that we were achieving the same purification as was achieved on a smaller scale in the laboratory. On May 9, 1942, samples of a batch of uranyl nitrate crystals, purified in the prototype extractor, were shipped to Princeton University, the University of Chicago, and the National Bureau of Standards for testing. The material passed all tests known at that time which could be applied for purity. On the basis of this successful "pilot plant" operation, a large-scale extractor was designed and built.

The construction of the processing facilities was something like a race, in which the designers tried to stay one day ahead of the builders. Part of the engineering work for the new plant, that for which drawings were essential, was done by Bob Ruppel and Bonney Francis. For equipment that could be built without reference to finished drawings, rough sketches served. Early each morning Charlie Winters, Walter Schmidt, Willard Bording, and Carl Schwabe met in Carl's office, where sketches of the equipment to be built that day were drawn on scratch paper. Then Walter and Willard went out and got it built. Some of the equipment that was installed was never drawn on paper at all, but diagrams were chalked in on the floor or the wall, and the construction went on from there.

Bill York, Bob Walbridge, and Charlie Harstick were fitting pipe in the new facility, and Charlie's favorite saying was, "Put 'em in, take 'em out, put 'em in," reflecting the alleged tendency of research people to make changes in equipment. Henry Schroer did the welding, Harry Haas did the sheet-metal work, John Schoenherr did some of the carpentry, and Bill Odam, "Red" Etter, and Cliff Drews were responsible for installation of electrical equipment.

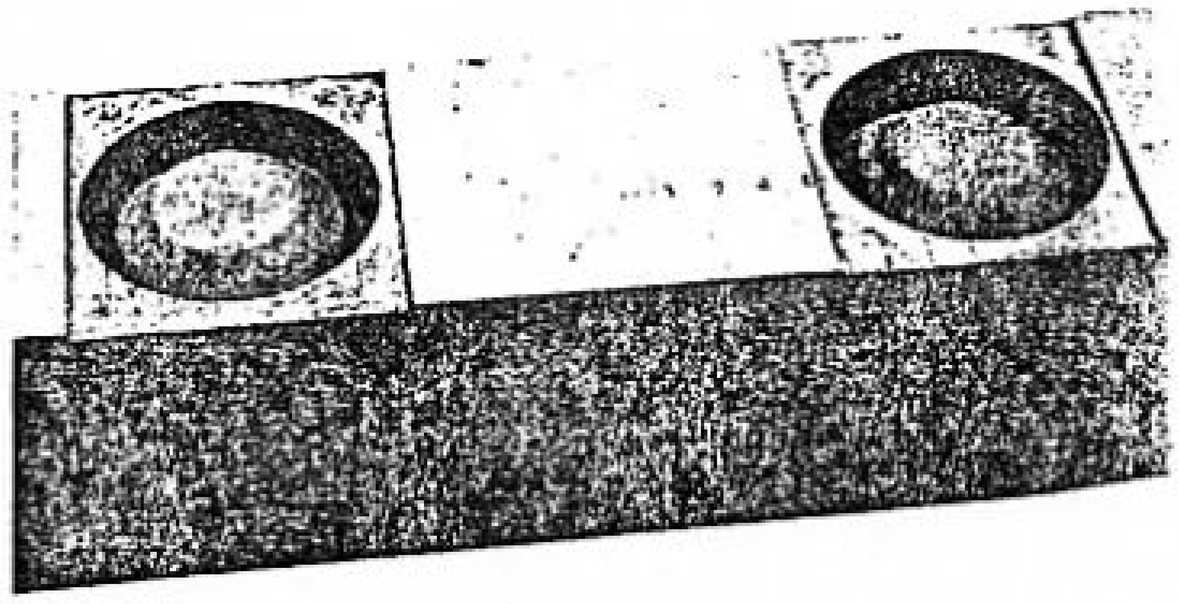
We were lucky to have some empty buildings (51 and 52) when we were ready to construct the plant. Almost all of the materials and equipment used came from a supply which the Company had accumulated prior to 1942 in anticipation of possible war time shortages. We had a number of 1,000-gallon stainless-steel tanks and an adequate supply of stainless-steel pipe, fittings, and valves. Most of the other equipment in the uranium plant was fabricated in our own shops. The operations of dissolving crude uranium oxide and of filtering and concentrating the resulting solution were to be done in Building 51. The ether extraction of uranyl nitrate and the aqueous re-extraction were to be done in Building 52, after which the purified uranyl nitrate was to be returned to Building 51 and converted to uranium trioxide.

When the extractor was completed and ready for service, it was filled with ether, which was then recycled through an ice-water-cooled heat exchanger until it reached a temperature of about 0°C. By this time, a 300-gallon pot half full of molten uranyl nitrate at a temperature of about 80°C was ready. This was to be mixed with the cold ether, and the big question was, "Can we get the uranyl nitrate into the extractor and mixed with the ether without an explosion or a fire?" As it developed, the mixing went off smoothly, the extractor operated as expected, and the aqueous phase was separated and drawn off. Then the ether solution containing the purified uranyl nitrate was given several countercurrent washes with small portions of water using several small, stainless-steel tanks associated with the extractor. Operating personnel soon dubbed the extractor and tanks "Snow White and the Seven Dwarfs."

As soon as processing was underway, the plant in Building 51 and 52 was operated 24 hours a day. By this time, even more Company personnel had been drawn into the project, and they worked willingly in the plant, in the laboratory, or wherever they were needed. It was this spirit of cooperation and willingness to undertake any necessary task manifested by so many people that insured the success of the operation.

Although we had a process operating to produce

In this rectangle of graphite are two pressed blocks of the original uranium oxides used in the first self-sustaining chain reaction --- oxides made in St. Louis by Mallinckrodt Chemical Works.

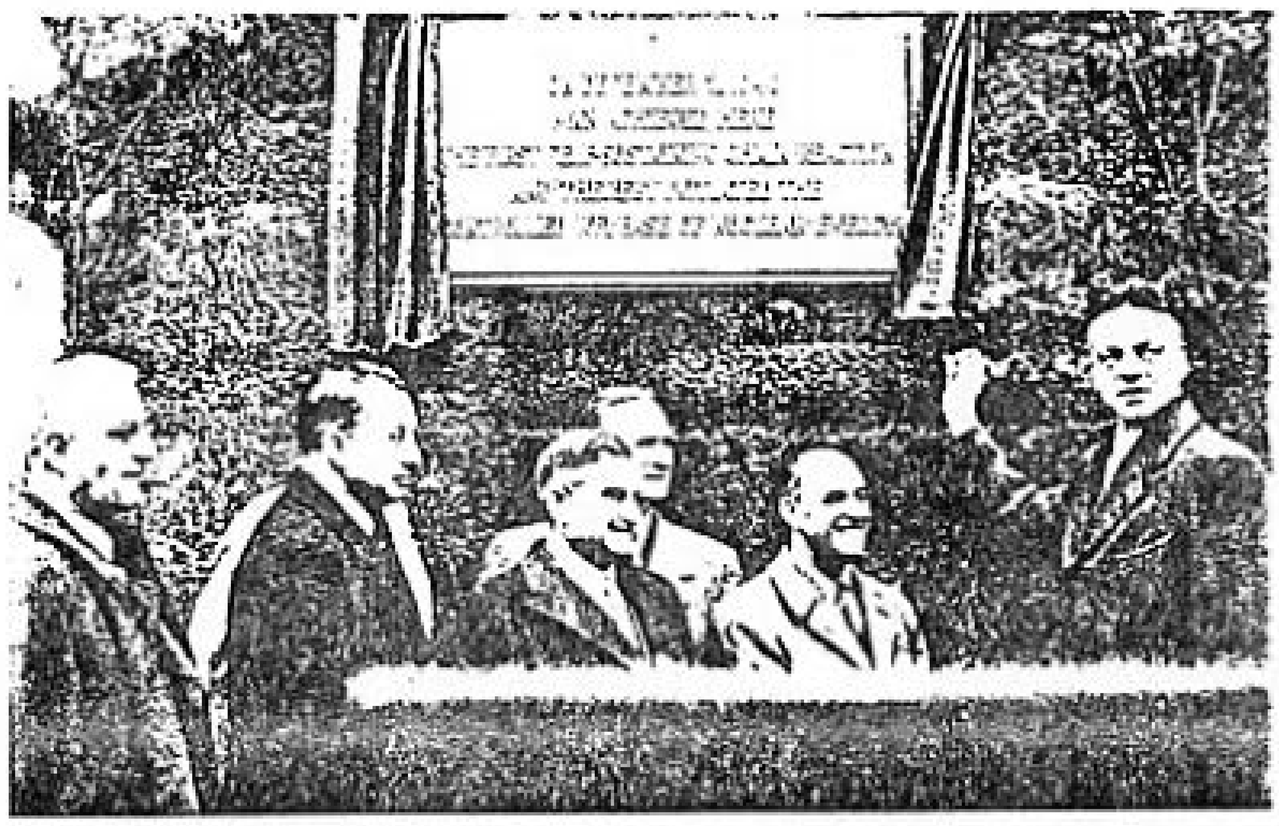


purified uranium oxide, we still did not understand exactly the degree of purity required by the Metallurgical Laboratory. During one of our visits to the University of Chicago, we told Dr. Enrico Fermi that MCW could probably do a better job of purification if we knew the limits on the impurities in the uranium oxide. Couldn't we have a list of all important impurities showing the maximum permissible concentration of each in the uranium oxide? Standing at the blackboard tossing a piece of chalk end-over-end and catching it, Dr. Fermi said, well, things just didn't work quite that way. He went on to say that all foreign substances acted as poisons in a uranium pile by absorbing neutrons—elements such as boron, cadmium, and the rare earths were among the worst. The particular individual impurities that were present and their concentrations were relatively unimportant as long as, in the aggregate, they did not absorb enough neutrons to stop the chain reaction. From this discussion grew the concept of a "danger coefficient" for each element of the periodic table as an indication of the element's effectiveness as a poison. The equivalent effect of the total amount of the impurities present became known as the "total danger summation" (T.D.S.), which was later used as an index of the quality of the uranium oxide.

Probably the most crucial application of the uranium dioxide produced by MCW was in the Metallurgical Laboratory's experimental verification that it should be possible to build a uranium pile in which a controlled, self-sustaining chain reaction could be produced. The key to the entire plutonium project was the neutron multiplication factor, *k*. According to the Smyth report, "If *k* could be made greater than 1 in a practical system, the project would succeed; if not, the chain reaction would never be more than a dream."

Dr. Fermi's group had been attempting for some time to build an exponential pile in which measurements could be made indicating that a value of *k* greater than one was theoretically possible. By August of 1941, they had built a pile which indicated that the maximum theoretical value of *k* was 0.87. Continuing their efforts and using materials of higher purity, the physicists were able to construct a pile by May of 1942 which indicated that a pile could be built for which the value of *k* was 0.98. This was close enough to a value of one that they believed they could achieve their goal if only they had still purer materials. But no one could be sure of this. The crucial time was almost at hand. Would the uranium dioxide produced by MCW be pure enough?

As Dr. Symth reported, "In July, enough purified uranium oxide from Mallinckrodt was available to permit building intermediate pile No. 9. As in previous experiments, a radium-beryllium neutron source was placed at the bottom of the lattice structure and the neutron density measured along the vertical axis of the pile.... For the first time the multiplication constant *k* so calculated from the experimental results came out greater than one. (The actual value was 1.007.)" And with this, the physicists had their answer. A pile could be constructed in which a self-sustaining chain reaction could be carried out.



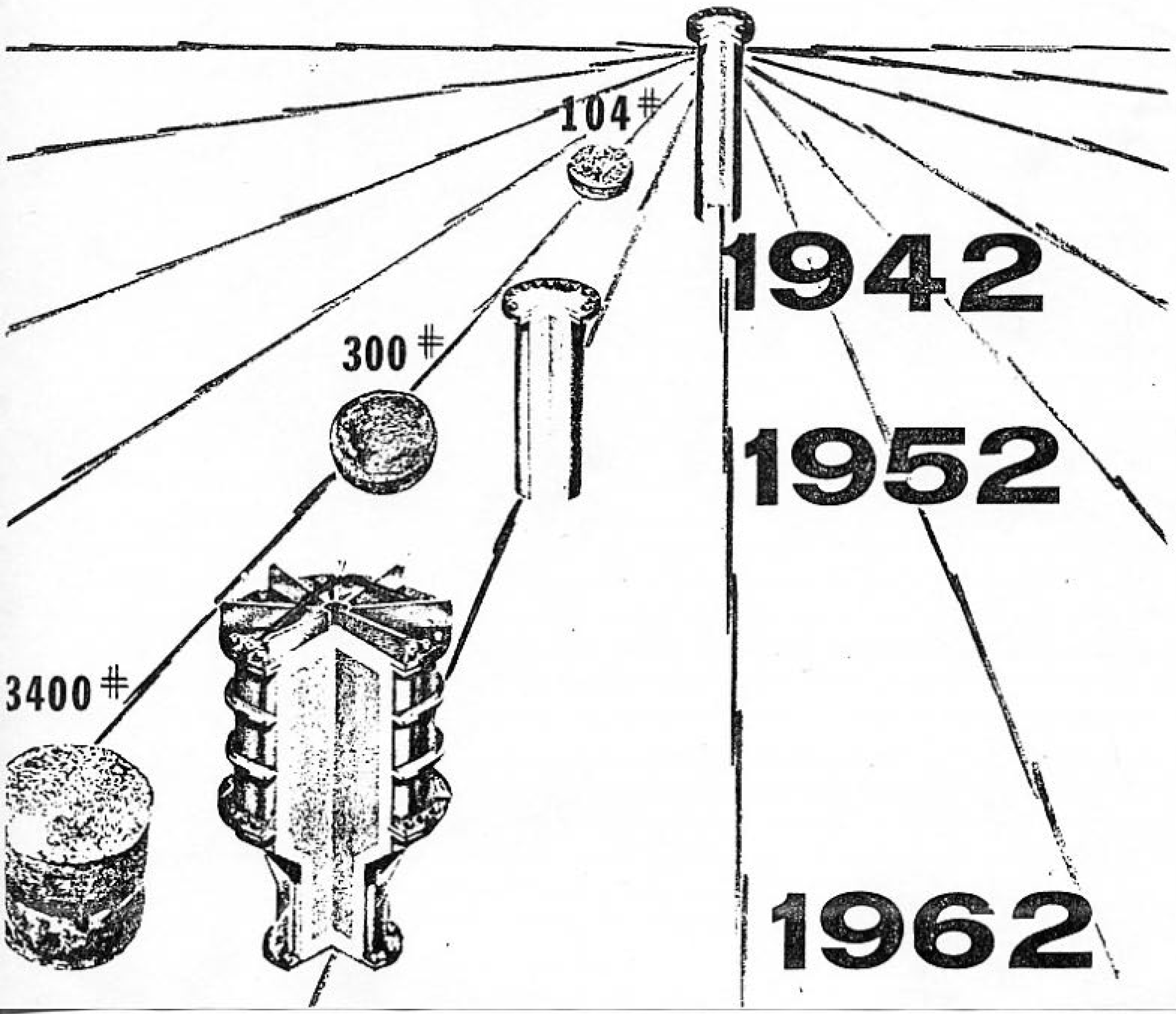
Dedication of the commemorative plaque on West Stands December 2, 1952. Left to right W. W. Waymack and R. F. Bacher members Atomic Energy Commission, F. Daniels and W. H. Zinn of Argonne National Laboratory, Enrico Fermi, and R. M. Hutchins, president University of Chicago.

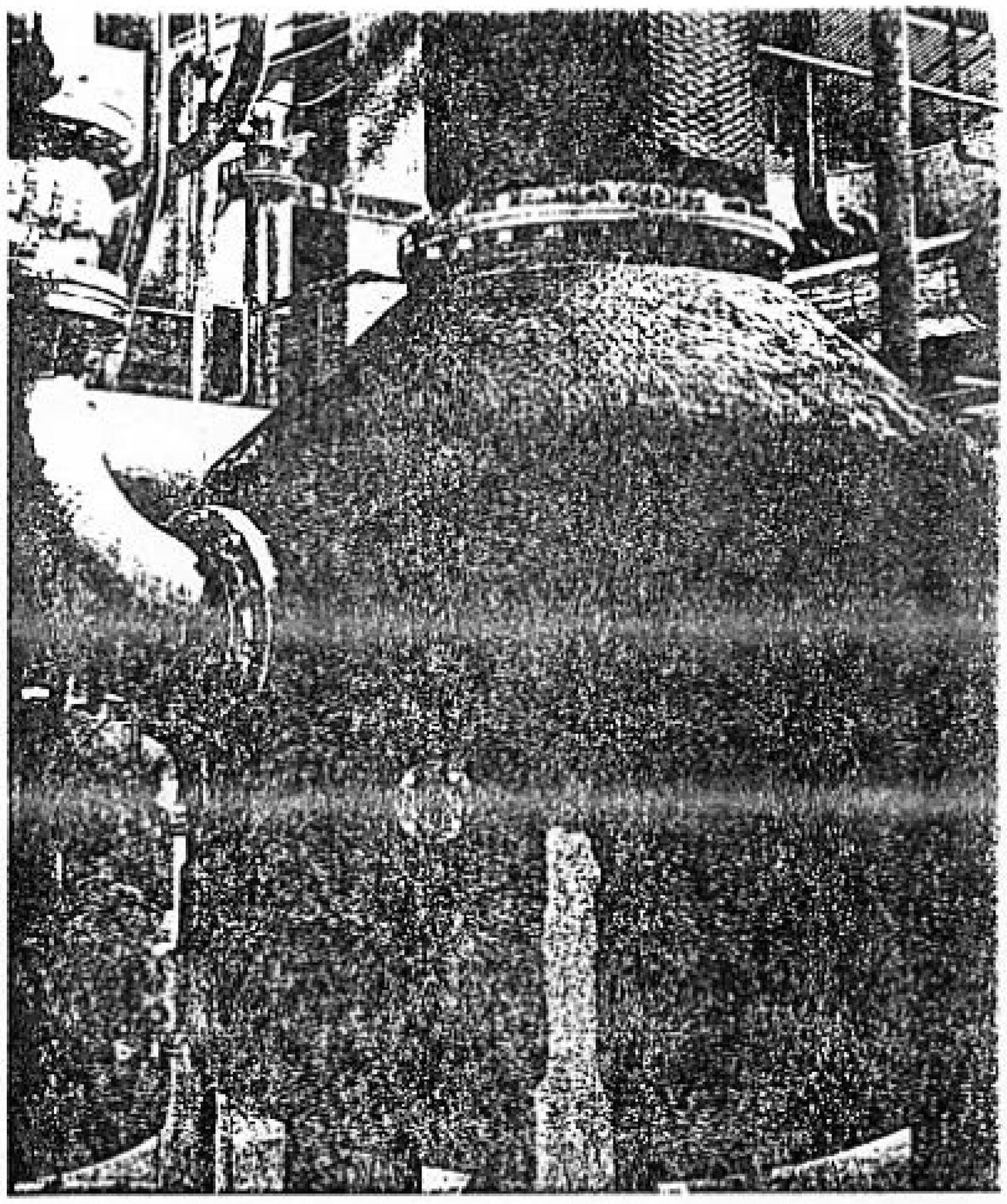
A second crucial application of Mallinckrodt-produced uranium oxide occurred on December 2, 1942 when the first self-sustaining chain-reaction pile was operated beneath the West Stands of Stagg Field at the University of Chicago. All of the uranium in this pile was in the form of uranium dioxide produced by MCW or uranium metal produced by others using as the basic starting material uranium dioxide from Mallinckrodt.

Mallinckrodt's little uranium processing plant was the sole source of supply of purified uranium dioxide to the Manhattan Project until well into 1943. It is indeed a tribute to the scientists in Chicago and to the many people who worked in St. Louis that the necessary data were obtained, equipment was designed and built, a plant was constructed and placed in operation, and a production rate was achieved of more than one ton per day within less than two months of beginning the project.

DEVELOPMENT AND TECHNOLOGY ..... THE STORY OF PROGRESS

It's purer because it's bigger! Larger metal pieces mean fewer surface impurities; no casting means no impurities from the melting crucible.





PULSE COLUMN FOR URANIUM RE-EXTRACTION - Used at Weldon Spring, this equipment returns uranium from the solvent to a pure aqueous solution which is then ready for the denitration step.

by Arch Ruehle

Twenty years of uranium production! It sounds like a long time - as though it should have long since become routine. And so it would have been but for the efforts of our technical and production people to find ways to do it better. It is a great source of satisfaction to us all that we can recount the results of these efforts only by the use of superlatives.

The 1942 scale-up of uranium purification from laboratory to ton-per-day production in less than two months was a spectacular accomplishment. This was soon followed by another "crash program" for the batch production of green salt. Shortly later, metal production was started, applying the magnesium process developed at Iowa State University in place of the expensive calcium process previously used. These batch operations, coupled with parallel operations by other companies, continued to supply the country's uranium needs during the next few years. Eventually most of the production was centered at the Mallinckrodt plants.

The Uranium Project now entered a period of ever-increasing demands for larger quantities, lower costs, and of course, continued high purity. The original source of raw material had been a high-grade concentrate from Canada, containing roughly 1% impurities. The world-wide search for uranium disclosed many new sources in Africa, Australia, Europe, and North America. Ore from each source contained a different set of impurities, and the uranium content varied widely. As these sources were developed, Mallinckrodt likewise developed processes to recover and purify the uranium from either original ores or from physical or chemical concentrates.

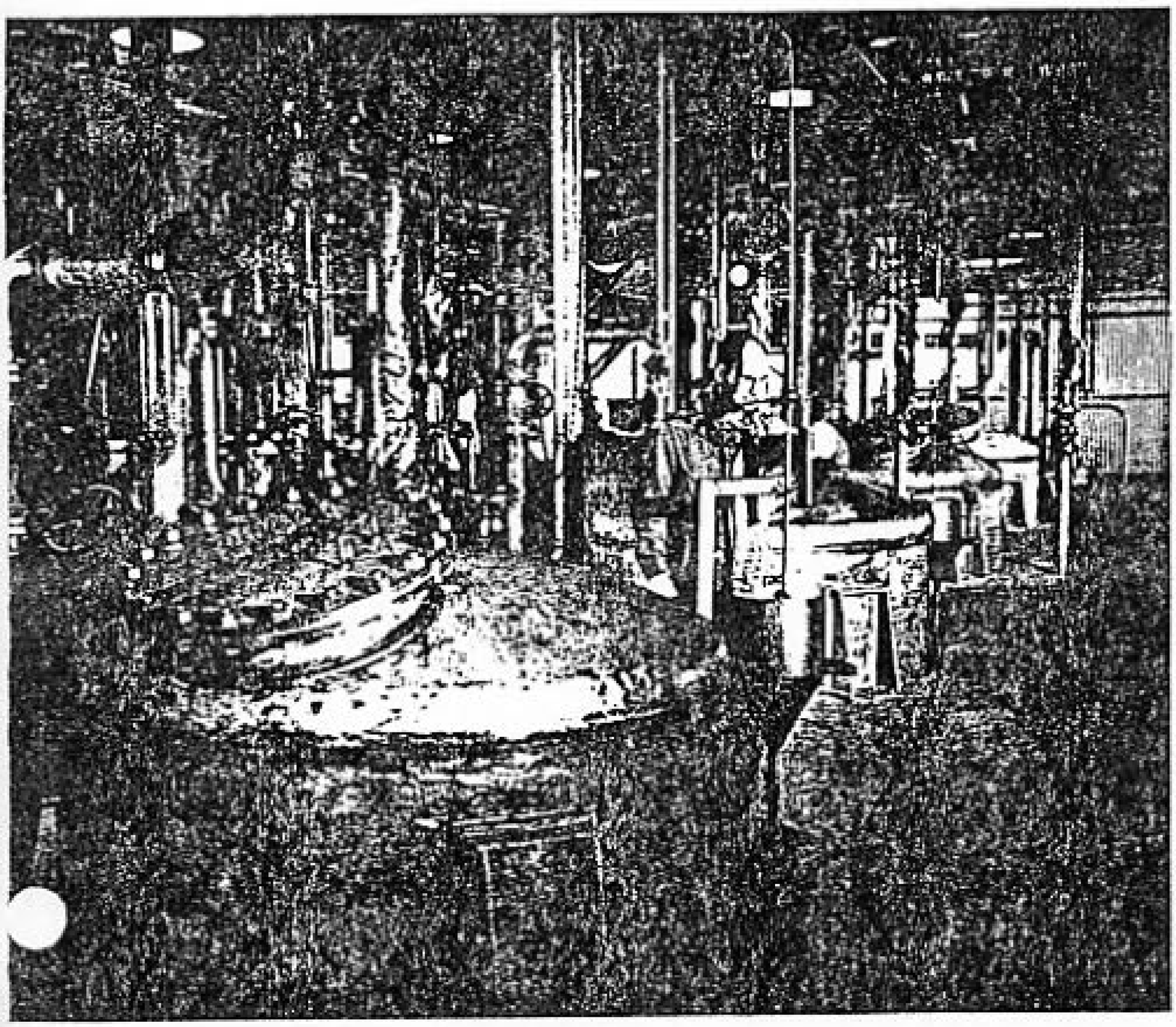
The first step came with the construction of the Plant 6 refinery. The ether extraction process was made continuous, using countercurrent columns instead of batch tanks. The first feed to this plant was pitchblende ore from the Belgian Congo, and with it came a host of new problems. The pitchblende contained radium, which had to be separated completely because of its hazardous nature and its high value. Some of the impurities would precipitate uranium if excess acid were absent, while others extracted with the uranium if excess acid were used. These problems were solved by using two extraction cycles in series. The first cycle used excess acid for high uranium recovery. The second was neutral for attaining very high purity, as in the batch process. The dual-cycle process had been subjected to painstaking study in the laboratory and pilot plant. When the plant started operating in 1946 it worked very well from the start, but not without incident. During startup, strong nitric acid was accidentally mixed with ether. This mixture reacted so violently it ruptured a tank. No one was injured,

but plenty were scared! After the shakedown of start-up troubles, however, this plant ran smoothly on larger and larger quantities of both pitchblende and ore concentrates from all over the world for the next twelve years.

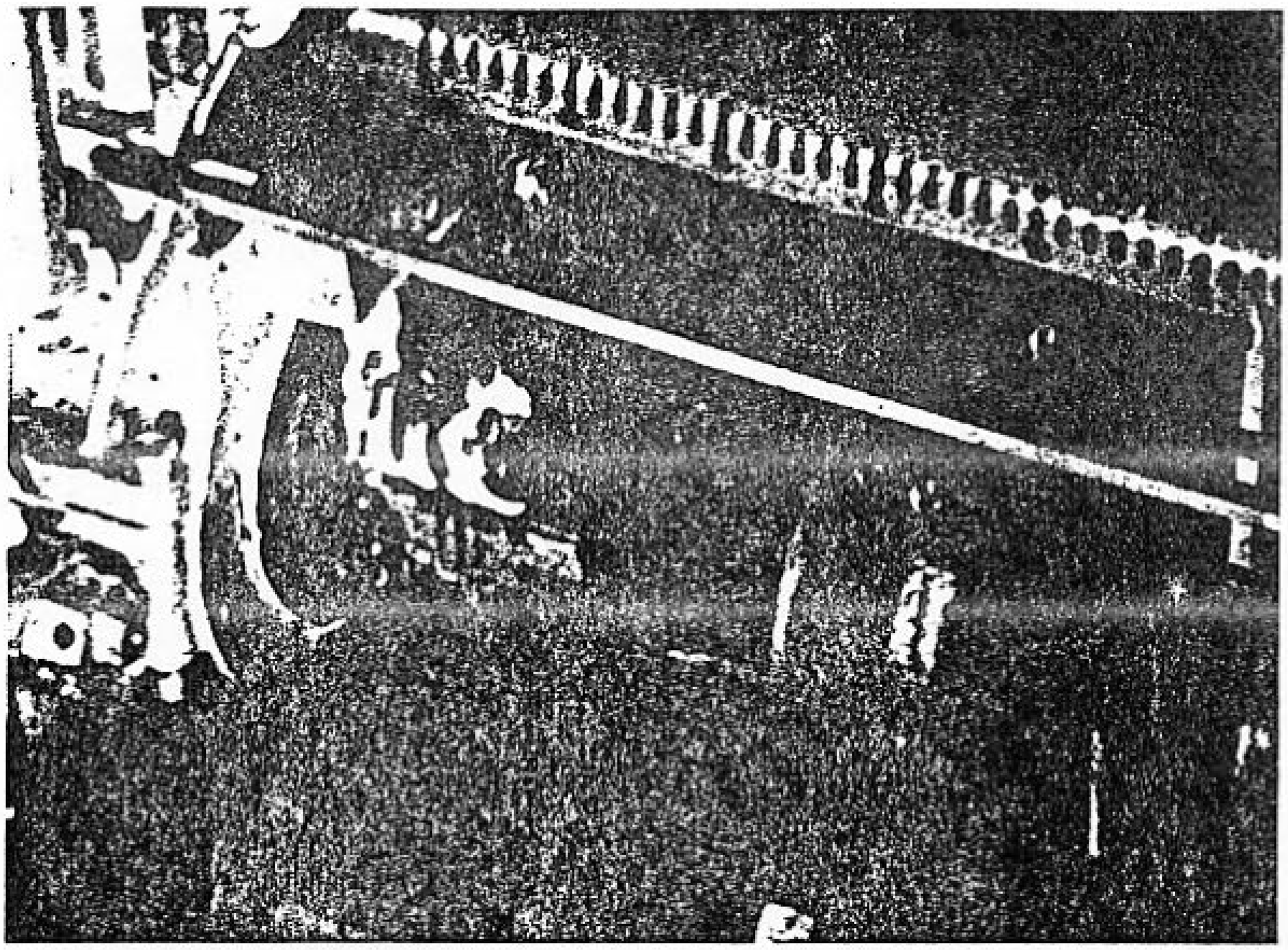
It was necessary to make changes and improvements, of course, to fulfill the severe production requirements. Changes were also required to improve efficiency. A major example of this was the development of the carbonate leach process to recover uranium from radium-bearing residues. These residues were created when radium was separated from most of the uranium by precipitating lead sulfate from the original solution of pitchblende in nitric acid. The lead sulfate, along with insoluble silica and some other impurities, acted as a collector for radium sulfate. It also carried some insoluble uranium molybdate and some soluble uranyl nitrate. Laboratory research showed that the uranium could be separated from the filter cake by leaching it with strong sodium carbonate solution, leaving the troublesome molybdenum behind as lead molybdate. No radium was lost by this treatment. Our production people operated the carbonate leach process so effectively that more than five million dollars worth of uranium was recovered during the period of its operation, and this was at a time when maximum production was of the utmost importance.

Increased oxide production finally strained the capacities of both the green salt and metal plants. Our technical people had proposed the concept of stirring the oxides and green salt, while conveying them countercurrent to the reacting gases. This concept was developed in the laboratory and pilot plant into a radically novel green salt process. The process was reduced to practice and first operated at Plant 7 in 1951, using screw reactors such as those still in use in our present green salt plant. The brown oxide and the green salt were purer and more uniform than the products from batch reactors. Costs were lowered greatly, and the whole operation was safer than ever before. This process was installed at all later United States plants for green salt production, and while it has been modified by the use of fluidized beds for the brown oxide step, developed by Union Carbide, the hydrofluorination equipment is still standard throughout the industry.

Following construction of a modernized and mechanized metal plant (6E), three major changes were made in metal operations to increase production, improve quality, and reduce costs. One of these was to increase the size of reduction derbies and of cast ingots, using only moderately modified equipment. Another change was to encourage vaporization of impurities from the melting crucible and to promote floating of



PUMPER-DECANTER FOR URANIUM EXTRACTION - This equipment is used at Weldon Spring for extracting uranium into TBP-hexane, leaving most of the impurities behind in the aqueous raffinate. This precedes the re-extraction step shown in photo on page 17.

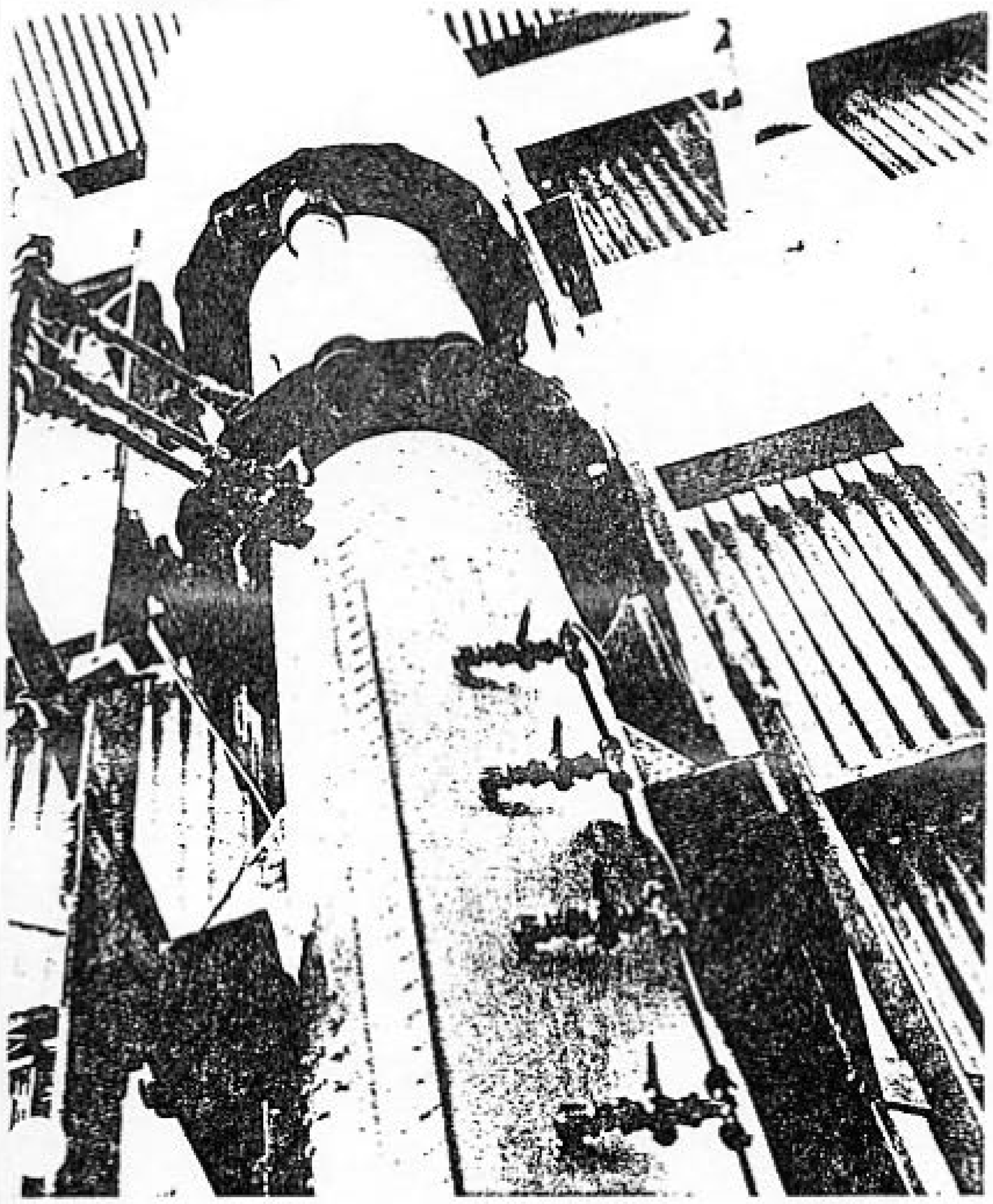


URANIUM EXTRUSION PRESS - The 3400 lb. dingot from the bomb step is extruded into a bar, cut into billets suitable for rolling, or extruded into rods from which reactor cores are machined.

impurities to the top of the mold. The result was a large reduction of both voids and inclusions in the metal ingot. The third change was to use recycle slag instead of dolomitic lime as the refractory liner of the reduction vessel. This not only substantially reduced cost but also avoided contamination of the metal with such highly undesirable impurities as boron.

Meanwhile, our research chemists and engineers were again busy on the refinery process. Low grade ores required chemical concentration at the source to avoid prohibitive freight costs. The best methods of ore concentration known at that time, however, left large quantities of slimy silica and other troublesome impurities like vanadium, molybdenum, and phosphate in the concentrates. Previous operating practices would have required much more equipment and would have caused high operating costs and large uranium losses. The development of slurry extraction to avoid filtration and the use of new conditions of acidity made it possible to utilize these chemical concentrates. Processing costs were lowered and production rates increased by these changes - a dual result typical of Mallinckrodt developments through the years. During this period, also, methods for recovery of uranium from high-fluoride residues were developed. This made it possible to avoid substantial scrap losses at a time when maximum production was still essential.

The contamination of uranium metal by carbon during melting in graphite crucibles and the trend toward lowering the non-metallic inclusions in reactor-grade metal together pointed to advantages in using as-reduced metal directly, i. e., producing a direct ingot (dingot). Since only the surface of as-reduced metal is impure, larger pieces should give better percentage yields than small ones. Accordingly, the scale of the reduction step was further increased (300 to 1400 lbs.), and later increased again to 3400 lbs. Such a large piece could be fed to the rolling mill only as a bar. Forging was used at first to convert the metal to bar form. Later, extrusion in the gamma phase (above 1422°F) was adopted because it is cheaper. The dingot process, like other developments at Mallinckrodt, was aimed at producing a purer material at lower cost. Since its development, however, the



EXPERIMENTAL FLUID BED - This transparent model is used to study the action of fluidized beds. The uranium compound is held in suspension while being carried through the reactor zone.

presence of small amounts of certain additives has been found to be desirable. Consequently, the controlled addition of such materials as silicon and iron is the current practice, and research in this area is still in progress.

As early as 1950 we began to study other solvent extraction systems that might be an improvement over the use of ether. We soon found that tributyl phosphate (TBP) in kerosene gave better uranium recovery from ores than did ether. The TBP-kerosene system used at Fernald, Ohio, was developed out of this original work. Likewise, the TBP-hexane process used at Weldon Spring was a further development derived from the favorable Fernald experience with TBP-kerosene and our further laboratory and pilot plant studies with an improved diluent. The pumper-decanter concept and the Teflon coated plates in pulse columns were other important Mallinckrodt developments incorporated into the Weldon Spring plant. Our production results demonstrated that we now have the most advanced extraction plant in existence.

To illustrate the effect of technical and operational development and to show how far we have come, consider a hypothetical case. Suppose there had been no change from the first production unit, but merely replication of units to increase output. It would today take about sixty such units, operated by 240 men per shift, to dissolve and purify the uranium. Equally ludicrous situations would apply to all other parts of the process if these had been left as originally operated.

This brings us to the current situation of working in a context of plentiful uranium and a relatively mature technology. Our technical accomplishments over the first fifteen years were those of meeting expanding production requirements first and lowering costs second. We never missed a production commitment, yet we succeeded superbly in lowering costs all along the line, year by year. However, as the motto that hangs on the wall in Harold Thayer's office says, laurels must be rewon constantly or they will be lost. So what have we done lately?

During the last five years we have continued our technical leadership in uranium processing technology by: a) lowering costs still further, b) developing further process improvements, c) developing methods to recycle scrap materials, and d) developing our understanding of quality factors affecting the use of our products and of methods to control these factors.

Much of the cost saving has been made by non-technical means, but much of it has also resulted from the technical efforts of our plant, research, development, and analytical people. These activities are still going on. For example, close examination of analytical control practices has resulted in maintaining good control with fewer and simpler analyses. Another example is the reduction to practice of azeotrope distillation to save hydrofluoric acid costs. Still another is the utilization of spare equipment for hydrogen control in metal by outgassing.

We have completed the development of fluidized bed processes for denitration, reduction, and hydrofluorination to further advance the technology of oxide and green salt production. A more uniform product at lower cost can be manufactured under conditions of greater safety by the fluidized bed technique.

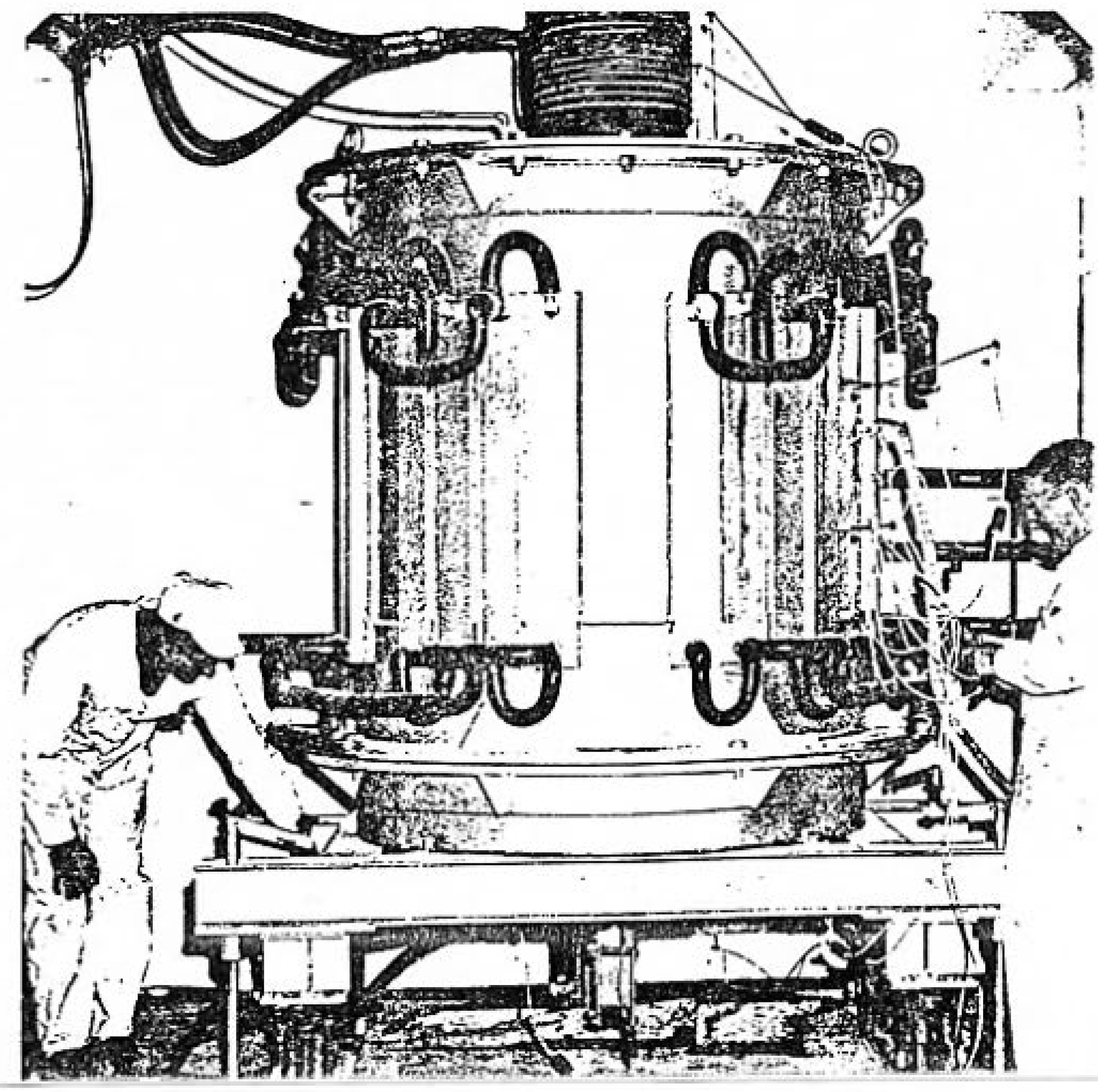
We are in the midst of developing alpha-phase extrusion (below 1220°F) to replace rolling and drilling in fabrication of fuel element core blanks. The advantages of this process should result in further processing economies.

We have recently developed processes for cheaper uranium recovery from scraps which must be processed chemically. Slag leaching with nitric acid should become a reality in the plant next year, while smaller streams of miscellaneous scraps are being processed currently in the chemical pilot plant.

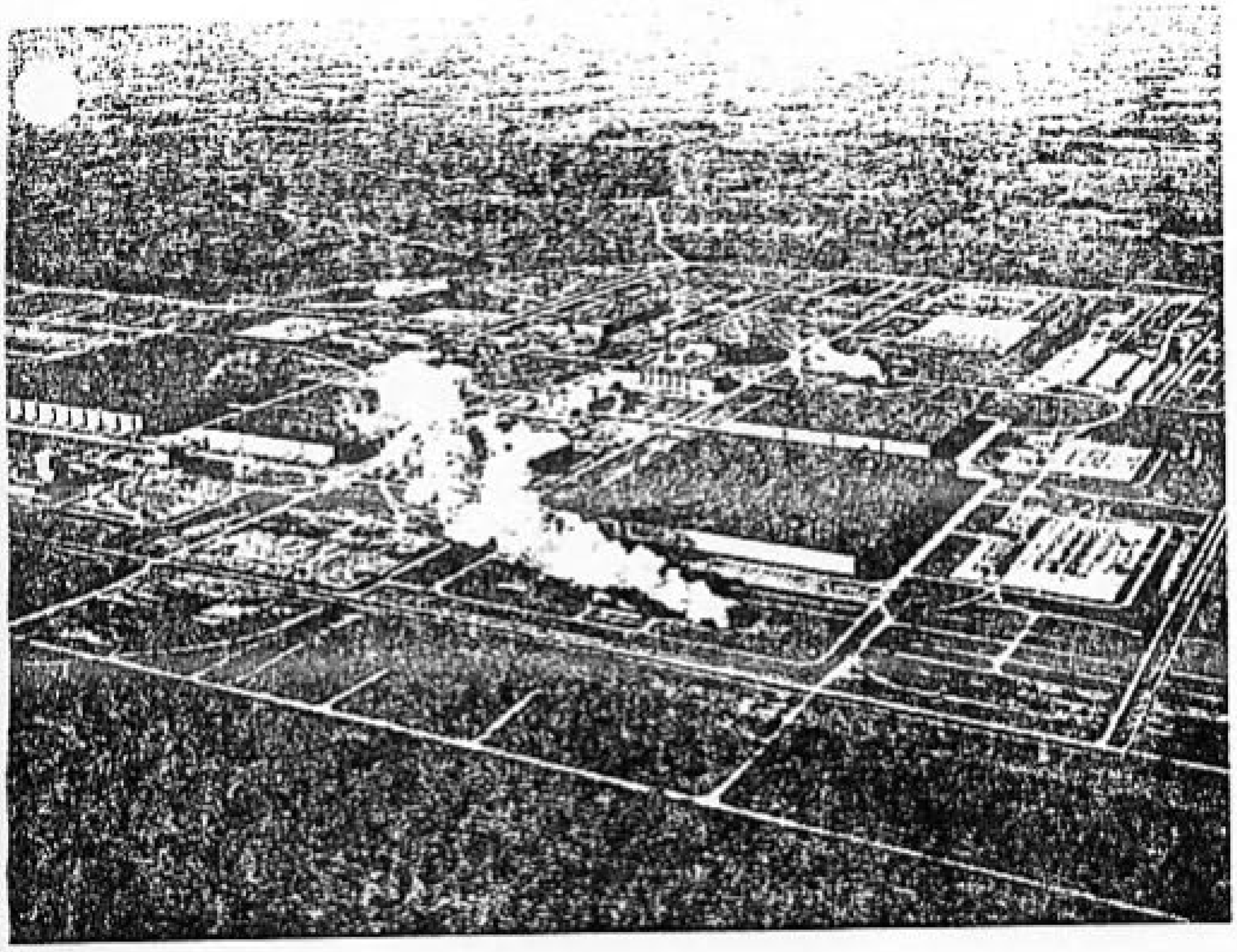
The most important scrap process under development, however, is the electrolytic process for metallic scraps. This process embodies the principle that electricity can be used as the tool for freeing scrap metal from oxide contamination. Results to date are very encouraging. Success of this development will not only lower scrap processing costs, but, will also gain a significant improvement in the quality of reactor fuel elements. Furthermore, the process contains the potential of replacing the entire current green salt and metal technology with a process for making metal directly from uranium oxides.

Finally, our experimental program on the microstructure of uranium metal is creating new knowledge we expect will be applied to producing even better reactor fuels in the future. Alloying, grain size and structure, and grain orientation are all pertinent variables which affect metal properties in reactors, and these are subject to searching study in the laboratory.

It seems evident that the technical leadership that has yielded such dramatic changes in uranium production technology since the industry began twenty years ago can be expected to continue in the future. What changes the next twenty years will bring is everyone's privilege to guess - it would be a mistake to guess that they will not be exciting.



ELECTROLYTIC CELL FOR URANIUM METAL PRODUCTION - In the pilot plant cell uranium dioxide is reduced electrically to molten uranium metal. This is withdrawn from the cell while uranium chips or uranium dioxide-carbon pellets are added to the electrolyte. The cell is affectionately known as "Old Silver."



The third gaseous diffusion plant in the AEC complex is located near Paducah, Kentucky. The facility, with three process buildings covering 150 acres, represents an investment of 765 million dollars. Union Carbide Nuclear Company operates the plant with 1400 employees.

harder than they had ever prayed before ...

"Then there came this tremendous burst of light followed shortly thereafter by the deep growling roar of the explosion."

And he added:

"The effects could well be called unprecedented magnificent, beautiful, stupendous and terrifying. No man-made phenomenon of such tremendous power had ever occurred before."

Then followed in rapid succession the August airdrops on Hiroshima and Nagasaki, the end of the most bitter war in human history, and the resulting sag in all military effort – including the atomic energy program.

The big question, amidst the relaxation that came with peace, was simply expressed: What is going to happen to the nuclear energy program? And the answer was not immediately apparent.

In 1947, Congress established the Atomic Energy Commission to take over the project from the Army, and the AEC continued to operate principal installations through private contractors.

After the Commission took charge of the program, long range planning was started, and while the military aspects of the atom continued to be of prime importance it was now possible to turn to the potential peaceful applications of nuclear energy. The atom could be looked to as a source of electric power, as a means for propulsion, as a tool of basic research, and as a servant in many forms useful to the field of medicine and in industry.

The feed materials production program continued to be of significance, particularly in the early 1950s, with the addition of two new gaseous diffusion plants – in Paducah, Kentucky and Portsmouth, Ohio – and with expansion of the facility at Oak Ridge.

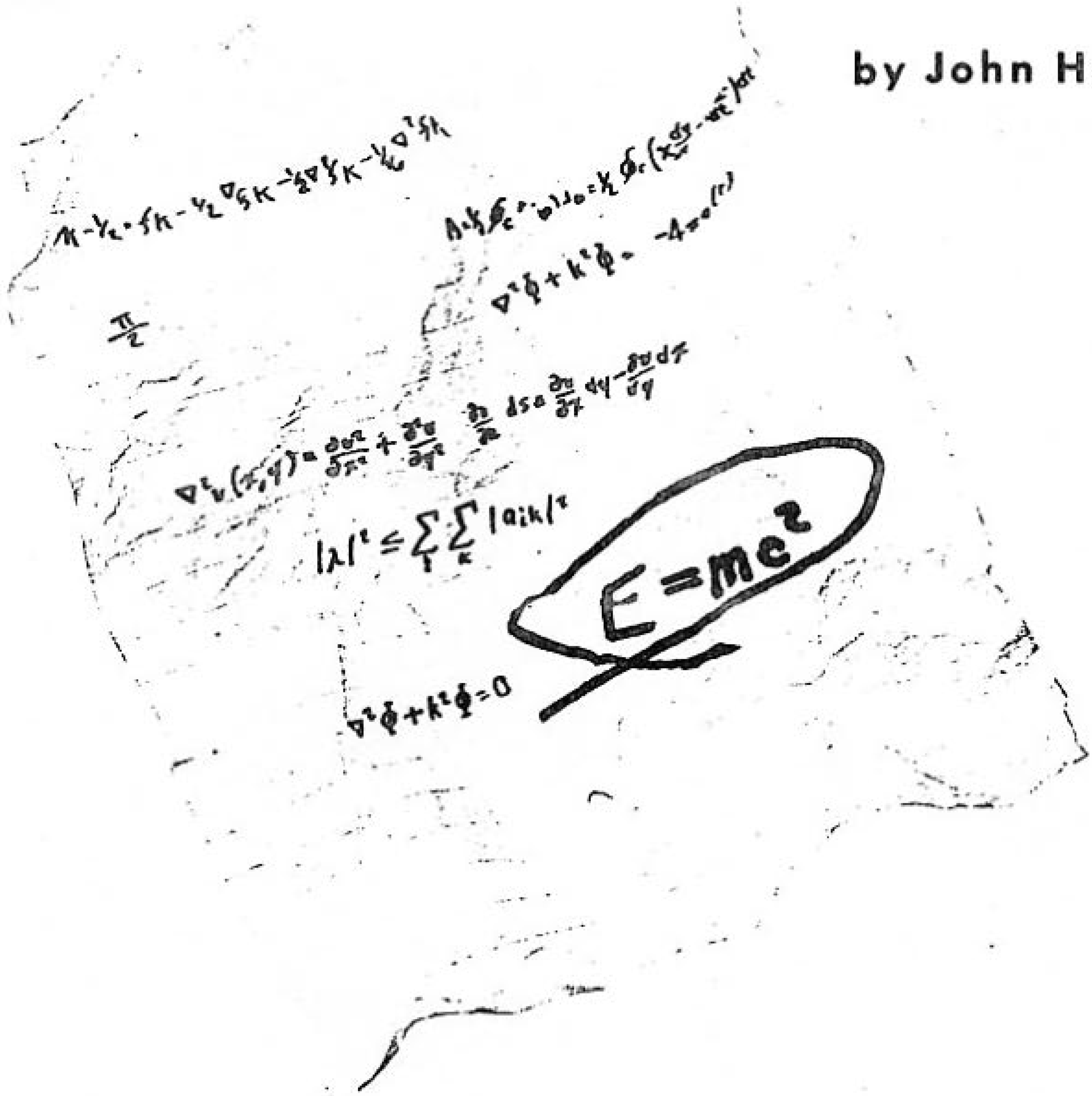
In 1954, the feed materials program, which previously had been administered by the Commission's New York Operations, was transferred to Oak Ridge Operations, and it continues today as a major portion of the ORO program.

In October 1954, the Commission decided to build a new feed materials plant at Weldon Spring, Missouri as part of an expansion program. By late 1957, it was determined that the operations in the downtown St. Louis plant could be consolidated at Weldon Spring, and shutdown of the downtown plant took place during 1958.

Because the people of Mallinckrodt Chemical Works at Weldon Spring are closely associated with the work of Oak Ridge Operations, perhaps a brief review of ORO would be of interest.

As the Commission's largest field office, Oak Ridge Operations carries out its programs in five states and in Puerto Rico. The feed materials plants at Weldon Spring and Fernald represent major keystones in the over-all production complex. The gaseous diffusion plants, which have been mentioned earlier, are at Paducah, Portsmouth and Oak Ridge. At New Brunswick, New Jersey, there is an analytical

by John Harris



One of the truly unique episodes
in human history --- the development of
nuclear energy --- might never have occurred
but for the towering genius of Albert Einstein
who gave the world

THE MAGIC KEY : $E = mc^2$

"It was a remarkable achievement," said Henry DeWolf Smyth, "to have developed and put into production . . . a process for transforming grossly impure commercial oxide to oxide of a degree of purity seldom achieved even on a laboratory scale."

With these words, one of the patron saints of the U. S. atomic energy program praised Mallinckrodt Chemical Works for its efforts in 1942 in producing uranium dioxide for the nation's fledgling nuclear project.

In those hectic early days, it was determined at the National Bureau of Standards that virtually all of the impurities in uranium oxide could be removed with relatively little difficulty. The key to the process was the unique solubility of uranyl nitrate in ether. The nitrate was formed by dissolving the crude oxide in nitric acid, and the impurities were left behind when the nitrate was, in turn, dissolved in ether.

The uranium then could be recovered, concentrated, and reduced to uranium dioxide.

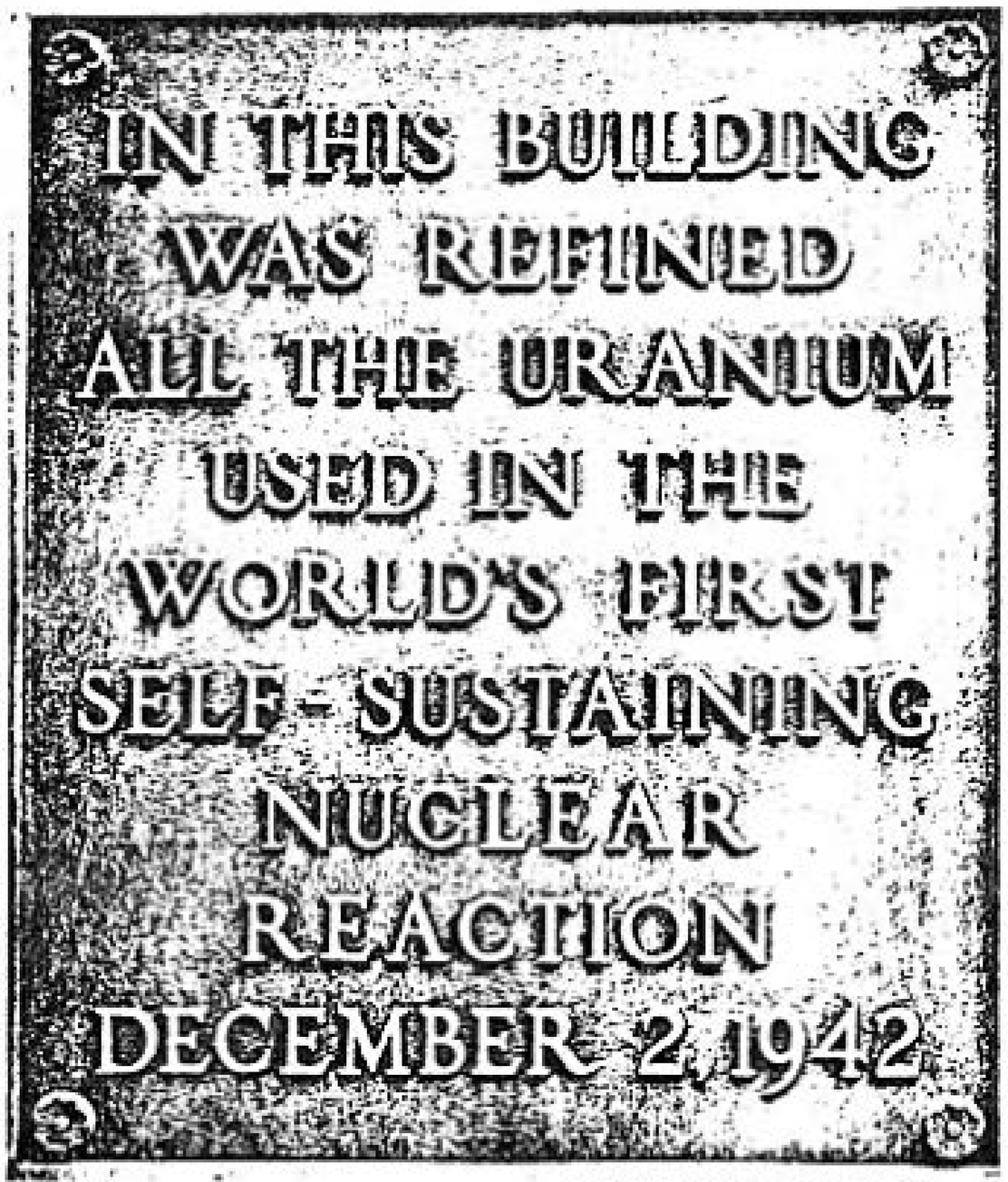
But even with this knowledge, there was one major difficulty—the scaling up of the laboratory procedures into a full production process. And for this complex assignment, the late Arthur Compton—a distinguished scientist who was responsible for much of the early work in nuclear energy—approached Mallinckrodt in St. Louis on April 17, 1942.

Mallinckrodt people were eager to be of help. One of the reasons Compton went to the company was the fact that Mallinckrodt had demonstrated its capabilities in working with tricky substances such as ether.

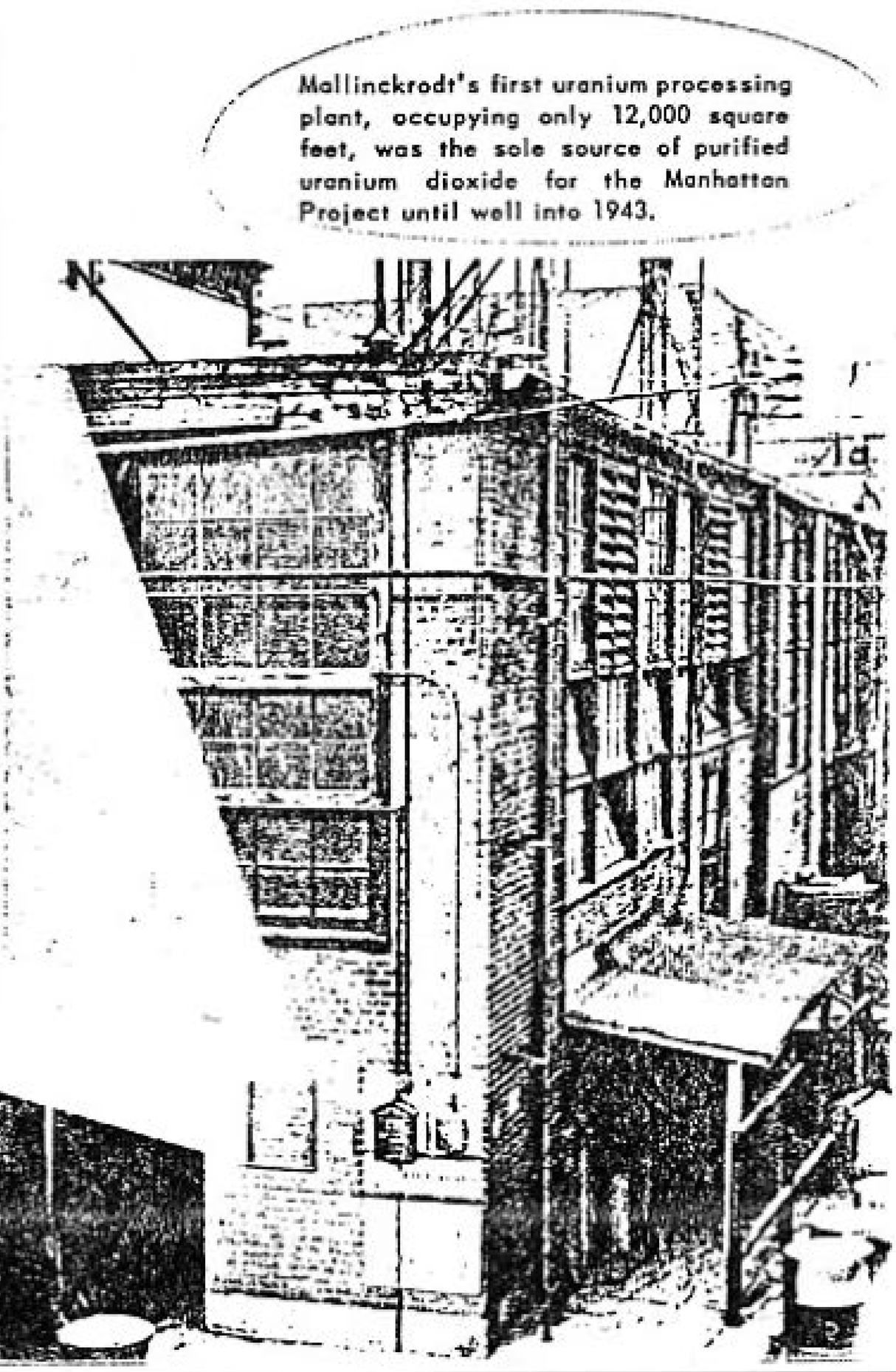
By May, the arrangements had been completed with the firm, and by July, Mallinckrodt was able to meet all immediate requirements for oxide in the production of uranium metal and uranium hexafluoride. In fact, the deliveries that started in July were at the rate of 30 tons a month.

Thus, Mallinckrodt's versatility and technical skills were called into service in the very infancy of the atomic energy program. And in the years which have intervened, the company has continued to make major contributions to the success of the atom, both as an implement for defense and as a tool for the betterment of man's environment.

But the fantastic story of the United States effort to develop nuclear energy—one of the truly unique episodes in human history—did not start with the 1942



This plaque, alongside the entrance of Building 51, is an ever-present reminder of the Company's outstanding accomplishment.



Mallinckrodt's first uranium processing plant, occupying only 12,000 square feet, was the sole source of purified uranium dioxide for the Manhattan Project until well into 1943.

laboratory, and the Puerto Rico Nuclear Center -- one of the newest ORO programs -- stands as a major training and research link between North and South America.

The total plant investment in Oak Ridge Operations amounts to more than 3 1/4 billion dollars, and the operating budget is about 500 million dollars a year. Employment in this vast complex amounts to a total of about 23,000 persons.

There have been two major areas in which the atom has found peaceful application -- in the production of electric power and through the numerous uses of radioisotopes. And in both of these areas, it is the uranium that is the essential ingredient -- to run the reactors that can produce power, or produce neutrons to "manufacture" radioisotopes.

Oak Ridge Operations has major roles in both of these peaceful fields. In power reactors, much research and development work has been undertaken in Oak Ridge National Laboratory, one of the world's largest research centers. Also at ORNL, a wide variety of radioisotopes are produced and shipped out, to every state in the union and to more than 60 nations.

These isotopes, while already in broad use, are versatile bits of matter, and increased application in medicine, industry and in research can be expected.

Obviously, the story of the atom hasn't ended. Perhaps in the later, longer view which historians of the future will take, it will appear that the saga of the atom had hardly begun in this year 1962.

There is no question but that the development of atomic energy is largely the story of people, people who have worked in concert and with dedication to make possible technical achievements which will long stand as monuments to the zeal and the imagination of man.

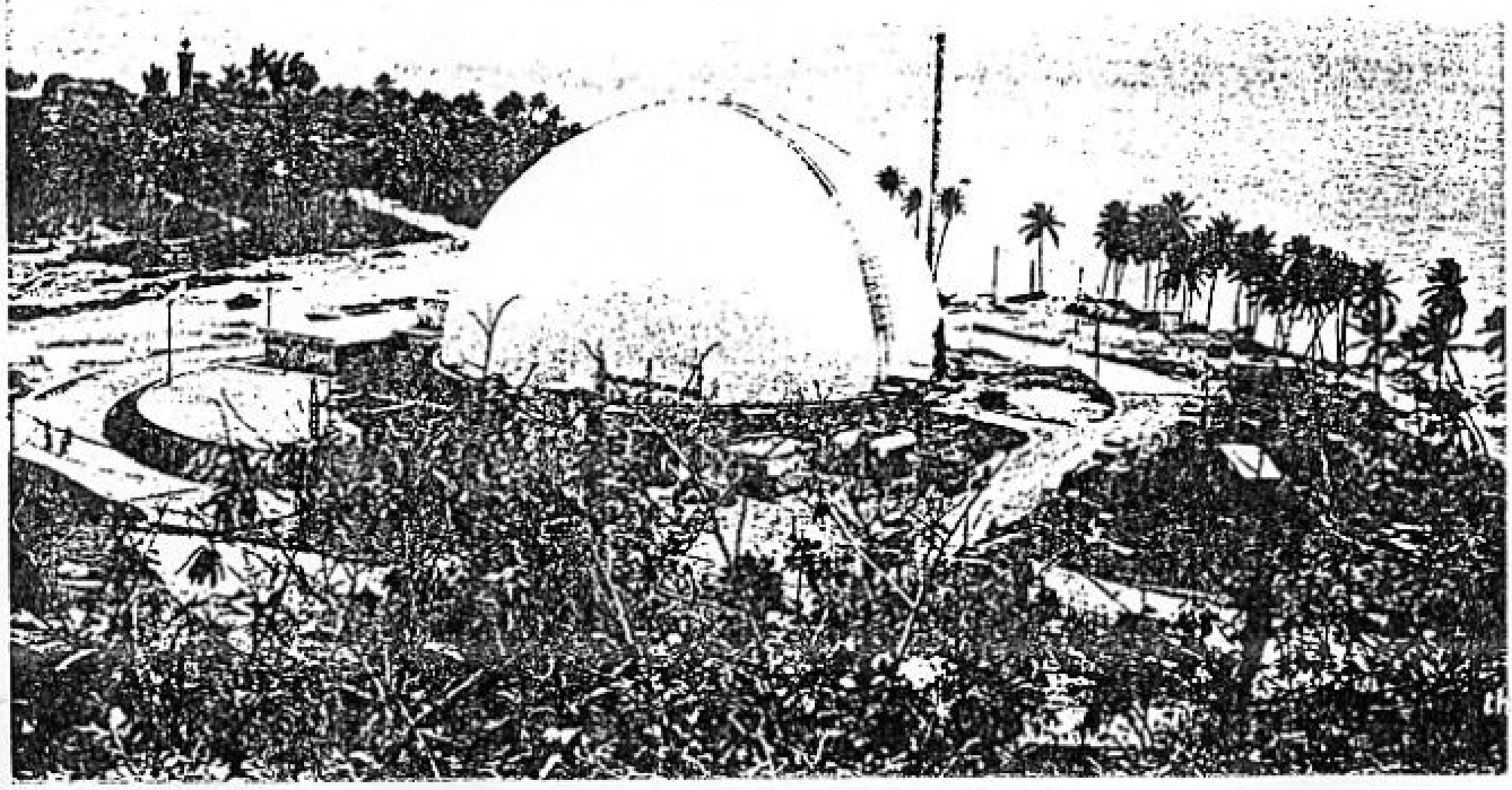
In his farewell address to the Manhattan project, General Groves voiced words that should inspire every person who was associated with the wartime project -- and this includes, of course, the people of Mallinckrodt. He said:

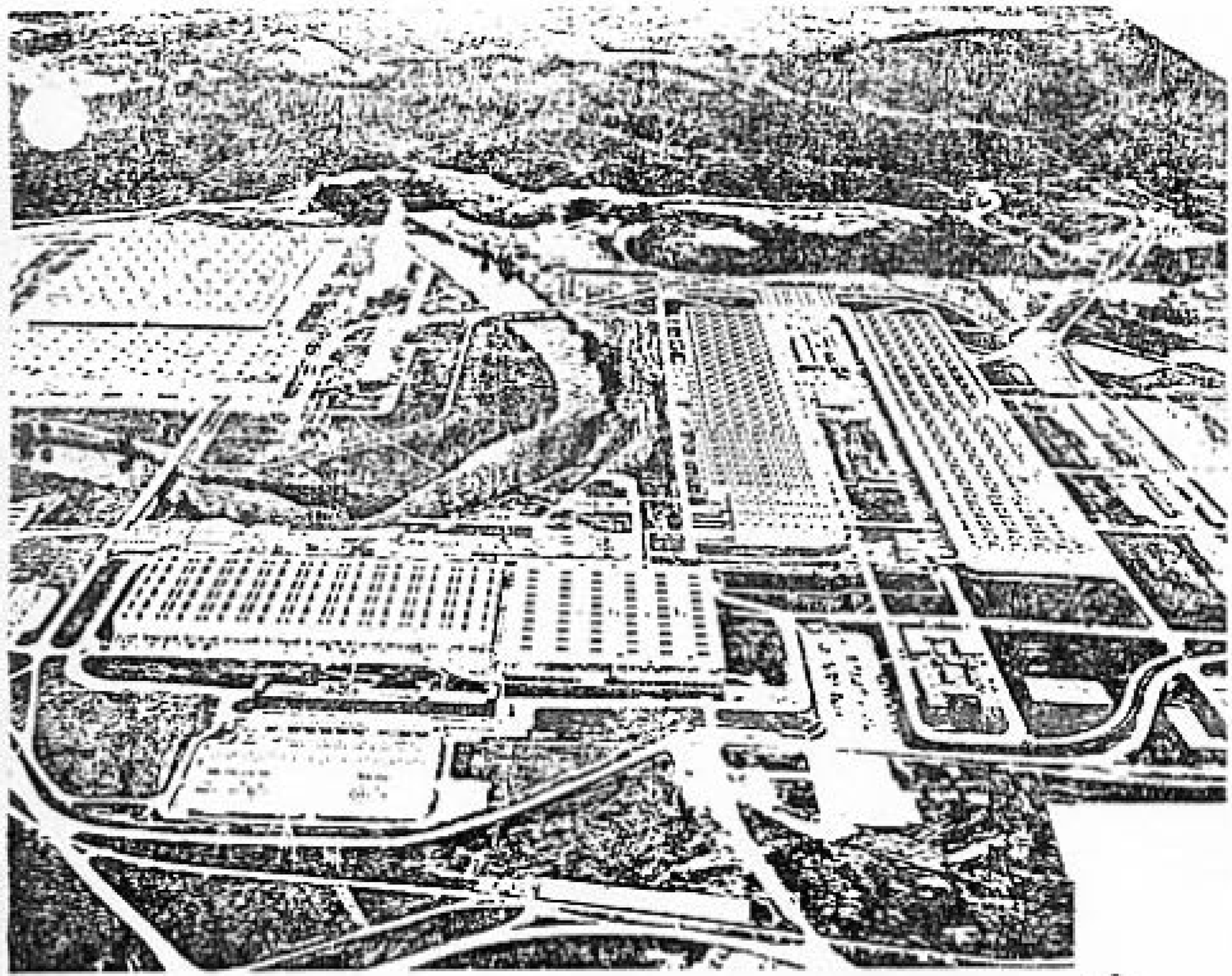
"Five years ago, the idea of atomic power was only a dream. You have made that dream a reality. You have seized upon the most nebulous of ideas and translated them into actualities. You have built cities where none were known before. You have constructed industrial plants of a magnitude and to a precision heretofore deemed impossible. You built the weapon which ended the War and thereby saved countless American lives.

"With regard to peacetime applications, you have raised the curtain on vistas of a new world."

Also part of Oak Ridge operations are several non-production type facilities. Typical of these is the BONUS (Boiling Water Nuclear Superheat) power reactor presently under construction at Rincon, Puerto Rico. A joint project of the AEC and Puerto Rico Water Resources Authority, the station's net electrical output will be about 16,000 kilowatts.

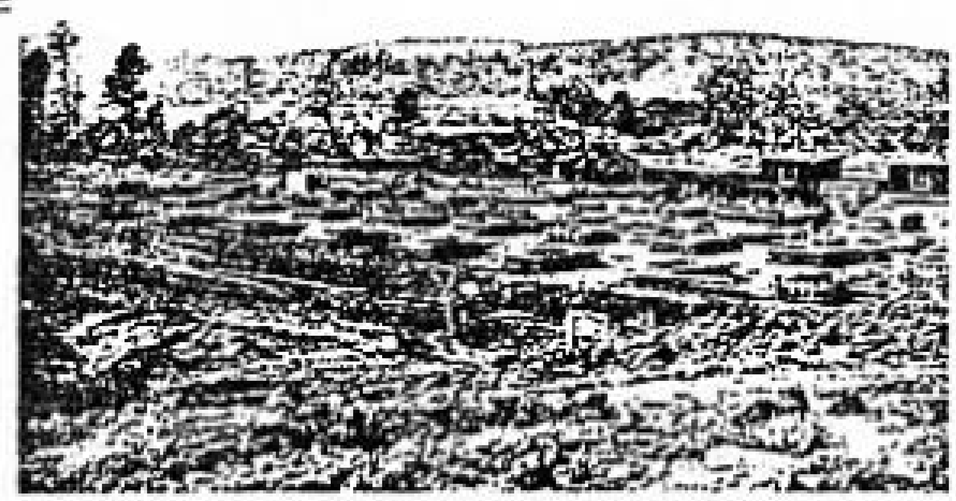
One of the newest programs is a training and research center operated by the University of Puerto Rico. Other institutions maintained by Oak Ridge Operations are the New Brunswick (New Jersey) Lab, Oak Ridge National Laboratory, the Oak Ridge Institute of Nuclear Studies, and a museum at Oak Ridge.





As it looks today K-25 covers 600 acres, employs 2800 people and represents a total investment of about 845 million dollars. Producing enriched uranium-235, the plant uses about 16 billion kilowatt hours of electricity annually and approximately 400 million gallons of river water each twenty-four hour period.

Construction began in 1943 on the world's first gaseous diffusion plant. This is a scene at the construction site as footings were being poured for the K-25 building. Located at Oak Ridge, Tennessee, and now operated for the AEC by Union Carbide, the first unit began operations on February 20, 1945.



agreement with Mallinckrodt. It had its origins much earlier, centuries earlier when brilliant minds first played with concepts that defied the imagination.

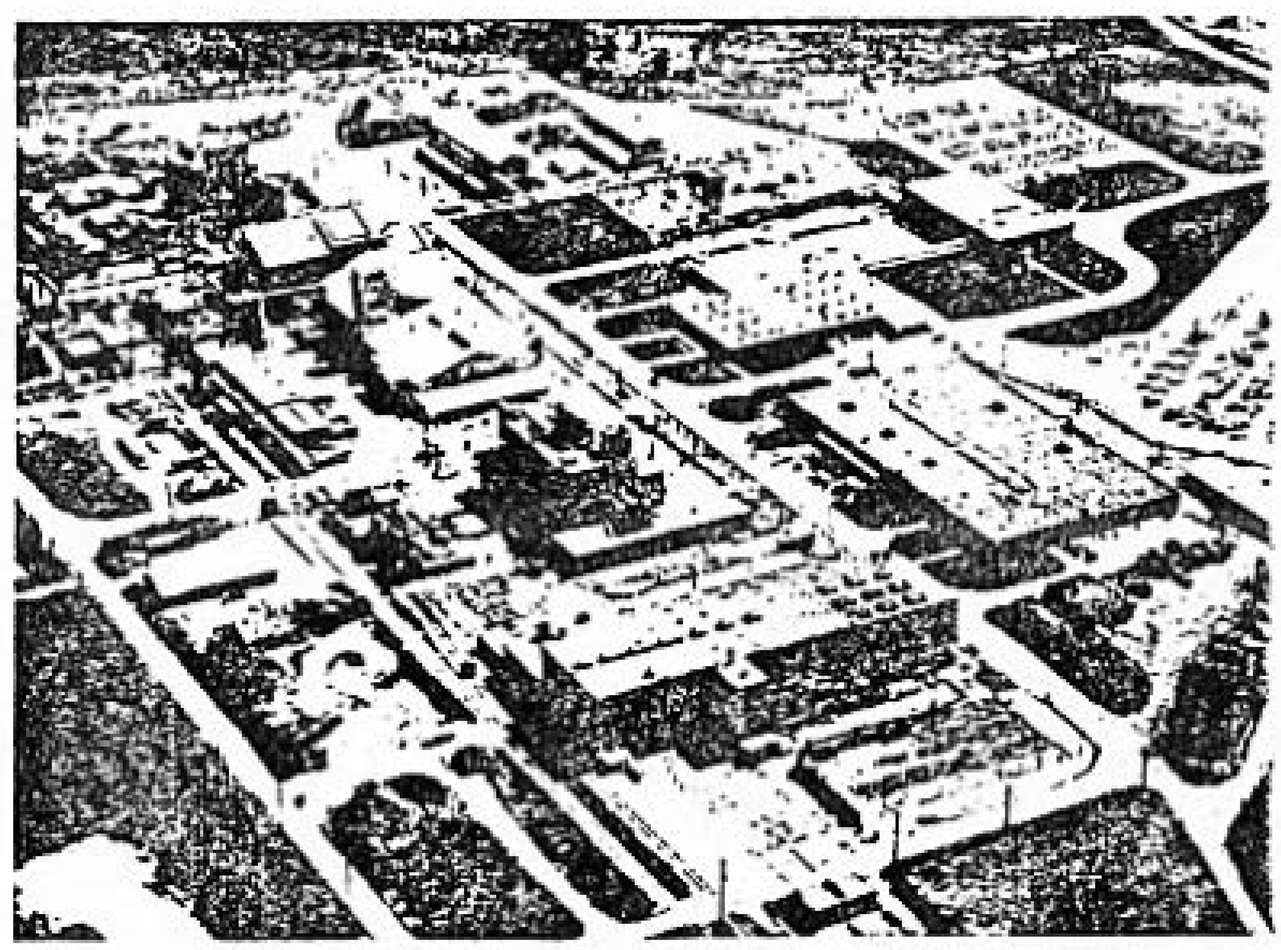
The story of the atom must go back as far as the early Hindu philosophers, who first enunciated the notion of the atomic structure of all matter. The Greeks, in the fifth century before Christ, originated a name for the small "indivisible" particles which they felt made up all material things. Democritus coined the word *atoma*.

Off and on in the ensuing years, thoughtful men pondered the possibility of the atom, but it was not until the 19th Century that modern atomic theory began to take on form and substance. An English schoolmaster, John Dalton, is credited with giving genuine credence to the vague conception of the atom.

The names of others who have contributed to the field are legion. But perhaps the whole story would never have unfolded without the towering genius of a humble German mathematician, Albert Einstein, who gave the world the magic key: E equal mc^2.

In the spring of 1939, with the German armies on the rampage in Europe, uranium fission was discovered, and a few weeks later the possible military implications of the discovery first were brought to the attention of the U. S. government.

G. B. Pegram of Columbia University arranged for a meeting between Enrico Fermi and representatives of the Navy Department. At this historic session, the Navy expressed interest and asked that it be kept



At Weldon Spring is the newest and most technologically advanced feed materials plant in the atomic energy program. The materials produced here are shipped to production reactors and gaseous diffusion plants in the AEC complex.

advised as work proceeded.

Then in the fall of that year, the matter first was broached to President Franklin D. Roosevelt, who appointed an "Advisory Committee on Uranium" and asked that this group investigate.

In November that year, the work received its first financial support from the government, when $6,000 was transferred by the Navy for the purchase of graphite and uranium oxide which would be used in measurements of the absorption cross-section of carbon. Six months later, the Government organized "The National Defense Research Committee," and the uranium group became a subcommittee of NDRC.

The program then began to hum. By December 1941, sixteen research contracts were in effect, mostly with universities, representing a total of about $300,000.

In the days prior to World War II, there was scant use of uranium. It is significant to remember that at the end of 1941, the only uranium metal in existence consisted of a few grams of good material which had been produced on an experimental basis by Westinghouse. In addition, there were a few pounds of highly impure powder which had been made by Metal Hydrides Company. The only considerable amount of raw material then available in this country was in the form of black uranium oxide, which could be obtained from a Canadian firm.

By the spring of 1942, higher purity black oxide was available, and it was this material that Mallinckrodt began to process through the ether extraction method.

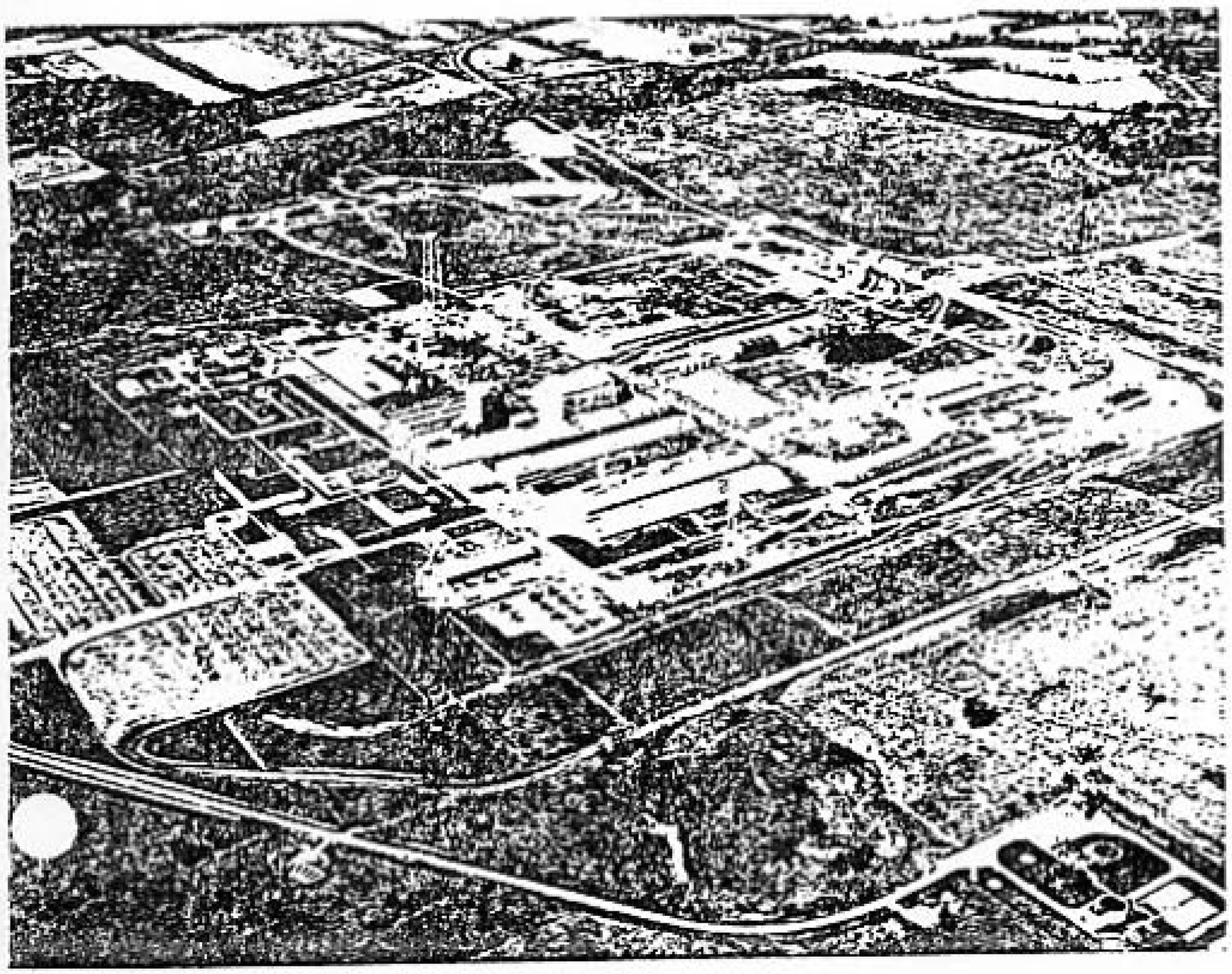
In the summer of 1942, the Army -- through the Corps of Engineers -- was given a major phase of the developing program, particularly in the engineering and procurement areas.

On June 18, Colonel James C. Marshall was directed to form a new engineer district, and by fall it was recognized that the program could no longer be carried out largely in laboratories on a theoretical basis. It was about this time -- in September -- that General Leslie Groves was assigned to head all Army activities in the project.

By now, it was generally accepted that a weapon of tremendous force could be made either from concentrated uranium-235 or from plutonium. Therefore, it was proposed to determine whether U-235 could be separated from U-238, whether natural uranium would produce sufficient quantities of plutonium, and whether the plutonium then could be separated from the parent material.

In December 1942, Fermi's pile operated as a self-sustaining system, greatly boosting the morale of the group of scientists who had theorized and calculated and pondered. Thus, the Metallurgical Laboratory at the University of Chicago had achieved its first objective and also at this same time was well on the way toward developing a process for extracting the plutonium produced in a nuclear reactor.

Suddenly, it seemed, large numbers of people and dollars was committed to the effort, Hanford, Washing-



The Atomic Energy Commission's feed materials production plant at Fernald, Ohio (a companion plant to Weldon Spring) is operated by National Lead Company of Ohio. Representing an investment of 113 million dollars, the plant employs about 2,200 persons.

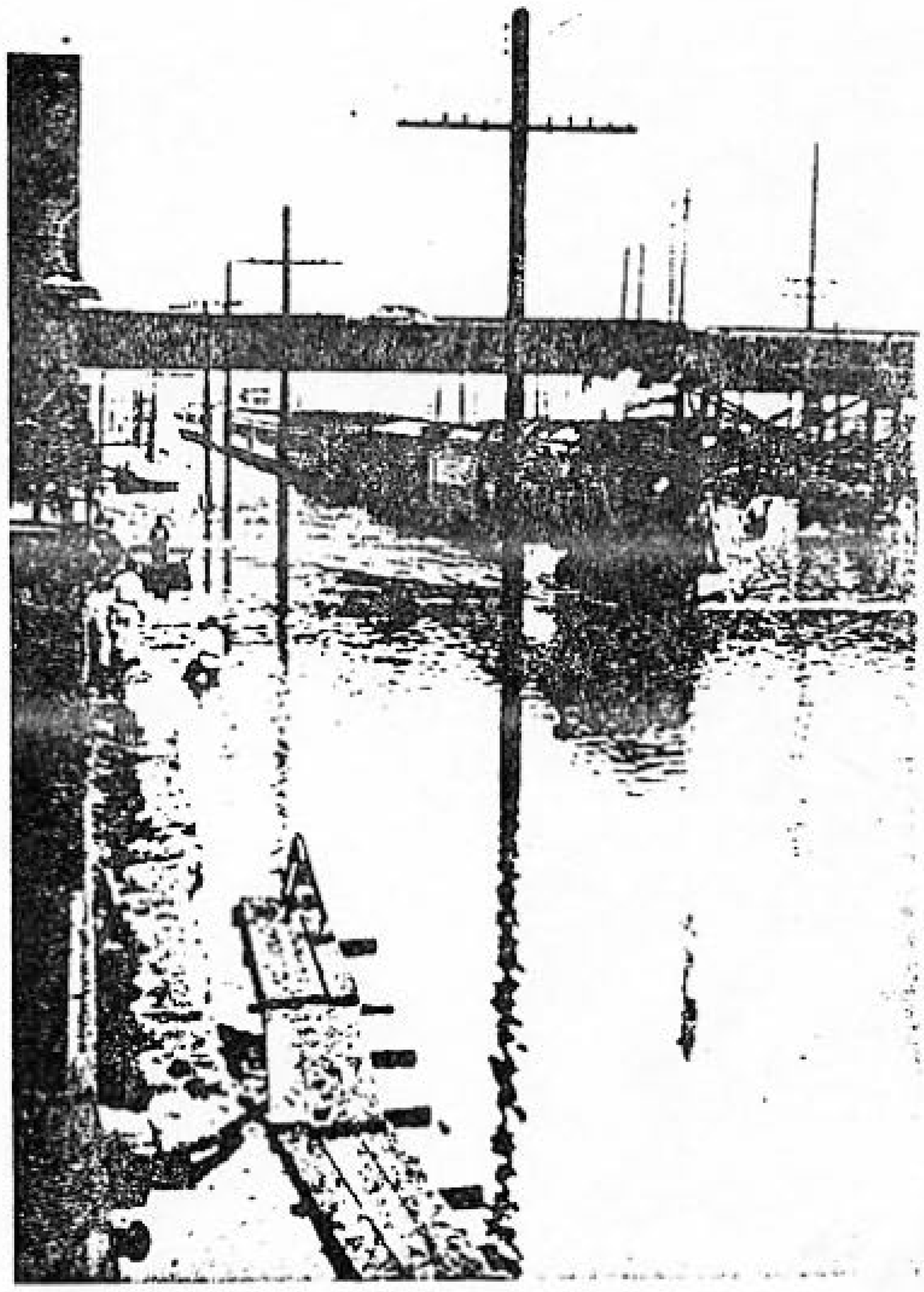
This was something special ---

The feeling of secrecy ---

Never a dull moment ---

The explosions, fires, floods, and the successes ---

"THESE THINGS I REMEMBER..."



Even with river stage reports from the Weather Bureau the 1943 flood was almost disastrous --- at one point the Mississippi rose six feet overnight. Mallinckrodt employees worked 18-20 hours sandbagging the east and south walls of main plant buildings to a height of five feet. (May 25, 1943 scene is looking north with McKinley Bridge overpass in the background.)

by Jeanelle Hoffert

Back in the Spring of 1942 some of the people still working for the uranium division were assigned to a special project. It's doubtful if a single thought was given to the possibility that this project might last for twenty years - and more. At the beginning it was just another assignment --- nothing to become particularly excited about. Soon, however, it became apparent - mostly from what wasn't said - that this was something special.

Working for Walter Schmidt, then superintendent of maintenance, Cliff Drews and Red Etter were electricians at the very beginning of the project....doing much the same kind of work they had done before. Henry Schroer, who had come to Mallinckrodt in 1925 as a tinner helper was the first welder on the job. Elmer Ehrhardt was a carpenter, and it was just another carpenter's job for him. A rigger when he came to MCW in 1933, Ray Esteep had become a pipe-

ton had been selected as the site for plutonium production, Los Alamos was the site for weapons research and development. And Oak Ridge was picked as the place to center the major effort to produce uranium 235.

Actually, three major separation methods were pursued at Oak Ridge -- electromagnetic, thermal diffusion and gaseous diffusion.

On February 1, 1943, ground was broken in Oak Ridge for the first building of the electromagnetic separation plant -- Y-12 -- where enriched U-235 would first be produced in large quantities. Incidentally, on that same date in another valley several miles distant, work also started on the Graphite Reactor, which was to serve as a pilot plant for the Hanford reactors.

Meanwhile, preliminary work was proceeding on the gaseous diffusion process, and construction of the main process plant for gaseous diffusion began September 10, 1943. This plant was called K-25.

The Y-12 Plant began production in early 1944, about a year before the gaseous diffusion operation started, and there was a tremendous urge later in 1944 to increase the output of Y-12. Since uranium in nature consists of only .7 of 1 per cent U-235, any method of increasing the U-235 content of material fed into Y-12 could greatly increase production.

A thermal diffusion plant was built in late 1944, in an extremely short period, and despite some disappointments with this process, the plant succeeded in boosting the production rate at Y-12.

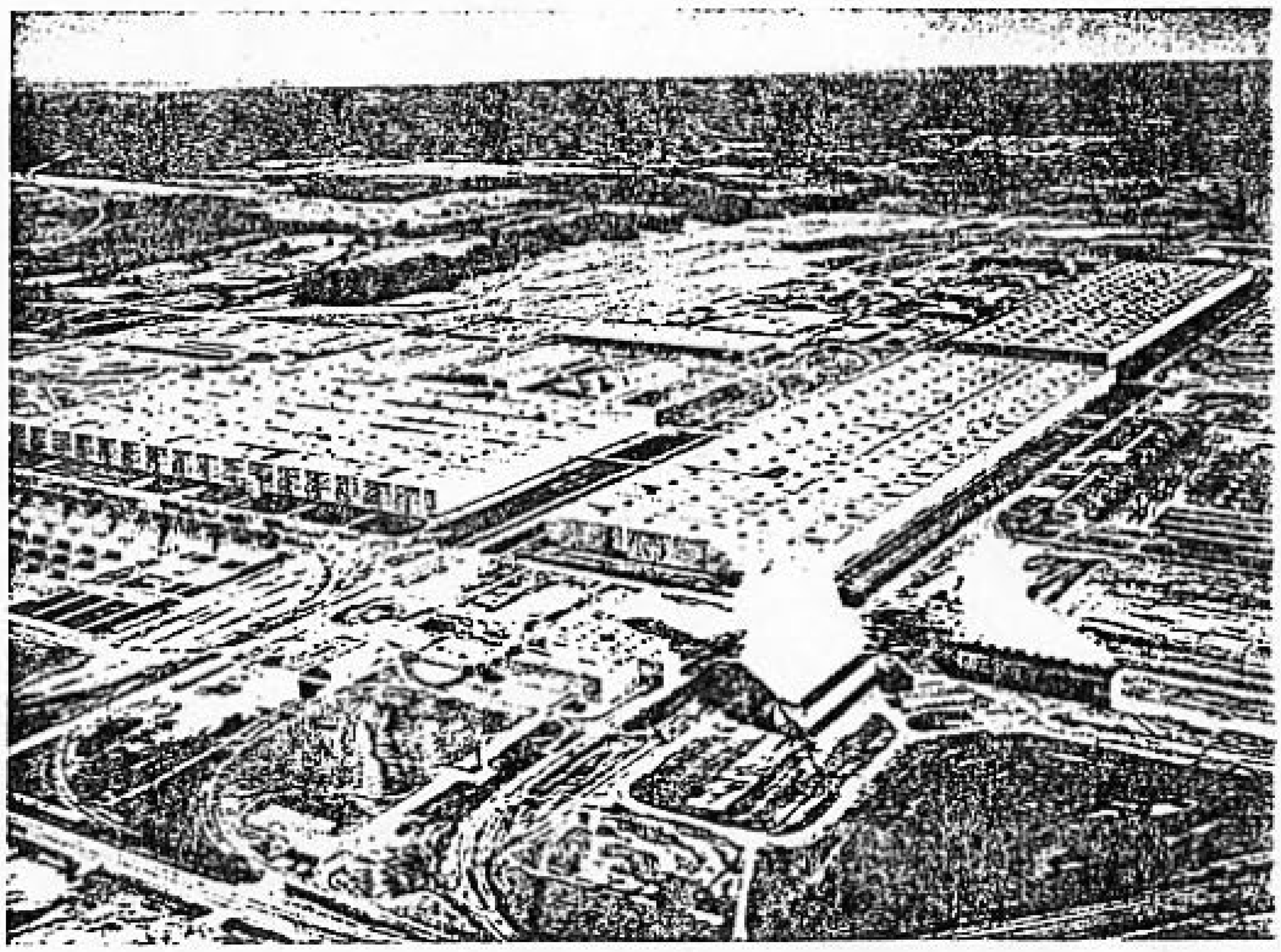
And while Oak Ridge had its problems producing uranium, there were other problems at other sites. Design of the plutonium reactors at Hanford was troublesome -- there were thorny questions to be solved on coolant, shielding, corrosion, welding. Originally eight separation plants were planned, then six, and finally four. But the work moved. At Los Alamos, an organization was recruited for work on "Project Y" as the bomb development program was tagged.

Los Alamos had difficulties from the outset in the procurement not only of skilled people, but of equipment and materials. The requirements were unusual and time was in short supply. Just as the people were recruited largely from universities, so was some of the equipment. Items such as Van de Graaff generators and a Crockcroft-Walton accelerator were obtained from schools.

And through 1944 and 1945, Mallinckrodt continued to produce high purity uranium in an attempt to feed the insatiable appetities of the program.

Time and space do not permit a detailed account even of the high points through the exciting years of development. But by July 6, 1945, a weapon was ready for testing, in a barren remote section of New Mexico desert. Perhaps this dramatic event can best be described by one of the witnesses, General Thomas F. Farrell:

"We were reaching into the unknown and we did not know what might come of it. It can safely be said that most of those present were praying -- and praying



The Portsmouth (Ohio) gaseous diffusion plant produces enriched uranium-235 for national defense programs and as fuel for nuclear reactors. Constructed at a cost of about 73 million dollars, the payroll totals 1,700 persons.

fitter and worked on the installation and maintenance of the equipment.

Emmett Schafer, Vince Buhr and Matt Kuehn were among the first operators when production was begun. Ed Ball, employed since 1940, was looking forward to his vacation that first week of May, 1942. Suddenly he was assigned to the Tube Alloy project, in the lab --- and the planned vacation was to be postponed for four years. Ray Vogel, a laboratory technician was performing work on emission-spectroscopy.

Soon, the feeling of secrecy which pervaded the project was joined by a stronger sense of importance and urgency. Still only a few knew what the product being worked on really was....and only some of the top brass knew just what the ultimate use was to be. Speculation ran high as to what the whole thing was about.

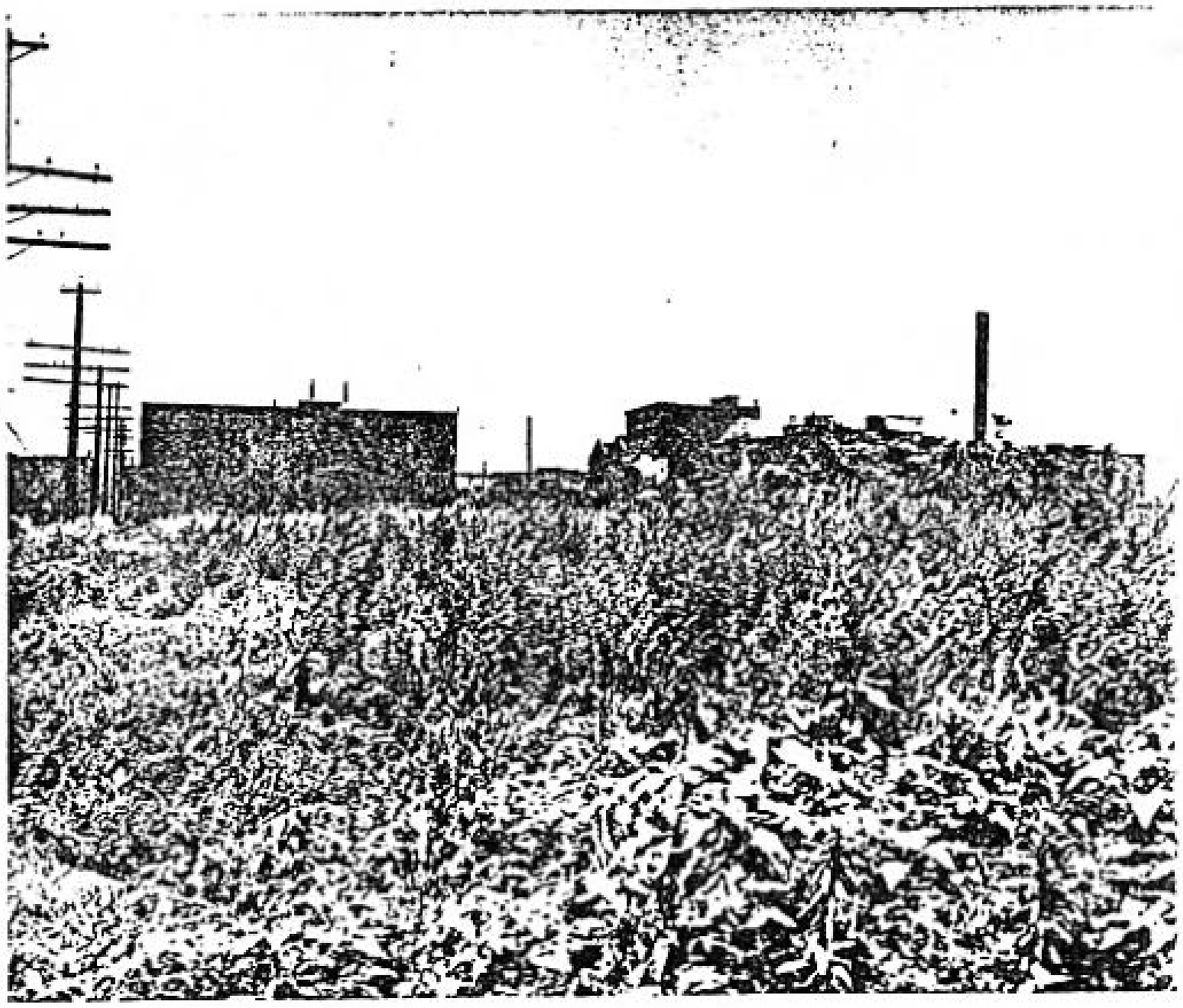
Ed Ball privately thought the eventual use would be a means of power - for ships and planes; Red Etter recalls the rumor that the material would be used in the manufacture of gases — in spite of its weight. Matt Kuehn remembers, "We knew we were working on something very important for the war effort. We knew it was uranium but didn't know just what part it was to play."

Vince Buhr, after seeing some of the material taken from the furnace one day, suggested to an engineer that it looked a lot like gun powder. The look he got made words unnecessary and any future speculations were kept to himself. Ray Vogel, using the analysts' method of rationalization, came to the conclusion that the uranium would be formed into metal and then used for armor-piercing shells.

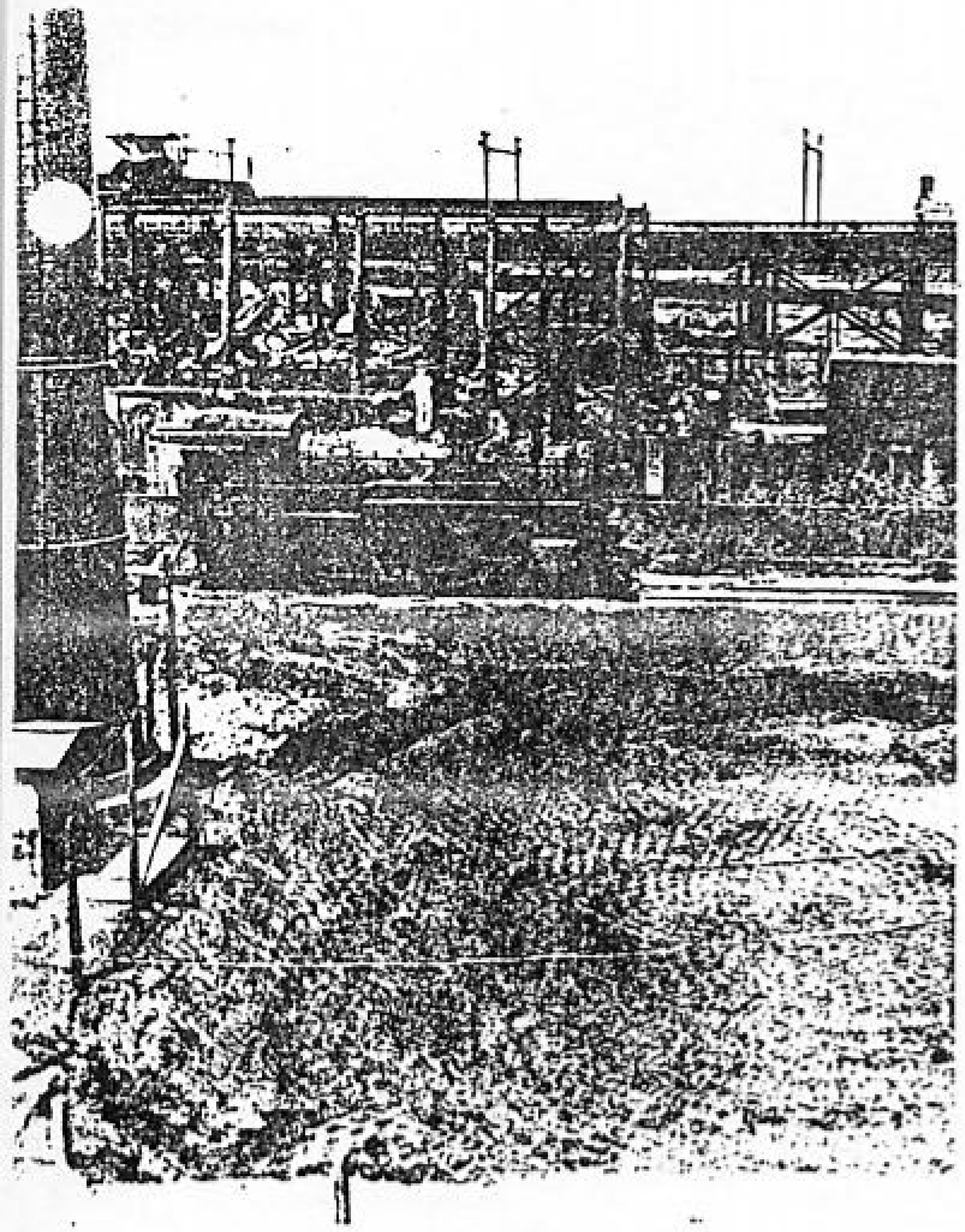
Perhaps the classic statement of all was the one spoken by an operator to Emmett Schafer later that year. "I don't know what the stuff is but they tell me it's radioactive --- so it must be for radios."

The work days were long, sometimes fourteen hours and more — and for many it was a seven-day a week grind. Holidays and vacations didn't exist as days off --- they were just more days to be worked. Men worked until sometimes it was an effort to just keep one's eyes open. Still, there was such a sense of the need to do the job there were few complaints. The spirit of working together on something so very important gave the men a feeling of closeness and a pride in working as a team. Enthusiasm and a kind of camaraderie existed among the group rarely ever found anywhere.

It was a time when no one paid too much attention



The former site of the Destrehan Plant today looks much like it did when this photo was taken June 15, 1945. In the short intervening 17 years, a $22 million plant was built and leveled, victim of obsolescence in the fast changing technology of the nuclear industry. (Line of poles on left extended along north side of Destrehan Street - main plant buildings are in the background to the west.)



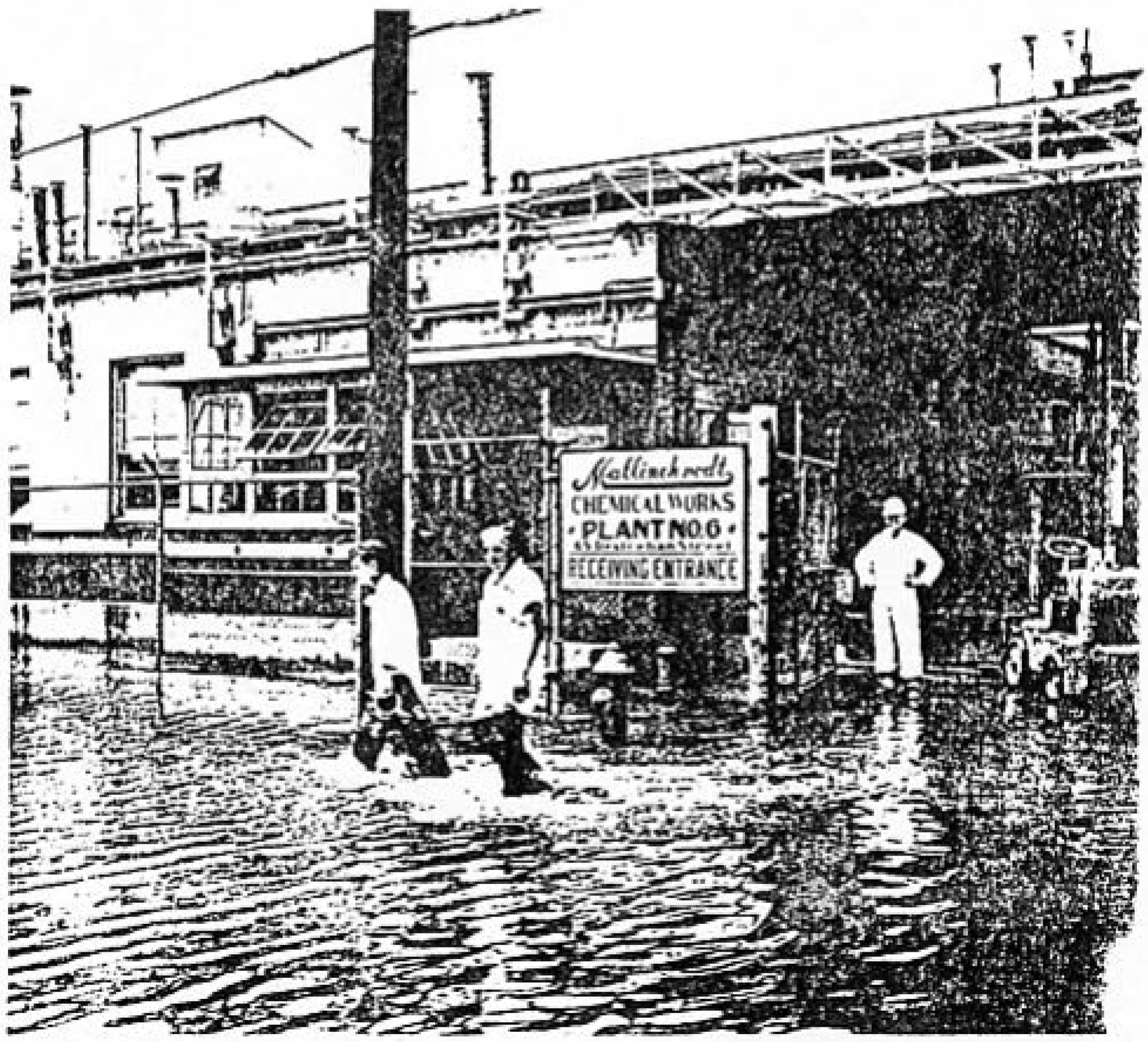
to doing just his assigned work. People did what needed to be done. The automation in our plant today was almost unthought of — most everything was dependent on manual labor. It was a time of "get the job done" as quickly and safely as possible under existing conditions. That remains true today but the situation differs greatly. Workmen supplied their own clothing and tools; health regulations as we know them today were almost nonexistent. Red Etter recalls the absence of official coffee breaks - but coffee and tea were made right in the plant — and you sat down and drank it amidst activities that didn't stop.

While enjoying our modern, spacious plant today we might find it difficult to imagine the crowded, almost primitive conditions in the early days of the project. Some of the problems existing in those days we experience even now — then again, others were unique only to that time and place. Delving into the memories of these men we find stories that might seem almost impossible today.

Henry Schroer recalls that during the excavation for the conversion of buildings 51 and 52, hundreds of Civil War cannonballs were found. They had been stockpiled by the foundry which originally occupied the building.

At first, there were a number of explosions and fires; when a new process was started it wasn't unusual to have everyone leave the building, because no one was sure just what would happen. Vince

In the banner construction year of 1948 the output of the old boiler house was inadequate and a Wabash steam engine was hooked up. Boosting capacity by 25%, "Old 2322" served faithfully until the new boiler house was completed.



The Mississippi went on the rampage again in 1951. But preparations were made in time to prevent any serious trouble.

Buhr well remembers the night ether fumes leaked to the pot room part of the building and the resulting explosion. Ray Esteep tells of the fires and how the fire department answered the calls and stood outside the building with water hoses ready in case the workmen inside were unable to extinguish the flames themselves.

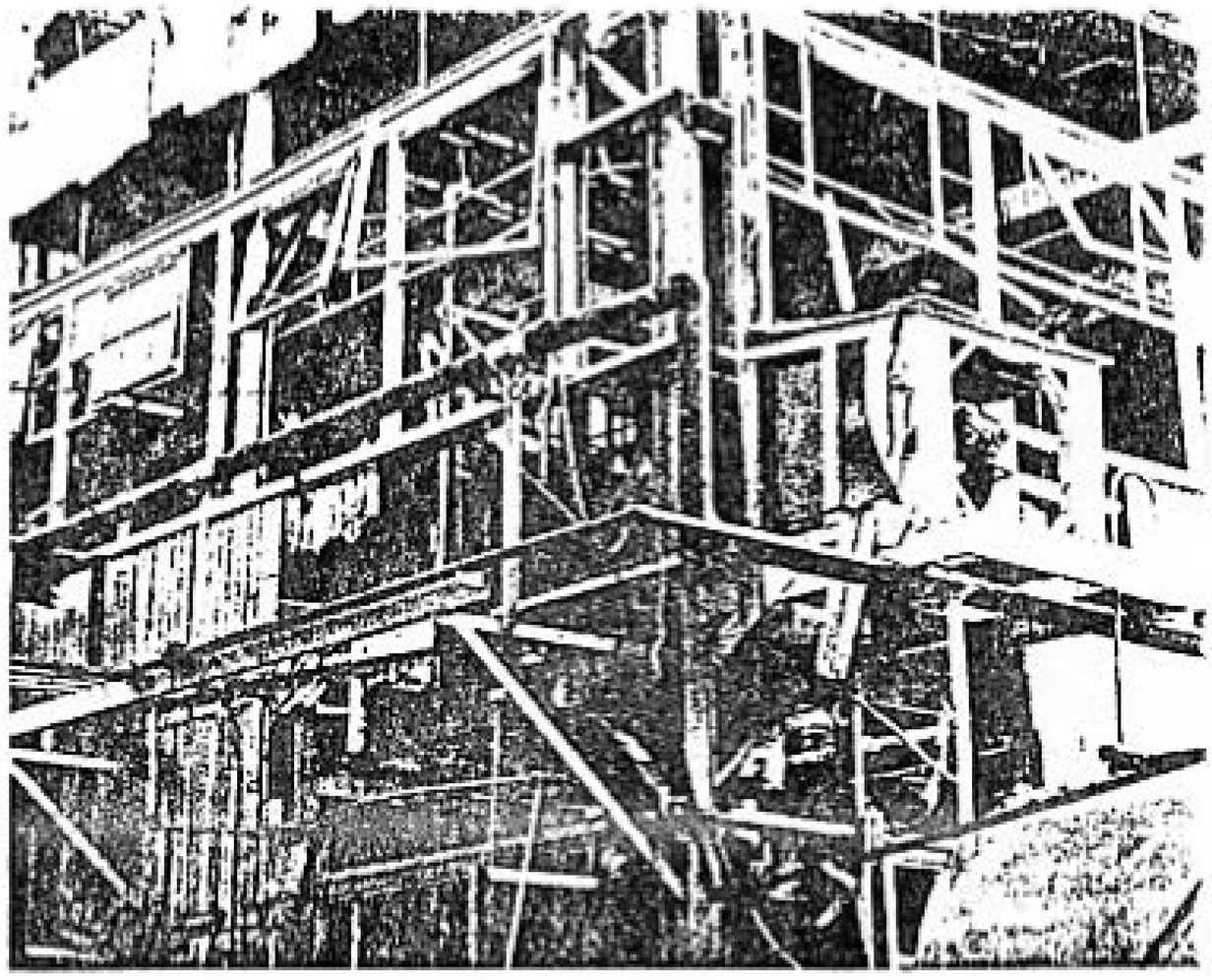
Emmett Schafer says today of that hectic and often confusing period, "There was never a dull moment from the beginning. It was interesting work - nobody seemed to know exactly what they were doing but enjoyed doing it."

Matt Kuehn recalls that the muddy old Mississippi flooded in 1943 --- and what a flood it was. The river rose six feet overnight and production in the main plant practically ceased. Every available man was put to work hauling mud to pack around timber bulwarks, and filling thousands of sandbags. The men of the project went about their duties as usual, and only after working hours did they help battle the rising waters. Such was the urgency of their regular work.

Orval Heflin well remembers the cold, damp night he and several others were patrolling the plant perimeter in rowboats. After twelve hours the tired, bedraggled men were huddled around a fire when from far up Destrehan Street came a small rowboat. Propelled canoe-fashion, the boat carried one passenger — dressed in dungarees, boots and a striped lab coat. The visitor brought encouragement and a beverage designed especially for boosting one's morale and warming the chilled bones. This was a measure of the man who was to become the second manager of the uranium division and later president of Mallinckrodt - Harold Thayer.

Amusing incidents resulting from the FBI security checks occurred to almost everyone. Ray Esteep's neighbors decided that he must be suspected of an awful crime when agents called on them for character references. Unable to explain, he had to let them think what they wanted to. The investigators checking on Ed Ball posed as loan company representatives. Unfortunately, Mrs. Ball was told of the questions by neighbors and it took a lot of explaining to convince her of his innocence, but Ed did - and without revealing the true purpose, too.

An operator working for Walter Schmidt read an article in the newspaper about uranium-235 — the story was about some work the Austrians were doing at that time. Later that day, as an Army official watched the men work, the man quite innocently asked if the material was similar to U-235. Shocked speechless, the Army man literally ran from the scene and soon returned with three more officials. A barrage of questions followed and they were stunned to learn that the operator had read the very small article and had connected it with the work Mallinckrodt was doing.



This 1946 photo was taken minutes after start up of the new ether house....excessive pressure in a small tank caused an explosion which ripped through the structure. The half-dozen men in the building miraculously escaped injury. Back in operation in two weeks, things went smoothly until the next explosion in the winter of 1951. It was perhaps even more spine-tingling. The automatic sprinkler system was activated --- the temperature hovered around 0° --- and the ether house glistened with a myriad of sparkling icicles.

Not until that day in August, 1945 did the men of Mallinckrodt know how vital their work had been to the winning of the war. A holiday was declared for the people of the uranium project - a brief respite for relaxing and celebrating. Then, on with the job, because there was still much work to do.

Production was increased and every available nook and cranny was used for expansion. New buildings were constructed and the facility was soon spread over twenty acres. The growth of uranium processing during that period was so swift it was almost always several steps ahead of construction of needed buildings.

The job that was done took a lot of imagination, resourcefulness and endless improvising. An example of this was the ingenious method devised for supplementing the steam supply when the old boiler house's maximum output became inadequate. To fill the need, a Wabash steam engine - "Old 2322" - was brought in. Welded to the tracks to prevent movement, it had to be cut with a torch and moved piece by piece when the new boiler house was operative and it was no longer needed.

Now, twenty years later, the special project is still going strong. These times and events are nice to think about occasionally, but no one dwells on them for very long. There remain too many new problems - always advancements and new techniques in this "uranium business."

THAT SPECIAL INGREDIENT

For almost a hundred years Mallinckrodt has been known for its versatility, its technical skills, and its quality goods. This special ingredient was responsible for the Company's entry into the nuclear business when all other efforts to produce quality-pure uranium had failed.

ANNALES

CHIMIE ET DE PHYSIQUE,

Troisieme Série

TOME CINQUIE'ME

PARIS,

FORTIN, MASSON ET C^E LIBRAIRIES,

PLACE DE L'ECOLE DE MÉDECINE, N° I.

IMPEIMERIE DE BACHELIER,

1842

One of the earliest papers on uranium chemistry was a pioneering article by French scientist E. Peligot that appeared in this journal.

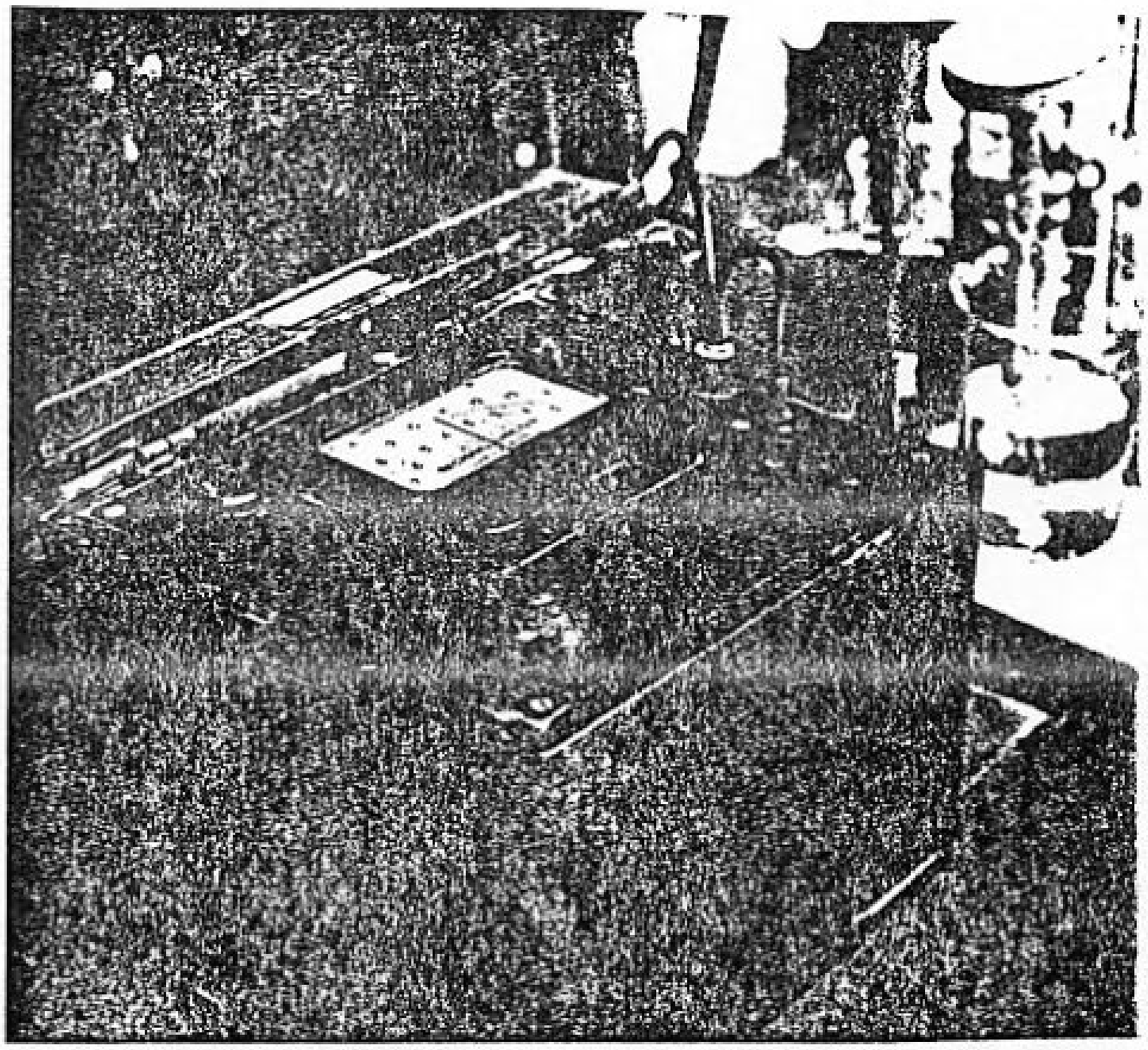
by Sam Tuthill
and
John Shepardson

In 1842, Peligot published a laboratory method of purifying uranium which involved the extraction of uranyl nitrate into ether. Exactly 100 years later, Mallinckrodt faced the problem of scaling this up to a plant-size process capable of producing tons of uranium materials.

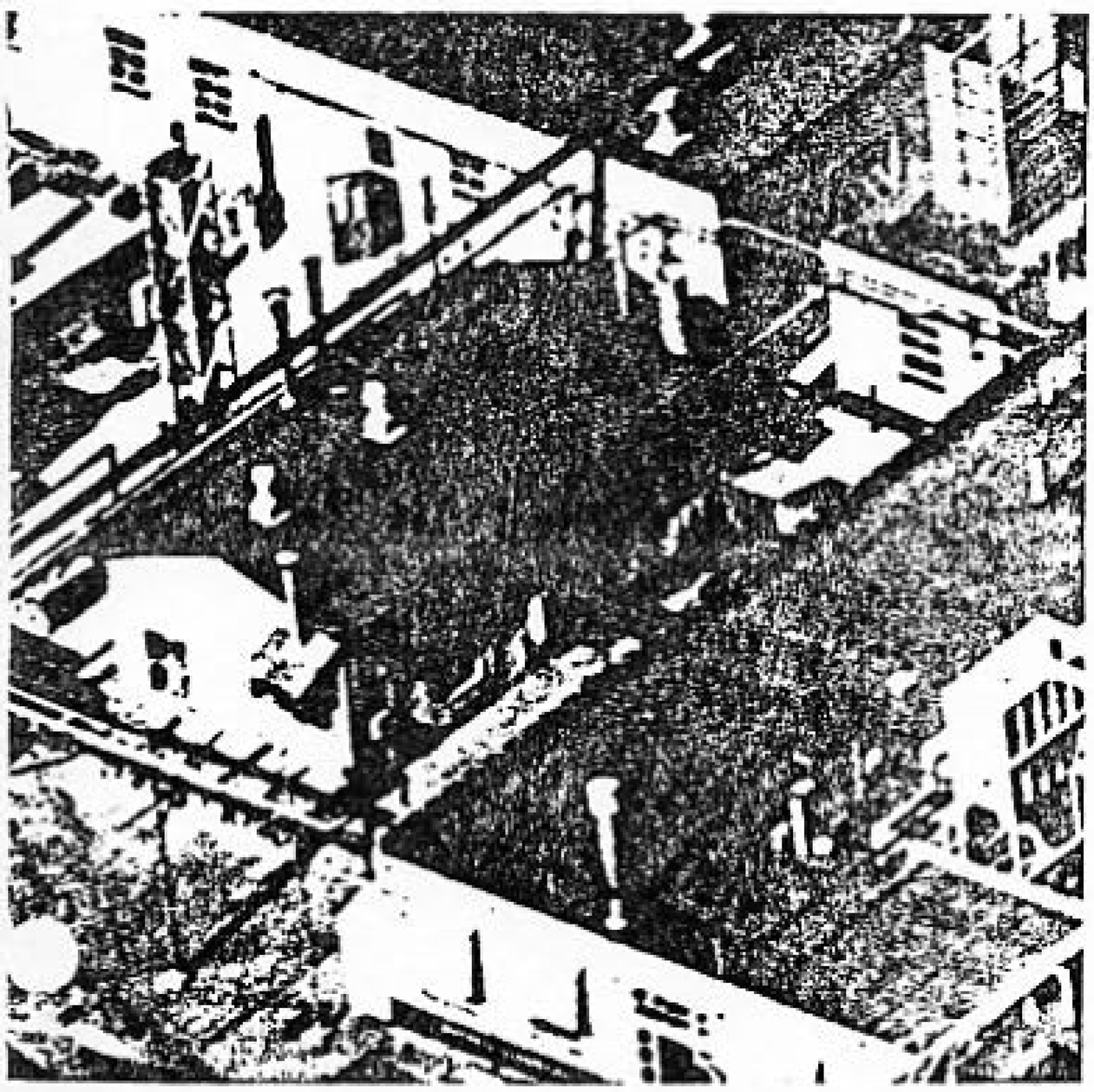
In April 1942, little was known about the exact behavior in the ether extraction of the various elements which occur with uranium. Mallinckrodt had sold uranyl nitrate for years as an analytical reagent. One of the first tasks was to "spike" this material with various possible impurities, such as iron, nickel, chromium, molybdenum, vanadium, cadmium and boron. The spiked uranyl nitrate was shaken in a separatory funnel with diethyl ether and water, the ether and water layers were separated, and each analyzed for the impurity which had been added. In this way, knowledge was acquired concerning the distribution of impurities between ether and water, and conditions defined for purification of uranyl nitrate by extraction and washing. Among those who participated in this early work were John Lemp, and James Boyd.

With a starting material of black uranium oxide from Canada, methods had to be developed for determining the uranium and for measuring the impurities in the first product, brown oxide. In those days, instrumen-

A pH meter --- in 1942 this, literally, was the only instrumentation for control of the uranium purification process. Contrast this with the modern instruments of today (see pgs. 50-52).



The shotgun building, center, and the analytical laboratory, right foreground, at the Destrehan Street plant. In the shotgun test, total impurities in the uranium product were tested for neutron absorption properties.



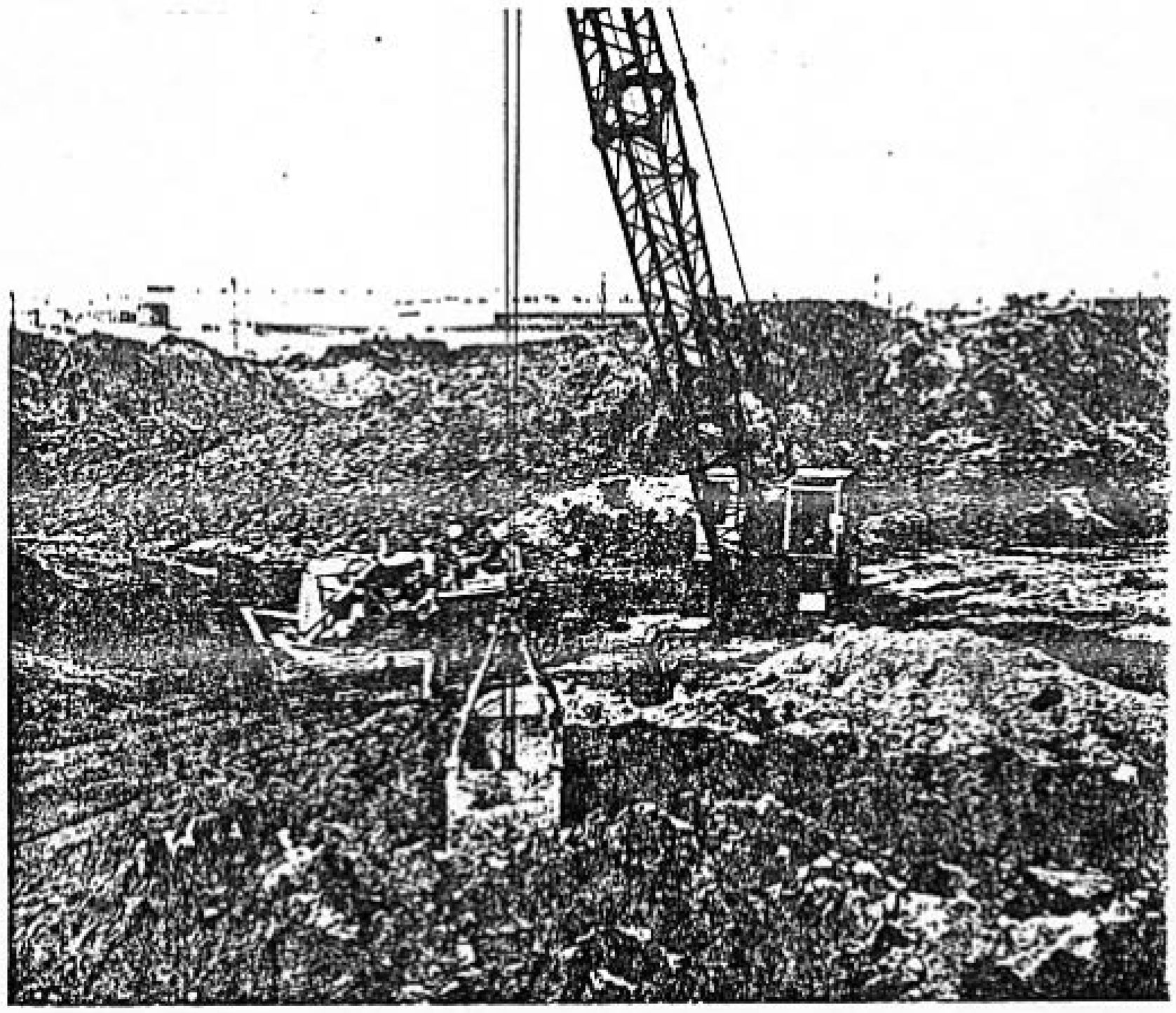
tation in the analytical laboratory literally was limited to one pH meter. Volumetric methods were set up for the assay and methods for the common impurities, such as iron, chromium, and chloride were not too difficult. However, for nuclear purposes one critical impurity is *boron at a fraction of a part per million. Methods for this were laboriously worked out, employing distillation in quartz equipment followed by the final development of a color. (We bought the turmeric reagent at a local grocery store!) Walter Dean and Dell Madsen set up the test which was run until it was replaced by a spectrographic method. George McElheny still remembers the almost endless distillations.

Then, as now, control tests played a vitalpart in the operation. In the plant, the ether extraction of uranyl nitrate was a batch process in which a number of washes of the ether layer with water were required. The question was when had sufficient washing been done. In finding the answer, Mallinckrodt made use of a radiochemical method.

All natural uranium contains radioactive UX_1, an isotope of thorium and one of the most difficult im-

Some materials, the mere mention of which might have been a clue that we were processing uranium, were code named. One of these was boron which was designated "vitamin."

Ore buying contracts in the early days stipulated that certain residues had to be held for eventual return to Belgium. This storage area near Lambert-St. Louis Airport still contains thousands of tons of barium sulfate and other radioactive residues. But most of these will be processed and removed by the end of 1963.

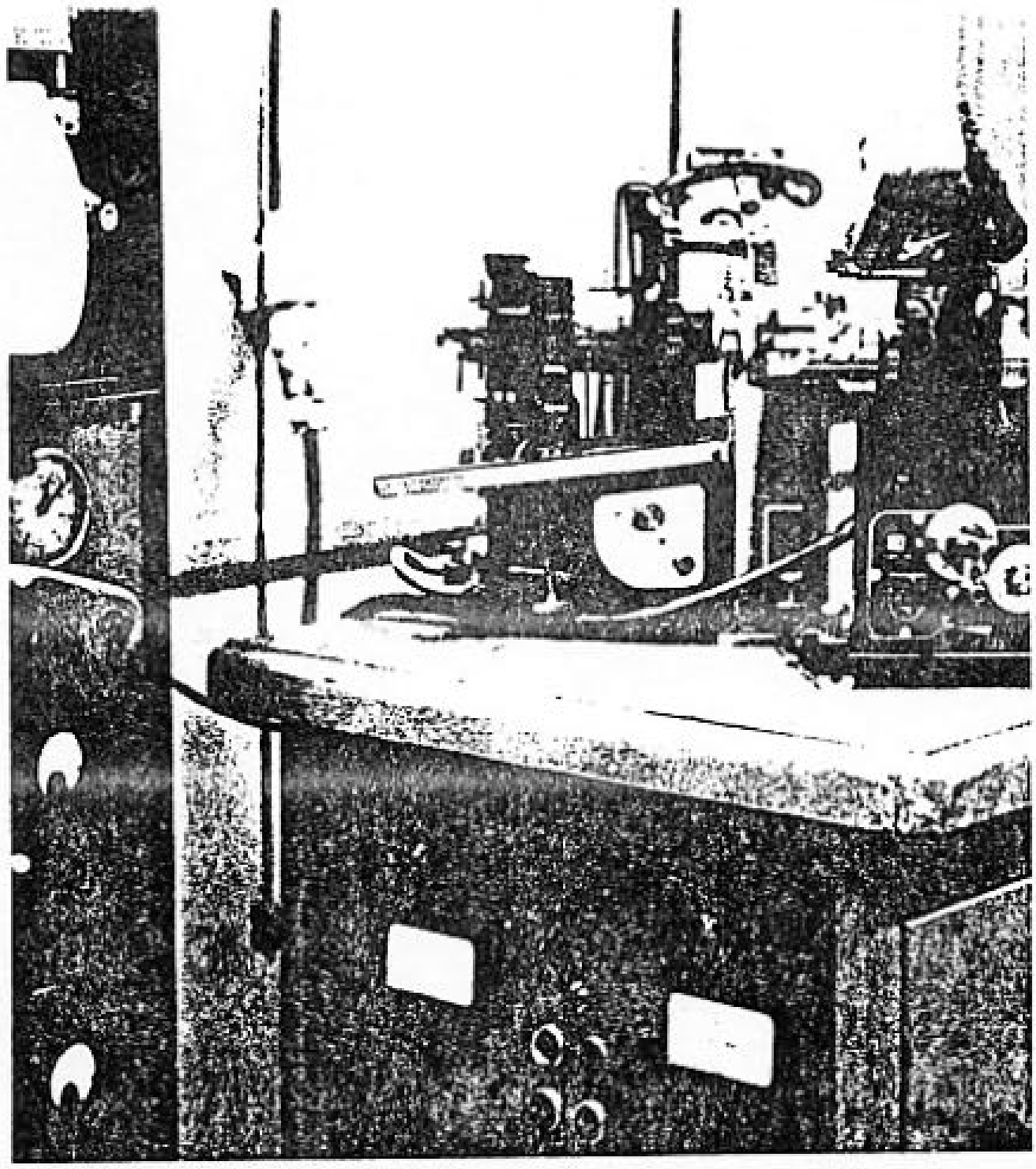


purities to separate. When its concentration was reduced to a low enough level, the concentrations of other impurities were found to be also at tolerable levels. We could follow the decrease in the concentration of UX_1 by measuring the decreasing radioactivity as the UX_1 was washed out. To perform the test, we converted a sample of uranyl nitrate from the ether layer to black oxide, and measured the radioactivity with a Geiger Counter. Instrumentation was provided by the Metallurgical Laboratory of the University of Chicago. Our analysts soon learned to put a big platinum dish of ethereal uranyl nitrate in the hood, touch a match to it, and jump back, as a first step toward the conversion of the sample to black oxide.

Other undesirable impurities in uranium are certain rare earths, of which gadolinium is by far the worst. At the beginning of the uranium work, and for many years thereafter, methods for determining the individual rare earths were not available. The famous Dr. Enrico Fermi and his co-workers had provided an answer by developing the "Shotgun Test," in which rare earths and other impurities were extracted with ether from a 25-pound sample of uranium oxide and concentrated into a few grams of residual uranium oxides --- hardly a micro analytical procedure. The extraction part of the test was set up and first done in a tent in the alley between Buildings 25 and K. Later the extractions were done in a building designed for the purpose --- Building 55. At the University of Chicago, impurities were measured for neutron absorption in comparison with boron standards and every night samples had to be placed on the No. 8 Alton train to Chicago. Charlie Conard and Harold Bell set up the equipment; Charlie Bemis, Frank Epelley and others ran the test during the war years.

Although laboratory instrumentation was practically nil by today's standards, Al Butler had been planning ahead, and a spectrograph for general Mallinckrodt use had been ordered from England in April, 1941. Charlie Harrington had been employed to set it up and run it.

The first spectrograph was destroyed by German bombs while still on an English dock. A second one fared better, and was eventually delivered to Mallinckrodt in the spring of 1942. By the time it was ready to operate, Dr. Harrington was needed in uranium process research, and was replaced by Barney Field. Eventually, many of the impurity analyses, including



This x-ray spectrograph is used in today's modern metallurgical lab to study crystallographic orientation in extruded uranium.

that for boron, were transferred to the spectrograph, using the famous carrier-distillation method developed at the National Bureau of Standards. In fact, it is hard to see how the volume of analyses could have been achieved in any other way. Then, as now, Ray Vogel was concerned with spectrographic work.

Mallinckrodt's initial production assignment was soon expanded to include uranium tetrafluoride and uranium metal. Plant 4 manufacturing facilities were built and a laboratory installed on the second floor. Gradually most of the analytical work was transferred to this laboratory, although the spectrograph and micro work remained in Building 25. One problem in the new laboratory was the jolters on the other side of the wall, which made beakers jump up and down at times — and made using an analytical balance a "shaking" experience!

Furnaces for making green salt were below the laboratory, and the reduction and casting furnaces were beside it. These, plus the normal St. Louis summer weather, made laboratory temperatures of 100°+ fairly common. Attempts to "air-condition" the laboratory by putting blocks of ice in the window, and drawing air over them with fans, were more successful in raising the humidity than in lowering the temperature!

Among those still with the Company, who worked in the Plant 4 laboratory are Chet French, Charlie Bemis, Stan Anonsen, Sam Huston, Fred Morecombe, Roy Hogan, Ray Renshaw, Frank Epelley, Al Thiele, Joe Scopel, and Jewell Lindsey.

The production of green salt and uranium metal brought new analytical problems. Methods had to be devised for nitrogen, carbon and hydrogen, and silica in the metal, as well as for impurities that could be determined spectrographically. Micro combustion techniques were employed, and specially designed equipment set up. Tests had to be devised to check the purity of the magnesium used to reduce uranium tetrafluoride to uranium metal, and the fused dolomite and calcium oxide used to line the reaction "bombs." Boron determinations were needed, and for liner materials these could not be done on the spectrograph — rapid chemical methods had to be developed.

As the end of the war approached Mallinckrodt was presented with a new problem — processing pitchblende ores. Again, much analytical support was needed. Pitchblende contains radium which presented grave radiation hazards. A section of Plant 4 labora-

tory known as "the cage" was walled off to isolate work with "hot" samples. Radium analyses was subsequently required, and equipment and methods were set up.

The new facility for processing pitchblende ores included an analytical laboratory for sample preparation, process control, and finished material testing as well as a micro laboratory and a spectrographic laboratory — plus a new shotgun building. Plant 6 was still under construction as the war ended.

The Manhattan District work brought many advances to the field of analytical chemistry. During the war years, a large cooperative analytical effort was carried out, in which Mallinckrodt played an important part. As the project became more organized, laboratories were set up at Princeton, New Jersey. Other work was done at the National Bureau of Standards, and in other companies, who also were manufacturing uranium materials. Many analyses were supplied by these other laboratories and extensive sample exchange programs were developed — the forerunners of similar programs still in existence.

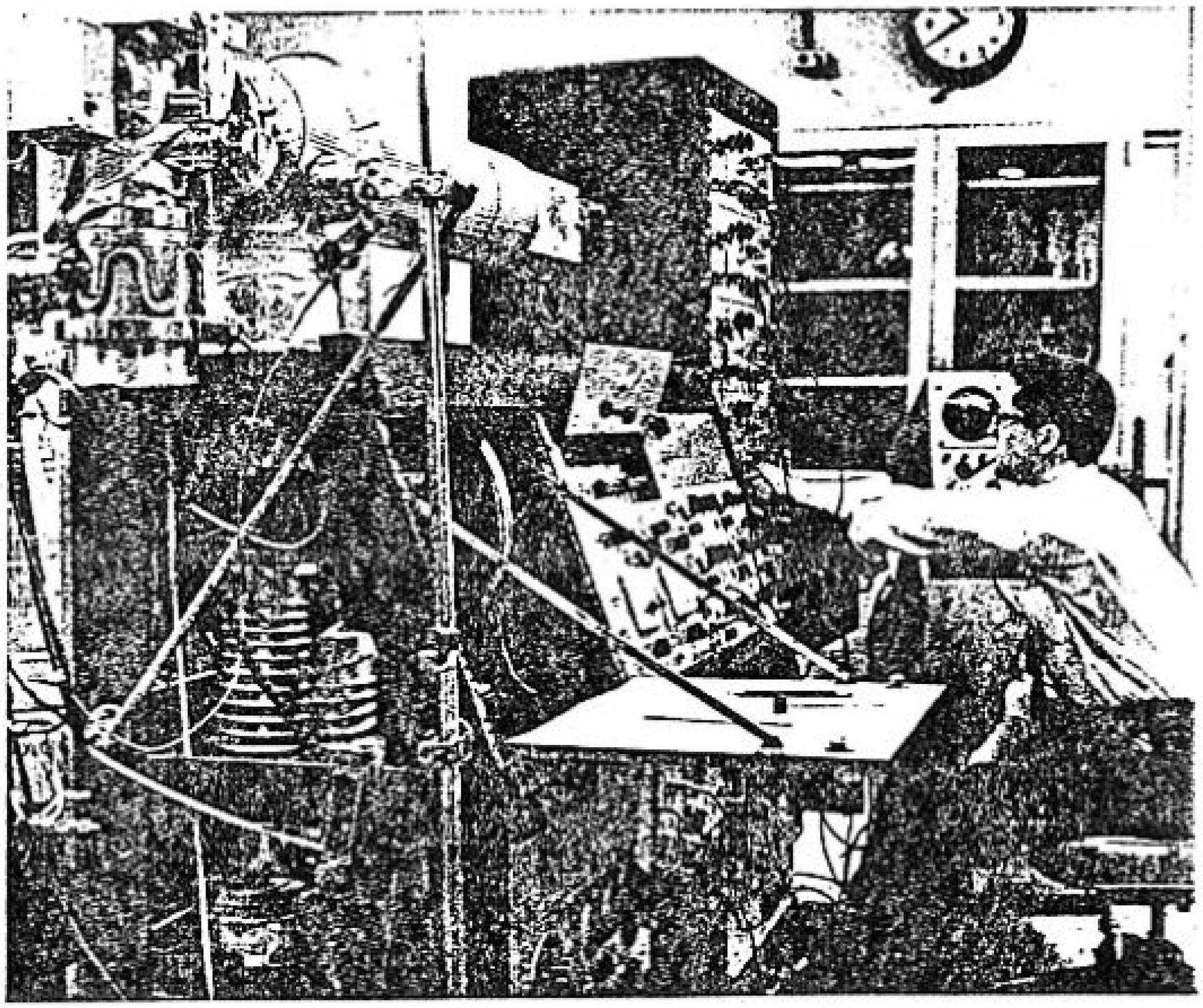
As far as Mallinckrodt is concerned, except for Building 25 and Building 55 (the old shotgun building), the scenes of much intensive analytical work are only a memory — replaced by the complete, modern, highly-instrumented analytical laboratories at Weldon Spring.

The second half of the laboratory story is like the first — one of change and growth. In the Spring of 1946 the Plant 6 analytical laboratory opened its doors to a staff of 30 people. By mid 1950 the number had increased to 50 and crowding became excessive. New lab rooms and office space, completed in the Fall of 1951, for the first time provided adequate space for the analysis of pilot plant samples and the development of new analytical methods.

Several interesting activities carried out at the Destrehan laboratory are now a part of history. The shotgun test was the most famous of these since it was the only procedure of its kind carried out anywhere in the country. The test, which determined the neutron absorption of impurities, was preceded by thousand-fold concentration of the impurities carried out by means of an ether extraction process.

Years later secrecy restrictions were removed and several manufacturers came out with commercial models of counting equipment based on the shotgun test. Many companies, supplying materials for nuclear reactors, were interested in this apparatus because it was ideal for their test purposes.

A second unusual activity was started by the laboratory when the U. S. Government began buying pitchblende from the Belgian Congo. The contract stated that we bought only the uranium content and that all non-uranium residues were to be held for



The mass spectrometer, a most versatile $50,000 instrument, is used in the analytical laboratory. It measures the time it takes ions to traverse the length of the flight tube, the cannon-like tube on the top of the console.

eventual return to Belgium. Basically, this was the reason why the Destrehan Street raffinate, the barium cake and the radium residues were trucked to the airport site and stored in huge piles.

The Belgians had contracted with the Ledoux Company of Teaneck, New Jersey, to be their representatives in the sampling and storage of these residues. Ledoux representatives worked at our plant observing sampling, sample preparation and checking the weights of residues going to the airport site. Otto Dietz and Gerry Roberts worked for many years in this Ledoux laboratory.

The most valuable element in these residues was radium and a separate accountability balance was maintained to insure that essentially no radium was going down the sewers to the Mississippi River. For this reason, samples were analyzed for radium content in what was known as My Laboratory. Ed Nelson operated it for years.

Nineteen fifty-four saw several significant changes. We started to spend considerable time planning the new uranium processing facility at Weldon Spring. All through '54 and '55 the planning for the Weldon Spring facilities was progressing with successive approval of general layouts, types of building construction, location of buildings and equipment, and on down to furniture requirements.

Also in 1954 we started the forerunner of the sampling plant at Weldon Spring. The Canadians, through the U. S. Atomic Energy Commission, had approached Mallinckrodt on the question of becoming the official sampling station for the Beaverlodge concentrates. We sampled the first two loads of this material from a roughly built wooden platform. During 1954, in spite of the caustic comments that the platform looked more like a hangman's platform, we sampled more than 14,000 drums of material with this crude equipment.

In this same year the routine of analytical testing was interrupted for several members of the laboratory by an assignment to watch over the processing of enriched uranium. We were assigned the special job of converting some slightly enriched uranium since Mallinckrodt had the only Commission facilities for reverting UF_4 to UO_2. The laboratory was charged with the responsibility of seeing that a critical mass of this enriched uranium did not accumulate in any one place thereby causing a criticality accident. It was interesting work but we all heaved a big sigh of relief when the last of the enriched material left the plant.

We saw the end of another activity when the last of the pitchblende was processed in the refinery in late 1955. The Ledoux representative left us and radium analyses were no longer required.

We began to look forward to the opening of the Weldon Spring plant in late 1956. In November of this year the laboratory at the Weldon Spring Water Plant was renovated for analyzing samples from the Missouri River and for training new analysts. The large amount of space available was a distinct change for people like Dave Swaney and Bob Springgate, who were in charge of this testing and training work. This temporary laboratory continued to be useful until about September, 1958 when conditions changed such that the reduced testing could be moved to the laboratory on the plant site.

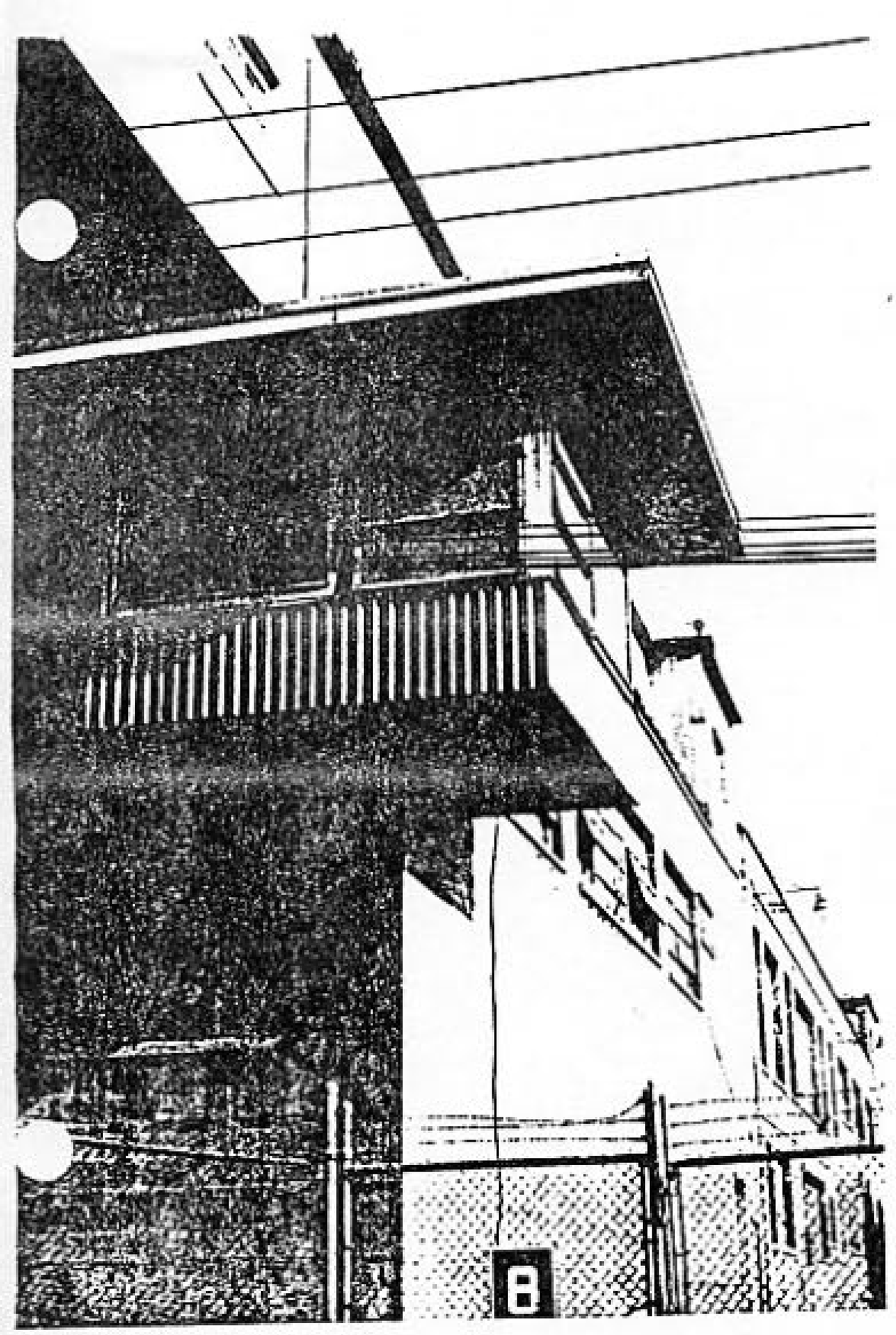
In April 1957 a few people moved to Weldon to set up the laboratory office area. The following month, a few analysts appeared to set up equipment for control of refinery operations. In the following months the work pace picked up rapidly as plant after plant went on stream, until the end of 1957 when there were about 100 analytical department people at both Weldon and Destrehan. In June of 1958 we closed the doors of the Destrehan laboratory for the last time.

It is interesting to look over some of the old records and see that many of the people who were with us in 1953 are still carrying on. An old manning table shows that at Destrehan the control group was being run by people like Joe Hansen, Roger Hopkins, Warren Biest and Jim Soukup. The testing of UO_3 and UF_4 was manned by Harold Thieman, Dave Oltman, Victor Breite, George Schweller and Hank Soehnlin.

In the sample room and shotgun laboratory there were Al Mohl, Gene Gehrin, Bill Linenweber, Dale Thoene and Frank Zielinski. Two present-day people in spectrograph work who were in it at that time were Ray Vogel and Art Sheller. In special analysis work were such familiar names as Cliff McBride, Bob Whorton, Fred Borton, Dave Swaney, John Dowdy and Pappy Lindsey.

Doing the very precise job of ore analysis were Joe Scopel, Chuck Powell and Tom Robertson, while the task of developing new analytical methods was carried out by Bill Ziegler, Gary Lang and Perry King. In the office area, which was well known for its rapid turnover, only one person - Carmelita McBride - has stayed with this work through these many years.

Looking back, 1950-1960 seems like a busy, productive and varied decade of experience. We never seemed to think of it as a routine job but always came in in the morning with the idea of "what's the new problem for today?"



Guard towers located at vantage points throughout the area gave a view of all fence lines surrounding the Destrehan plant. Rather small (about 4' x 4'), they contained a chair, an intercom with guard headquarters, and alternately a fan and small heater. Entry to the tower shown in the photo was gained through the services building on Destrehan Street. A constant vigil was maintained from these towers for four tense years.

From the earliest days of "the best kept secret in America's history" to today's routine security measures, there has never been a serious violation or betrayal of trust in the uranium division.

20 YEARS OF PLANT SECURITY WITHOUT A SERIOUS VIOLATION

by Harold Schlueter

In the spring of 1939 rumors began to be whispered among scientists about the possibility of a nuclear reaction from the fission of uranium — a reaction which could be capable of releasing an energy force a hundred million times greater than that of burning coal. This same year scientists voluntarily agreed to stop publishing any data which might be of military interest, with special emphasis on uranium work. By September of 1941 a definite possibility appeared that gave promise of making atomic energy a war time significance — formal censorship clamped down and security tightened.

Thus, from its earliest beginning days of April 1942, the new work going on in the small building off Broadway was hush-hush. And so it was in all of the many, many organizations involved in the atomic energy program — one site had little or no knowledge of what was going on at other sites. Security was tight all over the country. It was the best kept secret in America's history up to the time when the country was betrayed by some of its own people.

At MCW's uranium project, code names assigned by Washington were changed periodically to keep the picture as confusing as possible. The word uranium was taboo, and the project became identified with the name Tube Alloy Process. Documents looked more like a menu than a tally sheet, containing product names like orange juice, cocoa, derbies, biscuits, rolls, talcum, vitamins. (Some of these codes are

Secret code names for materials used in the 1940s came directly from Washington. They were changed periodically to keep the picture as confusing as possible. Some names were so appropriate they are still used today. Green salt *does* look like just that, and this October 27, 1947 letter changed the name to "talcum."

ATOMIC ENERGY COMMISSION

File No.:
AECSL-2

St. Louis, Missouri
October 27, 1947

Mallinckrodt Chemical Works
675 Destrehan Street
St. Louis, Missouri

Attention: Mr. S. E. Anderson

Gentlemen:

Subject: CODEWORD USAGE CODE TERMS

In connection with your current program in devising new code names of the various materials used on local project work, it is requested that you incorporate the new code names listed below in the lists which you are preparing:

New Code Name	Present Code Name
Derbys	Biscuits
Bells	Billets
Cocoa	Brown Oxide
Talcum	Green Salt
Juice	Orange Oxide
Beebe	Eggs
Oats	High Grade Ore

The above codes are being made uniform for a number of installations of New York Directed Operations.

Will you please proceed immediately to instruct your clerical and operating personnel to begin using these new code names as soon as possible?

Very truly yours,

James J. Koenig
Chief, Operations Branch

CONFIDENTIAL

still used in conversation today - like green salt, brown oxide, orange oxide, and others.)

In the early days of MCW's participation in the nuclear business the Federal Bureau of Investigation was responsible for security measures. In the summer of 1942 security became the responsibility of military intelligence, control was given to the Army and the newly created Manhattan Engineer District, Corps of Engineers took over. The FBI still conducted the security checks and it was the Bureau's responsibility to screen out and deny clearance to any person whose presence in the atomic energy program would involve a risk that would outweigh their potential value. It wasn't until 1956 that a revision to the Atomic Energy Act assigned to the Civil Service Commission the responsibility for handling routine clearances.

All outgoing shipments were classified and escorted by special couriers who were drawn from a guard complement maintained by the Manhattan Engineer District in Chicago. Most shipments went by rail, the material and the courier riding in a special caboose which was made a part of regular freight runs. Everything was done to make these runs inconspicuous but at the same time provide maximum security.

Incoming shipments of raw material, pitchblende from the Belgian Congo, traveled by ship from Africa and arrived in New York for processing. The concentrates were then shipped by rail on freight cars. Special cars were used because the material, packed in 55 gallon drums, gave off poisonous radon gas and the cars had to be of the ventilated type.

Offsite warehouse facilities at the Small Arms Plant were utilized for temporary storage of uranium metal and intermediate products. These materials were stored temporarily prior to being shipped to their ultimate destination: Oak Ridge, Tennessee; Electromet at Niagara Falls, New York for reduction; or to the Simonds Saw and Steel Company in Lockport, New York for rolling into final shapes for ultimate shipment to Hanford.

Physical access to the classified working areas was controlled through an exchange badge system. The system was administered so tightly and so successfully that even local inspectors from the Fire Department and other civil agencies found it impossible to get in.

With the start-up, in 1946, of the new refinery (Plant 6) physical security was provided for by MCW guards stationed on elevated towers having complete surveillance of all fence lines. These guards, operating around the clock, seven days a week, were equipped with side arms and riot guns.

The following year the newly formed United States Atomic Energy Commission established offices on the site, succeeding the Manhattan Engineer District and passing government control from a military to civilian agency. At about the same time, an MCW security office was established to administer the new commission's security regulations governing the classification and handling of "restricted data." This was mostly an administrative change, transferring to MCW the responsibility to see that educational programs

were initiated, manuals were prepared, file cabinets were fitted with combination safe locks, key controls were set up, security checks were initiated, tight rules were made for shipping of classified materials, and visitor controls put into effect.

And as an important part of the new security program, the responsibility for processing personnel clearances of all project employees, consultants, subcontractor people, and some Main Plant personnel, all was transferred to MCW. Everyone working on the project was photographed, fingerprinted and identification badged.

In 1949, plant protection functions became the Security Officer's responsibility inasmuch as the project came within Class "A" security category and compliance with stricter government standards was required.

Under Colonel William R. Gerhardt (U.S. Army retired), the activity now known as the uranium division adopted a further stepped-up security program. He directed the preparation of guard force manuals, and training and educational refresher courses in use of firearms, operation of the alarm system, fire safety and health physics regulations, property removal procedures, and security control of employees and visitors. The most noticeable change was the increased military appearance of guard force personnel in new uniforms and polished leather.

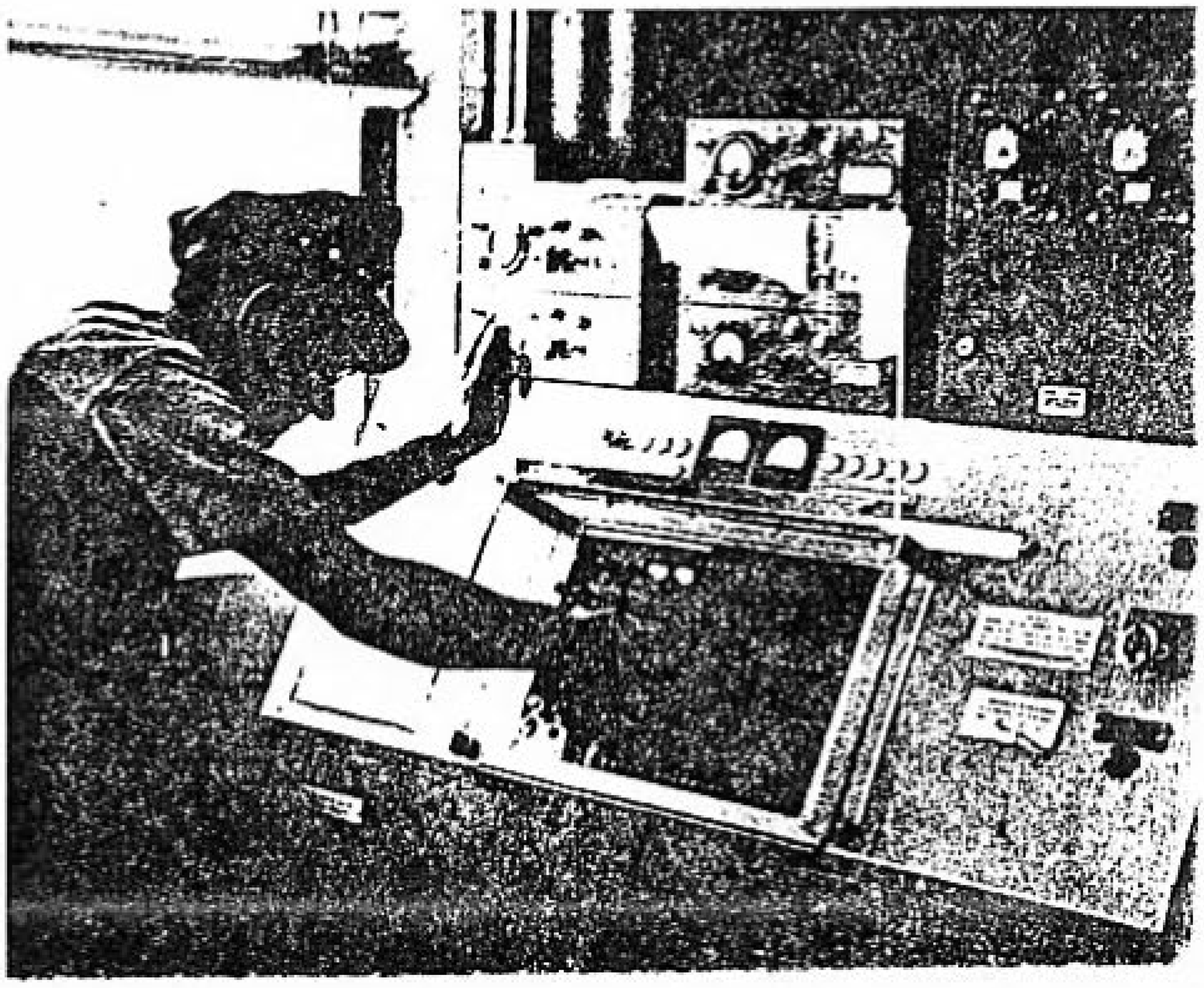
Also in 1949 a building program had been completed - new offices, health physics section, maintenance building and enlarged laboratory facilities. Later Plant 6E came into being and with it the adjoining buildings housing the cafeteria, laundry, employee locker and shower facilities, doctors' examination offices, security office, employee and visitor entrances and guard headquarters.

In 1951, Plant 7 (green salt plant), directly opposite Plant 6, was completed and operations started up. When Plant 4 ceased to process green salt the facility was used as a storage area, pilot plant and laboratory.

The security problems involving protection of Plants 4, 6, 6E and 7 were many and varied, with additional ones caused by the separation of plant sites by public streets. It always meant constant surveillance by guard escort whenever inter-plant movement of classified material was involved. The acquiring of the new site at Weldon Spring in 1956-1957 alleviated many of the security problems experienced in St. Louis.

Plant protection at the Weldon Spring site required a separate guard force organization, and as the Weldon Spring plant continued its growth and the St. Louis facilities diminished its operations, the guard force function did likewise. The deactivating of St. Louis area facilities brought about the discontinuance of the small guard force remaining.

Now that plant protection-security operations have become completely routinized we can look back over twenty years and say that there has never been a serious violation of security regulations, sabatoge or espionage, or betrayal of trust which could have proved embarrassing to either the Government or the Company.



This communications post is the focal point for all security-plant protection operations. Well trained in the techniques of fire fighting, first-aid, rescue and security, guards are on duty around the clock every day of the year --- alert and prepared to respond immediately to any alarm system.

The panel board shown in the photo contains receivers for ultrasonic alarm systems, fire and evacuation alarms. Not shown are a two-way radio control unit, emergency telephones and "beeper" equipment. In addition, there is a direct hook-up with the "Dew Line" the advance warning system maintained by the Government.