YANK
SEPTEMBER 7, 1945

THE ATOMIC BOMB

"Sixteen hours ago an American airplane dropped one bomb on Hiroshima. . . . That bomb had more power than 20,000 tons of TNT. It is an atomic bomb . . . a harnessing of the basic power of the universe."

THAT simple statement, made by President Truman at 10:30 A.M., August 6, electrified the world. It came as the climax of one of the most dramatic stories in the history of man's long search for the secrets of matter.

The story behind the atomic bomb is a detective story with no Sherlock Holmes for a hero. The number of scientists who took part in the search was without parallel. And when the first of the bombs hit Hiroshima it was a victory for the whole force. No star-performing "special investigator" could claim credit for the breathtaking, earth-shattering climax.

Brilliant deductions had been made, clue after clue tracked down to climactic discoveries. But although the individual findings of many men share the credit for the final, almost incredible success, that success was made possible primarily by the kind of leg work and laboratory work in which a metropolitan police force would take part—leg work and lab work entailing years of drudgery as well as drama, ill-omened activity as well as inspiration, false scents as well as cosmic clues.

The dramatic story opens with Dr. Lise Meitner, a woman scientist and director of the Kaiser Wilhelm Institute in Berlin. In 1938 Dr. Meitner is bombarding uranium atoms with neutrons and then submitting the uranium to chemical analysis.

To her amazement, she and her associates, Drs. Otto Hahn and F. Strassmann, find the element barium in the smashed remains of the uranium. They remember they had put in barium as a chemical "carrier" to precipitate a powerful new radioactive substance present in the debris, but when they try to separate the substance from the barium, it cannot be done.

There is one possible answer, and only one. The mysterious substance is itself barium—a radioactive barium that had been there before the other barium was put in.

But where did the radioactive barium come from? It was a scientific mystery of the first order. It was like finding champagne flowing from your faucet. It just couldn't be.

And then Hitler's racist theories came into the story. Dr. Meitner was a Jewess. Hitler had overruled his own Nuernberg anti-Semitic laws in order to try to compel her to stay in Germany, but Dr. Meitner, outraged by the "new order," escaped over the Dutch border and fled to Sweden, stopping in Denmark on the way.

With Dr. Meitner in Copenhagen, her former colleagues refused to face the facts of their revolutionary discovery. They reported in a German scientific publication that they could not bring themselves to believe that the radioactive barium came from the uranium.

Lise Meitner was more imaginative. Since the barium was not there to begin with, she reasoned, it must have come from the uranium. That meant it was the result of the uranium atom being split into two nearly equal parts.

She lost no time in getting in touch with her nephew, Dr. Otto Robert Frisch, who worked in the Copenhagen laboratory of the famous Danish physicist, Dr. Niels Bohr. Testing together for the radioactive barium, they saw for the first time the possibility of a geyser of atomic energy.

In the first weeks of 1939 Dr. Frisch succeeded at his task. He split the uranium atom.

Dr. Frisch cabled the news to Dr. Bohr, who was in the U. S. With Dr. John Dunning, Dr. Bohr and Prof. Enrico Fermi, both Nobel prize winners in physics, repeated the experiment at

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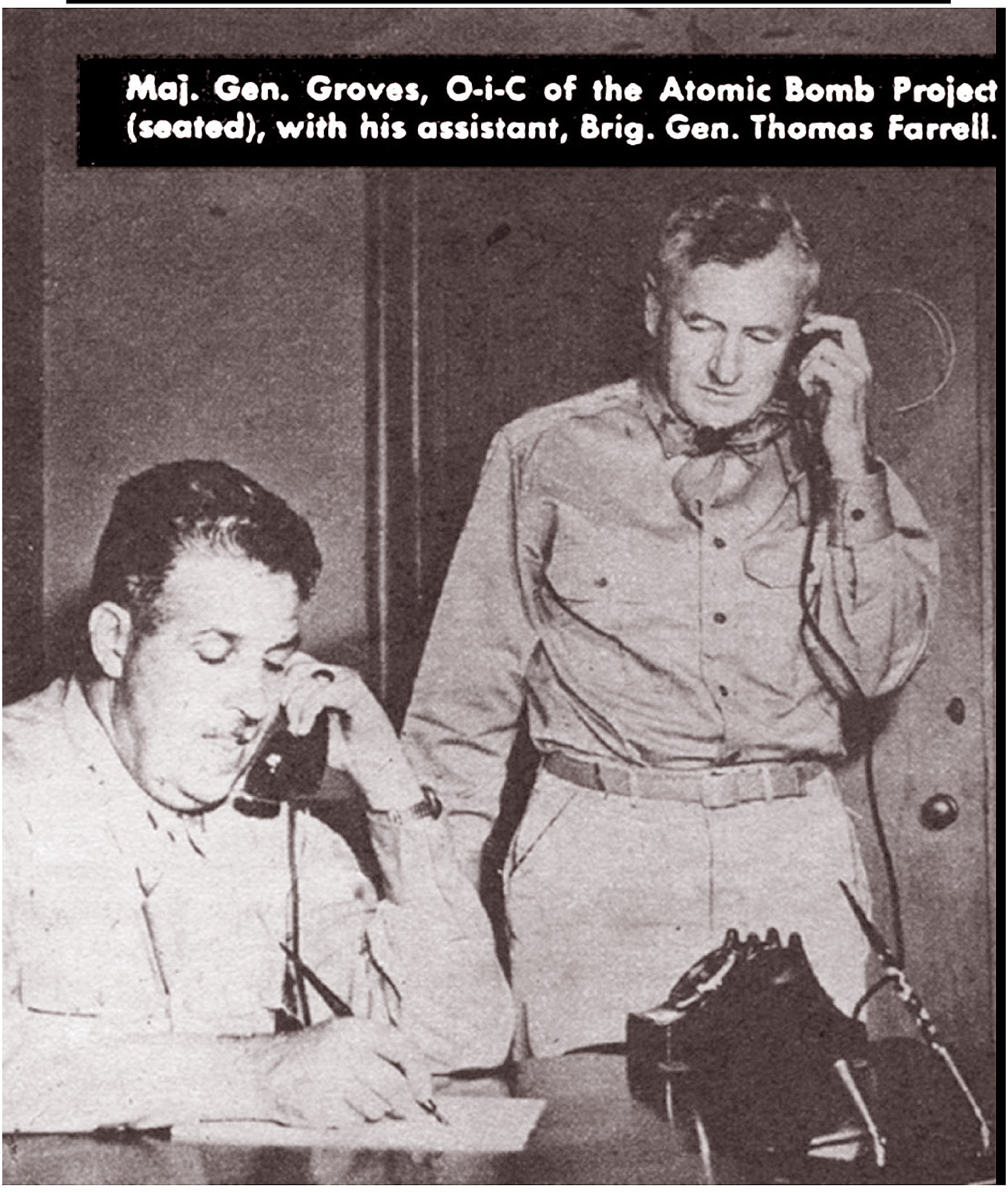
Maj. Gen. Groves, O-i-C of the Atomic Bomb Project (seated), with his assistant, Brig. Gen. Thomas Farrell.

Columbia University and announced the news to an astounded scientific world.

Prof. Fermi then revealed that five years before he had been firing atomic bullets and had been prevented from making the discovery of uranium fission—the splitting of the uranium atom in two—only by a mischance in his technique.

Prof. Fermi, incidentally, is pretty happy today about his failure. When he came so close to making that fateful discovery he was in Mussolini's Italy. Had he succeeded before his exile the Axis might have had atomic bombs with which to begin its war.

The Axis was thwarted again and again by its own tyranny. Among the scientists who helped produce the atom bomb were two Jewish physicists who were forced by the Nazis to emigrate to England and a Danish professor who was smuggled out of German-occupied Copenhagen with atomic secrets which he carried with him to London and Washington. The Nazis raided his laboratory but found nothing.

Another near-miss for the Nazis came when the collapse of France was imminent. Premier Edouard Daladier had sent a secret French mission out of Norway past German spies with heavy water for French physicists, among them Frederick Joliot-Curie, son-in-law of the great Mme. Curie. Heavy water is invaluable in certain methods of atomic fission and is difficult to produce. The water arrived in France just before the capitulation and was carried to England on one of the last ships to leave Bordeaux.

Germany nevertheless continued work on the atom, and Allied leaders were worried. Reports had the Germans working feverishly to forge a weapon from the atom's power. In Britain, alarmed scientists speeded their efforts to solve the secret of atomic fission.

In the U. S., American-born nuclear physicists were so unaccustomed to the idea of using their science for military purposes that they hardly realized what needed to be done. The early efforts to restrict publication on atomic subjects and to obtain Government support for further research were stimulated largely by a small group of foreign physicists living in the U. S. Up to 1940 information on research which was to lead to America's greatest secret weapon was open to any one.

One of the European physicists-in-exile in the U. S., the great Albert Einstein, had written in 1905 a simple equation which was to be the background for all the research in atomic energy. The equation was part of his relativity theory and indicated that light, which is a form of energy, has mass just as much as a particle of what we usually think of as matter, and that any particle of matter therefore is energy.

The astonishing thing about his equation was that it showed that if only a tiny bit of matter should be destroyed, the result would be enormous energy.

Backed by Einstein and his theory, a little band of scientists—native Americans and exiles from Axis-dominated lands—went to President Roosevelt to interest him in the possibilities of atomic power. The President, convinced that much might come from atom research, appointed a committee to look into the problem. Up to the end of 1941 the total expenditures on atomic research were small, although the amount of work done on the problem by scientists all over the country was great.

Shortly before Pearl Harbor the President wrote Prime Minister Churchill suggesting that any efforts toward the development of an atomic bomb should be coordinated or even jointly conducted by the U. S. and Great Britain.

That December the U. S. National Academy of Sciences issued a report supporting the efforts already made in the atomic field and expressing optimism about the future. Information received from the British was even more optimistic, and the President, the Prime Minister and their advisors decided that the time had come really to push the program. The atom bomb began to take shape.

It was decided to build production plants on a vast scale in the U. S., since Great Britain was already up to her neck in war production and was in range of German bombers and open to sea attack. Britain would therefore furnish her scientists to the U. S. and Canada would furnish indispensable raw materials.

There were many questions for the scientists to decide. First, they had to select a material to give the bomb explosive force. They had several forms of uranium to select from—the uranium "isotopes." There were three of them—uranium 234, 235 and 238, plus plutonium, the artificial element that can be created from uranium. Of these, the scientists knew that only 235 and plutonium could be used.

In a ton of uranium ore there are only 14 pounds of 235, and these are intricately mixed with the other isotopes. It would have taken more than 191 years to obtain a single gram of 235 and more than 75,000 years to obtain a single pound, under methods then in use.

Worst of all—uranium was one of the rarest elements in the world. It was found in pitchblende, which exists only in Canada and Africa in any quantities.

The project and its problems were put under the direction of a group of top-ranking U. S. and foreign scientists working in the newly-formed Office of Scientific Research and Development; its director, Dr. Vannevar Bush, noted electrical engineer, was detailed to report directly to the President. Later, the military value of the experiments became obvious to everybody, and the major part of the work was transferred to the War Department. Practically the same scientific staff continued working, with Maj. Gen. Leslie R. Groves, former Deputy Chief of Construction in the War Department and a veteran Engineer Corps man, in charge.

From here on, work on the atomic bomb became "top secret." In wartime Washington, where practically every project was hush-hush, the atomic work became the best-protected secret of the war.

Information on atom research was so compartmentalized that each person connected with it knew only what he or she had to know to carry out a particular job. A special intelligence organization was set up independent of G-2 to control the security side of the project. Even

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Little was left of Hiroshima when a reconnaissance plane flew over the devastated city to take this photo day after the first atom bombing. Many buildings and whole city blocks were vaporized.

the FBI was barred from the various installations throughout the country, except where its operatives had special permission to enter.

Congress had to content itself with no more than an assurance from the Army that the $1,950,000,000 appropriated for atom research was "absolutely essential to national security." Mere mention of atomic work on the floor of Congress might have been a tip-off to the Nazis and Japs.

Once the whole House Appropriations Committee became skeptical of the work, since progress was not so rapid as had been expected. One of the Congressmen called the project "too fantastic" and threatened to tell the House what he knew and demand more information. That threat brought Chief of Staff George Marshall before the committee in a hurried secret session; the committee heeded his plea to keep silent.

The Nazis and the Japs actually did have agents in the U. S. with specific instructions to get information on the bomb, if any, and on uranium. The Nazi spies were directed to make contact with key personnel at any atomic work plants and to determine the type of protective devices used. The FBI learned through a foreign power what the spies were up to and stopped them.

To make doubly sure that there would be no leak of information, about 20,000 news outlets—newspapers, radio broadcasters, magazines and book publishers—were asked by the Office of Censorship not to publish or broadcast anything about "new or secret military weapons or experiments." On the whole, they kept mum. But the Army really got in a tizzy when Superman gave a "preview" of the bomb.

One episode showed little Professor Duste challenging Superman to take a 3,000,000-volt charge from a cyclotron. Superman withstood the current, and the professor was so embarrassed by his failure to kill the big guy that he said, "The machine must be out of order."

What followed is still a military secret. At the request of the Office of Censorship, the artists who create the strip promptly discontinued reference to atomic power.

Strictest secrecy was maintained throughout the whole project, which was set up as a new district of the Corps of Engineers and officially designated the "Manhattan District." More than 179,000 workers were recruited throughout the country for work in the various laboratories and plants in which the atomic investigations were carried on. Prospective employees could be told only that the work for which they were being selected was "most secret." Many of the men who were finally chosen were unaware of the purpose of their jobs even after they had been employed for some months.

Although there was still some question as to which of the several theoretically possible methods of producing explosive atomic material was best, the Army decided to go ahead with the construction of large-scale plants—the biggest Army construction program of all time—because of the tremendous pressure of time. Two plants were started at the Clinton Engineer Works near Knoxville, Tenn., and a third at the Hanford Engineer Works, near Pasco, Wash. Here, too, secrecy was essential. Contracts were placed with no publicity. Parts were ordered in many cases without the manufacturers knowing what they were to be used for.

The Clinton site was selected for its large size —59,000 acres—and isolated location, and for safety against possible unknown hazards. The Hanford site, too, was isolated, on a 430,000-acre Government reservation.

At the Clinton reservation a Government-owned-and-operated city named Oak Ridge was built. The settlement contains houses and dormitories, churches, theaters and schools. Today it has a population of 78,000—fifth largest in Tennessee. At Hanford another city was constructed. Called Richmond, it has a population of 17,000.

Near Santa Fe, N. Mex., a special laboratory, most secret of all the secret plants, was built to deal with the hundreds of technical problems involved in putting together an effective bomb. In this largest and most complete physical laboratory in the world, Dr. J. Robert Oppenheimer, brains behind the bomb itself, headed a staff of technicians who worked day and night forging the weapon that gave the final blow to Japan.

All over the country thousands of large and small manufacturing plants and laboratories, universities and schools carried on research and worked to develop special equipment, materials and processes for the project. And all of them worked under a blanket of secrecy.

It was due to these hundreds of organizations and thousands of workers that a study which would ordinarily have taken 20 years was completed in just three.

The Atomic Age was ushered in on July 6 1945. A tense band of military men and scientists gathered in a remote section of the Alamogordo Air Base on the New Mexico desert 120 miles southeast of Albuquerque to witness the results of their years of effort—the first fateful test of the atomic bomb. It was 5:30 in the morning. A darkening sky, rain, lightning and peals of thunder heightened the drama.

Tension was tremendous. Failure was always possible, and too great success might have meant not only an uncontrollable, unusable weapon but the death of those who watched. The bomb might blast them and their entire efforts into eternity.

The nearest observation post was 10,000 yards south of the steel tower from which the bomb was to be detonated. Here in a timber-and-earth shelter the controls for the test were placed. At a point 17,000 yards from the tower which would give the best observation, the key figures in the cosmic project took their posts.

The time signals—"minus 20 minutes," "minus 15 minutes"—increased the tension. The watchers held their breaths.

Two minutes before the scheduled firing time most of them lay face down, with their feet pointing towards the tower. The moment came. There was a blinding flash brighter than the brighest daylight. A mountain range three miles away stood out in bold relief. And then there was a tremendous, sustained roar. A heavy wave of pressure bore down upon the observers. Two men who were standing outside the control center were knocked flat.

A huge, many-colored cloud surged majestically upward for more than 40,000 feet. The steel tower was completely vaporized.

The test was over. The bomb was a success.

What is this bomb like? What is its size? How is it constructed? Those are still top military secrets. Popular science writers say it is likely that the bomb contains plutonium, in great concentration, as well as some means to split it and make it release its energy in an explosion.

The detonating mechanism of the bomb must contain a slow-down device for the neutrons which are hurled at the uranium or plutonium atoms to produce an explosion. Only a neutron, which is, an uncharged particle found in the atom's nucleus, has much chance of getting through an atom's electrical ring of defenses.

Before the war scientists had succeeded, in their cumbersome cyclotrons, in bombarding uranium with neutrons and getting the neutrons through. It has been estimated that these neutrons had about one chance in 140 of hitting the nucleus. When that happened, the uranium atom split in two, and the result was no longer uranium but barium and krypton, a rare gas. That was transmutation, and together with it came the emission of energy, the mass of krypton and barium being less than that of the original uranium atom.

But major mechanical and laboratory advances have been made. It seems evident that scientists are now able for the first time to separate uranium in quantity and that a means has been devised to release neutrons to bombard plutonium and thus detonate the bomb at a desired period after the bomb leaves the aircraft. The War Department has released information showing that the weapon is fired before it hits the ground to increase its power to shatter buildings and to disseminate its radioactive products as a cloud. The mechanism that effects such a marvel must obviously be far simpler than a cyclotron, which weighs tons.

How quickly research on the bomb itself has proceeded is shown by the disclosure that the second atomic bomb dropped on Japan at Nagasaki, August 9, was a more powerful and a simpler one, which "made the bomb dropped on Hiroshima obsolete."

But the mechanical details of the bomb did not concern most Americans. When the news came that the greatest weapon in the world had been unleashed upon Japan, the nation's main reaction was one of awe. There was little rejoicing.

President Truman voiced the sentiments of the country when he said: "The atomic bomb is too dangerous to be loose in a lawless world. . . . We must constitute ourselves trustees of this new force—to prevent its misuse, and to turn it into channels of service to mankind. It is an awful responsibility that has come to us."

When the awe at the destructiveness of the new weapon began to wear off, the feeling that we were entering a new era—the Age of Atomic Energy—remained. The New York *Times'* three-word headline—the like of which had probably never appeared in a newspaper before—summed it up: "New Age Ushered."

Never before had one discovery so caught the imagination of people everywhere. Never before had it been obvious so soon that a scientific discovery would change the world.

All over the U. S. people started using words they barely understood: "Atom," "electron," "proton," "neutron," "uranium." The nation's press did its best to simplify the scientific principles of atomic energy for its readers. The War Department felt that the subject was too highly complicated for its officers to explain and called

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One of the giant production plants of the Clinton Engineering works at Oak Ridge, Tennessee.

in a civilian, the New York *Times'* science expert, William L. Laurence, to handle the press releases on the bomb and its background.

There was much disagreement as to when and to what extent atomic energy could be put to peaceful uses. The power, coal and oil industries protested vehemently that it would be years after the lifetime of any one now living before atom energy would take over.

One scientist close to the development of the atomic bomb compares it with the prehistoric discovery of fire and cautions that there was a lapse of centuries and centuries between the discovery of fire and the development of the steam engine. The atomic discovery does not seem as important as the discovery of electricity, this scientist says, although it may actually prove to be that important in time.

Others were more optimistic. In London, Sir John Anderson, who as Chancellor of the Exchequer in the Churchill Government supervised the British side of the atomic bomb research, said the discovery definitely is greater than that of electricity.

Prof. H. D. Smyth, chairman of the physics department at Princeton University and consultant on the atomic bomb, has written a detailed account of the history of the project and of its scientific background with War Department authorization. Smyth says: "There is good probability that nuclear power for special purposes could be developed within 10 years and that plentiful supplies of radioactive materials can have a profound effect on the treatment of certain diseases in a similar period."

The Rev. Alphonse Schwitalla, S. J., dean of the St. Louis University Medical School, sees in atomic energy a possible key to the mystery of life.

But to make sure that when the secrets of atomic energy become available for peacetime application they will be employed wisely in the interests of security and peace, the U. S., Britain and Canada have taken action to control patents in the field and to obtain control over the uranium ore which so far appears indispensable to the process. In each country, all scientific and industrial figures involved in the work have been required to assign their entire rights to any inventions to their respective governments, subject to financial settlement later.

To consider the long-term direction and control of U. S. atomic research, Secretary of War Stimson has appointed a committee to make recommendations. An advisory group of the scientists and industrialists most closely connected with the development of the bomb is already planning national and international control.

They hope, as the world hopes, that the new Age of Atomic Energy will be an age of peace as well. For if it is an age of war, that war might mean the annihilation of the human race.

—Cpl. JONATHAN KILBOURN

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