NEW YORK TIMES - NOVEMBER 28, 1945

ECONOMIST GUIDED EARLY ATOM STEPS

Dr. Alexander Sachs, Before Senate Group, Reveals His First Talk With Roosevelt

GERMANS' STUDIES CITED

They Were Stimulating Factor in Efforts of Our Scientists to Get the Bomb First

By ANTHONY LEVIERO

Special to THE NEW YORK TIMES.

WASHINGTON, Nov. 27 — The late President Roosevelt listened to a persuasive man in the White House on Oct. 11, 1939, two weeks after Poland was crushed, and got interested in atomic energy. Then with characteristic vigor he brushed aside the hesitations of American scientists and officials, set the atomic project on its irrevocable course and pressed it toward the historic climax that came at Hiroshima after his death.

As the early history of the world-shaking discovery unfolded today before the special Senate committee on atomic energy it was disclosed that an economist, not a scientist, was stage manager of the atomic drama. This economist, the man who drew back the curtain on nuclear fission for Mr. Roosevelt, was the Russian-born Alexander Sachs, who served the President as an informal adviser.

In the near background when the President began to act stood Prof. Albert Einstein. This distinguished physicist read a report of recent experiments a month and a day before the outbreak of World War II and wrote out a prediction of an atomic bomb. He told Mr. Roosevelt that such a bomb, carried by ship, could destroy a port and the surrounding region.

Wants Blessing, Not Scourge

In opening the first session of the Senate "Blue Ribbon" Committee, the chairman, Senator Brien McMahon of Connecticut, said atomic energy might well hold tremendous benefits to mankind, but that the best judgment was necessary to keep it "a blessing to mankind and not a scourge." He added that specific legislation would not be considered until all the facts were known. This was interpreted to mean the Senate committee would disregard the controversial atomic energy control bill, now be-

It was Dr. Sachs who told the story about Mr. Roosevelt to the committee, and he handed it his written record of those early events —a record interspersed with scientific papers and letters from and to the White House. Among them was the paper that Dr. Einstein had studied. It was a report by the American physicist, Dr. Leo Szilard, recounting his own experiments and also those of Professor Enrico Fermi, a fugitive from Fascism.

Dr. Einstein and Dr. Szilard were revealed by Dr. Sach' testimony as the first to worry about the implications for the United States of atomic energy in the hands of a hostile power. Dr. Einstein urged Dr. Sachs to do something, knowing that the economist could get the ear of the President.

So Dr. Sachs went to the President Oct. 11, 1939, with a letter from Dr. Einstein, Dr. Szilard's scientific paper and a memorandum by Dr. Szilard written in every-day language. Dr. Sachs had been dubbed as the "economic Jeremiah" for his gloomy views and predictions on Nazi power and world destiny in the years between wars.

Dr. Sachs also told the President that the Fermi and Szilard experiments were only one step ahead of those of Nazi physicists. Germany had already overrun Czechoslovakia, which had good uranium ore, and Hitler had forbidden its export. The Einstein letter pointed out that the most important source of uranium was in the Belgian Congo and Dr. Sachs added that he predicted the invasion of Belgium and the possibility of losing this source for the United States. That would leave only Canadian uranium for America, he added.

Nazi awareness on atomic energy was attributed by Dr. Sachs to the fact that the son of German Under-Secretary of State von Weizaecker, was a physicist, who eventually became head of the Kaiser Wilhelm Institute, and later of the Institute of Physics. The Kaiser Wilhelm Institute, said the Einstein letter, was "where some of the American work on uranium is now being repeated."

Einstein Letter Quoted

In the Einstein letter President Roosevelt read suggestions for government development of atomic energy and this prevision of the use of atomic force:

"In the course of the last four months it has been made probable through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears this could be achieved in the immediate future.

"This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extype may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port, together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air."

The memorandum of Dr. Szilard was in similar vein. Dr. Sachs suggested possibilities for industrial and medical use as well as military use.

As a result of the White House meeting, President Roosevelt told General Watson to bring together Dr. Sachs and Dr. Lyman J. Briggs, the then Director of the Bureau of Standards, and have them form a working committee. This was done, the group being organized as follows:

For the Government, Dr. Briggs, Lieut. Col. Keith F. Adamson of the Army, and Comdr., later Admiral, Gilbert C. Hoover of the Navy; Presidential representative, Dr. Sachs; cooperating scientists, E. P. Wigner, Professor of Theoretical Physics, Princeton University; Professor E. Teller, George Washington University; Dr. Fermi of Columbia University; and Dr. Szilard, then a visiting experimental physicist at Columbia.

The committee met on Oct. 21, 1939, and the discussion, according to Dr. Sachs, developed strong objections that those interested in the political-military implications were much too previous in converting a mere potential into an actual result of research. Hence they urged that the government should leave this project to the universities, which anyhow had evinced active interest.

Early in 1940 Dr. Sachs and Dr. Einstein were dissatisfied with the progress and scope of the atomic project and Dr. Sachs wrote to General Watson, pleading for larger aid that could be based on a favorable evaluation by Dr. Einstein of work then being completed at Columbia University.

In April, Dr. Sachs testified, he was back in the White House with new forebodings of Nazi aggressions and predicting invasions that would deprive the United States of contact with Western Europe. He reported that Dr. Einstein had information of the intensification of uranium research under the leadership of Weizsaecker's son, and that Dr. Szilard's work was proving more promising than Dr. Frederic Joliot-Curie's in France.

Dr. Sachs Is an American

WASHINGTON, Nov. 27 (AP)— In response to inquiries Chairman McMahon issued the following statement concerning Dr. Sachs' background.

"Dr. Alexander Sachs, presently economic advisor and industrial consultant, maintains his own offices at 72 Wall Street. Dr. Sachs was vice president and chief economist of the Lehman Corporation, an important investment corporation, during the entire Thirties.

Chron
Corresp
EC

September 20, 1945

Dear Mr. Secretary Wallace:

Upon my return from vacation, I was greeted by your kind and gracious notes of the 12th and of the 18th with the attached note from Secretary Stimson.

For the present, may I continue to deal with the broader issues?

When on vacation, I attempted to submit a reformulation of the broader issues in the course of a telegraphic dayletter for the special conference that had been convoked by Messrs. Raymond Swing, Norman Cousins and Richard Fagley. This I take pleasure in submitting to you herewith.

The extension I have attempted of the cultural-technological considerations opened up in the second part of my letter to you of September 6th will need still further development. For those who have particupated in what might be called the terminal executive phases of the atomic bomb project, as distinguished from the earlier phases, are already talking along lines that are characterised by a certain ignoration of the deliverance of the cultural history of the interlinking of scientific and social ideas, and technology and the social matrix that makes the commercial-industrial applications of technology profitable. There is a tendency to assume that the fallibilities of human judgment with respect to the eventual course of scientific applications are concentrated in the political realm. Practical wisdom consists not only in caution but in a realisation of the fallibilities of caution and of the importance of tempering uncynical disillusionment with inspired venturesomeness. Thus a lesson can be drawn from the history of the automobile industry and the refutation of the then expert judgment as to the superiority of electrical and steam driven over gasoline driven motors. Of even more pervasive and perduring importance is the lesson to be drawn from the susceptibility of expertism in general to what we learned to call during our defense phase of this war "maginot-mindedness."

Fortunately there continue to be scientists in our time who are perceptive of these broader political and cultural issues. As a _coda_ to the considerations I have already submitted to you, may I quote from an article by Professor A. V. Hill on "Science and

Secrecy" in the August 17th issue of the London Spectator:

"The truth is, I said then, that science and engineering have made the world very small in time and space. In the past, a spark of trouble here or there would be isolated; today it may flare up into a world bonfire. And the bonfire of the future will be no struggle between armed forces, but a deliberate attempt, by scientific methods and technical weapons, to destroy cities, to massacre populations and to make whole countries uninhabitable. If traditional methods of diplomacy and politics are in future to dominate international relations, - if nations nominally at peace with one another are to prepare secretly to wipe each other out, without warning - then what hope can there be that some fool or criminal will not set the process going? ...

"For, if political isolationism and aggressive nationalism are to exploit science and its applications, not for the benefit of mankind but in order to prepare in secret for mutual destruction, they are very likely to succeed; and mankind, like the pterodactyl too successful in its flying, may become extinct. Many civilisations of the past have disappeared; but those were in the days when the speed of a man and the power of a horse determined the scale of time and space in the operation of political, social and economic forces. Like a local infection in the body, the trouble was usually sealed off. Today with speeds of travel nearly as fast as sound; with communication as fast as light; with sources of power potentially available beyond even the dreams of yesterday; with possibilities of injury by physical, chemical and biological methods frightful beyond any hitherto imagined; with an almost complete collapse of previous ethical standards, and the demonstration of how scores of millions of highly educated and intelligent people can be led into hate and hysteria by the methods of the scientific advertiser and propagandist - today it will not be a mild local infection but an acute general septicaemia.

"My friends, I think, will acquit me of being given unduly to hysteria and alarm; but I am convinced, and others who know much better are convinced no less, that if these terrible fears for the future are not to be realised some drastic decisions are necessary very soon. Political isolationism, aggressive nationalism and secrecy in preparing scientific methods for mutual destruction, must stop. Scientific men themselves throughout the world must be allowed to work together in mutual confidence and sincerity. Ethical standards in their work must be restored, so that the misuse of scientific knowledge and discovery (the common property of mankind) either for selfish exploitation or for general destruction, will be regarded - like cowardice in a soldier or dishonesty in a banker - as the unforgiveable sin. If these conditions can be realised there is hope for a brighter and happier future for the world; if not, mankind driven by hatred, fear, hysteria and political catchwords, will plunge into irretrievable ruin."

With kind regards,

Yours sincerely,

Hon. Henry A. Wallace
Secretary of Commerce
Department of Commerce
Washington, D. C.

[Chron - Aug. 1946]

THE PHYSICS LABORATORIES

HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS

esearch

Laboratory

of Physics

August 6, 1946

Mr. Alexander Sachs
72 Wall Street
New York 5, N. Y.

Dear Mr. Sachs:

Please forgive me for answering your short note with such a long letter. I assure you that this is entirely against my usual habit.

Morrison informed you correctly that I have given much thought to the question of the German failure. He probably told you also that I was in a position to investigate all the German material on the uranium project and to talk to most of the men, mostly before VE day, and long before Hiroshima. In spite of this it is difficult to reach a conclusion, because such a question can not be answered in a purely objective manner, and the results will, therefore, be a matter of personal opinion.

I believe that enough warning lessons can be learned from the German failure to make it worthwhile to collect and disseminate the available information. I have tried to write some short notes about it, but so far have not been able to get them published. The reason for this is, first, that my style is very bad, and, secondly, whatever I have to say is more or less repetition of what I stated in my Senate testimony or of what has already been stated before by others. I think, however, that when it comes to learning a lesson, repetition is helpful.

There are, of course, several reasons for the German failure, and the main difficulty is to judge their relative importance. One serious mistake the Germans made was that even in their scientific work they indulged in some kind of hero worship. The better physicists in Germany had kept their exclusive confidence in the judgment of one man, namely, Heisenberg. An analysis of the uranium research work shows that his opinion was never doubted and that he was the principal source of ideas. It is clear that a problem like the uranium project is too big for one man, even the great Heisenberg. In fact, his ideas were wrong in some of the main points. I am certain that exactly the same scientific errors were made originally by our own physicists, but the divergence of opinions and an occasional strong friction between the men working over here helped the right ideas to come to the front.

I can illustrate the German mistake by a few concrete examples. Heisenberg had apparently studied only the simplest form of the pile theory. As a result all experiments used a too simple arrangement of uranium and the heavy water moderator, namely, in alternate layers. There was a group of army physicists, second-rate men, simultaneously working on a uranium pile. They were not considered competent by Heisenberg and his following. Nevertheless they guessed at and tried out an arrangement which gave better results than Heisenberg's. You can well understand the embarrassment and difficulties such an occurrence caused among the German physicists.

Another example is that Heisenberg and his following believed that it was necessary first to solve the problem of a uranium engine before one could tackle the problem of a bomb. In fact, apparently the only concept of a bomb which the German physicists had was that of an explosive pile. They seemed never to have taken the separation of pure U 235 or the production of plutonium as anything practical. They did some work on isotope separation, but merely for the purpose of slightly enriching the pile so as to make it work more easily. Of course, as you know, they never even succeeded in getting a pile to work. Houtermans repeatedly made the suggestion that a transuranic element might be separated more easily, but his ideas were mostly disregarded. At any rate, it was believed that such a scheme was still very far away in the future.

The Germans therefore thought that a uranium bomb would be a later by-product of the uranium engine. They had hoped that the engine could be constructed in a reasonable time, but did not believe that a bomb could ever be made during the duration of the war. I did not find anywhere an indication that they were aware of the enormous industrial effort necessary to realize either a uranium engine or a bomb. The whole affair was kept rather on an academic scale, even though it had the highest priority of all scientific war work. The German physicists, due to ignorance, lacked the confidence in success which our men had. They were nevertheless convinced that they were ahead of us in uranium research. When they first heard about Hiroshima they refused to believe it, and thought it was merely propaganda.

Another very serious mistake was made by the Germans throughout their scientific work, especially during the war. It consisted in placing incompetent men in influential scientific positions. It is not necessary, of course, to have active scientists in administrative places, but a man who guides science should have certain qualifications other than a doctor's degree and a membership card in the Nazi party. The leaders of the German equivalent of our O.S.R.D. and army scientific research were definitely second-rate scientists, not so much because they were Nazis, but because they were bad administrators and lacked the confidence of the scientists for whose work they were responsible. The same thing can happen over here if a man or a committee in charge of scientific research is chosen merely on the basis of belonging to the proper political party or to the armed forces.

Morrison also mentioned to you some reports by and about Professor Ramsauer. Ramsauer, who originally was an excellent research physicist, during the war was President of the German Physical Society, and for many years had been Director of Research of the A. E. G. He was thus in an excellent position to judge about German physics. We found some interesting secret reports by him, and later I had a long talk with im in Berlin and he submitted his opinion on the failure of German hysics in a written report to me. I have only one copy of his report n my possession. The material is no longer classified, but obtaining opies from the War Department or having it published by the Publication oard of the Department of Commerce is, of course, quite complicated.

Ramsauer is convinced of the key position of physics among the ure and applied sciences. He believes that physics is power, and that eans, also, military power. He tried to make his view-point known to he Army authorities and the Department of Education, and especially ointed out the decline of German physics under the Nazi regime. However, he had no success. The only people who listened to him were the ir Forces Research people. In fact, that branch of war research was xcellently organized, was rather independent of Nazi influence, and produced first-class results. In April, 1943, Ramsauer lectured before the erman Aeronautical Academy about the organization and achievements of nglo-Saxon physics. The main point of the lecture was to show how erman physics was being left behind, not only in productivity, but also n questions of organization, which had formerly been a proverbial attribut of the Germans. He made some concrete proposals, in this speech, or the improvement of German war physics. He was also very much in avor of creating a central agency to direct all physics. He stated that his proposals were followed up, the Germans "did not need to fear glo-Saxon physics." He added,"But if we are unable to do this, then d have mercy on us". This last part was eliminated by the censor in nting.

Ramsauer's report does not throw any new light on the German lure in the uranium project. He was not connected with this work. as over here, the Germans kept their "U-Club" (Uran Verein) rather usive. Within the group, however, there was little compartmentalisa- , merely a vague distinction between those who were actively engaged pile" work and those who worked on auxiliary problems of nuclear ics.

It is my ambition to make a thorough study of the various docu- available which give information about war research in Germany, not technical point of view, but from the point of view of organization e more human factors involved. Perhaps I can find some help in a t like this next year.

I hope that this information will be helpful to you. It is rd to judge from a letter just what point you might want to know out. I shall be glad to give you any further information you ant. No of this is any longer secret.

Yours very sincerely,

S. A. GOUDSMIT (signed)

S. A. Goudsmit

Chron
[illegible] - Szilard

February 4, 1946

CONFERENCE WITH DR. SZILARD

The report from Minden, Germany, of February 2nd by the A.P. of an interview with Professors Otto Hahn, Director of the Kaiser Wilhelm Institute of Chemistry in Berlin, and Dr. Werner Heisenberg of the same Physics Institute, is challenged by Dr. Szilard. In this report, Drs. Hahn and Heisenberg, living now close to the British headquarters, maintain that they had the atom secret in 1942, but lacked money and men to construct the facilities. Werner Heisenberg gave his story as follows:

> "We came to the conclusion that it was possible to harness power for driving machines, but under the prevailing conditions in Germany it was impossible to turn this power into bombs; by the end of 1941 we completed an atomic energy machine at Leipzig and further experiments proved conclusively that we could win atomic power from ordinary uranium. ... But we were unable to apply it because of shortages of manpower and materials. ... Germany by then had lost vast amounts of equipment in Russia which had to be replaced immediately. Money and factory facilities could not be given for research and production when they were needed to replace tanks, airplanes and guns. ... In June 1942 we made a report on our progress to Albert Speer" (Nazi munitions head) "(at the same time American atom scientists made a similar report in the United States). Then followed the great difference - America was able to start building the necessary factories on a huge scale. ... Germany could not even begin work on a scale large enough to produce just one bomb."

Similarly, Dr. Hahn referred to his discovery on the eve of the war of the fissionability of uranium, - discovered as a result of the investigations of himself and Dr. Fritz Strassman:

> "By the end of the war we had no less than 25 chemical elements and about 100 isotopes" (that is, substances of the same chemical behavior but with different atomic weights). He for one disclaims the attribution that he had made an atom bomb for America and says that he means to continue the study of radioactive substances to be used as tracers in biological, chemical, medical and other researches, - lines which he wants to continue in the British zone of Germany.

There is a divergence between the headings and the text of the report. The text of the interview does not present a definite claim by these scientists that Germany had the atom bomb. He heading does claim it. But irrespective of that difference, it may be categorically stated that the Germans did not have the atom bomb. The returned American scientists who examined the German scientific memoranda are convinced that Germany did not know that plutonium was fissionable. In order that there shall be an atom bomb, it would also be necessary to know and have on record in a memorandum the number of kilograms of uranium needed, etc. There are no such calculations in the documents examined.

NAVY BOMB EXPERIMENTS

Dr. Szilard concurs that one of the aims would be to show that the Navy is comparatively impregnable to atomic bombs. The assembly of 96 units may itself be calculated to prove that only a small number will be destroyed. It may be a safe guess that only the less modern ships will be included among those that will be destroyed.

The Navy may also be relied upon to capitalize on the factor of dispersion.

Considering it objectively, the design of the experiment leaves much to be desired. For the present only supersurface and onsurface attack will be tried. But it is subsurface that needs to be tried because then the medium is one of high conductivity and free from wind and ocean wave interference. In addition, the stripping of the gears of the boats and probably also the more expensive machinery eliminates the testing of the impact upon the functioning of even supersurface ships. From the point of view of naval operations, survived hulls are less important than the ability of a boat to continue in action or to get to a safe port.

February 4, 1946

ATOMIC BOMB'S EFFICACY AND THE CHALLENGE OF MAJOR SEVERSKY IN THE CURRENT READERS DIGEST

Major Seversky's article in Readers Digest was subjected to critical treatment by Raymond Swing in his broadcast of February 1st.

There will be a reply by Professor Phillip Morrison in a near term issue of LIFE. It will be satirical and picture Major Seversky sitting in his office in the Empire State Building while an atomic bomb drops on it. While the internal contents will be destroyed, there will be isolated cases of survival along with the outside frame of the building. After his comparatively miraculous survival, Major Seversky will be reporting that his article has been vindicated. But a week or so later it will be reported that he has died of the effects of radiation.

Chron

FC

February 20, 1946

Dear Mr. Blakeslee:

Thank you for your letter of the 19th and its accompanying material. In accordance with the desire that you expressed, I am enclosing for your files the reprint of the New Yorker article and also of the Times account.

As you have been kind enough to have found the material submitted to you useful for your rewrite, I am hastening to submit a few suggested changes that I trust you will find valuable for incorporating in the definitive revision of the chapter.

Sincerely yours,

Mr. Howard W. Blakeslee
Science Editor
Associated Press
50 Rockefeller Plaza
New York 20, N. Y.

SUGGESTED CHANGES FOR CHAPTER 8

Page 1 1. Title: THE ATOMIC PROJECT ORIGINATORS AND THE GUIDE TO THE PRESIDENT'S FORESIGHT

2. Opening paragraph along the following lines would express the theme of the chapter more effectively:

> The import and urgency of atomic research and its military applications were communicated to President Franklin D. Roosevelt by Alexander Sachs on October 11, 1939 in behalf of himself and Dr. Albert Einstein. Thus began the "chain reaction" in political policy and defense technology by which the Commander-in-Chief brought atomic research under the auspices of the Government and laid the basis for the unparalleled enterprise which culminated in the construction and use of the atomic bomb.

3. Change first sentence of the second paragraph to read:

> Within three months after the Germans, Otto Hahn and F. Strassman, had discovered uranium splitting, scientists on this side, who learned of it directly through the visit of Dr. Niels Bohr, sought to interest the American Government in the possibility of atomic bombs.

4. Third paragraph, first sentence - Change the words "the first" to "one."

> Note: The fact is that on the record the suggestion to Dr. Pegram was conveyed specifically by Dr. Wigner of Princeton and generally by the group under discussion.

Page 2 5. Page 2 - Line 4 - Change first and second sentences to read as follows:

> Sachs is American by upbringing, education and career, though Russian-born, and was then 46.

> Note: This is the tenor of the statement issued by Senator McMahon, as you will note from the New York Times story. The existing line 4 would be like featuring that Professor James T. Shotwell is a Canadian! In that case it is noteworthy that he received his collegiate education in Toronto, but since then he has been identified with American education and has been regarded and has functioned as an American and a representative of American opinion.

6. Second paragraph should be excluded, as it is a gossipy item that lowers the tone of your admirable chapter. Indeed, in a letter of November 7, 194[illegible] author of the New Yorker article, which is the basis for this item, I [illegible] its exclusion.

7. Closing paragraph - 5th line from bottom - Change opening sentence to read as follows:

"Sachs is a social rather than physical scientist. But ....."

Page 6

8. Page 6 - 3rd paragraph, 11th line from bottom - Suggest changing opening sentence to read as follows:

"Sachs urged the President to adopt a new organizational framework of his devising, suited to the unparalleled requirements of telescoping in a few years what up to then had required scores of years to translate a scientific probability into accepted technology."

9. Lines 7 and 8 from bottom, after "university laboratories," change to read:

"and to synchronize alternatives and stages of research and pilot-plant operations, in contrast with the time-sequences used in industrial research. Accordingly, in June 1940 ..... "

[Corresp. Szilard]

The University of Chicago

The Division of the Social Sciences

~~OFFICE OF THE DEAN~~

February 26, 1946

Dr. Alexander Sachs
72 Wall Street, Suite 1000
New York, New York

Dear Dr. Sachs:

You asked me to transmit to you Ross Gunn's letter which I mentioned to you when I approached you in the summer of 1939.

In June 1939, Anderson, Fermi and I completed a ~~the~~ major experiment. The outcome of this experiment was encouraging and raised our hopes that we shall be able to set up a chain reaction, using ordinary uranium. After the completion of this experiment I approached Ross Gunn, at the Princeton Meeting of the American Physical Society, which was held during the last days of June. I raised the question with Mr. Gunn whether the Navy would consider supporting Mr. Fermi's and my work, aimed at setting up a chain reaction with ordinary uranium. Ross Gunn's letter was the answer to my inquiry.

Very sincerely yours,

Leo Szilard

Leo Szilard

Enc.

[Corresp. - Szilard]

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February 26, 1946

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New York, New York

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Very sincerely yours,

Leo Szilard

Leo Szilard

Enc.

[Econ. Extracts: Lerner, Abba P.]

TO STOP THE ATOM BOMB

By A. P. Lerner
March 5, 1946

TO STOP THE ATOM BOMB

A Statement to be Made by a President

The atom bomb has not changed the great issue that has long confronted the human race. The first problem is still whether civilization will put an end to war before war puts an end to civilization. But the atom bomb has hastened the day of judgment. In the year 1946 the most fateful decisions will be made in determining whether the twentieth century will show the end of the human adventure or whether it will ~~marks~~ mark the beginning of its glorious fulfillment. ...

The real danger

We are drifting toward a war between the U. S. and Russia and we are moving toward this war with increasing speed. When the imminence of such a catastrophe first becomes apparent it is usually declared to be "unthinkable" - just as the last war was declared to be "unthinkable" around 1934. The threatening conflict has passed beyond that stage and everyone is thinking about it. ...

A similar running away from the issue is shown in the vast exaggerations of the importance of nuclear fission for peaceful purposes and even in the concern lest extravagant military precautions should unduly interfere with the freedom of scientific inquiry. Scientific research is of great importance. The ultimate benefits from the utilization of atomic energy for peaceful purposes may be tremendous. But surely every sane man would be delighted to sacrifice the next ten or ~~xx~~ even fifty years of scientific progress if there were reason for believing that this would seriously help to prevent the next war so that there will be a world in which science can advance. Our primary problem is not to defend scientific freedom or scientific progress, and it is not to prevent monopolistic restrictions on the peacetime application of nuclear energy. Our primary problem is to prevent the war between Russia and the U. S.

Deadly distrust

... The distrust is not made inevitable by the difference in our economic systems. ... We are not directly affected by the Russians' use of collectivist techniques of economic organization and the Russians are not harmed by our extensive use of private enterprise side by side with our public enterprises. The degree to which any country makes use of private or collective enterprise in its economy is a private matter that need affect other nations no more than its language or its table manners. Collectivist countries can exist side by side with capitalist countries and with mixed economies and all can gain from exchanging their products with each other in mutually beneficial trade. ...

... The Russians are brought up on a doctrine which teaches them that it is impossible for a capitalist society to maintain economic prosperity without engaging

NATIONAL PRODUCTION & WAR
EXPENDITURES OF THE U. S.,
BRITAIN, AND SOVIET RUSSIA

by

ALEXANDER SACHS

March 1946

[Atomics]

[Corresp. Teall]

April 4, 1946

Dear Miss Teall:

Now that you have afforded me the appropriate quotation from Pollard and Davidson and that I can match it against the Smyth account, I have no hesitation in telling you that my preference is most decidedly for the Smyth account. It tallies with my contemporaneous knowledge of the developments in 1939. Apart from the discrepancies between the two accounts, the style of the passage from Pollard is in a sort of Hollywood journalese.

Having voiced my preference as between the two, it may not be amiss to add that even the Smyth report needs sharper definition and elucidation. Such a more precise account has been given by Dr. Liese Meitner herself and either has or shortly will be published. From what I knew contemporaneously and what I have synthesized of the various reports from her, I submit that the following comes close to fulfilling the above requirement and so provides the desired amplification of Dr. Smyth's account:

When Drs. Hahn and Strassman made their demonstration of the results of the action of neutrons on uranium, Dr. Meitner - then in Stockholm as a late refugee - learned of it, I understand, directly from Dr. Hahn. The results were discussed by her with Dr. O. R. Frisch and they reached the conclusion that this represented a division of the uranium nucleus into two. They connected it with Professor Bohr's liquid drop model of the atomic nuclei. They also discerned the inference that the division of the uranium nucleus would generate a large amount of energy. But their line of thought did not lead to the possibilities of an atomic bomb. In the midst of the studies that Drs. Frisch and Meitner were pursuing, Dr. Bohr arrived for his stay at Princeton and reinforced the discussions set going by the reports of the work of Drs. Hahn and Strassman as published about that time; and the Columbia group pursued the problem along new lines of its own.

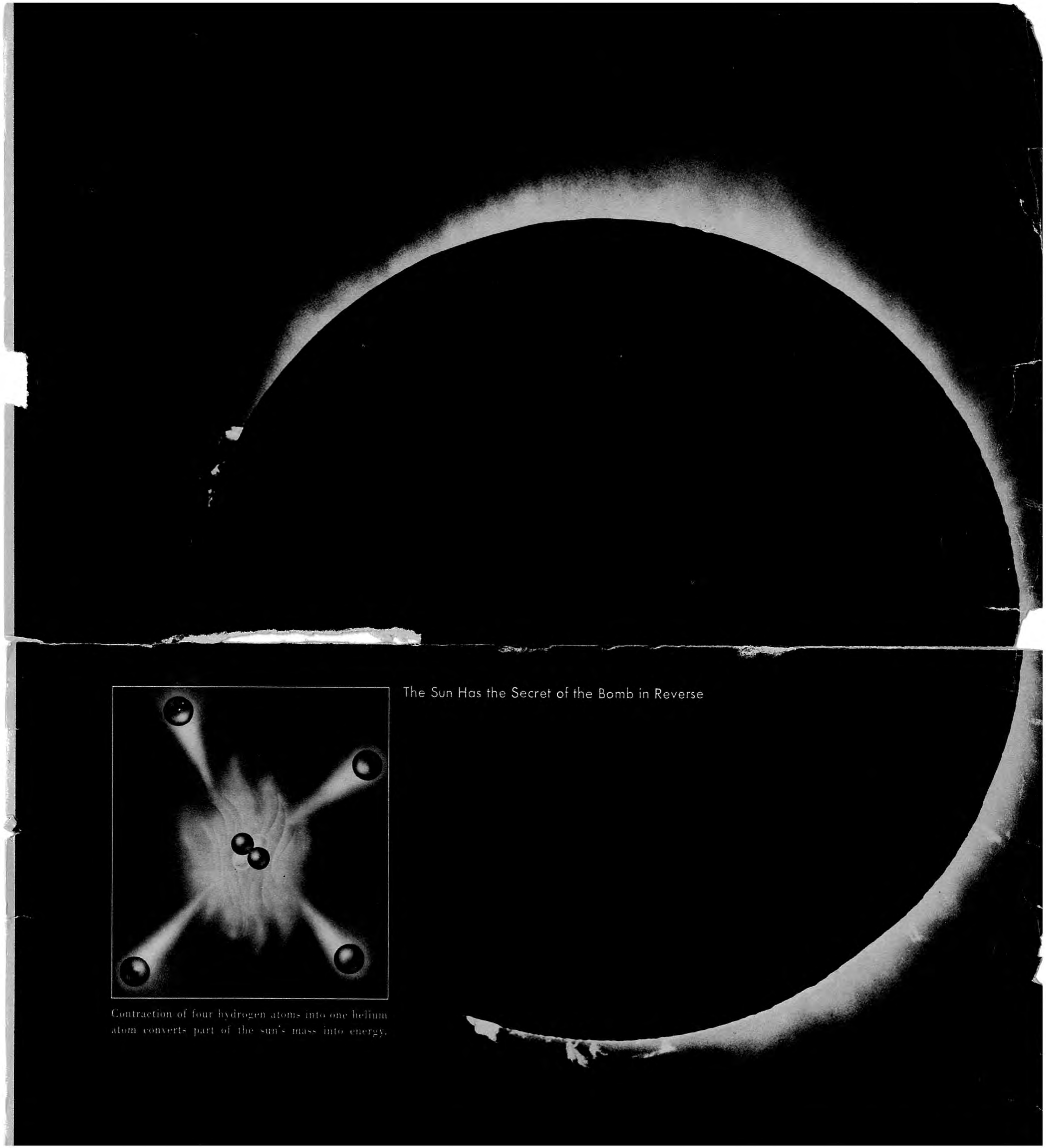
By way of definition of the advance made preeminently by the American refugee scientists upon the work that had been done in Germany, I am submitting the opening page and a half -

which incidentally is more condensed than my testimony before the McMahon Committee on November 27, 1945 - of my own special report of August 8-9, 1945 on "Early History Atomic Bomb Project in Relation to President Roosevelt, 1939-1940."

Sincerely yours,

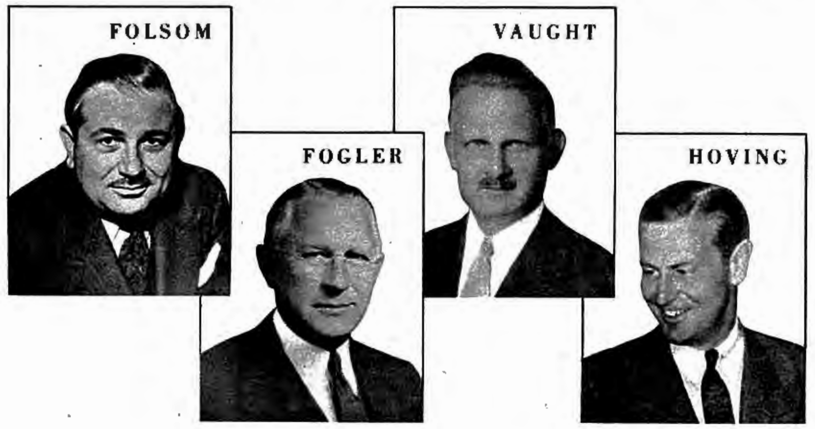
Miss Dorothy Teall
Hotel Irving
26 Gramercy Park South
New York 3, N. Y.

The Sun Has the Secret of the Bomb in Reverse



Contraction of four hydrogen atoms into one helium atom converts part of the sun's mass into energy.

MONTGOMERY WARD ALUMNI ASSOCIATION



"Most Likely to Succeed . . ."

ALUMNUS	POSITION AT WARD'S	PRESENT POSITION
Walter G. Baumhogger	V. P. (retail stores)	Pres., United Cigar-Whelan
Albert J. Browning	Genl. merch. mgr.	Dir., Office Domestic Commerce
John A. Donaldson	V. P. & comptroller	Controller, Butler Bros.
Harry T. Eaton	V. P.	
Raymond H. Fogler	Pres.	Pres., W. T. Grant
Frank M. Folsom	V. P. (merchandising)	V. P., R.C.A., Victor division
Charles W. Harris	V. P.	
Walter Hoving	V. P. (catalogue)	Starting new chain of stores
Houlder Hudgins	V. P. (furniture)	Pres., Sloane-Blabon
Howard W. Jordan	V. P.	Pres., Penn. Rubber Co.
Louis C. Lustenberger	V. P.	V. P., W. T. Grant
Harold MacDonald	V. P. & retail sales mgr.	V. P., Schenley Distillers Corp.
Harold L. Pearson	V. P. & Treasurer	
Bert R. Prall	V. P. (operating)	V. P., Dayton Rubber Mfg. Co.
Walter W. Rector	V. P.	V. P., genl. merch. mgr., American Fork & Hoe
Clement D. Ryan	Pres.	Partner, Whitney's Dept. Store, San Diego
Robert A. Seidel	Merchandising mgr.	V. P., W. T. Grant
Edward Staley	Asst. genl. mgr.	V. P., W. T. Grant
Rowland S. Stevens	V. P. (merchandising)	
George W. Vaught	Treasurer	V. P., B. F. Goodrich
Eugene R. Wimmer	V. P. (retail stores)	
William H. Yates	Comptroller	Pres., United Wall Paper, Inc.

33 per cent and profits approached the $10-million mark. In successive years sales climbed fairly steadily, and profits went over $13 million in 1935, over $20 million in 1936, and $27 million in 1939. In 1935, Ward's paid all arrears on its preferred stock, and in 1936 resumed dividends on common (paying 60 cents then, $2 now).

By 1939, at the age of sixty-five, Sewell Avery had scaled the summit. Eight years before, canny old Julius Rosenwald from his deathbed had begged Sewell, whom he admired very much, not to risk his reputation on the "hopeless task at Ward's." But Sewell had tackled it, to the mighty enhancement of that reputation. Indeed, Ward's seemed to have a chance of taking the measure of the late Rosenwald's own company, Sears, Roebuck. It was therefore natural to conclude, when Raymond Fogler was advanced to the presidency and Avery moved on to Chairman of the Board, that he considered his major work done. In the financial pages of U.S. newspapers the transition was noted in accents just short of canonization of Mr. Avery as the having out at this point. The uncharitable explanation is that he was incapable of separating himself from the power and prerogative of office. For himself he would say, as he always says, that he could not let his burden drop until he was sure of the hands that would relieve him. Certainly, as Avery was fond of pointing out, it was not a question of money. A better answer lies in, of all things, a love story. Sewell Avery had fallen in love with merchandising—that is, the kind of merchandise he had created at Ward's out of revulsion for the stuff he encountered when he first walked into the place.

"CHEAP, CHEAP, CHEAP!"

On Avery's third day at Ward's, he ordered out the famous black Cadillac and calmly drove over to Ward's hated and suspicious rival—Sears—to pay his respects to President Bob Wood. In the gypsum business, he explained to General Wood, his competitors were his good friends, and that was going to be his policy in the mail-order business. Besides, he purred, he was but a tyro in this game and could do with a little counsel from the experts at Sears. General Wood, not to be outscored, cordially invited Avery back to lunch the following week to meet and talk with the executive staff. The occasion was a bit slow in warming up. While Sewell and the General exchanged exhaustive views on the weather, the Sears men sat silent except for an industrious crunching of the hard rolls. Suddenly, Avery raised his voice to include the entire group. "Gentlemen," he said, "I am deeply disappointed. I had hoped to learn something about the mail-order business. Well, if you won't tell me anything, perhaps there is something I can tell you, and that is in our catalogues and in every other manifestation of our business we are outdoing ourselves to scream at the *public* a fact that is all too evident to anyone who has examined our merchandise: it is cheap, cheap, *cheap!*"

It would thus appear to be largely an emotional urge that started Avery on his campaign to upgrade the goods sold by Montgomery Ward to its vast, conglomerate clientele. For a hard-bitten and relatively plain-living businessman, he had

[*Continued on page 179*]

A SEWELL AVERY PRODUCTION

FORTUNE
May 1946

THE PHYSICS OF THE BOMB

by **Dr. A. K. Solomon**

In March, FORTUNE printed an article by Dr. Lise Meitner, "The Nature of the Atom," reviewing our growing knowledge of the structure of matter.

The atom, as seen in that article, is an infinitely tiny unit of matter, made up of three basic particles: *protons* (positive charge) and *neutrons* (no charge) bound together in a massive nucleus at the center, with *electrons* (negative charge) whirling around the core in distant orbits, like minuscule planets around a sun. The basic atoms of matter build up in mathematical order from hydrogen (one proton, one electron) to uranium (92 protons, 142 to 146 neutrons, 92 electrons). Atoms of the same element with different numbers of neutrons are called *isotopes*. The sum of protons and neutrons is an atom's mass number—for one uranium isotope it's 92 + 146, or U-238.

For over twenty-five years physicists have been chipping at atomic nuclei with subatomic particles fired at high speed, changing one element to another, transmuting most elements on a small scale with some small releases of energy. With the fission of uranium by neutrons in 1939, however, man for the first time split an atom almost in half, releasing energy of an order never before originated on earth. Dr. Meitner's article carried the story this far.

Dr. A. K. Solomon, research fellow at Harvard in physics and chemistry, takes up the account from fission to the bomb. He is a thirty-three-year-old American physicist who worked with the British on radar for most of the war and is now associated with the U.S. National Research Council. In 1940 he published a book, called *Why Smash Atoms?* later reprinted in the British Penguin series and now reissued by Harvard in a revised edition.—*The Editors.*

The atomic bomb is a technological development of the highest political significance. Nonetheless, it is a byproduct of our attempts to learn the laws of nature. This byproduct is not the first, nor will it be the last, to emerge as a result of untrammeled scientific research.

Modern nuclear physics may be said to have sprung from the triple scientific discoveries that illumined the years 1895 to 1897. In 1895 Röntgen in Germany discovered the X-ray; in 1896 Becquerel in France discovered radioactivity; in 1897 Thomson in England identified the electron. The work that began in these European countries has been extended and carried on all over the world.

From these beginnings followed the manifold investigations into the atomic nucleus leading up to the discovery in 1939, almost simultaneously in Denmark, France, and the U.S., of uranium fission. A further investigation of this phenomenon, the scientific inheritance of all the countries of the world, has led the U.S. to the development of the atomic bomb. There is no more reason now than there was in 1919 when Rutherford first transmuted matter to believe that the contemporary discovery is the pinnacle of scientific achievement.

The Sun: $E = mc^2$

The sun is the most familiar atomic-power plant known. It converts more than four million tons of mass into energy per second (yet has lost only about .01 per cent of its total mass since earth's formation), operating on the Einstein equation—energy equals mass times the square of the velocity of light.

Hydrogen makes it go

In the sun's interior (20,000,000° C.), four single-proton hydrogen atoms are welded in a cycle of six complex reactions (shown as one) to form one atom of helium. The loss of mass in this coming together of matter is small, but "burns" out 25.6 million electron volts of energy per cycle.

The Bomb: $E = mc^2$

The atomic bomb, working on the same Einstein equation, converts approximately one-thirtieth of an ounce of mass into energy in a fraction of a second. It releases a blast of radiant heat and energy comparable to one infinitesimal licking flame from the corona of the sun.

Uranium makes it go

The bomb goes to the other end of the table of elements to split the heavy uranium atom into two lighter ones (instead of putting light atoms together)

SLOW, FAST, AND FREE NEUTRONS

Hard upon the heels of the first report of the fission of uranium came scores of scientific papers and new discoveries. Perhaps the most significant was the discovery of the slow-neutron effect. Uranium fission could be produced not only by bombardment with normal, fast neutrons, but with even greater efficiency by slow neutrons—neutrons whose tremendous speeds had been slowed down. The explanation for this was first put forward theoretically by Niels Bohr, in collaboration with a former student. Early in 1939 they suggested that the slow-neutron effect was caused by a rare isotope of uranium—uranium-235, present in ordinary uranium ores only to .7 per cent. In 1940 a small amount of this isotope was separated in a mass spectrograph. Experiments confirmed the theory that U-235 was more readily fissionable by slow neutrons than fast.

In 1937, before the discovery of uranium fission, Hahn, Meitner, and Strassmann had shown that bombardment of uranium with neutrons produced a radioactive isotope of U-239, which gave off electrons and had half-life of twenty-three minutes. Loss of an electron meant that the atomic number had risen from 92 to 93, and a new element had been formed.* A careful series of observations in the late spring of 1940 confirmed the existence of this new element, now called neptunium, and showed that it was also radioactive. Neptunium itself decayed with a half-life of 2.3 days and emitted still another electron to form a second new element with an atomic number of 94, now called plutonium. This new element was expected to disintegrate with the emission of an alpha particle. The alpha particle has since been found; the half-life of plutonium is so long that during a human lifetime there is no appreciable loss by radioactive decay.

One further important observation was published. In addition to the highly energetic heavy fragments thrown off in fission, neutrons were emitted. The number was indeterminate, varying from about one to three per fission. At first no one could definitely state whether the neutrons were emitted at the instant of

m. Leibowitz

fission, or later. But this was not the most arresting problem. The mere fact that a single bombarding neutron could liberate great energy and at the same time produce at least one new neutron lent substance for the first time to the Sunday supplement's favorite stories about atomic energy. Hitherto the liberated energy in the transmutation of a single atom had been great, though puny in comparison with fission's 200 million electron volts. But atoms are very small, and many of the bombarding particles passed right through without penetrating a nucleus; only an infinitesimal number of nuclei were ever disintegrated. Consequently, the total amount of energy produced was woefully small. The prospect of new neutrons produced by the bombarding neutron changed that reasoning. For if one neutron produced, say, two neutrons, and each of these produced two more, fission would provide its own source of particles—and hence establish a chain reaction.

Broadly, this was the state of our published knowledge in the summer of 1940. Uranium fission had been discovered. Theory had predicted, and experiment confirmed, that the isotope U-235 was peculiarly sensitive to fission, so much so that it required only slow neutrons to do the trick. Two transuranic elements, neptunium and plutonium, had been further investigated, and their position in the periodic table established with reasonable certainty. Finally, it had been proved that for every neutron lost in the fission process, at least one additional neutron was found. Atomic energy was no longer impossible.

EXPERIMENTS IN CHAIN REACTIONS

The realization of the potentialities of atomic power did not lag far behind these discoveries. In March, 1939, Enrico Fermi discussed with the Navy the use of the atom as a weapon of war. The Navy expressed interest and asked to be kept informed. In the fall a second proposal was made, this time to President Roosevelt, supported by a letter from Einstein. The President set up a committee, and the government began to take an active interest. The first real allocation came in November, 1940—$40,000 for a year's work, on a contract given to Columbia University. It seems peculiarly significant that the subject was first broached to the U.S. Government by Fermi, an Italian who had fled from fascism. From the historical account of those early days, it is apparent that much of the driving force in this development came from Europeans now resident in this country.

Before any progress could be made in evaluating the speculations of the scientific world, it was necessary to back them up with sound experimental fact. The first thing to prove was that a chain reaction would work.

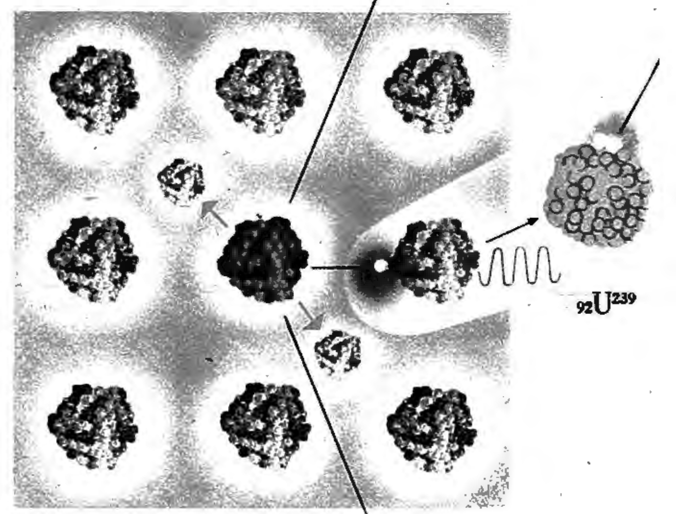
The problem was whether the additional neutrons produced would themselves be effective in disintegrating further nuclei. This problem is not easy. There are a number of competing fates that await the neutron wandering through a lump of uranium. First, if the lump is small, the neutron may escape through the surface into the atmosphere. This escape can be minimized only by making the amount of uranium very large. Second, the neutron may be captured by absorption into the nuclei of impurities in the uranium. Some impurities have a probability of neutron capture vastly in excess of uranium. Third, the neutron may be captured by uranium in a way that does not produce fission. It is this process that occurs when a neutron is captured by U-238 to produce U-239, leading to the end product, plutonium. Only a neutron not lost to any of these processes is available to cause fission of another uranium atom.

THE ATOMIC PRODUCTION LINE

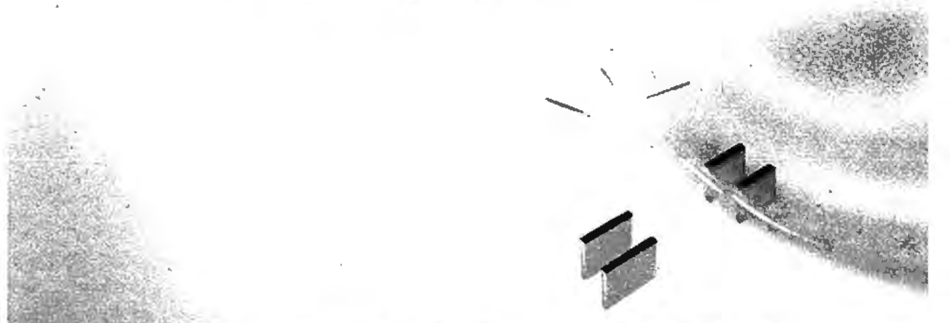
In a lump of plain uranium metal two major isotopes are distributed in these proportions in a speck the size of a dot over an "i":

2,532,000 trillion atoms of U-238 (99.28%)
18,000 trillion atoms of U-235 (.71%)

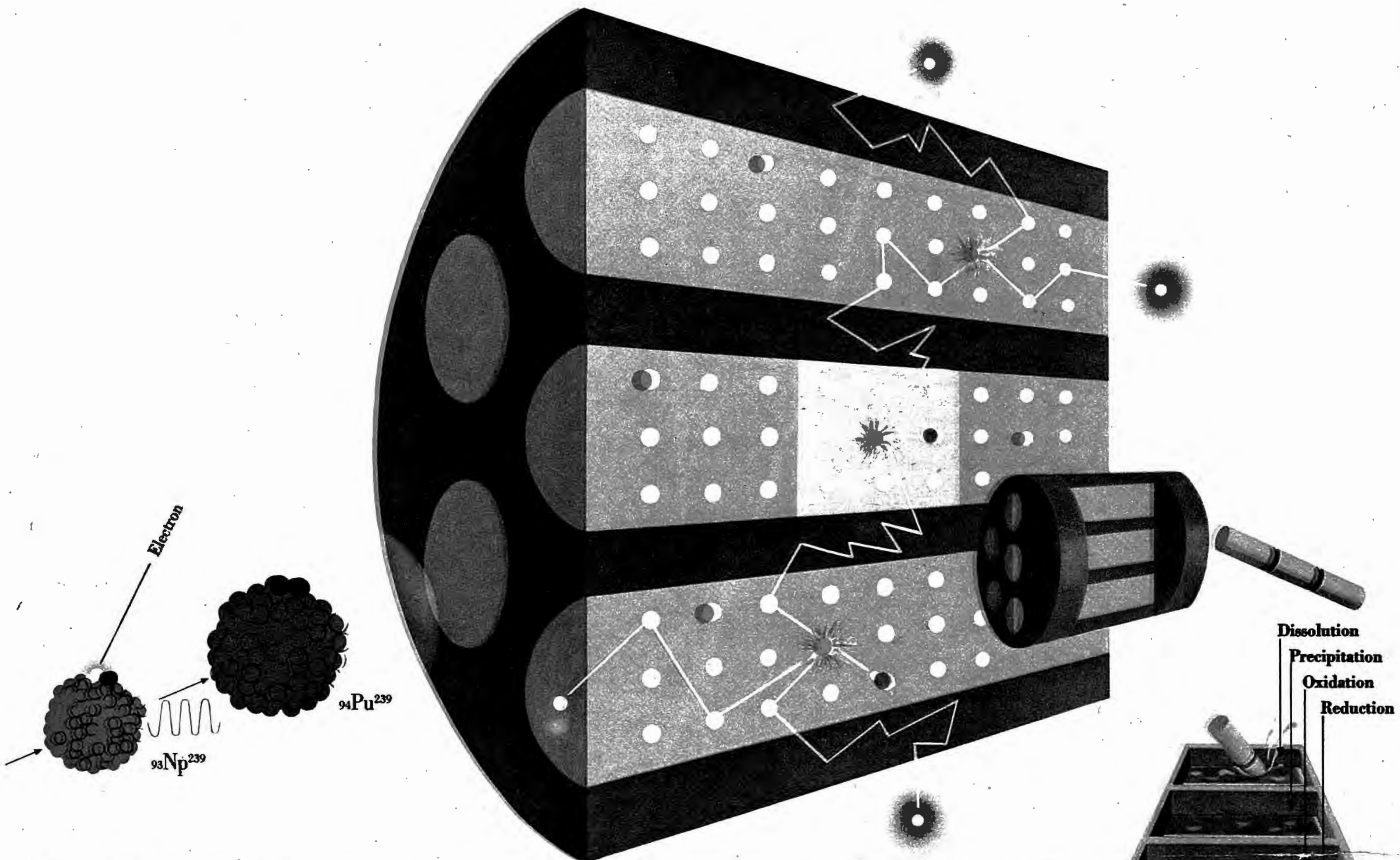
In the tiny cross section below, U-238 nuclei are shown in yellow, U-235 in red. Both are fissionable, but U-235 more readily than U-238, and to an even higher degree by slow neutrons than by fast. U-235 is so fissionable that it often splits spontaneously or on impact from stray neutrons from the atmosphere. But no explosions occur in natural uranium because no chain reaction can get started. U-235 splits up and releases free neutrons. But these may escape into space, be captured by impurities, or whizz into a U-238 nucleus to form U-239, which turns in two brief radioactive steps into plutonium-239 (a new element even more fissionable than U-235).

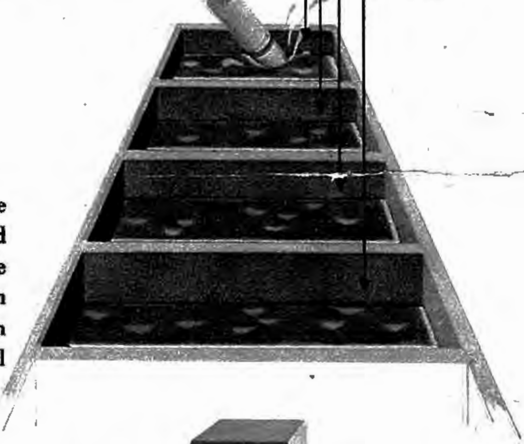


Only rarely does one of these neutrons find another U-235 to split. If the physicists could separate U-235 out of the lump or get enough plutonium deposited in it for separation, pure explosive products would result. Neither had ever been done. So they set out to work both sides of the street.



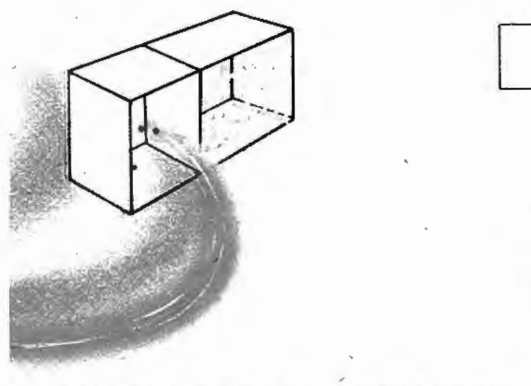
Electromagnetic Process: A uranium salt is ionized and a beam of ions is shot into a large magnetic field, where their paths are immediately curved in a semicircle. The lighter ionized atoms of U-235 travel a shorter

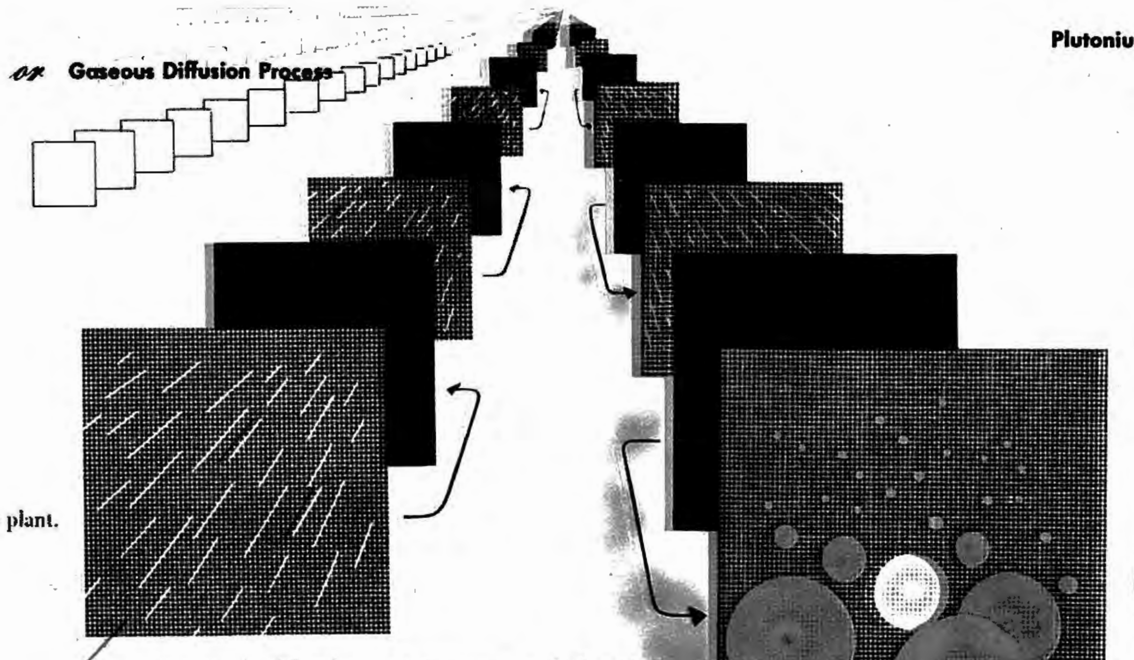


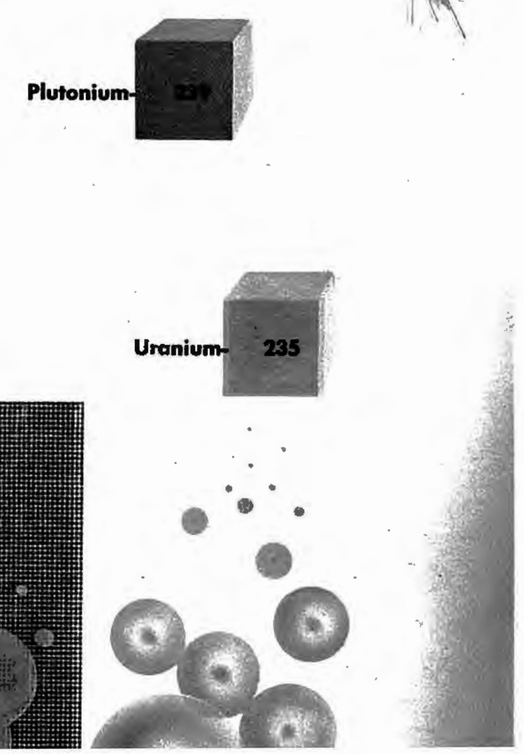


Plutonium: To get plutonium, the pile schematized above was devised. Cylinders of pure uranium slip into blocks of pure graphite and the reaction (light area) now goes to work. U-235 splits, releasing neutrons — one of them joining a U-238 to form plutonium (green). But the escaping neutrons go through the graphite, are slowed down by collision with carbon atoms, penetrate the other cans of uranium, carom off U-238's at low speed, and finally hit and split other U-235's to release more neutrons and form more plutonium. This sets going in the trillions of atoms a controlled chain reaction. Upon it was built the great Hanford plant on the Columbia River, generating as a waste byproduct of uranium fission energy about equal to the output of Boulder Dam. Uranium cans are fed through the piles, then go through remote-control chemical processes that separate the pure plutonium metal.

Uranium: **Electromagnetic Process** *or* **Gaseous Diffusion Process**







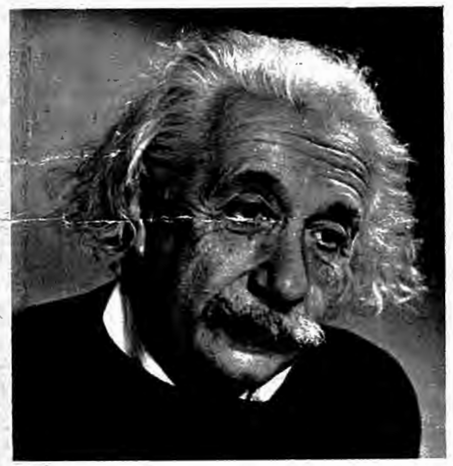
Both processes were used in the Oak Ridge plant.

A uranium gas is diffused

another stage and through

Slow neutrons—the most efficacious in bombarding U-235—were used in the first serious attempt to produce a chain reaction. Slow neutrons can be produced only indirectly. When a neutron hits any nucleus, its energy is divided between the colliding particles in inverse proportion to their mass. If it hits a light nucleus, like hydrogen, with a mass almost equal to the neutron, the energy is shared equally between the two. Consequently, when a beam of neutrons is shot into material containing much hydrogen, like paraffin or water, the neutron is soon slowed down by successive collisions until it can lose no more energy. Heavier elements than hydrogen can also serve as slowing-down elements, called moderators. To be effective, a moderator should not itself absorb neutrons from the limited supply. Since hydrogen could absorb neutrons to produce heavy hydrogen, the other light elements were closely scrutinized. Carbon was finally chosen as moderator because, in addition to being quite nonabsorbent, it alone could be produced in pure and large enough quantities in a reasonable time.

Experiments in mixing carbon with uranium soon showed that a lattice arrangement—alternating blocks of carbon and lumps of uranium—would be better than a homogeneous mass. The reasoning was this. In fission, fast neutrons are released. For greatest effectiveness in further fission, they must be slowed down. But before they reach a slow enough speed to be effective in causing fission in U-235, they pass through a dangerous region—a speed corresponding to an energy of about twenty-five electron volts. U-238 has a very high probability of capturing twenty-five-volt neutrons to form U-239. By carefully spacing the uranium in a lattice, this danger could be made very small. For if a neutron once escaped from its originating lump of uranium, it would have to travel far enough through the carbon moderator to slow it down well below the twenty-five electron volt region before it reached the next lump of uranium. Thus the neutron loss to capture by U-238 could be reduced, and the number of free neutrons available to cause fission would be enhanced.



E = mc²

With the right moderator, with adequate purity of materials, and with a lattice structure, the chance of neutron capture by nonfission processes was certainly minimized. But there still remained the possibility of loss to the surrounding atmosphere. For any given surface area a sphere has the greatest volume. Since neutrons are produced throughout the volume of the material, and since they can be lost only through the surface, the best shape for a lattice—or pile, as these experimental lattices came to be called—was spherical.

With the shape determined, size became important. Enough neutrons had to be produced so that the number lost to the atmosphere would be negligible. This condition immediately set a lower limit to the size of the experiment. Once all conditions inside the pile are adjusted to their best value, more neutrons can be produced only by an increase in size. And for given conditions inside, a certain critical size must be exceeded before the chain reaction can go. If the pile is smaller than the critical size, the number of neutrons lost to the outside makes the reaction impossible. As soon as the pile exceeds that size, a chain reaction is possible. The reaction needs no detonator since there rays, by the secondary effects from normal radioactive disintegration of uranium, or by spontaneous fission. Such were the basic factors in the early experiments.

POWER FROM THE NUCLEUS

All during 1941 experiments were carried out in laboratories throughout the country. In July at Columbia University the first lattice structure of graphite and uranium was set up. This pile was a cube about eight feet on each side. It contained approximately seven tons of a commercial grade of uranium oxide.

The best way to describe the operating principle of a pile is to characterize it by its multiplication factor, k. The necessary condition for a chain reaction is that each bombarding neutron produces slightly more than one new neutron—and k is the multiplication factor for the impinging neutron. If throughout the whole pile, one new neutron is produced per bombarding neutron, k is 1.0. If, on the average, only one-half a neutron is produced, k is 0.5; if two are produced, k is 2.0. The critical condition for a chain reaction is that k be at least unity. This is an exact way of stating that the reaction will proceed only if, after subtracting all the neutrons that are lost to the competing reactions, one new neutron is produced by each bombarding neutron. In the first lattice at Columbia, because of the impurity of the materials, this condition was not met and the reaction would not go.

In January, 1942, much of this experimental work was concentrated in the Metallurgical Laboratory at the University of Chicago. One of the immediate objectives was to set up a natural uranium pile of sufficient size and purity to make the chain reaction work.

Pure materials were difficult and slow to get in quantity, but physicists were not idle while stocks were accumulating. In one set of experiments they investigated the emission of delayed neutrons. It had been observed, and in fact published, that a small percentage of neutrons were emitted after fission was over. Investigation showed that this fraction was about 1 per cent. Of this 1 per cent, some were emitted only a few seconds after fission, while a few stragglers delayed as long as a minute.

The importance of delayed neutrons was that they provided a means of controlling the chain reaction. The value of k could always be made smaller by the introduction of neutron-absorbing materials, such as cadmium, into the pile. Consequently cadmium rods were inserted in the pile whenever it was necessary to suck neutrons out. Then k could be set up at a value so that, with the rods in place and neutrons blocked out, the chain reaction would be stopped. With rods out and the neutrons allowed to pass, k would be slightly greater than unity and the reaction would go ahead. The delayed neutron contribution gave a period of grace, lasting up to a minute, in which the reaction could be controlled if it showed any signs of being too active. In practice, a cadmium rod, with its depth of penetration into the pile governed automatically, provided safe and effective operation at any specified power level.

In November, 1942, construction of a new pile began in the now famous squash court under the West Stands of Stagg Field. Purified material was at hand, and calculation indicated that a k several per cent greater than unity should be realized. There still was not enough pure uranium to do the whole job, and the lattice was padded with uranium oxide. The pure metal was reserved for the center, where neutron density was highest.

other layer included lumps of uranium at the corners of squares. As new layers were added, holes were left for the cadmium rods and recording instruments. Each day that the pile grew, measurements were taken to check its performance against calculations. For safety the cadmium rods, normally in the retard position, were removed only once a day for these measurements. "This was fortunate," says the official report, "since the approach to critical condition was found to occur at an earlier stage of assembly than had been anticipated." Only three-quarters of the pile was up when critical size was reached. As a result the final structure, containing about six tons of pure uranium, looked less like a sphere than a gigantic doorknob.

On December 2, 1942, the controls were adjusted and the pile allowed to operate. It produced energy—one-half of a watt. Here was the first proof that the calculations and months of work were justified. Here was a chain reaction that produced energy from the atomic nucleus. This magnificent achievement is not to be measured by the amount of energy produced; the achievement is that on December 2, 1942, man first showed that nuclear power could be tapped and tamed.

THE SEPARATION OF U-235

Because of the urgency of war, there was no time to complete one experiment before launching another. Many possible processes had to be explored simultaneously, as the greatest precaution lest the enemy arrive at the answer before us. There was reason to believe that he was working on the same problem.

A prerequisite for any bomb at all was a supply of ready materials. All during work on chain reactions at Chicago, others were busy with the problem of separating U-235. This isotope, so particularly suited for fission, would clearly be of great use either for the construction of smaller piles to give atomic power or for construction of the bomb itself.

In the exciting days that followed the realization of the importance of U-235, many efforts were made to separate it from the much more abundant U-238. Such a separation cannot be carried out by simple chemical means because chemically all isotopes behave almost identically. Many ingenious schemes were proposed, but only two finally went into major production. Neither of these depended on novel principles, and hence the danger of large unexpected difficulties was minimized.

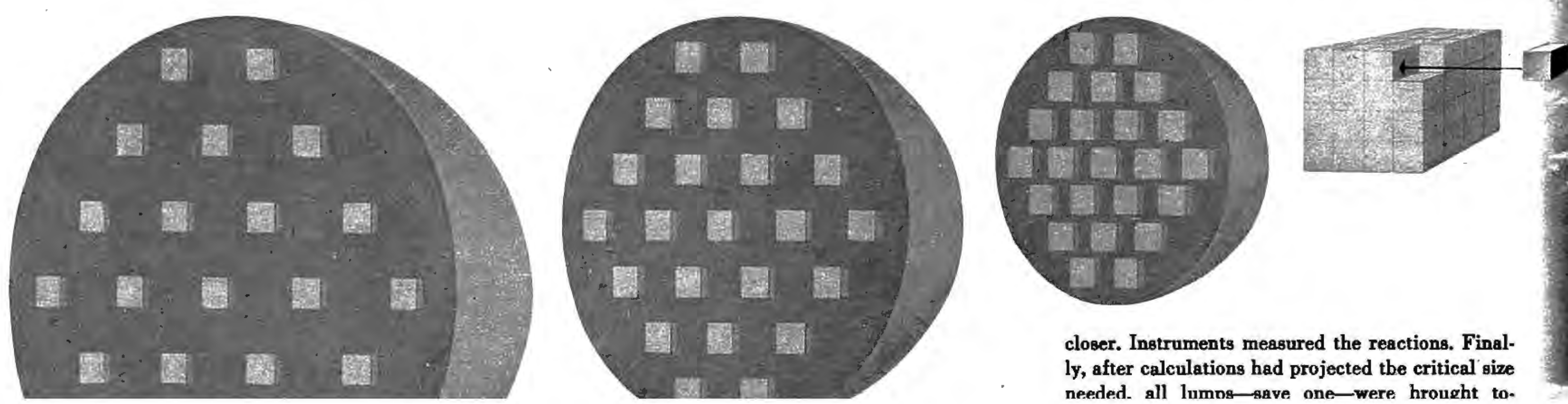
The first of these schemes, gaseous diffusion, was originally suggested for separation of gases in 1896. This plan depends on minute differences in the velocity of individual gas molecules. All the molecules in a gas are constantly in motion. At any given temperature, molecules of lighter gases travel faster than those of heavier ones. Between isotopes of a single gas, the difference in average speed is very small because it depends on the square root of the molecular weight. The gas used for U-235 separation was uranium hexafluoride, with a molecular weight of 349 for U-235, and 352 for U-238. If uranium hexafluoride gas is forced through a porous barrier, which it passes with some difficulty, the faster molecules will get through sooner. But the difference in speed is so small that the isotope separation through a single barrier is very slight indeed, and it is necessary to repeat the process many times through many stages.

Translation of this scheme into engineering reality required a tremendous plant, much ingenuity, and great patience. To supervise the atomic-bomb project, the Army in 1942 activated a new engineering district, called Manhattan District. Major General Leslie R. Groves, selected to head it, inspected and approved a seventy-square-mile site at Clinton (later known as Oak Ridge) in the Tennessee Valley. This vast Tennessee enterprise was called the Clinton Engineer Works.

Work was begun on the gaseous-diffusion plant in the summer of 1943. The many stages necessary to achieve any appreciable separation of the isotopes demanded a huge plant to produce U-235 in the amounts required. The job was not made easier by conditions at the site itself. Clinton Engineer Works was remarkable for its "seas of mud, clouds of dust, and general turmoil." However, by the summer of 1945, the plant was in operation.

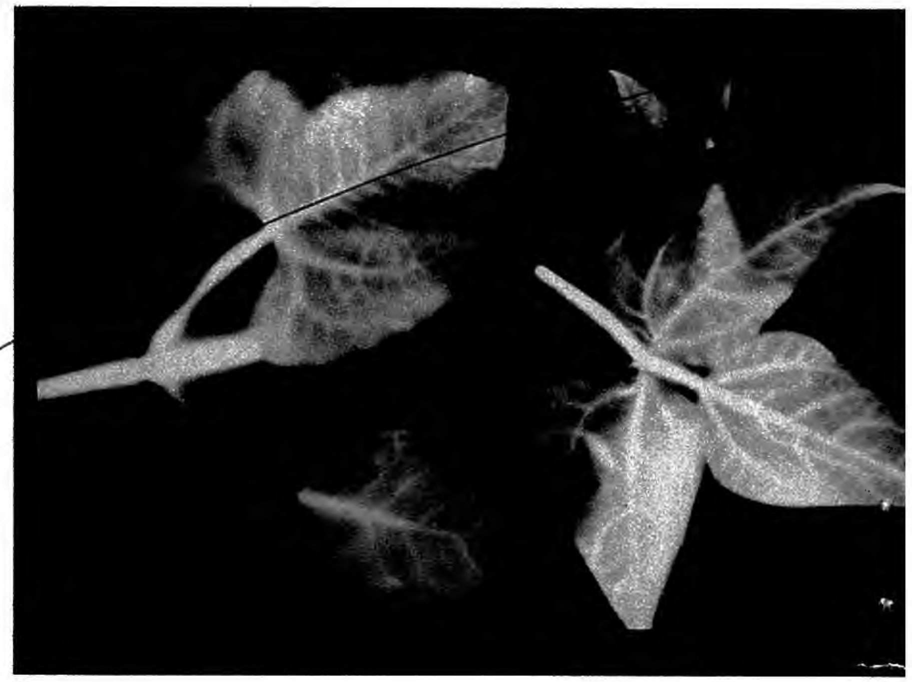
Electromagnetic separation was the other mass-production process chosen. It also depended on well-known principles. In a uniform magnetic field, positive ions will travel in a circle provided they all enter the field with the same velocity and all have the same mass. If the mass is different, the radius of the circle will be different; in fact, the radius of the circle is directly proportional to the mass of the particle. This provides a better separation factor than the gaseous-diffusion process, in which the effect is proportional to the square root of the mass.

Building up to the bomb **At Los Alamos, lumps of enriched U-235 were embedded in another lattice or pile, using a hydrogenous moderator, to begin tests for an uncontrolled chain reaction—or explosion. The pile was torn down and rebuilt many times, using less and less moderator, bringing the U-235 lumps closer and closer. Instruments measured the reactions. Finally, after calculations had projected the critical size needed, all lumps—save one—were brought to-**



Armed with the idea of an electromagnetic separator, Ernest O. Lawrence, inventor of the cyclotron, and his group at the University of California shot a beam of ions into a large vacuum tank placed between the poles of a magnet. As soon as the ions entered the magnetic field, their path was curved into a semicircle. A catcher was placed at the other end of the tank, its spacing carefully arranged so that it would collect only U-235 ions and not the heavier ones. The major problems, concerned primarily with the production of an intense beam of ions, were finally solved, and on December 6, 1941, Lawrence reported that he could deposit one microgram of relatively pure U-235 in one hour.

Acting on these results, and the substantiation of further research, General Groves in November, 1942, authorized construction of a production plant at the Clinton Engineer Works. Twelve months later the first series of electromagnetic separators was ready for operation. For nearly a year following it was the only plant in production. Now Niels Bohr has stated, in a recent interview in Copenhagen, that the U.S. is producing a total of three kilograms of U-235 a day. In four years we have achieved an increase in production almost one billion-fold.



THE BOMB IS A BYPRODUCT OF PREWAR RESEARCH

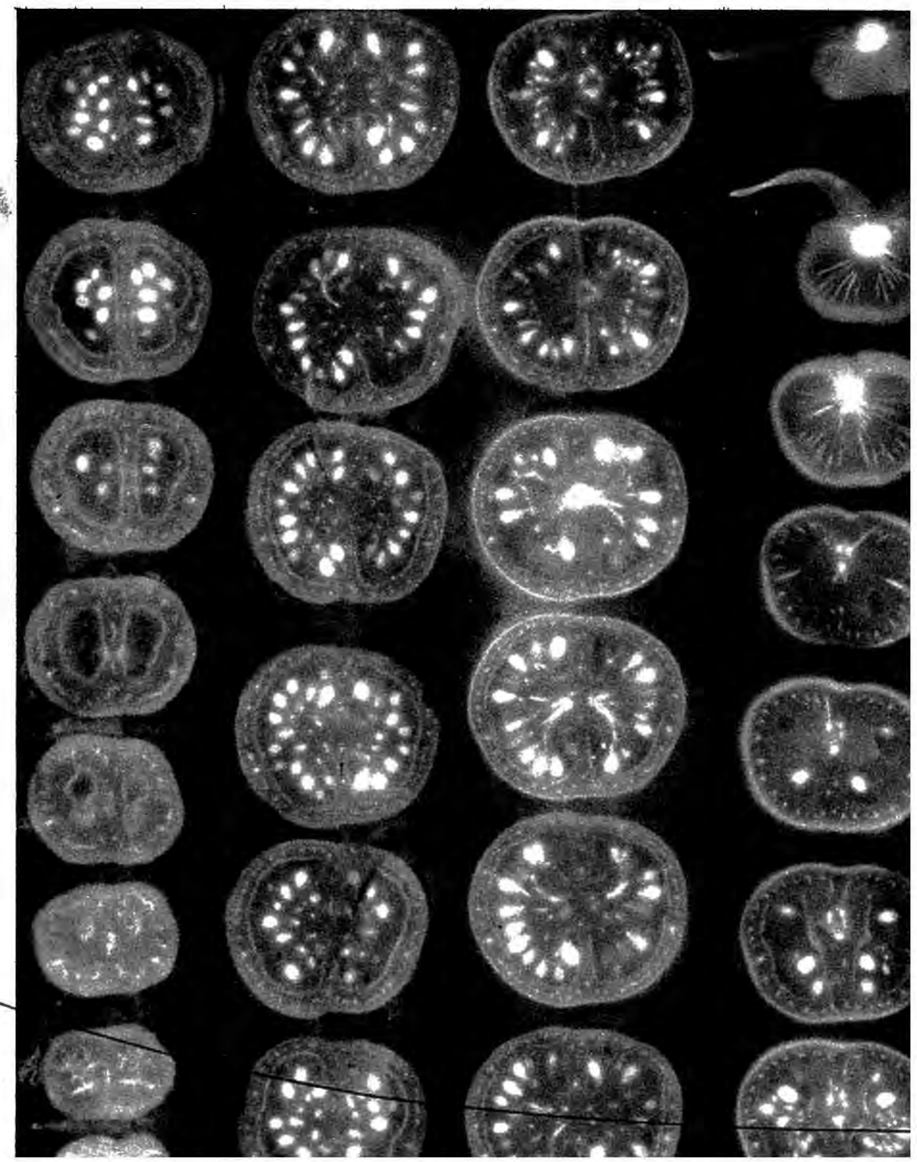
THE MAD VENTURE IN PLUTONIUM

To a physicist, the production of U-235 is dwarfed by the true story of plutonium production. On the face of it, no madder venture has ever been coldly planned by scientists of a civilized nation. A bald statement of facts is staggering. Plutonium was an element unknown in a natural state on earth. By the end of 1942, we had manufactured in this country 500 millionths of a gram of it. Thereupon, in January of 1943, we decided to go into production, and started to build a plant with an output on the order of one billion watts to produce about 1,000 grams of plutonium a day. As if to make the problem more interesting, any such plant would give off radiations in the course of the creation and processing of plutonium that would be of a magnitude hitherto unknown. Those were the bare bones of the problem.

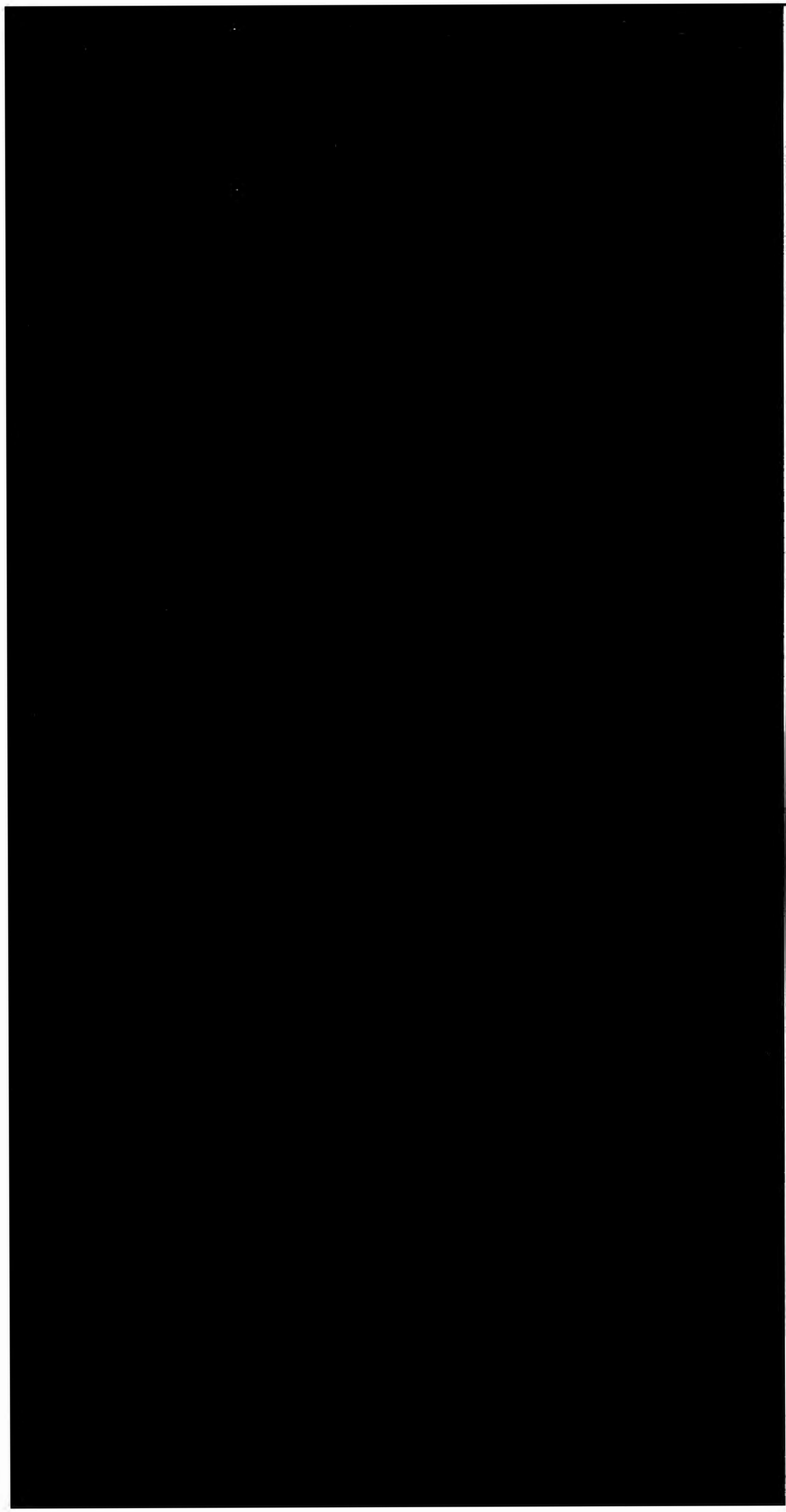
$E = mc^2$

Good ideas often occur in many places simultaneously. A number of scientists independently suggested the production of plutonium in piles. Some of the vast number of neutrons that are available in a pile would surely be captured by U-238 to form U-239. By natural processes this isotope would decay into plutonium. The advantage of getting plutonium, against the process of extracting U-235, was that this new element could be separated from uranium by normal chemical means. The nucleus of plutonium-239 is very similar to that of U-235, and on theoretical grounds it was expected to be even more easily fissionable than U-235.*

With the decision to go into large-scale production came

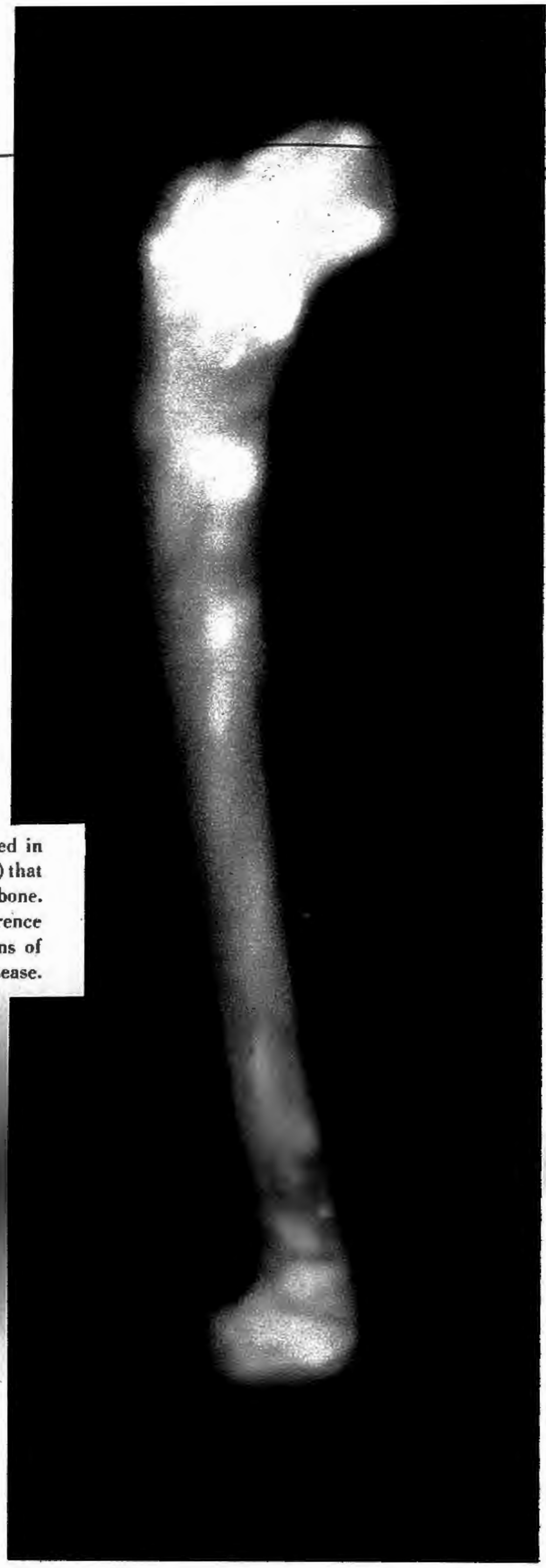


*The theoretical grounds are complex but interesting. The theoretical reasons why plutonium should be more easily fissionable depend upon two basic factors in fission. Liability to fission is governed by the ratio of the square of the atomic number to isotopic weight—which means, in general terms, that you must have an atom of high atomic weight with a high ratio of protons to neutrons for fission to take place. In addition, the heavy atom must have an odd number of neutrons so that a bombarding neutron pairs with



Radioactive Carbon,

fed to plants to study how green leaves use solar energy to make organic compounds out of carbon dioxide and water (photosynthesis). Radioactivity takes its own picture (left), puts in a tracer element for chemical analysis. This radioactive byproduct of nuclear research, just before the war, overturned previous ideas as to how photosynthesis works. Solution of this old problem would rival atomic energy.



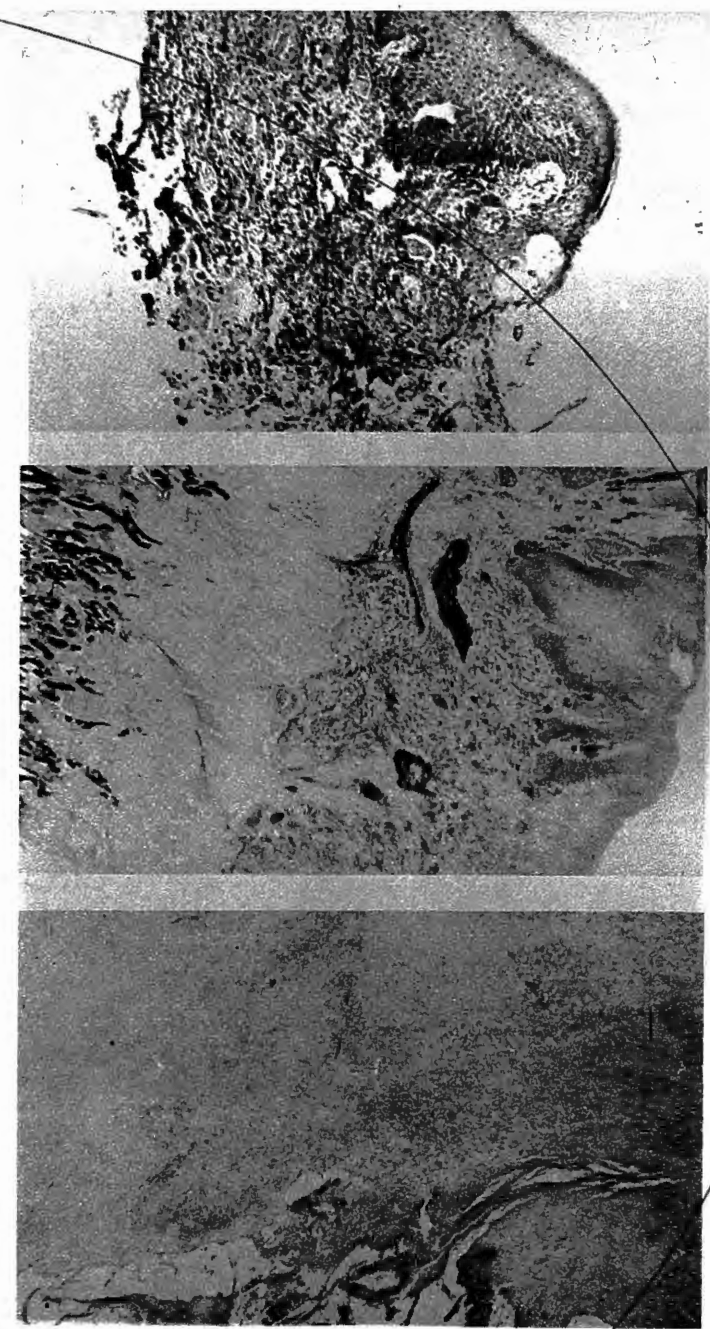
Radiophosphorus,

fed to mice and rabbits, showed in glowing radioautographs (right) that phosphorus is deposited in bone. This gave Prof. John H. Lawrence the idea of feeding it to victims of leukemia, that fatal blood disease.

Leukemia is caused by excess production of white blood cells in bone marrow. Radioactivity kills at the source. Two prewar years of work showed promise, but not yet a cure.

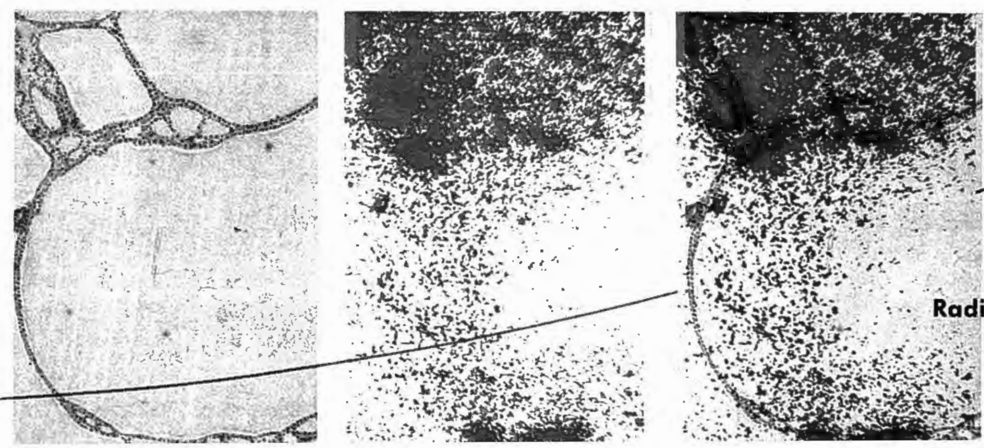
Radioactive Zinc,

fed to tomato plants by Prof. D. R. Hoagland, shows how such radioactive tracers, byproducts of the cyclotron, were putting the study of plant nutrition on the path of new discoveries before the war. Zinc is barely present in tomatoes, yet radioactivity makes them scintillate like fruit of another world.



Neutron Bombardment Kills Cancer

Just before the war, Prof. R. S. Stone of the University of California set out to study the killing effects of direct neutron bombardment of cancer. Neutron beams, directly from the cyclotron, were found more destructive of tissue than X-rays. Early clinical work indicated that controlled beams were particularly effective against some stubborn types of cancer. Above is an example of neutron therapy: (top) cancer of the mouth before treatment; (center) four months after, pale band is dead tissue but both mucous membrane and cancer have regrown; (bottom) seven months after, surface ulceration but no cancer. As in early X-ray therapy, ulcerations difficult to heal and scarring are aftermaths. Much more research is urgently needed, after the interruptions of war. But over-worked cyclotrons aren't up to it, for, in addition to all of their primary use in nuclear research, they are turning out small quantities of all radioactive elements mentioned here, and more. These materials could come in enormous quantities as byproducts from the atomic-bomb production piles, if they are released without unending military delays. The bomb can enormously speed up all of this research, if its byproducts are freed to do it.



Radioactive Iodine in the Thyroid

Drs. Joseph Hamilton and Mayo Soley have devised an ingenious technique in basic studies of the iodine uptake of the thyroid—a major gland in controlling body health. Left to right: a microphoto of abnormal thyroid many new problems. Uranium could no longer be imbedded in static lumps in the pile, as at Chicago; it had to flow through the pile as the neutrons worked to produce plutonium. New material had to be fed into the pile as the processed uranium was taken away for chemical separation. Dissipation of one billion watts required a magnificent cooling system. Both conditions, material flow and heat dissipation, could be satisfied with an arrangement in which tubes filled with uranium passed right through the lattice. With suitable isolation and protection of the uranium, the cooling material could be pumped through these same tubes. New material could be inserted in one end of the tube and the processed material pushed out the other. After much further research this new lattice arrangement was shown to be satisfactory for a working plutonium pile.

Originally, the Clinton Engineer Works had been chosen as the site for the work. But upon reconsideration of the problems and dangers, General Groves decided that Clinton was not isolated enough. A new site, known as the Hanford Engineer Works, was chosen at Hanford, Washington, on the Columbia River near the power of Grand Coulee Dam.

The Columbia River, "the finest supply of pure cold river water in this country," provided the cooling. Water was pumped through the piles in aluminum tubes—aluminum, because it absorbs neutrons with difficulty. Since uranium reacts with water, uranium slugs had to be sealed in cans. The cans, also made of aluminum, were required to transmit the great heat of the process to the water flowing by. At the same time the cans had to keep the gaseous and other fission products from getting out. The problem of "canning," which was the crux of the operation, was not satisfactorily solved until the last moment.

Chemical separation of plutonium from the uranium was another difficulty because the processed uranium contained only about one-tenth of 1 per cent of plutonium—a figure only one-seventh as large as the content of U-235 in uranium ores. In addition, when the slug emerges from the pile, it is contaminated by a large assortment of fission products, whose elimination is not easy. The method finally used relied on cycles of precipitation, dissolution, oxidation, reduction, and further precipitation.

But over all these processes hung the dreadful pall of radiation. With no radiation, the job to be done was difficult enough; with radiation it took on epic proportions. Piles of this magnitude give off radiation infinitely greater than anything experienced before. At Hanford it was first necessary to protect the personnel from hazards. Periodic checks of white-blood count became routine. Much research was carried out on the effects of radiation. Tolerances were established; instruments were invented to measure whether the tolerable radioactivity was exceeded. These included "Sneezy," which measured the radioactive dust concentration in the air, and "Pluto," which measured contamination of desks and equipment. Geiger counters were used at the exit gates to sound an alarm when anyone contaminated passed through the gates.

Other difficulties arose when the "hot" uranium slugs were taken from the pile for chemical processing. The slugs were transported underwater to a series of concrete cells almost completely buried in the ground. When the uranium was first dissolved, myriads of fission products, all intensely radioactive, were freed. Tall stacks were built to carry off the radioactive gases and discharge them high in the air. And the whole complex of processes—dissolution, precipitation, oxidation, reduction—very properties of matter. No one could confirm experimentally the effect of radiation on the materials comprising the pile. Experience has now shown that the electric resistance, the elasticity, and the heat conductivity of the graphite in the piles all change with exposure to such intense neutron radiation. The whole pile was enclosed in heavy concrete walls made airtight to avoid inducing radioactivity in the very air. Men could work with their hands, building the pile, testing the controls, making all the final adjustments, with no danger to health at all. But once the pile began to operate, no human could approach without fatal effects.

LEADING UP TO THE BIG EXPLOSION

Slow neutrons served best for a controlled reaction, as in the gigantic piles for the production of plutonium. But for an explosive reaction, the minute fraction of a second taken to slow the neutrons down was too long. Fast neutrons were required, even though less efficient. Further research was necessary to determine the critical size for a fast-neutron bomb. To bring off the explosions at a predetermined time was perhaps the most difficult of all the problems remaining.

From time to time between 1942 and 1944 many physicists had disappeared from their previous wartime pursuits to take up residence in an unknown spot. That spot was Los Alamos, situated on a New Mexican mesa, thirty miles from Santa Fe. From its beginning the Los Alamos laboratory was directed by J. Robert Oppenheimer of the University of California. Oppenheimer had been a theoretical physicist with a brilliant, inquiring mind. However, the mind that could solve problems in theoretical physics soon reoriented itself, and Oppenheimer dealt easily with the trying administration, as well as manifold technical problems, of a laboratory set up expressly to create an atomic bomb.

By 1944 a great many keen physicists, foreign as well as American, had been imported to Los Alamos by Oppenheimer. All during the early period of work in this country, the British had also been busy in England and Canada. The original impetus to undertake the project had been strengthened and confirmed by British advice and counsel from the earliest days. At Los Alamos, a British delegation headed by Sir James Chadwick made many contributions to the success of the laboratory. Niels Bohr, after a desperate escape from Denmark, spent much time there assisting in the work.

Since the atomic bomb depended on fast neutrons, experimental verification of the results in fast-neutron fission was needed. One such set of experiments is described in the official report. A pile was built containing a mixture of uranium and a hydrogen moderator. It is not stated explicitly that uranium containing a higher than normal amount of U-235 was used; but certainly many experiments using enriched materials must have been carried out. In its original form, the pile contained enough moderator to be a slow-neutron reacting pile. After the first results were obtained, it was torn down and rebuilt with less moderator. More results were obtained, and the pile was again rebuilt, containing still less moderator. This process, as it went on, approached more and more closely the conditions to be found in a bomb, when in the absence of moderators the fast-neutron reaction would predominate.

For the atomic bomb, as for the pile, there is a critical size below which the number of neutrons escaping from the material is so great that there will be no sustained reaction,

The Physics of the Bomb

[*Continued from page 122*]

was to keep the critical size small. A further device to aid in this direction is a tamper, a nonabsorbent envelope surrounding the bomb, which reflects the neutrons back into it.

To bring about the greatest explosion, the bomb must be held together as long as possible so that the nuclear reaction will have worked on the maximum amount of material. Once the bomb has begun to disintegrate, the reaction will stop because the neutron density will become too low. So in an effective bomb there is the double problem of providing enough neutrons to make the bomb explode and of holding the bomb together as long as possible to make the explosion as violent as possible. The tamper aids in this last because, in addition to reflecting neutrons back into the bomb, its own inertia makes it harder for the bomb to blow up.

The very nature of critical size imposes a peculiar limitation on the experiments that are possible. Normal explosives can be tested in small quantities. Not so the nuclear explosion, for it must be tested with amounts exceeding the critical size, or not at all. This imposes a heavy responsibility on the theoretical calculations in bomb research. A large group of theoretical physicists had been established at Los Alamos. As they gained experience, methods were devised to obtain closer and closer approximation to the true answer, until accurate calculation gave the critical size and much other important data.

But the major problem was detonation. The bomb had to be transported in fragments smaller than critical size, for once critical size was reached there were plenty of stray neutrons to bring about unpremeditated detonation. A large-caliber gun was proposed to shoot one part of the bomb into the other for detonative assembly. Such a novel projectile would have to travel at high speed along an accurate trajectory to provide perfect contact. For, should the bomb detonate before assembly was completed, it might go off with a fraction of the calculated energy released. Should it fail to detonate, we might present the enemy with our greatest secret, complete with a supply of the necessary material to help him in his experiment. The complexity of the problem can be gauged from the fact that three of the seven experimental divisions at Los Alamos were concerned with detonative and explosive problems.

THE GREAT BALL OF FIRE

Finally, on July 16, 1945, came the test that crowned the long years of calculation, experiment, and manufacture. Careful though the work had been, checked and counterchecked by repeated tests, the final result was always in doubt. The scientists and technicians at work on the bomb at a remote and isolated spot on Alamogordo Air Base must have been tense with excitement. All through the night final arrangements were being completed, and everywhere the tension grew. The description by William L. Laurence of the New York *Times* is melodramatic but still the best.

"Silence reigned over the desert . . . From the east came the first faint signs of dawn.

"And just at that instant there rose from the bowels of the earth a light not of this world, the light of many suns in one.

"It was a sunrise such as the world had never seen, a great green supersun climbing in a fraction of a second to a height of more than 8,000 feet, rising ever higher until it touched the clouds, lighting up earth and sky all around with a dazzling luminosity.

The Physics of the Bomb

[*Continued from page 173*]

orange, expanding, growing bigger, rising as it was expanding, an elemental force freed from its bonds after being chained for billions of years.

"For a fleeting instant the color was unearthly green, such as one sees only in the corona of the sun during a total eclipse.

"It was as though the earth had opened and the skies had split."

"THE LONGHAIRS HAVE LOST CONTROL"

With achievement came relief. The work was done—the bomb was proved. But this first climax was not the end; it was a beginning. There is a story that goes the rounds. One of the high military officials watching the experiment grew tenser and tenser as the moment drew near. Stirred by the terrible fury of the explosion he burst out, "My God, the longhairs have lost control." And so we physicists have. Not precisely in the way he feared, but in a way equally terrible.

It must be clear from this article that the atomic bomb is no secret. It obeys the fundamental laws of nature. The exact details of its composition, operation, and detonation are still military secrets. But these are technological details that will yield to persistence and imagination. The great question was—would the bomb work? We have demonstrated the answer to all the world. With this knowledge, these results can be duplicated in a few years, at far less cost, by any capable group of scientists throughout the world.

Having demonstrated this fact, the physicists have indeed lost control. A few years hence, a nation, any willful nation, can destroy our major cities in a few hours. For this we have no remedy. We may indeed be able to destroy their cities afterward, but the whole basis of our communications and our economy—that is, the heart of our ability to make war—will have been wrecked. We have proved the atomic bomb and, in

[*Continued on page 176*]

The Physics of the Bomb

[Continued from page 174]

so doing, we have placed ourselves at the mercy of the world.

The implications of this fact are clear. Beyond all else, this country must strive to establish a peaceful concourse of nations. This fact transcends all worry about our national economy and prosperity.

Certain subsidiary facts appear. As a military necessity this nation has taken steps to acquire control of all American uranium deposits. If, as now seems likely, useful power can be developed from nuclear disintegration, this government will have perforce nationalized a major source of power. This is but one example of the intricate intermingling of this new destructive power with necessary social action. Throughout all the results that stem from these new discoveries, the same intermixture will be found.

This article is no place for predictions on the possible future uses of this new source of energy. The applications of new power supplies lie in the province of engineering, not physics. From physics we can learn that the size of the piles and the necessity of heavy shields against radiation make nuclear power for airplanes and automobiles impractical at this time. We can also deduce that since other elements besides uranium are fissionable, these may in the future serve as a further source of nuclear power. Much work probably remains to be done, but it seems apparent that nuclear energy will become available at least on a powerhouse scale.

One byproduct of the pile will be production of radioactive isotopes on a scale hitherto unknown. Immediately the prospects of their use in biological research and in medicinal healing will be vastly enhanced. New physical tools will probably become available, and as further information is released, the whole field of nuclear physics can be expected to respond to this new stimulus.

Still it is by no means clear that the vast amount of nuclear knowledge that has been assembled in the course of these projects will be published and made available to physicists. It is unfortunately not even clear that we shall retain freedom of research in investigating the basic nature of matter. Certainly no better method could be found to stultify progress, both scientific and technological, in this country than to retard research. Free, unhampered scientific research, supported by the government, by industry, by universities, is a fundamental necessity. The atomic bomb and the prospects of atomic power are but milestones along the way. Atom smashing has uncovered one secret in the nucleus. Infinitely more remains to be uncovered before we can truly understand the nature of matter. To achieve this end, further free research is the only key.

Credits:

Page 114—Drawing: Matthew Leibowitz; photograph of sun's corona by J. F. Chappell, Lick Observatory, University of California

Page 115—Howard Coster

Pages 116 and 117—Design by Matthew Leibowitz

Page 118—Fred Stein

Page 119—Drawing: Matthew Leibowitz; photo U.S.A.A.F. from Acme

Page 120—Official U.S. Army; Hansel Mieth—*Life*; courtesy Dr. J. H. Hoagland, University of California

Page 121—From *Molecular Films: the Cyclotron and the New Biology* by Hugh Stott Taylor, Ernest O. Lawrence, and Irving Langmuir, Rutgers University Press; courtesy Dr. R. S. Stone, University of California (3 photos, right); from "Deposition of Radioactive Iodine in Human Thyroid

[Corresp.: Baade]

B

Institut für Weltwirtschaft
an der Universität Kiel

Tgb.-Nr.......................

Kiel, den June 27th, 1949

Fernruf: 1885, 1886, 7717
Drahtanschrift: Weltwirtschaft

To
Mr. Alexander S a c h s
72 Wall Street
N e w Y o r k , N.Y.

Dear Mr. Sachs,

With pleasure I remember the conversation we had together in New York and these days I had a special cause to do it: - Professor H a h n from Göttingen lectured in Kiel on history of international cooperation regarding atomic energy research. After the lecture I had a long conversation with him and stated that until now, he had not known anything about the special part you played in a deciding stage.

That time you gave me your booklet "Background and Early History Atomic Bomb Project in Relation to President Roosevelt". Naturally, Professor Hahn is very much interested in the new points of view which result from it. I believe it would be a great pleasure for him if you would also send him a copy of this booklet.

Sincerely yours

Fr. A. Baade

(Professor Dr.Fritz Baade)

This is the address of Professor Hahn: -

Herrn
Professor Dr. H a h n
G ö t t i n g e n
Bunsenstr. 10
British Zone, Germany

G. & R. 5992

[Corresp.: Baade]

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Professor Dr. H a h n
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April 19, 1946 File Kelly (letter of May 15) Corresp. Kelly, Haight

OUTLINE OF BOOK ON

PERSPECTIVES ON ATOMIC ENERGY AND WORLD SECURITY

I.

1. The "fear and trembling" impact of the atomic bomb on our fissionized culture and mentality.

2. (a) The flight into apocalyptic politics led by the physical scientists who underwent a "conversion" experience.

   (b) The groping through fragmentary "thinking aloud" by these scientists and by publicists and political leaders towards utilising the atomic bomb disarmament as the presumed only alternative to total annihilation.

   (c) The tentative projection in the Truman-Attlee statement of mid-November of a flexible serial formula of "secret sharing" linked to a concert of power and an objective of disarmament.

3. (a) The political atomic bomb of the fission by Soviet Russia of the triumvirate of hegemenous powers and the reversion of Russia into extroverted imperialism and introverted insulationism, synthesising Czarist objectives with totalitarian techniques as writ large in the Nazi "White War" of the Thirties.

   (b) The combined physical and ideological aggression by penetration in the Far East and in the Near East, and the establishment under the cover of unilateral implementation of past agreements of a new mid-Europe attached to the Russian system through political overlordship and economic exploitation: The public reaction in the democracies to the implications of the Soviet policies of uni-willed extensionism and the recoil from the spectacle of how areas within their orbit have become the "endarkened places of the earth and the habitations of cruelty" (Ps. 74, 20).

   (c) The resultant abandonment by the American as well as the British Government of appeasement politics and the search for an effective policy of firmness as illustrated in the still unresolved issue over Iran that has thus far delayed the tempo and the tenor of the Russian encroachments.

   Thus in contrast with the apocalyptic politics entertained by the concerted scientists and public-spirited bodies up to a few months ago, need is felt for a policy easier to characterize negatively than to implement positively. The new attitude may be described as follows: If it be conceded as probable that we are confronted by a Soviet equivalent of the German piecemeal aggressionism of the later Thirties, then the issue is not the sloganized choice between one world or none - between such monolithic one world and disarmament beginning with self-deprivation of the inventors' rights over the atomic bomb - but between yielding to such predatory tyranny and the concerted assertion of the rights and interests of our world and those of our kindred in political culture and economic foundations of the democratic order, and the timely utilisation of this short-of -peace sequel to military victory in view of the demonstration prior to combat war of the vanishing time-borrowing margin for defense, especially under the new four-dimensional framework of war technology.

II.

1. Synoptic history and a mathematical model of the nature of war since the advent of progressive science with the Renaissance and the discovery of America.

2. (a) Summary determination of the growth in the intensity of war and interpretation of the atomic weapon as the emergence of a four-dimensional framework for war.

   (b) The corresponding evolution of diplomacy into a four-dimensional framework as a result of the newer diplomatic techniques of infiltration and mastery forged by the totalitarian systems in anticipatory frustration of the scope and time for the organization of defense.

3. Historical-analytical considerations as to the difficulties and impracticabilities of utilizing the atomic bomb for either psychologically or militarily coerced world unity:

The deliverance at the inception of this Republic as to the presuppositions of federalism, as stated in the 2nd Federalist:

> "Providence has been pleased to give this one connected country to one united people - a people descended from the same ancestors, speaking the same language, professing the same religion, attached to the same principles of government, very similar in their manners and customs, and who by their joint counsels, arms and efforts, fighting side by side throughout a long and bloody war, have nobly established general liberty and independence."

The generalization of this thesis by Lord Balfour in 1927 was as follows:

> "Constitutions are easily copied, temperaments are not; and if it should happen that the borrowed constitution and the native temperament fail to correspond, the misfit may have serious results. If, for example, they have no capacity for grading their loyalties as well as for being moved by them; if they have no natural inclination to liberty and no natural respect for law; if they lack good humor and tolerate foul play; if they know not how to compromise or when; if they have not that distrust of extreme conclusions which is sometimes misdescribed as want of logic; if corruption does not repel them; and if their divisions tend to be either too numerous or too profound, the successful working of British institutions may be difficult or impossible" (Preface to Walter Bagehot's "The English Constitution").

The sidelight afforded by the schism between French and British Canada as to the difficulties of imposing uniform military policy even in respect to defense, where there are deep historical emotional differences.

The experience of the transformation of the British Empire into a Commonwealth as a historical laboratory test that progress towards unity within the democratic order requiring consent is not along lines of an imposed monopoly of military power and the disarmament of members:

> The definition of the new Commonwealth given at the Imperial Conference on November 19, 1926, in which it was pronounced that the British Empire, "considered as a whole, defies classification and bears no real resemblance to any other political organization which now exists or has ever yet been tried."

III.

1. (a) Exploration of probability patterns in war technology in the next war in connection both with pre-atomic, limited wars and global wars inclusive of atomic weapons.

   (b) Urgency at each stage of available and accruing knowledge and formulation to spell out the pattern of American security and war prosecution in atomic age, if the democratic victors are not to repeat the error of the last war of ignoring the transformative significance of new dimensional war weapons and technology.

2. (a) Summary evaluation of the war efforts of the three hegemenous Allies in relation to the Axis and in relation to one another (with reference to the calculations employed in the last war in the course of advisory service to the late President).

   (b) Resultant better perspective on power comparisons of the democratic order vis-a-vis the Soviet order.

   (c) Statistical evaluation of scientific leadership of the major powers since the turn of the century by reference to Nobel Prize Laureates.

   (d) Recent historical sidelights on the differences between free and regimented science.

      (i) Sidelights from the German researches on the atomic bomb itself; on the constriction of productivity in fundamental science in the wake of totalitarian policies.

      (ii) The purge against the scientists in Russia in the immediate prewar period: liquidation on December 16, 1937 of the entire Astronomical Council of the Moscow Academy of Sciences. The emergense in the war period of collaboration with the West; of a lone plea of a free science detached from immediate State utilities by academician Kapitsa in an address in 1945 to the Praesidium of the Soviet Academy (alluded to in Nature, March 10, 1945).

(e) The bearing of the foregoing on the so-called Acheson Report: Apart from the presumed questionable assumption of the permanent dependence on uranium in the face of emerging new research of the breaking up of the atomic nucleus which would broaden the resources, there is a more fundamental issue which through a kind of beblinkered expertise was not faced by the Committee. That issue is the social-cultural preconditions of sharing of atomic research with a totalitarian system. It is recognised in scientific treatises, as well as in Philosophy of Science, that there are such preconditions or postulates for the carrying on of physical research. Thus Norman Campbell in his Physics: The Elements gives as minimal postulates for the subject matter that scientific matter is the interpretation of phenomena by the principle of "uniformity" and the "procedure of communicability." In a fuller statement these would include the principles of rationality and causality and the procedures of truthfulness and the goal of the promotion of cumulative knowledge. It is submitted that there are corresponding postulates which we have as preconditions to be met for the carrying on of joint research and thus for the execution of the kind of program envisaged by the Report.

IV.

1. Summary of the five-fold problems and tasks.

(a) The problems of foreign policy in relation to the split triad of victorious powers.

(b) The consequential reorientation on the problems of international control of atomic and related weapons and the interrelated tasks of world security.

(c) The reorganization of the Defense Services attuned to the radical foreshortening of time-borrowing.

(d) The newer tasks in cooperation between the Services and American industry in the effectuation of a dynamic offensive-readiness applicable to our technological industries in evocable detail.

(e) The bearings of economic and technological history upon the emergent problems of civilian atomic development.

Corresp - Kelly, Hugh J. [Chron file May 46]

May 15, 1946

Dear Mr. Kelly:

The receipt at long last from the Government Printing Office of the corrected text of my opening testimony before the Senate Committee on Atomic Energy enables me to collate and submit the documents referred to in the course of the luncheon foregathering with you on April 19th devoted to a discussion of the book in progress on "Perspectives on Atomic Energy and American and World Security." The intervening lapse of time has afforded through the medium of the Paris Conference of Foreign Secretaries such a vivid demonstration of the validity of my orientation on the world situation, as summed up in the Outline and the sections of the Book and other material read to you, as to invest with long-term value and significance this enterprise in synthesizing the history of the atomic project with the perduring problems of national security, economic progress, and the survival of Western civilization.

Accordingly, I am submitting herewith two sets of the material that was used at our conference. The already alluded to connection between my challenge of the one-world-or-none thesis and the outcome of the Paris Conference renders advisable that the outline of the book to be included herein should be that which was used at the time. Furthermore, as indicated to you at the end of our conference and in a later telephone conversation, I have been engaged in developing the outline to encompass a more articulated resumé of the themes of the book and selected highlights of the more novel theses regarding (a) the problems of foreign policy in relation to the split triad of victorious powers; (b) the consequential reorientation on the problems of international control of atomic and related weapons and the interrelated tasks of world security; (c) the reorganization of the Defense Services attuned to the radical foreshortening of time-borrowing; (d) the newer tasks in cooperation between the Services and American industry in the effectuation of a dynamic offensive-readiness applicable to our technological industries in evocable detail; and (e) the bearings of economic and technological history upon the emergent problems of civilian atomic development.

Assuming that the interest already evinced by you will become crystallised into a final decision, the accruing additional material, which I believe I would be able to complete by the end of the month, could then be submitted for your consideration as a governing framework for the book.

The composition of the collect transmitted is given on the appended page.

With kind regards,

Sincerely yours,

Mr. Hugh Kelly
McGraw-Hill Publishing Company
330 West 42nd Street
New York City

A. <u>Background and Early History of the Atomic Bomb Project</u>

1. Reprint of opening testimony on November 27, 1945 before the Special Senate Committee on Atomic Energy, entitled "Background and Early History Atomic Bomb Project in Relation to President Roosevelt" (corrected version of testimony - which at first was given in Part I of the hearings, pages 1-29 - was presented as an appendix to Part V, pages 553-73, that completed the record of the hearings).

2. Memorandum of orientation on the interwar period submitted to President Roosevelt in the spring and the autumn of 1939, as described on pages 554-5 of the reprint.

B. <u>Contemporaneous Interpretations and Contributions to Strategic Development</u>

1. Interpretation of the D-Day strategy presented before the A. T. T. Economists Conference, June 30, 1944, and confirmation of its basic thesis by General Jodl a year later in the New York Times interview of June 22, 1945.

2. Memorandum on the "Final Phase of the European War and Emerging Phases of Far Eastern War Liquidation," October-November 1944 (alluded to on page 561 of the reprint of the testimony).

C. <u>Challenge of Prevalent Philo-Russian Views in Public and Official Circles and Plea for Policy Reorientation to Deal with Inevitable Russo-Allied Rifts</u>

1. Letter of April 21, 1945 to R. G. Wasson (a vice president of J. P. Morgan, who has been an independent student of Russian affairs). In this letter I sought to expose the crystallized myths involved in the views of Sir Bernard Pares, Walter Lippmann and publicists generally that Russian foreign policy had been directed in the Thirties to collective security and that the purge was to eliminate German collaborators.

2. Letter to General Donovan of April 23, 1945 regarding transmittal of similar material.

3. Comprehensive memorandum of April 1945 entitled "Soviet Foreign Policy, Totalitarian Processes and Russo-Allied Rifts." (As this would be over-long for the purpose, it will suffice to glance through page 1 and pages 33-35.)

4. Letter to R. C. Leffingwell of March 17, 1944 challenging the then fashionable theories about Russia expounded by Professor Sorokin before the Council on Foreign Relations and ending with a plea that "the prevalent zeal for cooperation

with the mixed Byzantine totalitarian order be matched by concern for the restoration and reflorescence of the Western democratic order."

D. Challenge in the Wake of the War's Use of the Atomic Bomb of the Apocalyptic Politics that Became So Prevalent Between September 1945 and March 1946

1. Extract from a letter to Mr. Arthur E. Morgan, December 27, 1945.

2. Letters to Mr. Lewis Douglas of January 16 and February 15, 1946.

3. Letter to General Donovan of February 14, 1946 defining the three imperatives as to (a) "rational integration of atomic and correlative maximal weapons into our war technology and defense"; (b) lifting "our current tasks in peace-making bargaining into the broader perspectives of our needs and responsibilities as the major defender of Western Civilization and our interest in the renascence of the power as well as economic positions of the British Commonwealth and Western European democracy"; and (c) the requisite institution of "select advisory groups to the General Staff and to planning branches of the Army and Navy, so that the questions can be dealt with on discovered new principles and appropriate methods during this indeterminate twilight between war and peace."

E. Outline presented on April 19, 1946 of the book on "Perspectives on Atomic Energy and World Security"

[Chron-May 1946]

May 23, 1946

Dear Henry:

Supplementing the enclosures transmitted a month ago, with the inclusion in the just completed record of hearings before the Senate Committee on Atomic Energy of a corrected transcript of my opening testimony, I am enabled to transmit to you this self-contained statement on the "Background and Early History of the Atomic Project." As the synthesis of the complex history was given extemporaneously - apart from the reading into the record of documentary material - it may be of interest to highlight two leading themes of that testimony for their bearing on the dual problems, of national security and economic development of atomic energy, confronting us in this short-of-peace sequel to the war, so out of key with the apocalyptic politics advocated by many scientists and publicists:

1. The timely acceptance and inauguration of the project by President Roosevelt stemmed from the cumulative development in the period prior to the outbreak of combat war in 1939 of a concerted attitude and concern as to the implications of the international crisis of the interwar decades; and

2. The foreshortening of the opportunity for time-borrowing under heightened war technology required then, and correspondingly requires now, a new organizational framework characterized by initial and progressive adequacy and flexibility of scale and acceleration of coordinated stages and alternatives in the fundamental research and applications.

In view of the declaration made by a distinguished group of religious leaders on the subject of the use of the bomb, the reference on page 561, paragraph 4, of my testimony deserves to be articulated in detail. The consideration given at the time of my analysis of the Finale of the War in November 1944 to "the form of the use of the bomb" was related to a series of recommendations made to and favorably received by President Roosevelt. The just disclosed report that was submitted in June 1945 by a committee of scientists of the Chicago Project includes a similar emphasis on the need for advance warning, but conditioned use on agreement and consent of the other United Nations, and so differs markedly from the earlier proposal. Specifically, the program presented in November 1944 was as follows: Following a successful test, there should be arranged (a) a rehearsal-demonstration before a body including internationally recognized scientists from all Allied countries and, in addition, neutral countries, supplemented by representatives of the major faiths, (b) that a report on the nature and the portent of the atomic weapon be prepared by the scientists and other representative figures, (c) that thereafter a warning be issued by the United States and its Allies in the project to our major enemies in the war, Germany and Japan, and (d) after an interval, an ultimatum be issued, coupled with the announcement that atomic bombing would be applied to indicated areas from which human and animal life should be evacuated within a designated time limit.

This conjunction of international auspices with advance warning and provision for evacuation of the areas to be subjected to atomic bombing, while it would have reduced the surprise impact and destruction of life, would not, save for a little delay, have diminished the military effectiveness of the threat of total annihilation in bringing about unconditional surrender. Furthermore, by enhancing our political and moral position, it would have etched in on the conscience of mankind and history the "no escape from retribution" to the aggressors.

In the unfolding of events, neither the originally recommended course nor the variant proposal urged many months later by a group from the Chicago Project was implemented, presumably due in part to the difficulties of the transition in the wake of President Roosevelt's death and the pressures upon the new Administration from the onrushing finale of the Far Eastern war.

Thus at the end, as at the beginning, was struck the note of the requisite fusion of political strategy with war technology and now also with civilian development of atomic energy, under the unresolved tensions of this short-of-peace sequel to war.

With kind regards,

Sincerely yours,

Dr. Henry P. Van Dusen
Union Theological Seminary
Broadway at 120th Street
New York City

[Br - Corresp. File]

July 1, 1946

Dear Mr. Bradshaw:

In connection with your invitation to participate, along with the Princeton group, in your imminent projections on the atomic bomb and in furtherance of our telephonic discussion, I am enclosing a couple of reprints of the revised transcript of my opening testimony before the Senate Committee on Atomic Energy. The revision was made in the very interest of historical completeness and accuracy referred to in General Groves' comment thereon last month. The contemporaneous reporting of that testimony in the Times may provide a helpful summary.

Cognizant of the high standards of accuracy and integrity that inform and pervade your documentary programs, I venture to draw the attention of yourself and your colleagues to pages 553-560 of the testimony, as providing a summary description of the advisory relationship that I bore to the late President through the period and the setting of the presentation of the proposal embodied in the letter and documents submitted to him in that visit of October 11, 1939. The accompanying documentary report on the Early History of the Project, presented August 8-9, 1945, in the wake of the use of the bomb, to the White House and to the War and Commerce Departments, contains reproductions of the documents that I submitted and read to the President. For your convenience I am adding a duplicate set of the documents that figured in the President's decision to undertake the project, followed as that was by the appointment in November that year of an advisory committee consisting of Professors Compton, Einstein and Pegram, and myself. This collect consists of the following:

1. Exhibit 1 - Memorandum on "Imminence World War in Perspective Accrued Errors and Cultural Crisis of the Inter-War Decades," dated March 10, 1939, by Alexander Sachs

2. Exhibit 2a - Letter by Professor Albert Einstein to President Roosevelt of August 2, 1939;

3. Exhibit 2b - Memorandum on recent experiments in atomic disintegration, dated August 15, 1939, by Dr. Leo Szilard, as revised by Alexander Sachs;

4. Exhibit 2c - Photostatic reprint of article in <u>Physical Review</u>, April 1939, by Drs. Leo Szilard and Walter H. Zinn, entitled "Instantaneous Emission of Fast Neutrons in the Interaction of Slow Neutrons with Uranium";

5. Exhibit 3 - Letter to President Roosevelt dated October 11, 1939 by Alexander Sachs;

6. Exhibit 3a - Conclusion of lecture in 1936 by F. W. Aston of Trinity College, Cambridge, on "Forty Years of Atomic Theory," included in the volume called "Background to Modern Science," published in 1938 by the Cambridge University Press, which the writer received at the turn of 1939.

I would appreciate your returning to me when they have served your purpose the enclosed Report and the six items contained in the above listed collect.

Will you be good enough to advise me at your earliest convenience regarding the Princeton appointment?

Sincerely yours,

Mr. D. Y. Bradshaw
March of Time
369 Lexington Avenue
New York City

[Subj.: Int'l Situation - Russia

C O P Y

BORIS PREGEL
630 Fifth Ave.
N.Y.C.

July 12, 1946

Dr. Alexander Sachs
72 Wall Street
New York City

Dear Alex:

I am sending you herewith the translation of the excerpts from the Russian Technical Press, concerning two works - one of Dr. L. D. Lendau, and one of Prof. S. I. Vaviloff. The explanation on Prof. Vaviloff's work does not seem to be very accurate and some things are not quite understandable.

As for the disintegration of the atomic nuclei by cosmic rays, you will find the following an explanation of what you asked me:

> "In 1937 a new phenomenon was discovered - multiple disintegration, or "evaporation" of atomic nuclei induced by cosmic radiation. These processes happen very seldom and for that reason the photographic emulsion presents the most convenient method for their registration. Two Austrian physicists, M. Blau and H. Wambacher found a relatively great number of so-called "evaporation stars" on photographic plates exposed for a long time to cosmic radiation on the top of high mountains. Each star is produced at a point where an atomic nucleus, heated by the passage of a high energetic cosmic ray particle, is partially evaporated. The evaporated atomic nuclei are Silver, Bromine, Nitrogen or Oxygen, the elements present in photographic emulsions. In these processes a great amount of energy is freed in the form of radiation. The number of stars increases rapidly if we expose the plates on higher altitudes. These experiments were repeated and extended by American Physicists (T. R. Wilkins and H. Shapiro) and Russian Physicists, especially A. P. Zhdanov who recently was awarded the Stalin Prize."

With my very best regards, I remain

Sincerely yours,

BP/br
enc.

BORIS PREGEL

[Chron - July 1946]
[Corresp. - Szilard]

July 22, 1946

Dear Leo:

As a result of earlier calls upon me by Drs. Halban and Kowarski and later of other members of the French Scientific Delegation, the discussion from time to time turned on the earlier history and decisive phases in atomic research. Last Saturday at tea Dr. Kowarski adduced his view that the prevailing theory which attributes to Dr. Hahn primacy in the discovery of fission is incorrect, and that the right credit for it should go to Frisch and concurrently to Joliot and himself, who independently discovered it at around the same time.

In support of this hypothesis and historical revision, Dr. Kowarski cited a passage in Hahn's article which distinguishes between what he found as a chemist and the physical interpretation, from which he shrinks.

It was when the news reached Frisch in his Scandinavian place of refuge that he completed his own work and was led to a positive affirmation of fission.

I should greatly appreciate your taking the trouble to comment on this problem at length and your giving me in full the passage in Hahn's article to which Dr. Kowarski referred. I had hoped to see you at the Atomic Institute sessions that were held in Washington a week ago, and trust that before long your work will bring you to New York.

With kind regards,

Sincerely yours,

Dr. Leo Szilard
1155 East 57th Street
Chicago, Ill.

[Corresp. Szilard]

1155 East 57th Street
Chicago, Illinois
July 29, 1946

Dr. Alexander Sachs
72 Wall Street
New York 5, N. Y.

Dear Dr. Sachs:

Many thanks for your kind letter of July 22nd.

It seems to me that Hahn's statement, identifying the radioactivity as due to barium, and tentatively mentioning that uranium might split into two about equal fragments, was the big discovery, and that everyone who learned of this immediately knew what to do to follow it up. It is my understanding that Miss Meitner learned of Hahn's results through Hahn's paper and had no suspicion any earlier that fission might take place.

This really answers the question raised in your letter and I am sorry that I cannot agree with Kowarski, for whose opinion otherwise I have high regard.

Sincerely yours,

Leo Szilard

Leo Szilard

[Corresp - Go]

File

July 22, 1946

Dear Dr. Goudsmit:

At a luncheon gathering of speakers and guests in connection with the Atomic Institute sessions held in Washington on July 15th and 16th, a question was raised by Dr. Dawes from the Carnegie Institute as to the reasons for the failure of German nuclear research during the war. Allusion was then made by Dr. Phillip Morrison and myself to your notable testimony before the McMahon Committee. At the banquet that night, where I had the pleasure of sitting alongside Dr. Morrison, the subject was again taken up with special reference to what I call the postulates of free inquiry in fundamental research. It was then that Dr. Morrison told me that you had prepared a report on the basis of an interview with a Dr. Ramsauer supplementary to your testimony, and he suggested that you are likely to have copies for distribution.

Accordingly, I should greatly appreciate it if you would send me a few copies, and if you will also indicate whether it would be proper to show one to Dr. Kowarski of the French Scientific Delegation to the Atomic Commission, who, too, is interested in this subject.

Sincerely yours,

Dr. S. A. Goudsmit
Physics Department
University of Michigan
Ann Arbor, Michigan

Gmc

THE PHYSICS LABORATORIES
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS

RESEARCH
LABORATORY
OF PHYSICS

August 6, 1946

Mr. Alexander Sachs
72 Wall Street
New York 5, N. Y.

Dear Mr. Sachs:

Please forgive me for answering your short note with such a long letter. I assure you that this is entirely against my usual habit.

Morrison informed you correctly that I have given much thought to the question of the German failure. He probably told you also that I was in a position to investigate all the German material on the uranium project and to talk to most of the men, mostly before VE day, and long before Hiroshima. In spite of this it is difficult to reach a conclusion, because such a question can not be answered in a purely objective manner, and the results will, therefore, be a matter of personal opinion.

I believe that enough warning lessons can be learned from the German failure to make it worthwhile to collect and disseminate the available information. I have tried to write some short notes about it, but so far have not been able to get them published. The reason for this is, first, that my style is very bad, and, secondly, whatever I have to say is more or less repetition of what I stated in my Senate testimony or of what has already been stated before by others. I think, however, that when it comes to learning a lesson, repetition is helpful.

There are, of course, several reasons for the German failure, and the main difficulty is to judge their relative importance. One serious mistake the Germans made was that even in their scientific work they indulged in some kind of hero worship. The better physicists in Germany had kept their exclusive confidence in the judgment of one man, namely, Heisenberg. An analysis of the uranium research work shows that his opinion was never doubted and that he was the principal source of ideas. It is clear that a problem like the uranium project is too big for one man, even the great Heisenberg. In fact, his ideas were wrong in some of the main points. I am certain that exactly the same scientific errors were made originally by our own physicists, but the divergence of opinions and an occasional strong friction between the men working over here helped the right ideas to come to the front.

I can illustrate the German mistake by a few concrete examples. Heisenberg had apparently studied only the simplest form of the pile theory. As a result all experiments used a too simple arrangement of uranium and the heavy water moderator, namely, in alternate layers. There was a group of army physicists, second-rate men, simultaneously working on a uranium pile. They were not considered competent by Heisenberg and his following. Nevertheless they guessed at and tried out an arrangement which gave better results than Heisenberg's. You can well understand the embarrassment and difficulties such an occurrence caused among the German physicists.

Another example is that Heisenberg and his following believed that it was necessary first to solve the problem of a uranium engine before one could tackle the problem of a bomb. In fact, apparently the only concept of a bomb which the German physicists had was that of an explosive pile. They seemed never to have taken the separation of pure U 235 or the production of plutonium as anything practical. They did some work on isotope separation, but merely for the purpose of slightly enriching the pile so as to make it work more easily. Of course, as you know, they never even succeeded in getting a pile to work. Houtermans repeatedly made the suggestion that a transuranic element might be separated more easily, but his ideas were mostly disregarded. At any rate, it was believed that such a scheme was still very far away in the future.

The Germans therefore thought that a uranium bomb would be a later by-product of the uranium engine. They had hoped that the engine could be constructed in a reasonable time, but did not believe that a bomb could ever be made during the duration of the war. I did not find anywhere an indication that they were aware of the enormous industrial effortnecessary to realize either a uranium engine or a bomb. The whole affair was kept rather on an academic scale, even though it had the highest priority of all scientific war work. The German physicists, due to ignorance, lacked the confidence in success which our men had. They were nevertheless convinced that they were ahead of us in uranium research. When they first heard about Hiroshima they refused to believe it, and thought it was merely propaganda.

Another very serious mistake was made by the Germans throughout their scientific work, especially during the war. It consisted in placing incompetent men in influential scientific positions. It is not necessary, of course, to have active scientists in administrative places, but a man who guides science should have certain qualifications other than a doctor's degree and a membership card in the Nazi party. The leaders of the German equivalent of our O.S.R.D. and army scientific research were definitely second-rate scientists, not so much because they were Nazis, but because they were bad administrators and lacked the confidence of the scientists for whose work they were responsible. The same thing can happen over here if a man or a committee in charge of scientific research is chosen merely on the basis of belonging to the proper political party or to the armed forces.

Morrison also mentioned to you some reports by and about Professor Ramsauer. Ramsauer, who originally was an excellent research physicist, during the war was President of the German Physical Society, and for many years had been Director of Research of the A.E.G. He was thus in an excellent position to judge about German physics. We found some interesting secret reports by him, and later I had a long talk with him in Berlin and he submitted his opinion on the failure of German physics in a written report to me. I have only one copy of his report in my possession. The material is no longer classified, but obtaining copies from the War Department or having it published by the Publication Board of the Department of Commerce is, of course, quite complicated.

Ramsauer is convinced of the key position of physics among the pure and applied sciences. He believes that physics is power, and that means, also, military power. He tried to make his view-point known to the Army authorities and the Department of Education, and especially pointed out the decline of German physics under the Nazi regime. However, he had no success. The only people who listened to him were the Air Forces Research people. In fact, that branch of war research was excellently organized, was rather independent of Nazi influence, and produced first-class results. In April, 1943, Ramsauer lectured before the German Aeronautical Academy about the organization and achievements of Anglo-Saxon physics. The main point of the lecture was to show how German physics was being left behind, not only in productivity, but also in questions of organization, which had formerly been a proverbial attribute of the Germans. He made some concrete proposals, in this speech, for the improvement of German war physics. He was also very much in favor of creating a central agency to direct all physics. He stated that if his proposals were followed up, the Germans "did not need to fear Anglo-Saxon physics". He added, "But if we are unable to do this, then God have mercy on us". This last part was eliminated by the censor in printing.

Ramsauer's report does not throw any new light on the German failure in the uranium project. He was not connected with this work. Just as over here, the Germans kept their "U-Club" (Uran Verein) rather exclusive. Within the group, however, there was little compartmentalization, merely a vague distinction between those who were actively engaged in "pile" work and those who worked on auxiliary problems of nuclear physics.

It is my ambition to make a thorough study of the various documents available which give information about war research in Germany, not from a technical point of view, but from the point of view of organization and the more human factors involved. Perhaps I can find some help in a project like this next year.

I hope that this information will be helpful to you. It is very hard to judge from a letter just what point you might want to know more about. I shall be glad to give you any further information you might want. None of this is any longer secret.

Yours very sincerely,

S. A. Goudsmit

S. A. Goudsmit

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[Chron - Aug 6 1946]

THE PHYSICS LABORATORIES
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS

Research
Laboratory
of Physics

August 6, 1946

Mr. Alexander Sachs
72 Wall Street
New York City

Dear Mr. Sachs:

.....

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The Germans therefore thought that a uranium bomb would be a later by-product of the uranium engine. They had hoped that the engine would be constructed in a reasonable time, but did not believe that a bomb could ever be made during the duration of the war. I did not find anywhere an indication that they were aware of the enormous industrial effort necessary to realise either a uranium engine or a bomb. ... The German physicists, due to ignorance, lacked the confidence in success which our men had. They were nevertheless convinced that they were ahead of us in uranium research. When they first heard about Hiroshima they refused to believe it, and thought it was merely propaganda.

Another very serious mistake was made by the Germans throughout their scientific work, especially during the war. It consisted in placing incompetent men in influential scientific positions. It is not necessary, of course, to have active scientists in administrative places, but a man who guides science should have certain qualifications other than a doctor's degree and a membership card in the Nazi party. The leaders of the German equivalent of our O.S.R.D. and army scientific research were definitely second-rate scientists, not so much because they were Nazis, but because they were bad administrators and lacked the confidence of the scientists for whose work they were responsible. The same thing can happen over here if a man or a committee in charge of scientific research is chosen merely on the basis of belonging to the proper political party or to the armed forces.

Morrison also mentioned to you some reports by and about Professor Ramsauer. ...

... In April, 1943, Ramsauer lectured before the German Aeronautical Academy about the organization and achievements of Anglo-Saxon physics. The main point of the lecture was to show how German physics was being left behind, not only in productivity, but also in questions of organization, which had formerly been a proverbial attribute of the Germans. He made some concrete proposals, in this speech, for the improvement of German war physics. He was also very much in favor of creating a central agency to direct all physics. He stated that if his proposals were followed up, the Germans "did not need to fear Anglo-Saxon physics". He added, "But if we are unable to do this, then God have mercy on us". This last part was eliminated by the censor in printing.

.....

sg/er (signed) S.A. Goudsmit

[Corresp - Gumbel]

August 13, 1946

Dear Dr. Gumbel:

Upon my return I was glad to find your essayed translation of Kowarski's article. I have attempted to check it by going over it with Miss Kronfeldt, and am submitting to you on the attached an alternative version of the first page that commends itself to me as preferable from the standpoint of faithfulness to the original and clarity of meaning. As an illustration of the painstaking effort required, take the first sentence of the second paragraph. Surely romancier is not "dreamers" but "novelists," and énoncer is "articulate" or "express," and not "promote"; whereas contaminer has to be expressed less literally as "affect"; and finally, the croissant is not "crossing," but as you correctly gave it, "increase."

It thus seems to me that the first effort was too hurried. There was more concern about giving the general sense than the precise equivalent of the French text.

As this matter of the early history of the atomic experimentation is important, I am anxious to have the Kowarski interpretation in exact form. Will you therefore go over this translation and subject it to thorough-going revision.

With kind regards,

Sincerely yours,

Dr. E. J. Gumbel
Bpx 4
Haines Falls, N. Y.

FISSIONABLE NEUTRONS AND THE CHAIN REACTION

Paper read by

L. KOWARSKI

at a meeting of the French Physical Society
(June 8, 1946)

Translated by E. J. Gumbel

The subject of this paper sums up and delimits the domain of experimental nuclear physics, the exploration of which was the first stage in the progress made toward the conquest of atomic energy. It is in this stage relating to pure physics that the pioneer effort of French science was able to manifest itself in a particularly efficacious way.

Imaginative novelists were the first to articulate the idea that liberation of atomic energy on a large scale would be possible as soon as we succeeded in creating a nuclear chain reaction - a reaction where the atoms, in disintegrating, would affect neighboring atoms in sufficient numbers so that the number of atoms disintegrating would increase with time. I found this idea fairly clearly expressed in the novel "Last and First Men," published by Olaf Stapledon in 1929. It was only natural that the professional scientists were waiting to learn something more about nuclear processes before taking the risk of expressing opinions of the same sort.

Frederic Joliot mentions the concept of a divergent chain reaction in 1934 in one of his first papers about artificial radioactivity. I believe that Leo Szilard, at about the same time, developed a more advanced hypothesis in the same direction based on data, which we now know to be erroneous, concerning the constitution of Beryllium. In this hypothesis, and those which followed, a new factor was recognized: the neutron which, at that date, had just been discovered, was particularly adaptable to the role of transmission agent from nucleus to another. In fact, it ~~was already~~ known then that the neutron is even quite able to bring about nuclear reactions of many kinds ~~of different natures~~ and especially when it is deprived of kinetic energy, whereas the particles previously known, such as the proton or the alpha particle, are efficacious only in a rapid state, and lose the ability to enter into reaction with neighboring nuclei shortly after their emission.

The problem thus boils down to the following: Is there a nuclear reaction which can be induced by the impact of one neutron and give rise to several neutrons? (Producing one neutron is insufficient, for the reaction thus propagated would not be capable of amplifying itself.) The discovery by F. Heyn in 1937 of the reaction known as ~~called~~ (n,2n) well fulfilled this definition; but, since the initial neutron had to be very rapid, and the emitted neutrons were not, the conditions necessary for the propagation of the chain reaction were not fulfilled.

[Corresp - Gumbel]

THE UNIVERSITY OF CONNECTICUT
STORRS, CONNECTICUT

Mr Alexander Sachs
72 Wallstreet
New York (N.Y.)

Dear Mr. Sachs,

Please find enclosed a clipping from P.M. which might interest you. I shall be back in New York in the beginning of next week and I am looking forward for the pleasure of meeting you.

Very sincerely yours

Sept. 12. 46

E. J. Gumbel

A-Bomb Figures In Civil Suit

A civil suit dating Oct., 1942, as a milestone in U. S. development of the atomic bomb has been filed in Federal Court here by the Eldorado Mining and Refining Co., Ltd., of Canada.

The action, seeking an accounting of $2,500,000, lists as main defendant Boris Pregel, a French citizen described as controlling the Canadian Radium and Uranium Corp. of New York and International Rare Metals Refinery, Inc.

One charge said that the U. S. arranged in Oct., 1942, to purchase uranium from the African Metals Corp., and asked Pregel to handle the extraction. Eldorado did most of the work, but received only a fraction of the contract pay, it was claimed.

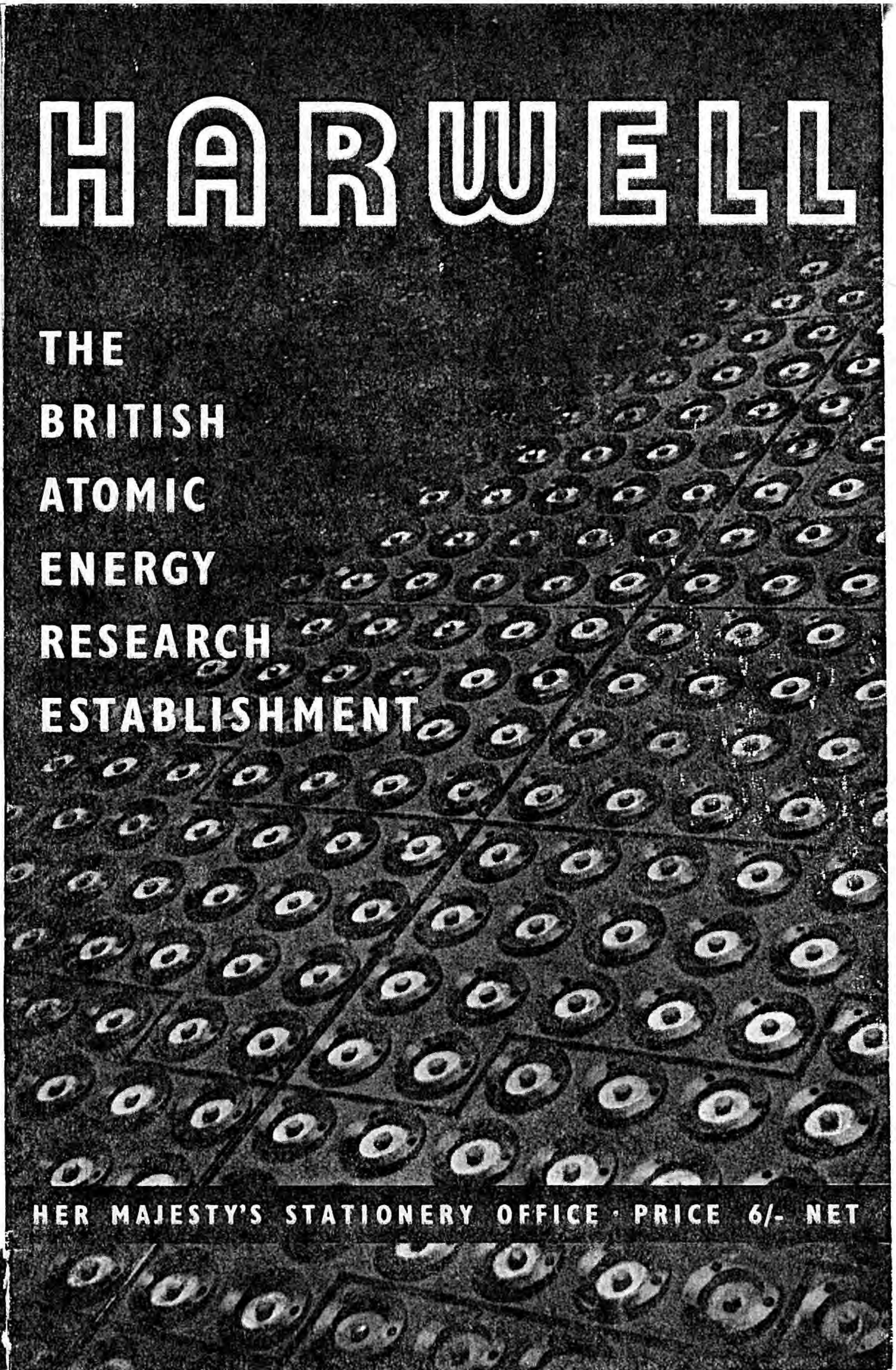
P.M. Sept 10. 46

[Econ. Extracts
Har]

1946-1951

HARWELL

THE BRITISH ATOMIC ENERGY RESEARCH ESTABLISHMENT



HER MAJESTY'S STATIONERY OFFICE · PRICE 6/- NET

[Corresp - Br]

File

January 17, 1947

Dear Mr. Bryant:

In responding to your letter of January 13th, the suggestion that the document is to be included in a book prompts, in turn, the idea that you might want to present it in its proper historic perspective and context. As you returned to me the original documentary material, I am resubmitting to you the documents that constitute the setting for my presentation of the Atomic Project to the late President Roosevelt:

A. Transcript of my testimony on November 27, 1945 which opened the hearings before the Senate Committee on Atomic Energy, entitled"Background and Early History Atomic Project in Relation to President Roosevelt";

B. The memorandum,referred to on page 555 of the testimony, of March 1939 submitted to the President, interpreting the political and economic history of the interwar decades and recommending preparedness geared to the urgency for time-borrowing under heightened war technology.

Coming to a close-up of the original presentation, it is advisable to amplify the correction that I ventured to give in the opening testimony (page 555) of certain popular misimpressions that have come to be popularized. In the wake of the article by Dr. Leo Szilard that was published in the <u>Physical Review</u> of April 1939, further experiments were made in June that year by Drs. Fermi, Szilard and Anderson, the outcome of which was to encourage the hope that by using ordinary uranium a chain reaction could be set up. In the closing days of that month of June a meeting was held of the American Physical Society at Princeton at which a representative of the research departments of the Services was in attendance. With the approval of Dr. Pegram, the head of the Physics Department of Columbia University, this technical advisor was approached for governmental aid in the pursuit of the next stages of the experiment. By that time, as I testified, the work had already gone beyond the work on uranium fission in Germany by Drs. Hahn and Strassmann, the importance and import of which had been discussed by Dr. Nils Bohr of Denmark in his visit to the United States and particularly at Princeton early in 1939. The negative reaction of the Services was foreshadowed in the oral comment by the technical advisor of the Naval Research Laboratory in attendance at that Princeton meeting of the Physical Society. It was formally and definitively reaffirmed in a letter, copy of which happens to be in my possession, that was sent to the inquirer at Columbia.

In view of the inability of the Columbia scientists to secure governmental interest, it was decided in consultation with me to approach the White House, as stated in the penultimate paragraph on page 555 of the testimony. The broad plan of procedure suggested by me was to prepare a dossier for the President composed of the following: (a) a history of the research thus far, with special emphasis on the significance of the path-finding work in Germany and the new avenues being opened up in the United States, looking to a chain reaction from uranium fission; (b) a corroborative letter from Dr. Einstein, as the outstanding scientists known to and esteemed by the President; and (c) a letter- memorandum by myself linking up support of the scientific work - which was the main aim of the scientists - with the broader international problems and defense strategy that had already engaged the President in the light of my prior conferences with him.

It remains to underline what was stated in my testimony, that while the documents were being prepared in accordance with the procedure I had worked out, the culminating international crisis passing into war necessitated the concentration of all of the President's energies upon the revision of the neutrality laws passed prior to the war. As I was in touch with the White House during those critical months, I was keenly aware that Presidential action of a favorable kind could not be secured and, what was more, in the super-emergency the President would transfer the consideration of this problem of governmental aid to the very technicians in the Services who had already acted unfavorably on the proposal that had been submitted to them by the Columbia Department of Physics in June of 1939. Accordingly, I deliberately deferred scheduling a conference with the President on this subject - the general tenor of which had been indicated - until it had become clear that the Neutrality Act revision issue was out of the way. Hence the opening sentence of the revised letter that I gave him in my conference with him on October 11, 1939 read: "With approaching fulfillment of your plans in connection with revision of the Neutrality Act, I trust that you may now be able to accord me the opportunity," etc.

The enclosed response to your requests consists, therefore, of this triad of documents forming Exhibits 2A, 2B and C that were filed for the record as an integral part of my testimony and that had been included in my prior report of August 8-9, 1945 to the new President and the then Secretaries of War and Commerce.

Sincerely yours,

Mr. W. S. Bryant, Jr.
Director of Research
The March of Time
369 Lexington Avenue
New York 17, N. Y.

January 18, 1947

LChron - Jan 1947
6.

Extract From

THE ROLE OF IDEAS ON THE ACCUMULATING WORLD CRISIS OF THE THIRTIES AND THE SITUATION AT THE OUTBREAK OF THE SECOND WORLD WAR IN THE CONVERSION OF PRESIDENT ROOSEVELT TO THE ATOMIC PROJECT

I. Orientation on the Nature of Totalitarianism, and the Problems of the Thirties Up to Our Entry into Combat War

1. Just because the salient fact about this postwar has been the unavailability thus far of a viable peace settlement - such as was accomplished in 1919 and provided for a decade a workable basis for postwar reconstruction - it is important to recognize and treat as a continuing background of this epoch the crisis that began with the breakdown in the Thirties of the first postwar reconstruction. Moreover, it is important to recognize that the breakdown has been due to more than economic forces. The fundamental causes and broader aspects were stressed in submissions by this "economic Jeremiah" from the outset of the Great Depression, and were summed up as follows in a memorandum of late 1932 to the then President-elect, Franklin D. Roosevelt:

> "The outstanding feature of this great depression is that the economic order developed since the Reformation and the Great Society developed since the fall of the Roman Empire have come to be threatened not by the destructive impact of external or natural forces, but by a disintegration from within because of an incipient failure of concerted will and political wisdom." ("Selected Memoranda on Problems of National Recovery."

To complete this sketch of the background and to provide both comparison and contrast with the present situation, it is necessary to add that following the German reoccupation and remilitarization of the Rhineland, the thesis was submitted to the late President Roosevelt that German aggression had entered upon a stage of accumulating criticalness for the West. This was by way of marked challenge to the position adopted by the leading public figures and academicians of the English-speaking world, who had interpreted that flagrant act of aggression upon the postwar settlement as but the finale of liquidating the presumed inequities and iniquities of the Versailles Treaty. The concurrent proceedings of discussions at Chatham House on March 18-25 and April 2, 1936 bore witness to the widespread bemusement not only of the political leaders, but of prominent historians, social scientists, and public figures generally with the German apologetics for the expansionism of the mid- and later Thirties, that was keyed into self-determination for their own national minorities and the alleged German "have not" position in relation to economic resources. With the exception of a small minority of the twenty-four speakers - though ably represented by Harold Nicolson, Wickham Steed, and the Earl of Winterton - the large majority of the twenty-four conference discussionists accepted the Rhineland reoccupation and approved the tenor of the interpretation given by the Director of Studies at the Royal Institute of International Affairs. Because of the neglect throughout the Twenties of the task of dispelling the errors about the Peace Conference that had come to be propagated at its very inception, under the impetus of Keynes's "Economic Consequences of the Peace," the influential public opinion of the second interwar decade had become attuned to and a resonator for the German-Nazi apologetics and propaganda. At that momentous conference of political thinkers and figures, Professor Arnold J. Toynbee, fresh from a visit to Germany and a visit with Hitler just before the departure, as he described it, of "the Chancellor and Herr von Ribbentrop to the country where they had probably decided upon the plan of entering the Rhineland," gave the following interpretation of the situation, - in the indirect repertorial form employed in the report of the proceedings:

"The real crisis was not so much the immediate problem in the Rhineland as that of Eastern Europe. It was because France had made a treaty with Russia that Hitler had gone into the Rhineland. Mr. Toynbee considered that British policy towards Eastern Europe might be a decisive factor in determining German policy in that quarter at the present moment. It was certain that Hitler wanted our friendship, and he might even be prepared to pay a rather high price in order to get it. It was also true that Hitler was on strong ground with his own people when he was able to say that he was demanding the restitution of Germany's rights; but he would be on much weaker ground if he were to go out frankly to acquire something which Germany had never possessed before, as would be the case, for instance, if he were to take up the Rosenberg Plan. It would be more difficult to carry his people with him over the non-German regions of Eastern Europe, and the backing of the people is of even more importance with a dictatorial government than it is with a democratic government. In this matter, he would be much more likely to be swayed by the general attitude of Europe than he would be in anything that touched the restitution of German rights. His policy towards Eastern Europe was probably not yet decided, and the line we took would make a great deal of difference." (Special Supplement to "International Affairs," of the Royal Institute, p. 18, April 1936)

By contrast with that, in a review of the then situation with th President, a thesis was submitted that has applicability to the current as well as to the conflict of the Thirties between the totalitarian systems an our democratic order. The thesis started with a differentiation of totalit ianism from the types of tyranny and dictatorship previously known to histo ranging all the way from the Greek and the Roman to the medieval to the Tsa ist. Whereas the older type of absolute personal rule effected some adjust ment with customary or traditional power, however truncated in scope, the n absolutisms of postwar Russia and Germany were built upon the negation - wi the aim of total suppression - of all other internal power. They are thus far different from alternative or arrested types of political development, and are instead retroversions, mediated by contemporary mechanical and psyc logical technology, towards a primitivism of the social order reduced to brute power. The definition developed later in the course of the "White War" victories of the Nazies was, to quote a still later use of it in connection with the finale of the European War, as follows:

> "Tyranny implemented with modern technology, deliberately uprooted from the Western tradition of an ecumenical order of law and conduct that in principle has been common to the variously articulated societies that compose the Great Western Society particularly since the Renaissance."

2. The occupation of the Rhineland on March 7, 1936 was the turning point. From that event on, Europe became clouded over by war, or to use the extraordinarily relevant and illuminative expression of Thomas Hobbes, "war weather," as a state of unassured peace. This concept from "The Leviathan" was the source of cumulative thought and application in the conferences with President Roosevelt from 1936 on, as alluded to on the second page of my testimony before the Senate Atomic Energy Committee at the end of 1945, to be dealt with later on herein. The accrual of "war weather," took the forms of the following succession of international events: (a) the Spanish mixed internal party and class war and external competitive invasions, (b) the resumed Japanese aggression on China, (c) the Soviet purges as internal war for the attainment of monolithic power, and (d) the Munich Agreement of September 29, 1938 as abdication by the West to Germany of Central as well as Eastern and South-Eastern Europe.

Shortly after Munich, a submission to the President, in the form of a memorandum that was read aloud, contained the following adaptation of the Hobbesian concept to the then situation:

"The orientation towards the world crisis that has been developed in prior reports and needs to be borne in mind continually is that we are already in what Thomas Hobbes, who lived through the British civil war 300 years ago, justly called 'war time tract' and 'war weather.' 'For war consisteth not in battle only but in a tract of time wherein the will to contend by battle is sufficiently known. For as the nature of foul weather lieth not in a shower of rain but in an inclination thereto of many days together; so the nature of war consisteth not in actual fighting but in the known disposition thereto during all the time there is no assurance to the contrary.'" ("The Leviathan," Part I, Chapter 13, Section 62)

Then on the eve of the completion of Nazi control over Czechoslovakia in mid-March 1939, a synoptic review of the interwar period was submitted to the President - that with permission was given as an address before St. John's College at Annapolis - on "Imminence World War in Perspective Accrued Errors and Cultural Crisis of the Interwar Decades." The ensuing phase from the spring to the autumn of 1939, when placed against the historical mural just provided, is dominated by a configuration of executed Soviet policies that must be reinterpreted and redesignated. In essence it (the Pact) was an elaborate arrangement containing (a) an Eastern equivalent of the Rhineland occupation, (b) Soviet acquiescence in German occupation of strategic gates to the East and South-East; but (c) a Soviet acquired reprieve interpreted by it as a deflection of the Nazi attack to the West in the hope that both would be exhausted at the end of the war, and (d) joint participation in what was regarded by the Soviet leaders as a continuation of Tsarist-Prussian diplomacy in the re-partition of Poland and the Balkans.

But these newer types of tyrannies, as already indicated, have an inherent aversion to the processes of power-sharing and power-balance. That prevented the Nazi leadership from pursuing a longer-range policy of delay and cunctation that might have served it well. Correspondingly, it prevented the Politburo from pursuing a policy of accommodation to the Nazis. And so it undertook, immediately after the partition of Poland, campaigns of absorption applied to borderland countries, and made inroads upon the Nazi sphere of influence. Thus by the momentum of the internal dialectic of totalitarian systems and their mutual mental imperviousness came the Nazi invasion of Russia on June 22, 1941, after Germany had acquired the previous year control over strategic Continental Europe, and after it had embarked in April 1941 on the conquest of Yugoslavia and Greece.

II. The Bearing of this Orientation on the Conversion of the President to Undertake the Atomic Project as the Instrument for Placing the United States at the Head of War Technology

1. The interpretation of the world situation during the interwar period, as described, played a major role in persuading the President to undertake the initial scope of the Atomic Project and in securing his resolute adherence to its effectuation during the war; and it was in mindfulness of the importance of that role that the introductory part of this writer's testimony on the "Early History of the Atomic Project in Relation to President Roosevelt" was devoted to a definition and evocation - albeit in much more summary fashion - of the main themes developed herein thus far. ¶ Thanks to the accumulative awareness of the portent of the Nazi toalitarian power and a sustained interest over the Thirties in its victims - that was cannalized in aid to scientists - the present writer watched the progress of German science in relation to war technology. And as a by-product of association with refugee scientists and connections in England, he followed a notable series of ten lectures that were delivered in Cambridge in 1936 and 1937, with the progress in physics and atomic physics covered in two lectures by

the late Lord Rutherford, and the trend of atomic research by F. W. Aston. The book containing these lectures, entitled "Background of Modern Science," was received after Munich. The turn of the year witnessed the publication in Germany of the successful atomic fission by O. Hahn and F. Strassmann. The concurrent and sequential researches by his friends - which aimed to establish a chain-reaction from the fission - led him to read the original article by Hahn and Strassmann, and to be struck by the penultimate paragraph, stating that "as nuclear chemists connected to a degree with physics, we could not make up our minds to make such a sudden jump contrary to all known results of nuclear physics, and that there is still a possibility that a series of coincidences might have deceived us in our results." The assurances given by friends that this was the most crucial experiment in contemporary physics, and that the next problem was the possibility of a chain-reaction betokening the utility of fission both for explosive and energy purposes, heightened this writer's interest and concern. For there reverberated through his mind the concluding hope and warning of F. W. Aston's lecture by way of answer to those who focussed on the destructive implications and consequences from such research:

> "Personally I think there is no doubt that sub-atomic energy is available ~~or~~ all around us, and that one day man will release and control its almost infinite power. We cannot prevent him from doing so, and can only hope that he will not use it exclusively in blowing up his next-door neighbor."

Thus a new type of Jeremiahesque concern about the portent of Nazi leadership in this research overcame the writer. By June 1939, Fermi, Anderson, and Szilard completed at Columbia University an experiment which, in the language of the last of the three, "raised our hopes that we shall be able to set up a chain-reaction using ordinary uranium." At the Princeton Meeting of the American Physical Society held during the closing days of June, Drs. Szilard and Fermi approached Mr. Ross Gunn, the Technical Advisor of the Naval Research Laboratory, with a view to securing Navy support for setting up the work on such a chain-reaction. The response on July 10, 1939 was a complete negative. The subsequent efforts by Dean Pegram of the Columbia physics department faculty and Graduate School were equally unavailing. It was thus that the task was entrusted to the writer to make representations to President Roosevelt, and in the ensuing months a collect of material was prepared, inclusive of drafts of letters to be signed by scientists known to the President, - preeminently Dr. Einstein. Though the collect was available by late August, the President's preoccupation with the imminence of the outbreak of war and the requisite removal of the Neutrality Act induced the writer to defer the presentation until the President could accord him time and thought appropriate to the magnitude and import of the Project.

It remains to emphasize that the President, once apprised by the writer of the implications of the atomic research for preparedness, was struck by a dual need: to prevent, in the language quoted from the original conversation, "the Nazis from blowing us up," and what was of equal importance, to prevent the Nazis from exploiting such progress as they would make for the purpose of the induction of fear and terror in our population.

2. The next and culminative stage in the Project came in the late spring and early summer of 1940, when after the fulfillment of the forebodings that had been voiced in communications about the envelopment of the Lowlands, Norway and France, the issue was whether to pursue the Project

with the andante movement of university physical research - then acceptable to and preferred by most of the scientists involved in the work - or so to accelerate the tempo and enlarge the scale as to render highly probable the fulfillment of the final end, - the production of an atomic weapon. While this problem was discussed towards the end of the testimony, on the basis of documentary material, the abbreviation imposed by the Chairman led to certain omissions which were but adumbrated in the contemporaneous record left with the Committee. It was then maintained before the President that a radically new historical departure in approach and method was needed: Whereas on the historical pattern, and particularly the development of the radio from the Hertzian waves of the early Eighties, the normal time-requirement for atomic power and weapons would be a generation, our aim had to be to telescope the work in a tenth of the time, - three years. Hence, instead of proceeding from the small and the tentative to the large and thorough, instead of experimenting by limited trial and error until the attainment of the tested-out alternative, it was incumbent to prosecute the experiments on a diversity of stages and phases, and to counterpoint the alternatives, and thus to avoid that tendency to premature crystallization and rigidification of theory and practice that, in conformity with their ideology, might well come to characterize the experimental activities of the Nazi scientists.

3. The moral that was drawn by the two conferees, President Roosevelt and the writer, who were reflecting on that extraordinary piece of unhistorified history in the summer of 1940, so overladen with darkness for the democratic cause, was the following: Although Nazi Germany had the lead in atomic research, the monolithic character of the regime and its

systemic exclusion of the play of free and pluralistic thought would militate against the progress of atomic research just because it was so new and just because the required condensation of the normal historical course for the evolution from an idea into a finished instrument would call for pluralistic novelties and resourcefulness. The President summed up his conclusion and conviction by saying, "I almost think there is something providential about the challenge and the opportunity put up to the American democracy and people."

[Subj. File: US - Post War Recon

October 22, 1947

Subject file

Int'l (U.S. Position ... Defense)

<u>ATOMICS, THE AMERICAN-SOVIET SPLIT, AND THE INTERNATIONAL DRIFT TOWARDS WAR</u>

(Conference with Dr. Leo Szilard at His Request)

I.

Dr. Szilard submitted a proposed article for the <u>New Yorker</u> in the form of a fantasia on a Soviet trial of him as a war-criminal in the event of a Soviet conquest of the United States. The presumed antecedent events were that biological warfare forced the unconditional surrender of the United States because of the loss of life by children. In the wake of that, an atomic physicist arrested him and gave him the option of collaboration or standing trial. The alluded to position that he had adopted against the use of the bomb and his refusal to continue atomic bomb research after the war were held points in his favor. In addition to the trial of atomic scientists, President Truman and ex-Secretaries Byrnes and Stimson were tried for having violated the UN Charter and having resorted to the type of indiscriminate warfare that under the Nuremberg Trials was regarded as constituting criminal warfare. One of the basic charges was that on the basis of the report of the U.S. Strategic Bombing Survey it was not necessary to use the bomb to end the war with Japan. The conclusion of the fantasia was that the sentences were not executed because the virus let loose by the Russians was afflicting their own children and the anti-virus - while it worked in the laboratory - could not work in mass-production. So American scientists and the American pharmaceutical industry had to be mobilized to engage in the campaign. This led to the adoption of a different policy towards the United States and the restoration of sovereignty, etc.

My advice was not even to offer such an article for publication because not only would it be misinterpreted, but because it was based on the entirely wrong assumption that America had anything to apologize for in the use of the bomb, and that one can be detached about the conflict between the United States and the Soviet. To my mind the bomb had to be used against Japan, notwithstanding the retrospective picture by the Bombing Survey of how far gone Japan had been. Without the bomb the various armies in the field would not have yielded to the orders of the Emperor; and in the light of the political assassinations instigated by the military in the period of the Thirties in the interest of military aggression, the probability was nearly a certainty that the Japanese armies in North China and South - East Asia would have continued the war on their own. Independently of that, the policy deadlocks with Soviet Russia are of Soviet making, and it is the duty of Americans - including that of the atomic scientists - to stand back of the Government policies of firmness towards Russia and aid to the countries that are not dominated by Soviet Russia and that are willing to cooperate in peace and reconstruction.

There was a second article which he showed to me and which is being scheduled for early publication in the <u>Bulletin of the Atomic Scientists</u>. It is an open letter to Stalin to work towards peace. But as a prelude to a concrete peace proposal to him for the amelioration of world tension it is proposed that Stalin engage in direct propaganda with facilities for counter-statements by us. While the objections that I voiced for the proposed article for the <u>New Yorker</u>, and my inference would be that it would not be offered for publication, the second article is in a sense already in the works.

Turning to an articulation of objections for my own personal record, as distinguished from the more circumspect interchange with Dr. Szilard, because I do not share Dr. Szilard's political outlook and because I hold that outlook to be grounded much more in naivete than in ulterior motivation of external sympathies. First and foremost I challenge his view that there can be any case for moral neutrality on the part of any American or any member of the Western European world in the struggle between the two policies. The assumption back of his thought - and of the dominant elements in the Chicago physical and social science concerned with atomic physics and world government - is equivalent to the appeasement theories of the middle Thirties as espoused at the time by men like Arnold Toynbee and Lord Lothian. The relevant statement of Dr. Toynbee, as given in that series of conferences in Chatham House after the German reoccupation of the Rhineland, is as follows:

> "It was certain that Hitler wanted our friendship, and he might even be prepared to pay a rather high price in order to get it. It was also true that he was on strong ground when ... he was demanding the restitution of Germany's rights ... The present rulers of Germany were extraordinarily undecided themselves ... and our actions might be the deciding factor in the shaping of their policy."

What might be called the "Chicago school of thought" towards the contemporary international crisis - as revealed in the apocalyptic politics of Chancellor Hutchins particularly, more moderately by Professor Urey, and more annoyingly by Professor Szilard - starts from a similar assumption that Soviet Russia has a case because we did a wrong in using the bomb, and have not provided a basis for security for Russia subsequent to the use of the bomb. During the White War of Hitler I challenged, in direct conversations with Toynbee as far back as 1931 and with Lothian even more frequently, the view that Hitler had a sound case, and that the motivation was the alleged one of unifying German nationals instead of preparing for war and extracting concessions by continuous undermining of European peace and anticipatory prevention of the organization of defense. While I have not disclosed my views to Dr. Szilard because I have consistently held him to be obtuse on political problems, I have maintained in my conferences with the late President and with other eminent Americans that the policy of conciliation towards Russia was foredoomed to failure! Beginning with my memorandum of April 1943 on "Soviet Foreign Policy, Totalitarian Processes, and Russo-Allied Rifts" I have held that the fostering of schisms and exploitation of the war situation and the postwar difficulties would be the Soviet policy. Indeed, before the President went to Warm Springs he had heard from me that Russia would follow a policy of "no-peace, no-war" after the end of hostilities. Earlier, in my memorandum of October-November 1944, I urged that my conviction that Japan would have no alternative but capitulation after a German defeat, that the Far-Eastern War should be prosecuted without Soviet aid, and that the recommended modification of the unconditional surrender formula should be worked out forthwith so as to provide inducement for a coup d'etat by the Imperial Household and the liquidation of the Far Eastern War quickly after the end of the European War, - and using what I called "the exponential weapon" in the context of such a reoriented political and military strategy.

Returning to the talk with Dr. Szilard, the question was put to him by me for general significance, as to the extent of the Soviet's use of German scientists. He replied that while a great many have been taken in, the most important of the German physical scientists used are Professor Hertz - a son of the great Heinrich Hertz - and Professor Volmer. These are eminent physicists in their late fifties. In Dr. Szilard's opinion it is work in biological warfare that may be fraught with greater danger by reason of the marked progress that Russia has made in medical and biological research. It was out of mindfulness of that - in his fictional sketch prepared for an audience like the <u>New Yorker's</u> - that he assumed that in the event of a war and Russian success it would be through biological warfare.

October 22, 1947

II.

When we turn to consider the probable ways in which the present crisis may unfold, it would seem that this tension cannot continue indefinitely and that once America has embarked upon a great rearmament program, incidents could arise.

There are those who hold that America would not engage in any preventive war, - all the more so because so many elements of the American public feel somewhat conscious-stricken over the resort of the bomb against Japan. But how can a state of war-readiness or war preparation without active resort to war be carried on in practice? In the past, defensive rearmament only followed aggression by another power against unprepared powers that could still struggle. Thus the United States had the time for preparation while Continental countries were overrun and Britain was fighting. American preparedness was consummated in three stages of increasing magnitude and scope: Between the fall of France (June 14, 1940, when the German Army entered Paris and the 21st of June, when the Franco-German Armistice was signed), the Battle of Britain (September 1940) and the German invasion of Yugoslavia and Greece (April 6, 1941) the main program of defensive rearmament was laid out. Then from the German invasion of Russia on June 22, 1941 and up tothe attack on Pear Harbor (December 7, 1941) the big capital expansion program for arms production was executed. Finally, from the reverses suffered by the United States in the Philippines (culminating with the surrender of Bataan on April 9, 1942) and the losses of the British and Dutch positions in the Far East (the fall of Singapore, February 15, 1942), the bombing of Dutch Harbor by Japan (June 3, 1942) and the unsuccessful Allied operations on the Continent (the raid on Dieppe in August 1942), the preparations had gone far enough to permit the landing of American and British troops in Morocco and Algiers (on November 8), and then the opening of the Russian counter-offensive to save Stalingrad (on November 19, 1942), which culminated with the breaking of the siege of Leningrad (on January 18, 1943) and surrender of a large part of the German Sixth Army in Russia (on January 31, 1943), - all of which were the sort of minor military operations and checks to the enemy that facilitated the major use of 1943 for the completion of America's capital goods preparations and entry upon volume production of armaments as Lend-Lease for the Allies and as means of war prosecution for the major offensive of 1944, focussed on the invasion of Normandy in May 1944. In sum, war preparedness on the new technological plane for decisive strikes took the United States from late 1940 to at least late 1942, or fully two years, while during all this time other peoples absorbed the shock.

By contrast, in the present short-of-peace postwar - that might become prewar - there are no corresponding shock-absorbers. What then would be the procedure for prosecuting the war against Russia if Russia took France and Italy - and it could do this by the movement of its armed forces. We would act promptly. But if this should take place within the next half year, we would still be lacking the air-force, the army and naval forces, and the materiel of war. Accordingly, the hypothesis is suggested that this very unavailability of a shock-absorber would call for resort to the atomic bomb in order to destroy the Russian technological base for war preparedness. This would leave Russia merely in possession of its army and the use of that army for taking over the Continent. If it did take over the Continent, could it make the Continent - with its superior technological talent and technological machinery - enable it to prepare for war? We certainly could use the time - say for two years - to effect adequate preparedness for launching attachs.

[Ecm. Extracts, Bo]

Det Kgl. Danske Videnskabernes Selskab.
Mathematisk-fysiske Meddelelser **XVIII**, 8.

THE PENETRATION OF ATOMIC PARTICLES THROUGH MATTER

BY

NIELS BOHR

KØBENHAVN
I KOMMISSION HOS EJNAR MUNKSGAARD
1948

September 3, 1948

Dear Simon:

Since your generous offer in mid-June of good offices with the President, I have been awaiting the completion of and your return from vacation before submitting material bearing on the according of recognition for my war services.

Against the background of long and confidential service to President Roosevelt, dating back from 1933, there emerged into public prominence as a result of the Smythe Report - published several months after his untimely death - my role as the originative proponent before him of the Atomic Project in 1939, and later, on November 27, 1945 - in connection with my testimony as the opener of the hearings before the Senate Atomic Energy Committee - allusion was also made to the service performed for the President in November 1944 as the proponent of a reoriented political strategy towards Japan - in the memorandum on "The Final Phase European War and Emerging Opportunity for Liquidating Far Eastern War" - that served as a basis for the climactic military strategy which so markedly foreshortened the duration of the Japanese War.

During your vacation interval there occurred the surprise of the inclusion of my name in the list of honors by the British Government through the new Ambassador, Sir Oliver Franks, in completion of the honors and awards for war services. The citation read at the ceremony at the British Embassy was as follows:

> "Honorary Commander of the Civil Division of the Most Excellent Order of the British Empire
>
> Doctor Alexander Sachs' intelligent stimulation of effective ideas and his unusual activity in the field of technical research had a profound effect upon the course of the last war. His particular achievements as Economic Adviser to the Petroleum Industry War Council in 1942 and 1943, and later as Special Consultant to General Donovan, were of the utmost practical value to the Allied Cause."

The transmission of word about this to a limited number of friends and colleagues during the war evoked a variety of tributes from which there is selected for your attention just two from the former War Secretary, Judge Patterson, and the military administrator of the Atomic Project, Lt. General Groves. And the responsive greeting a few days ago by General Donovan upon his return may be linked up with the original reaction and tribute of Sept. 21, 1945.

The award by our collaborative ally in the Atomic Project of the selfsame C.B.E. honor that had been accorded to such American associates in the Atomic Project as President Conant of Harvard and Professor Arthur H. Compton lends special timeliness to your suggestion of the corresponding award by our own Government to the initiator of the "Presidential Medal for Merit in recognition of distinguished war service."

The approach of the anniversary of the original submission to President Roosevelt on October 11, 1939 provides an extraordinary topical opportunity for using the occasion (a) to dramatize the farseeing and courageous statesmanship of the President, (b) to feature the salutary functioning of the deliberative democratic process through the interaction of public-spirited citizens, as represented by the individuals who approached the President after the technical advisors of the Services had turned the Project down in June 1939 (see letter of July 10, 1939) and who after securing his favorable consideration were contacted with such governmental officials as Dr. Lyman Briggs, Director of the Bureau of Standards (who, too, should be accorded some recognition) and who then through joint re-deliberation with representatives of the Services laid the groundwork for the timely implementation into the most novel instrument of war technology. The current reversion to more primitive democratic forms of people's courts rendered the more undemocratic by the contemporary technology of emotive publicity trials is fraught with the danger of, on the one hand, abridgement of the fundamental right in a democracy to fair trial by independent judiciary, and, on the other hand, of the submergence of the deliberative and consultative functions of governmental organs in association with individuals and groups of citizens as was signally illustrated by the origination of governmentally fostered atomic research and the organization of the great Atomic Project. That process as it functioned in 1939 harks back to and harmonizes with the original conception of the American type of government as formulated in the very first number of the Federalist: "It seems to have been reserved to the people of this country by their conduct and example to decide ... whether societies of men are really capable of establishing good government from reflection and choice."

For the facilitation of your kind undertaking I am submitting herewith a copy of the original documentary historical report prepared and transmitted August 9, 1945 on the "Early History Atomic Project in Relation to President Roosevelt, 1939-40" and a reprint of my testimony of November 27, 1945. After the weekend I shall also submit to you a convenient dossier on the war work involved, which while dominated by (a) the Atomic Project, also included (b) a technical plan for Atlantic security lanes against submarines that was eventually put into effect, (c) rationale that led to the construction of a network of petroleum pipelines for transporting oil to the Atlantic Seaboard and correlative instruments for the "upbuilding of oil stocks in the United Kingdom as a pivotal base for offensive warfare against the Continent," (d) the gauging of our accumulation of superior power over the Axis and the consequential timing of the finale of the European War, and of the special opportunity, in this writer's judgment, that emerged at the beginning of 1945 for accelerating liquidation of the Far Eastern War with the aid of the "exponential weapon," and (e) supplementary advisory services, such as the special one to General Donovan from the inception in 1941 of the activities that were later structuralized in the Office of Strategic Services.

With kind regards,

Sincerely yours,

Hon. Simon H. Rifkind
United States Court House
Foley Square
New York City

Enc. No. 13
[Chron File. Dec. 1971]

March 24,1949

Dr. Alexander Sachs
72 Wall Str.
New York City

Dear Mr. Sachs:

I thank you cordially for your masterpiece of a letter. ...

With kindest regards,

sincerely yours,

A. Einstein

Albert Einstein.

[Corresp. - Commins]

File

June 21, 1949

Dear Mr. Commins:

I want to thank you for your note of June 20th and for your observations regarding the incidental material sent you. In keeping with the French expression that what goes without saying may go better when said, let me refer you to the opening characterization in the May 2nd letter of the collect transmitted to you, - namely that it dealt with "correlative to tangential issues."

I take it that the main subject of our concern is the potential interest in a book on atomic energy and world security. This would cover not only the history of the Project, but what has been and continues to be neglected, - the political strategy that was the basis for the efficacious use of the atomic bomb. There is an unwritten chapter involving Mr. Forrestal's courageous contribution in marked deviation from the views of the Services. Without attempting to summarize, some noteworthy hints and penetrative lights on these problems are contained in a letter to Mr. Lewis Douglas of February 26, 1947. As to the larger historical setting, which even in my long testimony was too summary, you may be interested in the enclosed statement of the beginning of 1947 prepared for a high Government official. But the past would have to be linked up with the present and would have to take into account not only the impasse in the UN negotiations, but a reorientation on the problem of international sharing, with due mindfulness of the dilemma created for us by M. Joliot-Curie. In contrast with the international-legalistic approach there are recognized concepts and techniques in inventions ~~patent licensing~~ that are both suitable and protective, and these could afford a new basis for going forward in collaboration with those meeting tests that would be outlined. Even though this designation of my approach is too sketchy, it contains a germ of an important idea that I must ask you to treat as confidential, and have for this reason so designated this letter.

Finally, as one who has been something of a pioneer in the fusion of the historical perspectives of science and economic and social progress, the discussion of atomic energy and world security has to be dovetailed with the economic and social transformations in the wake of the prospective inauguration of the Atomic Age. A century ago, John Stuart Mill, in the first edition of the "Principles of Political Economy," summed up the interaction of the Industrial Revolution and the economic order in terms that proved to be far too foreshortened and pessimistic: "Hitherto it is questionable if all the mechanical inventions yet made have lightened the day's toil of any human being! They have enabled a greater population to live the same life of drudgery and imprisonment." I venture to submit that a century hence a prospective author writing to another publisher would be justified in regarding contemporary economics and politics as equally foreshortened and pessimistic with regard to the opportunities for the currently anathemized welfare state.

With reciprocated thanks for the stimulating experience of having met and talked with you,

Sincerely,

Mr. Saxe Commins
Random House, Inc.
457 Madison Avenue
New York City 22

(Corresp.: Finney)

File

January 27, 1950

Dear Mr. Finney:

In furtherance of the preliminary review that you were kind enough to afford me yesterday of your draft article, I should like to submit a few more suggestions.

With regard to page 1, the middle paragraph, it seems to me, should be preceded by the immediately subsequent paragraph dealing with the memorandum and that a background should be provided by means of the basic thesis of the memorandum as to the need for and kind of peace formula for Japan. The term "negotiated peace" used in paragraph number 7 falls short of the requisite accuracy of definition for the political-strategic framework in which the bomb was to be used, and indeed was used. The penultimate paragraph on that page, regarding the destruction of copies, involves a confusion between the memorandum of end-October-early November 1944 and the proposal of the invited international witnessing of the demonstration. It is only the formulation of the international auspices that was left without the preservation of a copy. The memorandum on the finale of the war in Europe and the opportunity for hastening the end of the war in the Far East was not regarded as confidential in that sense, and its content was later discussed with General Donovan, whom I served as a Special Consultant, and who received a copy of it, I believe, early in 1945. Accordingly, I would suggest a coordination and revision of the paragraphs in the second half of the page along the following lines:

> In a conference and in a preserved memorandum for it at the end of October 1944, bearing the title "Final Phase European War and Emerging Opportunity for Liquidating Far Eastern War," he had urged the President to effect "a new political strategy for the surrender by the resurgent Imperial House of the homeland in order to save it from total annihilation." This attitude toward the problem of Japan was foreshadowed in a letter he had written to the President on May 8, 1944, commenting on submitted charts and projections on "the progressive war efforts of the Grand Alliance against the Axis." In that letter he stated that "victory over Germany will accelerate the defeat of Japan earlier than has generally been regarded as the differential time-span between the

two ends of the Axis." The key of the "new political strategy" recommended in the autumn of that year, 1944, was a proposed modification of the unconditional surrender formula, because he deemed it to be true that "the social structure of Japan is in a far better position than Italy's was to effect an exit from the war" due to the fact that "the Imperial Household has preserved its intimate association with the leaders of ... classes that can point to a record of resistance to the aggression of the militarists upon the internal political order of Japan." For these reasons it was held that "between now and the fall of Germany those elements are bound to become more influential. The strangulation of Japan that we will be able to effect at a distance will make the broad masses regard the military as the cause of their misery ... The more one reflects on the utter hopelessness of the outlook for Japan from spring on, the more confident can one be that Japan's Ruling House and classes will not engage in national suicide. This means that the talk so glibly indulged in by military commentators of two more years of war against Japan is as irrealistic as the talk of a Hitler-directed guerrilla warfare after we will have taken the Ruhr ... It is submitted and urged that an adjustment can be made with Japan, providing we are content not only to avoid destroying, but to use constructively the institution of the Emperor ... integrated with safeguards."

In the setting and for the implementation of the proposed "new political strategy," the atomic bomb - for which he used the code word "exponential weapon" - was to be used to provide a dramatic warning to aid the Emperor and the other classes that had been swept from power ~~in~~ since mid-1937 to get rid of those elements of the militarists who would not give up save until after invasion, and who meanwhile ~~who~~ would continue to fight with Kamikaze suicide squads.

For the effectuation of this plan a program of psychological warfare was developed. In that connection the President enlised the services of James V. Forrestal, then Secretary of the Navy, to recall the then Captain (now Admiral) Ellis M. Zacharias from the West Coast, etc. (as on top page 2 of your article).

With regard to the last paragraph on page 3, it would be definitely advisable to give the title of the memorandum of April 1943 because of both its backward- and forward-reaching impacts and significance. The title, as you know, of that long study was "Soviet

Foreign Policy, Totalitarin Processes, and Russo-Allied Rifts." The implication of the intractability of negotiations with such powers is pertinent to the newly emerged issue dealt with in Mr. Alsop's column in today's Tribune.

With respect to the section of the article beginning on page 12, the last paragraph overlapping into page 13 might be condensed, to avoid a disproportion of background.

With kind regards,

Sincerely yours,

Mr. N. S. Finney
Cowles Publications
852 National Press Building
Washington, D. C.

(Corresp.: Finney)

File F

February 1, 1950

Dear Mr. Finney:

Just as towards the end you caught some minor but necessary changes, a re-reading after an interval has evoked recognition of a few more that I feel confident you will wish to take care of.

Galley 1

(1) Towards the middle, or specifically in the middle of paragraph 9, after "James V. Forrestal," correct "then Under-Secretary of the Navy" to already Secretary of the Navy. (He became Secretary, I believe, in May 1944.)

(2) Towards the end of third paragraph from bottom, reading "on the Kremlin's apparent intention to seize control of Europe," - that form of expression reads the future too much into the past, as the ability to extend Russian domination over Europe would have depended upon how much of demobilization we would be effecting in the future, - a matter dealt with in the last memorandum that counseled a more conservative policy than was actually applied. Accordingly submit the following as appropriate and correct: after "based on the Kremlin's apparent intention" omit "to seize control of Europe" and substitute the following: in Europe and on assumed extension of the emergent "Russo-Allied Rifts.

(3) In the last but one paragraph, referring to General Watson, insert before word "matters" the word some.

Galley 2

(4) Third paragraph, in place of "in February 1945 just before" to read as follows: at end of February 1945, shortly before, etc. (As I recall it, a day before the end of February the President attended General Watson's funeral and on the opening day of March he delivered his report on the Crimean Conference to Congress. He left for Warm Springs after the middle of March. Hence the suggested adjustments to conform with the actual series of events as recalled.)

(5) Line 4 of this third paragraph, in place of "expectation" use the word assurance.

(6) Ensuing paragraph, #4, first line: The word "agreed" is too strong. Suggest instead was interested, and in place of "with" use in.

(7) The second sentence: The opening word "they" is too sweeping and should be replaced by this expression: They contained many who, etc.

(8) In the final line the changes written down by you inadvertently omit the expression you originally had - "as well". This should be restored.

Galley 3

(9) Closing paragraph, line 1: The expression "at the turn of the 16th century" is a little ambiguous, and might mean the passing from the 15th to the 16th instead of as it actually was (in 1596) from the 16th into the 17th century. Suggest, therefore, changing "at the turn" to towards the end.

(10) Line 5 of that closing paragraph, reading "never for" needs to be improved in view of the fact that England did not fall to the Armada threat and that the Armada had already been defeated by them. Accordingly the line should be emended to read never again be subject to, etc.

(11) In the ensuing sentence, and particularly line 9 of the closing paragraph, the word "learned" should be replaced by narrated. This means that the biographer Archibald Napier had documented what was already at the time known.

Galley 5

(12) End paragraph 2, closing words should read come towards the end of breakfast, as is apparent from the rest of the narrative.

Sincerely yours,

Mr. N. S. Finney
Cowles Publications
852 National Press Building
Washington, D. C.

(File F - Finney) (Correspondence - Finney) (Cook Article (Finney) Jan. 1956)

HOW FDR PLANNED TO USE THE BOMB

1 What did President Roosevelt intend to do with the atomic bomb?

It is a strange fact that the biographies and memoirs of Roosevelt's official associates supply no answer to this question.

3 Dr. Alexander Sachs, recognized in the famous Smyth report as the man who persuaded Roosevelt to launch the atomic energy project, has now come forward with an answer.

4 The president, he says, planned to demonstrate the bomb before international representatives of governments, science and religion, before he ordered it dropped on America's wartime enemies.

5 Dr. Sachs, a New York economist and student of the history of science, bases his assertions about what was in FDR's mind when he died on conversations he had with Roosevelt as late as ~~February, 1945.~~ December 1944

6 He says that they discussed a plan to use the atomic bomb for a series of dramatic warnings to the Emperor Hirohito to get rid of the militarists who dominated Japan and negotiate a peace with the United States.

7 A memorandum advocating a negotiated peace with the Japanese Emperor was read by him to President Roosevelt shortly after the 1944 elections, Dr. Sachs says. FDR expressed agreement with ideas contained in the memorandum, and told Major General Edwin (Pa) Watson, his aide, about his views.

8 The memorandum, according to Dr. Sachs, contained a detailed plan for use of the bomb. Roosevelt told Dr. Sachs to leave the copy of the memorandum he had brought with him at the White House, and to destroy any other copies.

Dr. Sachs says this plan, in which use of the bomb was an integral part, had been set in motion before Roosevelt's death at Warm Springs, Ga., in April, 1945. James V. Forrestal, then undersecretary of the Navy, had recalled Captain (now Admiral) Ellis M. Zacharias from the west coast to prepare the series of broadcasts in Japanese that played their part in Japan's ultimate surrender.

A sidelight of Dr. Sachs story, not directly related to the atomic bomb, is that he urged Roosevelt to revise America's wartime policy toward Russia. Sachs says that at the time he died, Roosevelt was considering appointing a three-man "Colonel House commission" to draft a new Russian policy based on the Kremlin's apparent intention to seize control of Europe.

The relationship between Dr. Sachs and President Roosevelt was known to close mutual friends. But the extent of Dr. Sachs' activities as a personal, non-official adviser on atomic energy and grand strategy is little-documented, except in Dr. Sachs' own files. The president's executive officer on matters of atomic energy was General Watson. Forrestal, whom Dr. Sachs says returned from the Pacific in a state of emotional shock that impelled him to reach for any honorable way to end the war, was intermediary with Zacharias. These people are dead, including the president himself.

Dr. Sachs' lips were sealed by a pledge of secrecy to Roosevelt himself. He did not feel himself released until the Smyth report disclosed how he labored to persuade FDR to undertake the atomic energy project, and even then he felt doubt about describing his association with the project during late phases of the war. He has discussed this association with acquaintances in conversations and letters, but the public has not heard the story.

Here is Dr. Sachs' version of the last chapter of President Roosevelt's life:

Its roots go 12 years deep in time, back to 1932 when FDR was still governor of the state of New York and campaigning against Herbert Hoover for the presidency. Dr. Sachs, then as now with Lehman Corp., had won himself a reputation in England and the United States as an economist of unusually deep grasp in monetary matters. Through mutual friends, Roosevelt asked Sachs' advice on a projected campaign speech on the Gold standard. Sachs tells how he responded with a very blunt suggestion that Roosevelt leave the gold standard to people who knew something about it. FDR heeded Dr. Sachs' counsel, and appreciated the refreshing candor with which it had been given. Thus began as unusual an association of two men as American history records.

Its culmination came in February of 1945, just before the failing president left Washington for Warm Springs. In the course of a long, relaxed conversation at the White House, President Roosevelt accepted a view of world events Dr. Sachs says he first put forward in April of 1943--the view that American policy could not be based upon expectation of a friendly and cooperative Soviet Union. The president undertook to reverse the philosophy underlying his administration's expectation of a postwar era of one-worldism, to challenge an American public opinion friendly to the USSR, and to found a new policy based on the realities of Russian imperalism and the Kremlin's emerging "no-war-no-peace" drive for European domination.

He agreed, says Dr. Sachs, with the contention that the ordinary state and military agencies of federal government were so fixed in the patterns of the old policy that they could not hope to develop a new one. They suffered, Dr. Sachs explains in his own phrases, from hardening of the categories, beblinkered thinking, encrusted ideas. Roosevelt planned to name Dr. Sachs, Lewis Douglas, and one other man, not designated when he died, to a special presidential commission that would make a fresh review of the facts and present fresh conclusions so forcibly as to command the change FDR sought.

Plans for using the bomb had an earlier culmination. This occurred after the 1944 elections, during the first week of December to Dr. Sachs' recollection. Roosevelt and Sachs met at the White House where Sachs says he read what is here called his lost memorandum. At the conclusion of the two men's long conversation, the president nodded his agreement to Dr. Sachs' proposals for the use of the atomic bomb.

"For God's sake tell someone," Sachs pleaded.

The president agreed to "tell Pa," (General Watson). Dr. Sachs is satisfied that General Watson was told. His plea to President Roosevelt that someone be told was prompted by his own observation that FDR's powers were waning, and his anxiety that he, who had been insistent upon holding no official position whatever, might not be sole possessor of such a secret. The president, in Dr. Sachs' poignant phrase (he thinks it comes from Shakespeare but cannot find the line) was becoming "yonderly minded." Lengthening pauses spaced FDR's conversations with Dr. Sachs, pauses during which the president was there, yet in a sense not there. The line and coherence of FDR's thought was not broken by these pauses, which Dr. Sachs respected in silence, but the continuity of the president's on-pressing drive was momentarily suspended as if he listened inwardly to another, private harmony.

Here, as recaptured later by Dr. Sachs in a letter to Secretary of War Robert P. Patterson, is the proposal for the atomic bomb's use with which FDR expressed agreement in December, 1944:

"Following a successful test, there should be arranged (a) a rehearsal demonstration before a body including internationally recognized scientists from all Allied countries and, in addition, neutral countries, supplemented by representatives of the major (religious) faiths (b) that a report on the nature and the portent of the atomic weapon be prepared by the scientists and other representative figures, (c) that thereafter a warning be issued by the United States and its allies in the Project to our major enemies in the way, Germany and Japan, that atomic bombing would be applied to a selected area within a designated time limit for the evacuation of human and animal life, and, finally (d) in the wake of such realization of the efficacy of atomic bombing, an ultimatum demand for immediate surrender by the enemies be issued, in the certainty that failure to comply would subject their countries and peoples to atomic annihilation."

(Dr. Sachs' recommendation that representatives of the major religious faiths attend the atomic bomb demonstration called for something more than Catholics, Protestants, etc. He wanted representatives of Mohammedan and Bhuddist faiths as well.)

This was the understanding in early December of 1944, and so far as Dr. Sachs can recollect or was informed, it remained the understanding until President Roosevelt's death on April 12, 1945. Yet a simple re-statement of the plan as put down by Dr. Sachs in July, 1946, from his memory of the lost memorandum, can lead to profound mis-understanding of what was in the minds of Dr. Sachs and President Roosevelt when they last discussed their shared-secret of the vast atomic project that was then approaching fruition. Indeed, incomplete information about the plan on which the minds of Dr. Sachs and Franklin Roosevelt then met has already been tortured and twisted to make it appear that had Roosevelt lived Hiroshima and Nagasaki would never have occurred. It has been whispered that President Truman knowingly brushed this plan aside in favor of the military demonstration decided upon by an interim committee headed by Secretary of State James F. Byrnes and Secretary of War Henry Stimson. This committee, Secretary Stimson records, submitted its conclusions to a panel of distinguished scientific advisers, who, partly because they could not, in the light of the facts suggest an alternative, raised no objection to the way in which the bomb was used.

Dr. Sachs emphatically disagrees with those who argue that the American-British-Canadian team of nations that made the bomb is morally guilty for the use made of it. While he continues to believe that the broad sense of his proposal for an international, inter-religious demonstration of the weapon's powers could have been made when the bomb was tested at Alamagordo, New Mexico, he is convinced that the essential features of President Roosevelt's plans for using the bomb were actually carried out. Dr. Sachs decries the kind of "apocalyptic thinking" that makes the precise use of the atomic bomb the central overshadowing item in the unfolding of the president's much-more-comprehensive plan to bring about the surrender of Japan through negotiations with Hirohito after a stroke of state.

He points out that there was a warning to Japan--numerous warnings culminating in the ominous Potsdam Declaration. He continues in the belief that, had these warnings been sharply dramatized by such a disclosure of the bomb's awful powers as he conceived, Japan's military junta might well have thrown in the sponge earlier. Yet, he emphasizes, it was the bomb's terrific impact that sealed victory in the psychological war President Roosevelt had set in motion by having Captain Zacharias recalled to Washington to speak to Japan in the Nipponese tongue. Dr. Sachs has no word of criticism for the responsible men who made the fateful, final decisions in carrying through broad plans that were never seriously questioned by Roosevelt's successors, despite the great unpopularity of all suggestions that a deal should be made with the Japanese emperor.

He does have a sharp word for persons who now give currency to an American "guilt complex" at the use of the bomb. He compared this "self-denigration" to the soft-thinking about Germany which followed World War I, and he warns that the upshot could be similar.

His story of the conversation with President Roosevelt at which decision was reached on use of the bomb as an integral part of ending the slaughter in the Pacific suggests that Roosevelt may have had in his mind a question whether the bomb should be used at all. (It must be remembered that in December, 1944, there was no certainty the weapon could be made or would be ready in time to provide a shocking accent in the mounting horror of scientized killing.) Dr. Sachs says his way of dealing with President Roosevelt was to prepare a careful memorandum and read it aloud, pausing to discuss any fact or concept that raised question in FDR's mind. Sachs would then attempt to support a crucial point by a story drawn from history--Roosevelt was an avid, ranging reader of history with relish for a telling passage, particularly when it was new to him. The discussion on this December day revolved about the subtle point of a stateman's responsibilities to history, and the rightness or wrongness of visiting the world with a new agent of destruction. Dr. Sachs was ready with a story.

Back at the turn of the sixteenth century, John Napier, the Scotsman who invented the logarithmic tables, became greatly interested in engines of war because of his Protestant zeal that Britain should never fall to such a threat as the Spanish Armada. Napier's biographer and descendant, Dr. Sachs told the president, learned that the Scotch mathematician had not only devised such weapons as sets of burning mirrors and primitive tanks, but had come upon an invention which succeeded in annihilating all animal life in an area of a square mile. His biographer, Sachs told President Roosevelt, recounted that Napier was "so disquieted that he buried the machine," feeling that "mankind had many engines with which to destroy each other and that....he would never willingly increase them."

With this story as his key, Dr. Sachs says he convinced President Roosevelt that it was neither possible nor desirable to suppress such a discovery as was being brought to birth within the Manhattan District. But that the weapon must, at the very least, be demonstrated so that the complexities of its impact upon human development would be felt. This, in its strange and somewhat indirect way, was the crux of the president's decision--a decision with an elaborate background that can be understood only by some grasp of the relationship between FDR and Dr. Sachs, his most unusual confidential adviser.

The beginning of this relationship has been described. At first meeting President Roosevelt found in Dr. Alexander Sachs an enormously well-informed man who preferred complete anonymity and had no hesitation whatever about rebuking the president when he believed him to be in error. Few who knew Roosevelt well can be surprised that he formed an attachment to Dr. Sachs. The attachment grew through the years. It grew for reasons that are clearly on the record. In his own and related fields--modern economics--Dr. Sachs has a startling record of having been right when the pack of more orthodox thinkers were wrong. He foresaw that the National Recovery Administration would be a failure and be held unconstitutional, and very frankly advised FDR of what he anticipated. Yet he backstopped the late Hugh Johnson through the NRA days. There are numerous other instances of the sort.

One central belief held steadily by Dr. Sachs in the years when World War II was gathering was key to his peculiar helpfulness to Roosevelt. Sachs demonstrated historically that the Great Depression was something more profound than a collapse in the economic sphere. It was a collapse of the Great Culture of western Europe. During the 1932 campaign, Dr. Sachs asked FDR who he considered his principal opponent. "Why, Herbert Hoover, of course," the New Deal candidate replied. "You are wrong, Mr. Roosevelt," Sachs says he told his friend. "Your enemy is Adolph Hitler."

Long before other advisers to FDR warned him that the great threat was aggressive war by the dictators, Dr. Sachs was correctly interpreting events in Europe and Asia. Partly because of his deep feeling of alarm about the on-coming war, Dr. Sachs kept a sharp eye on unfolding events in the scientific world. As the "thirties" drew toward their end a providential combination of circumstances made Dr. Sachs perhaps the only man who could have advised President Roosevelt about atomic energy.

His long record of giving the president sound advice in economic matters caused FDR to rely upon him. His steadfast refusal to accept any public favor or assignment convinced Roosevelt he had discovered a counselor who genuinely desired anonymity. Dr. Sachs lifelong interest in fundamental science (he is reputedly a first-rate mathematician) caused him to follow and understand the emergent possibility of unlocking the huge energies inside the atom. He attended a series of lectures in England in 1936 at which Lord Rutherford and A.W. Aston clearly forecast atomic energy. He secured one of the few careful translations made of the history Hahn-Strassmann report on atomic fission.

During the latter phases of the Nazi purge of non-Aryan members of the great German scientific community, Dr. Sachs laid out the bulk of his life savings in personal rescue work. Some of these emigre scientists lived in England with Dr. Sachs help. Others came to the United States and Canada. Through them Dr. Sachs got the most expert, personal advice. Thus, in 1939, when the Navy departmeht flatly turned down proposals for an atomic project on the advice of American scientists, Dr. Sachs was being told by such men as Drs. Leo Szilard and Albert Einstein that the possibility of atomic weapons could not be neglected.

Dr. Sachs says he undertook to familiarize President Roosevelt ~~with~~ both on the scientific possibilities of atomic energy, and the political possibilities if Germany became able to terrorize the Democratic world with an atomic devastator. It is hard now to recall what things were like in early 1939. Austria had been swallowed by Hitler. Czechoslovakia, deserted by shock-sick England and France, had been taken over without a shot. The United States had no means for offensive war. Dr. Sachs says he became FDR's personal Jeremiah on the subject of atomic weapons with real fear that Germany might succeed in terrorizing the whole world.

During the late spring and summer of 1939, Dr. Sachs says he talked with President Roosevelt repeatedly about starting an atomic project. The story of how he enlisted the assistance of Dr. Einstein to help convince the president is told in the famous Smyth report, and Dr. Sachs testimony before the congressional atomic energy committee fills in a good deal of detail. But Dr. Sachs has never publicly told the story of the crucial meeting at which President Roosevelt decided to commit himself to making an atomic weapon.

On October 11, 1939, Dr. Sachs read a long memorandum to President Roosevelt and presented him with statements from Dr. Einstein and Dr. Szilard. The president was impressed, but not convinced he should embark on such a costly course of action. (Dr. Sachs advised him that producing an atomic weapon might well cost two billion dollars.) Dr. Sachs says he asked President Roosevelt if he could see him the next day. The President invited him to come to breakfast.

Dr. Sachs tells how he spent most of that night either at his room at Washington's Carlton Hotel, or in nearby Jackson park trying to think of something he might say that would bring the president to order a study of the feasibility of atomic weapons. He recalls returning to his hotel room at dawn, and of dozing in a chair while waiting the operator's wake-up call. He did not go to bed for fear he would lose the thread of what he wished to tell the president.

He came back to the White House, he says, to find Roosevelt seated alone at his breakfast table while a butler attended him. As he sat down the president said:

"What bright idea have you got now? How much time would you like?"

Dr. Sachs says he replied that he would not take long. "All I want to do is tell you a story." This is Dr. Sachs' recollection of the story.

He told the president that many years before, while he was in his final year at Columbia University, he had become acquainted with a philosopher and theologian, Professor Dickinson Sergeant Miller. Later, through this friendship, he met and talked to a visiting British divine, the Rev. Father John Neville Figgis. Father Figgis, he explained to President Roosevelt, had written a book on history entitled "From Gerson to Grotius," and this interest in European history caused Father Figgis to be chosen as literary executor and editor of the lectures and writings of Lord Acton, a famous English political historian with whose work President Roosevelt was acquainted.

Father Figgis, Dr. Sachs told President Roosevelt, discovered that Lord Acton had been asked an unusual question about English history at one of his lectures. Could Lord Acton mention an outstanding instance of England being saved from national peril, not by its own efforts, but by the failure of an enemy to seize advantage of an opportunity to destroy England? Dr. Sachs explained that, according to Father Figgis, Lord Acton asked a day to consider the question.

The next day, Dr. Sachs told President Roosevelt, Lord Acton was ready with his answer. There was an outstanding example of how England had been saved by an enemy's mistake. During the Napoleonic wars, after Bonaparte had tried to land his armies on England's shores and failed because of the English channel's tricky tides and currents, a young American inventor came to the French Emperor with a suggestion.

The inventor was Robert Fulton, and his suggestion was that Napoleon build a fleet of steam ships that could overpower the channel's currents. Then Napoleon would be able to land his armies, and a helpless England would be at his mercy.

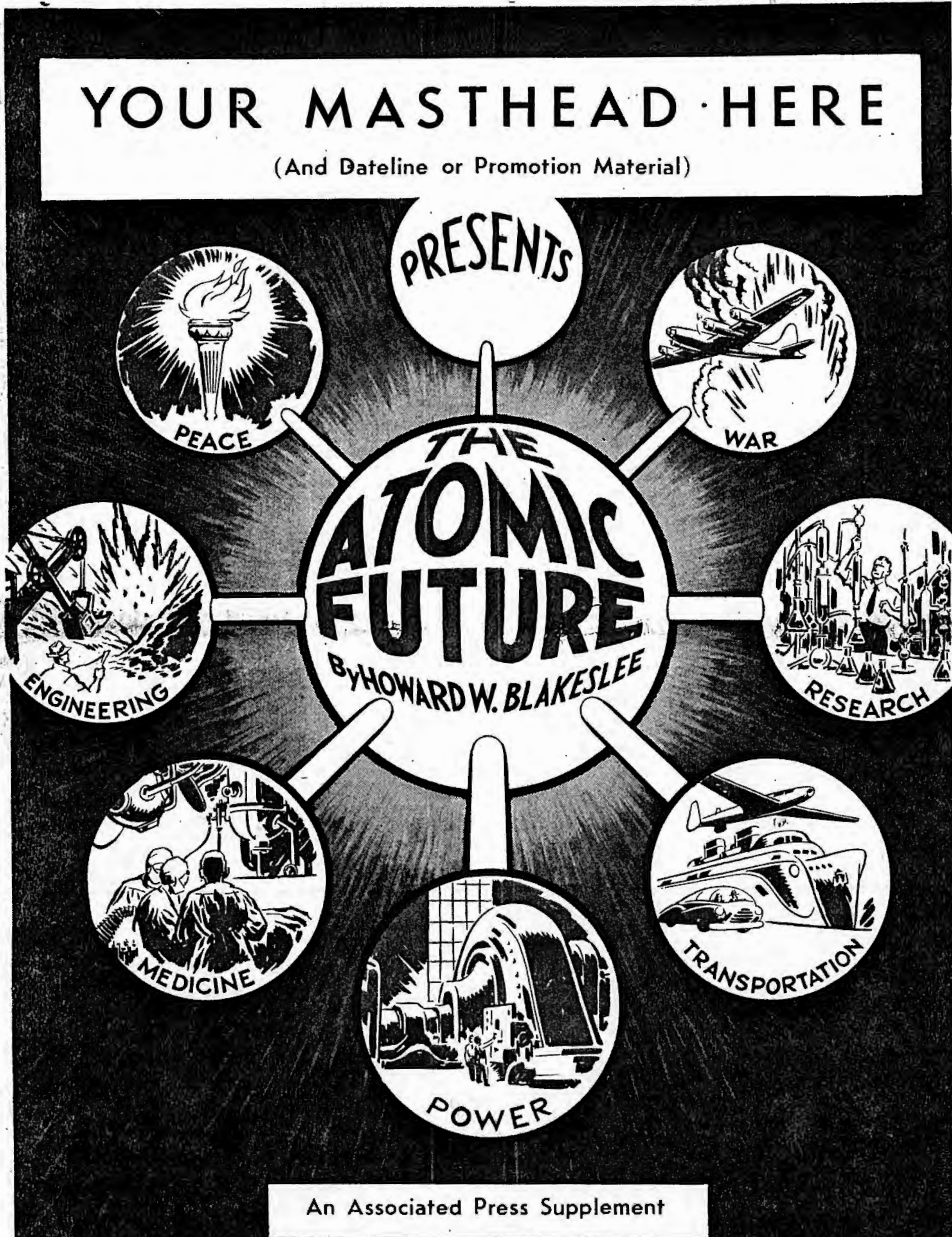
Dr. Sachs repeated Lord Acton's story of how Napoleon scoffed at Fulton's idea. And he told President Roosevelt how Lord Acton held that if the French Emperor, then at the zenith of his power, had only had the humility to entertain a new idea the nineteenth century history of England might have been far different.

Dr. Sachs says President Roosevelt sat silent when he had finished his story. "That seemed like a very long silence to me," he recalls. "I suppose it was two or three minutes, but it seemed like half an hour." The butler, Dr. Sachs remembers, was clearing away the dishes, and without saying anything President Roosevelt scribbled something on a piece of note paper and handed it to the butler. A moment later the butler returned with a tall package. When he unwrapped it, Dr. Sachs saw it was a magnum of Napoleon brandy. The butler drew the cork, and not until then did Mr. Roosevelt speak. He ordered the butler to pour.

When each man, President Roosevelt and Dr. Sachs, held a pony of the old brandy, the President clicked his glass with Dr. Sachs and drank. Twice again the president ordered the butler to pour. Then, with a friendly gesture, he told Dr. Sachs he would take action on atomic energy. General Watson was directed to follow through.

May 3, 1946

File Blakeslee
Correspondence File



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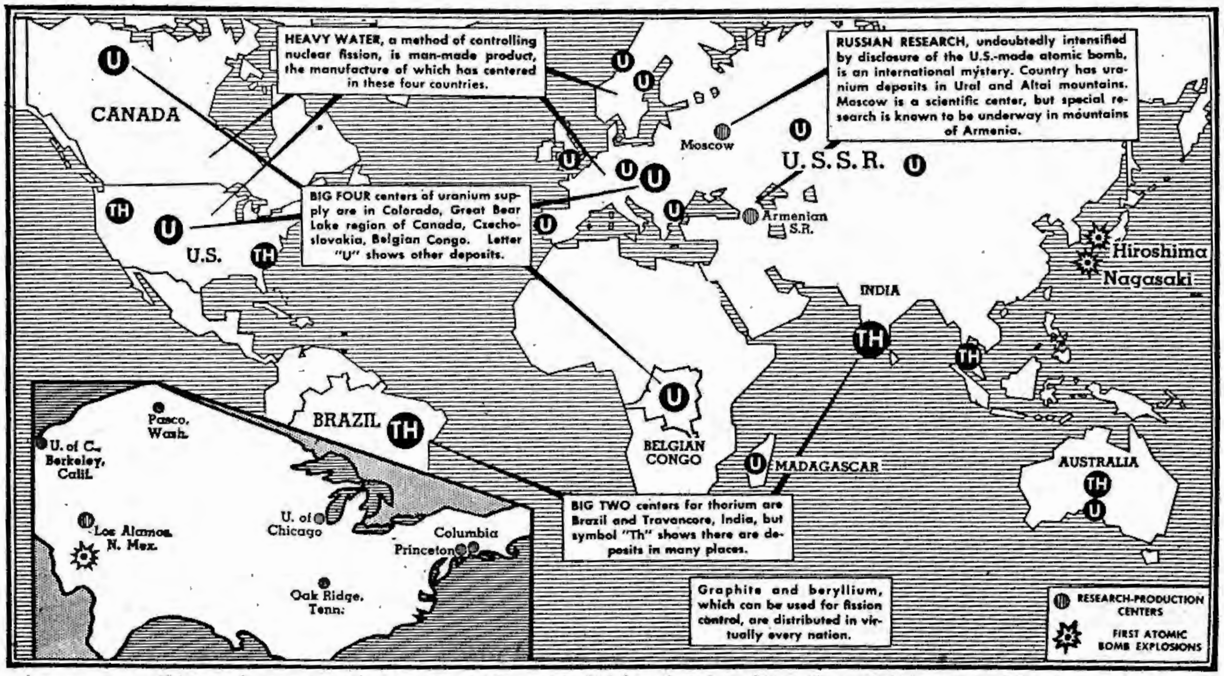

This map shows some of the areas around the world which have been brought into the spotlight by the atomic bomb.

The Atomic Language

ALCHEMY—The medieval chemistry which sought to transmute base metals into gold, to find the universal cure for disease and to prolong life indefinitely.

ALPHA PARTICLE—The nucleus of a helium atom. Many elements emit these particles during radioactivity.

ATOM—Smallest unit of a chemical element.

ATOMIC OVEN—A power source whose heat comes from splitting atoms.

ATOMIC WEIGHT—Weight of an atom in atomic units. This unit is one-sixteenth of the average weight of oxygen atoms. A hydrogen atom, lightest weight of all the elements, weighs almost exactly one atomic unit.

BETA RAYS—Rays made of electrons or positrons.

CLOUD CHAMBER—A sealed box with glass top, filled with air or other gas rich in moisture. When the gas expands any atomic particle or atom, flying through the cloud chamber, shows its presence by a string of water droplets, resembling clouds, in the form of long thin trails. The water droplets condense on the electrified gas particles created by the passage of the atomic particle.

COSMIC RAY—An atomic particle coming from space with energies that usually drive it completely through the earth's atmosphere and deep into the ground.

CYCLOTRON—An electro-magnetic instrument that impels atoms or atomic particles around in a circular course until they have speeds corresponding to millions of volts of energy.

DEUTERON—The nucleus, or core, of an atom of heavy hydrogen. This form of hydrogen has an atomic weight twice that of ordinary hydrogen.

ELECTRON—One of the three primary particles that form all atoms. Electrons have a negative electrical charge. Their weight is an 1800th that of the other two particles, namely protons and neutrons.

FISSION—A division of the nucleus of an atom into two nearly equal parts.

GAMMA RAYS—The rays from radium and many other elements during radioactivity of the latter. They are identical with X-rays. X-rays are produced by power tubes and in the early days never were as penetrating as the similar rays from atoms.

HEAVY WATER—Water whose hydrogen atoms are deuterium, that is, heavy hydrogen of twice the weight of ordinary hydrogen.

ISOTOPE—The name for different kinds of the same chemical element, where the difference is in atomic weight. All the isotopes of any element have the same number of outer electrons as the element itself.

MESON—Also called mesotron. A particle, apparently complex in structure, intermediate in weight between an electron and the heavy particles, neutrons and protons.

NEPTUNIUM—A heavy metal created in atomic ovens by transmutation of uranium.

NEUTRON—One of the three primary particles that form all atoms. It has no electrical charge and is 1800 times heavier than an electron.

NOVAE—New stars, so called because they are explosions in existing stars that were previously either invisible or much fainter. Novae are temporary, reverting usually to about their former brightness in a few months or years.

NUCLEUS—The core of an atom. It is composed of protons and neutrons.

POSITRON—A positively charged particle of the same light weight as an electron.

PLUTONIUM—A heavy metal, produced by transmutation of uranium in atomic ovens. Plutonium atoms split to make bombs and to furnish atomic power.

PROTACTINIUM—Element 91, a heavy metal, next below uranium in atomic weight. Protactinium's atoms split with 200,000,000 electron-volt energy releases, but this element is very rare.

PROTON—One of the three primary particles that form all atoms. Protons are heavy, about 1800 times the weight of electrons, and have positive electrical charges.

RADIOACTIVITY—The emissions of rays by the nucleus of an atom.

THORIUM—Element 90, a heavy metal. Its atoms are the third heaviest among natural elements.

TRANSMUTATION—Changing one metal, or one element, into a different metal or element.

URANIUM—Element 92, a heavy metal. Its atoms are the heaviest of the naturally occurring elements. One of uranium's isotopes, U-235, splits easily. The principle isotope that forms 99 percent of uranium does not split easily enough to make bombs or power. (Plutonium, which is element 94, exists in nature but in amounts too small to be more than detectable.)

WAVE LENGTH—The distance between two wave crests.

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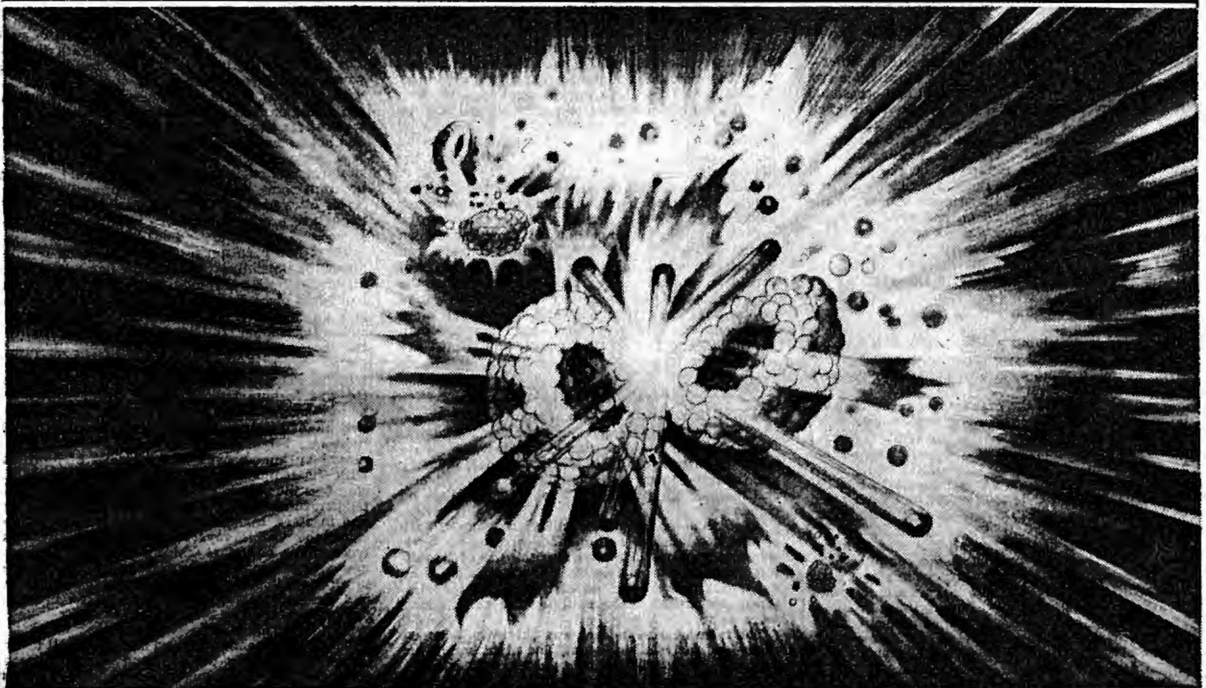
THE ATOMIC FUTURE

By HOWARD W. BLAKESLEE
Associated Press Science Reporter



"The explosion at Hiroshima on Aug. 6 slammed a door shut on the past."

—The Association of Oak Ridge Scientists

IMAGINE a slice of pineapple out of a can, magnified until the slice is nearly half a mile wide, and its color jade green because it is made of glass. That is the symbol of the atomic bomb, stamped on the face of the desert in New Mexico, where the surface of the earth boiled in the most terrific heat this world has ever known.

This symbol lies in the south central part of the state not far from that part of the old Santa Fe trail which early Spaniards called *Jornada del Muerto*, which means "journey of death." That part of the trail was so named because travelers sometimes died of thirst. Adjacent to this trail is an immense oval amphitheater, roughly fifty miles by eighty, which goes today by the military code name of Trinity. This name designates the proving ground for atomic bombs. The place is mostly bordered by mountains which are steep, sharp-peaked, in browns, deep reds, and dark yellows, with low bushes around their feet. The oval itself is a great mesa. The earth is light brown to yellowish-grey and is covered sparsely everywhere with low bushes and occasional bunch grass.

At one entrance, at the foot of a spur of the Oscura range of mountains, stands a steel tower about one hundred feet high, used as a lookout by the desert patrol of the United States Army which guards all of Trinity. Out on the mesa is a small military camp, in the form of several rows of barracks, with a mess hall and a lecture hall.

Still farther out toward the center of the mesa is a massive dugout, a structure of heavy timbers faced by many feet of earth. This earth faces in the direction of a place miles away having the military code name of Zero. That is where the first atomic bomb was exploded just at early dawn on July 16, 1945. The dugout was the nearest observation point.

THE DESERT'S PROPHECY

NEVER before was there a crater like Zero. There the prologue of the future is stamped on the desert. The outlines, and some details of everything to come, can be seen or sensed.

Zero emitted X-rays, or gamma rays, intensely at first and diminishing later. The solid earth was pushed down about six feet. The pressure that did this was a military secret but the British announced an astonishing figure. They said that pressure was millions of times one atmosphere. One atmosphere is fourteen-and-a-half pounds per square inch. This figure was probably a typically British understatement. The heat that boiled the face of the earth was millions of degrees Fahrenheit. That is far hotter than the surface of the sun, and higher than many estimates that used to be current about the temperature in the sun's interior.

It is quite possible that there never was any crater in the universe just like this. For atomic explosions do not appear to occur naturally on planets. They seem very rare in stars, where they do not leave craters. The two bombs on Japan were exploded at heights much greater than the bomb in New Mexico. Those heights were deliberately chosen so that the ground of the Japanese cities should not be made radioactive like Zero. The Japanese physicist, Nishina, who was in Hiroshima the day after the explosion, said the earth there was not unduly radioactive. The bomb at Zero was exploded at the top of a 100-foot-high steel tower that vaporized in the ensuing heat.

HOWARD W. BLAKESLEE, the author of this supplement, has been an outstanding newspaperman for more than 40 years and one of the country's leading science reporters for almost 20.

Winner of a Pulitzer prize for science reporting in 1937, the Wilson L. Fairbanks award in 1939 and the National Headliners Club award in 1940, Blakeslee is known widely for his ability to write simply and interestingly so that readers can understand even the most difficult scientific subjects. When the atomic bomb was first announced, his stories explaining its principles were featured in newspapers throughout the world. He has visited the bomb production plants and interviewed many of the scientists who helped develop the first bomb.

Blakeslee has been an Associated Press staff member since 1905, has served as news editor in Atlanta, Chicago and New York, and as The A.P.'s science expert since 1928. He is a member and past president of the National Association of Science Writers.

The Zero crater is three concentric rings, with a total diameter of nearly one mile. The inner ring is a shallow saucer, of bare, brown earth, about 300 feet in diameter where some of the soil was blown out by the explosion. Outside that the second concentric ring is the green glass surface where the earth fused and boiled. The diameter of the glass ring is nearly half a mile. Outside the glass is a third ring that is bare desert earth, denuded of bushes and everything, just as if it had been swept clear by a gigantic broom.

The depression in the crater is about one thousand feet in diameter. This hollow is in the form of a big shallow saucer, with a smaller saucer at its center. The larger saucer is where the earth was forced down by the pressure, and comprises much of the jade glass area. The smaller saucer is the blown out portion of the center. Each saucer is about six feet deep at maximum, making the total depth at the center about twelve feet.

EXPLORING ZERO

ABOUT six weeks after Zero was formed, a large party of observers entered the crater and walked all over it. They were led by Major General Leslie R. Groves, the head of the atomic bomb project. All of them put heavy canvas packs over their shoes. The canvas was to insure against any small particles of sand sticking unnoticed to shoes. Most of the sand was as safe as ordinary dirt, but here and there a minute particle might be emitting X-rays, gamma rays or other rays such as high speed electrons or heavier particles. Gamma rays are highly penetrating X-rays.

In the three-hundred-foot dirt saucer at the center of the crater the concrete feet of the vaporized tower were standing apparently undamaged. They were about waist high. They were round, narrow piers, and out of the top of each projected some stubs of steel which originally were part of the base of the tower. Above all three piers these pieces of steel had been cut off at the same level as if the job had been done by one sweep of a giant knife. But the cuts were not those of a knife. The metal had been pulled apart like soft molasses candy.

The glass ring outside the central crater was made of desert earth, largely sand, that had fused in the terrific heat to depths of a quarter to half an inch. Only the top surface of this fused area was glass. The glass ranged from the thickness of an eggshell down to very thin paper. Underneath, the fused

BLAST, HEAT AND RAYS MAKE ATOMIC BOMB A SUPER-KILLER

earth was merely hard and as black as if it had been soaked in petroleum.

Everywhere the glass was covered with bubbles—millions of them, frozen into every conceivable size from little more than a pinhead up to an occasional half-inch in diameter. They were so fragile that many broke at a touch. Most were jade green, but here and there the color shaded off into turquoise. There were some red bubbles, and occasionally a strong blue due to a difference in the chemical composition of the soil at those points.

Small stones lying in the central saucer of the crater had evidently boiled on one side, leaving a very thin hard crust which did not scratch off. Here and there was a stone whose surface on all sides had been converted into powdery blue. A few stones apparently had cracked in the heat. In the fused earth there were occasional odd formations, such as the shape of a perfect egg. One of these when picked up had a shell of green glass completely covering it. The lump was so fragile that it broke under the pressure of two fingers, revealing an interior of desert sand, most of it apparently entirely unaffected by the heat.

Near the center of the crater lay a brick with all but its face buried in the earth. When this brick was dug out it could be broken by two hands into dozens of small pieces. It had been baked by the flash so thoroughly that not only did all of its original chemical components group themselves into little pieces that could be split apart, but each piece was likely to be of a different shade of color from the one adjoining.

The inner ring of the glass surface was about as uniform as the inner ring of a slice of pineapple. The outer edge was entirely different in shape. This edge was jagged, saw-toothed, and with long spikes thrust outward sometimes a hundred feet or more. This entire glass surface was shaped almost exactly like the familiar drawing of an explosion by a comics artist. In fact, the glass surface was a real explosion frozen on the face of the desert.

The bare zone outside the glass marked the limit of the area of total destruction on the surface of the ground. In the air this diameter of nearly a mile was not the limit of virtually total destruction. In all explosions the earth's surface is likely to be the safest place at any given distance, as was learned by millions who "hit the dirt" in the war that produced this atomic bomb.

Inside the three rings of total destruction on the earth's surface numerous instruments had been set up on the ground to give readings of the explosion. All were destroyed. That particular destruction was very satisfactory in this case, because the instruments were set there to tell what happened if the bomb fizzled. Before the explosion a line of telegraph poles only shoulder high and very heavy, carrying several dozen wires, had run from the base camp miles back into Zero. Within the mile-wide crater, poles utterly disappeared and most of the wire vaporized. Here and there was a fragment of wire, and in the crater a few unexplained chunks of iron were still emitting enough X-rays weeks afterwards to take photographs through solid objects. For a long distance outside the zone of total destruction the poles were destroyed or down. Mostly there was nothing above ground to be destroyed in this mesa except low bushes. Some of these outside the zone of total destruction appeared to be leaning away from the center of the explosion.

Just outside the outer zone of bare earth sat a huge iron vessel shaped somewhat like a milk bottle. This bottle was sitting erect without a visible tilt, an evidence that sufficient mass is some protection against the force of even an atomic bomb. Over the vessel there had been a tower. Its remains were lying out on the desert beyond completely blackened and spread almost flat.

The iron bottle was set up for an unexplained experiment. It was made of steel about six inches thick. Although the blast did not blow it over, there were radio-active rays which might have penetrated into steel even at that distance. The iron vessel was suggestive of the sort of protection that heavy armor on war ships may afford. These suggestions apply only to bombs exploded in the air and in no way to atomic bombs detonating under water.

About three weeks after the explosion, the desert in that vicinity bore the smell of dead snakes, ground squirrels, and other small animals. The morning after the explosion, a bat was found many miles away hanging to a rafter, apparently unhurt. The animal's eyes were open and it made no attempt to get away from men who examined it and touched it. It was oblivious to everything that went on.

Zero's face bears the records of three great forces, all of them useful for the future. One is heat. An observer of the explosion, many miles away, his back to Zero, and facing a mountain range that was not very close, felt on his face the reflected heat from the mountains at the instant of the explosion. In a camera, six miles from the explosion, the first two frames of the film were partly burned. On the sensitive emulsion small spots were destroyed by the heat. After the first two frames, there was no further spotting, a fact that shows how rapidly the heat dissipated.

Temperatures of this sort were never before available. Although their maximum is far too great for useful ends, the energy that produces them can be spread out over longer periods of time, and so can be harnessed for work. The pressures likewise can be reduced to smaller packages, within the range of use in existing machines, and in machines of the future that will be made of stronger alloys than any now existing. The nuclear rays are far more numerous and powerful than any radiations man has possessed. The services they can perform are surprisingly broad.

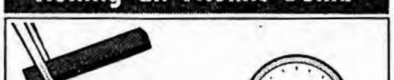
'HANDLE WITH CARE'

THERE is no such thing as a small atomic bomb. The smallest is tremendous in power. No laboratory explosions could be used in advance to measure what will happen. In New Mexico, science, industry and the Army made a plunge into unknown violence, and the morning of the first explosion they took no chances.

More than one hundred miles away men were around hotels inside and outside, carrying unobtrusive meters, some of them about the size of a fountain pen. It was certain that there would be no dangerous rays, in fact no rays at all, at that distance. Nevertheless the meters were read. There were no rays.

The town nearest to Zero was Carrizozo, between thirty and forty miles distant. The night before the explosion, about 300 military trucks, with complements of military police, parked in an inconspicuous area nearby. Orders were that if during the night the wind should blow from the direction of Zero, every person in Carrizozo was to be removed to a safer distance. The Army was not looking for any danger of rays shooting directly and all the way from Zero into Carrizozo. But it was a certainty that a huge cloud of radio-active particles of the air itself, and of the dust and other impurities of the atmosphere, would be shot high into the heavens. An unfavorable wind might bring some of this over Carrizozo. The wind did not blow that direction and the people were undisturbed.

Rolling an Atomic Bomb



A small amount of X-rays or gamma rays is harmless to man, animals and plants. In fact everyone lives in them continuously. The radium in the earth, as it decays, turns at one stage into a gas called radon. A little of this gas is always in the air, everywhere, emitting rays. There are also other sources of X-rays from cosmic rays and a few other radiations, present in the air. The fact that a radiation meter shows X-rays is meaningless, even in an area near an atomic bomb explosion, unless the intensity of the rays increases considerably.

That morning a few men were knocked down by the air blast from the explosion at varying distances. The greatest distance was twenty miles. These blasts were not different from a big wind, and the men were not hurt. Some of the scientists smeared suntan cream on their faces and hands, even when they were as far as twenty miles away. A flash as bright and hot as an atomic bomb creates some ultra-violet rays which might cause an almost instantaneous sunburn, although the burn itself would not show up until some time after the exposure. In laboratories ultra-violet rays have been created powerful enough to produce a sunburn with only one or two seconds of exposure.

There had been much discussion among scientists about the possibility of an atomic bomb causing the air or the earth to explode. Those discussions mostly had taken place five years previously, and all theory and experiments had shown the impossibility of such catastrophes. But in the tension that morning the observers thought of everything.

One young man about twenty miles away was lying on his stomach. His heels pointed toward Zero. He was looking toward the Oscura mountains. It had been raining a short time before and the air was still slightly misty. When the explosion came, the light was brighter than anything ever before witnessed by human eyes. The intensity of light rises with the temperature of the source, which in this case was the atomic bomb flash. Although there are temperatures of millions of degrees inside the sun and in stars, human eyes never see that light because the visible rays come from the outer surfaces of sun and stars which are cooler than man's new atomic bomb. As the flash occurred, it seemed to this man that the Oscura mountains were on fire, and the intervening mists appeared as bright as flame. That observer said softly to himself:

"Oh! Oh! This is it."

The flash expanded into an immense ball at first almost as round as the sun, and then mushroom-shaped. After the dazzling whiteness faded there was a display of color. Observers of all of the atomic bomb explosions have differed in their color descriptions. They agree about the white color of the mushroom fading in intensity to cream. Most of them agree also on an amber color below the mushroom. One of the New Mexico watchers said that at the base of the mushroom stalk he saw an impenetrable column of dust descending back to earth. Brigadier General Thomas F. Farrell, assistant to General Groves, said that the colors lighting the peaks and crevasses of the mountains and the whole country were searing and golden, purple, violet, grey, and blue.

EFFECT OF THE RAYS

WITHIN two months after the explosion at Zero there were numerous reports that the backs of some cattle in that area had become streaked with grey. This was a smoky color the length of the back and in a strip about a foot wide at the most. Thirty-five or forty calves were seen by State Inspector Alfred Hunter on a ranch about thirty miles northeast of the bomb test site. All were frosty-backed. At another site about sixty miles away a few cattle had frosty backs. In one case a bull and several cows were reported to have developed sores that looked like sunburn on their backs.

These frosty backs probably were due to particles made radio-active by the explosion that afterward may settle down rather sparsely from altitudes of ten to twenty miles. There is an explanation of what may have caused this greying in some spectacular laboratory experiments made a good many years before this first atomic bomb. In those experiments, cathode rays of high intensity directed against the fur of animals caused it to turn grey at the spot which was struck. If the rays were continued long enough, the hair at that spot afterwards fell out and a sore developed. Cathode rays are streams of electrons. They are stopped very quickly by air. Some of the particles that are transformed by the rays in an atomic bomb explosion afterwards emit electrons. They may also emit X-rays but not necessarily. If particles emitting these electron rays should settle on the backs of animals in sufficient quantity, they would be expected to duplicate the grey hair and possibly sores produced in the laboratory.

It would be very unlikely that human beings would incur any similar damage. For even a very thin layer of clothing would afford sufficient protection against these short-range rays. The most striking fact about the rays of all sorts created by an atomic bomb explosion is their temporary nature. Some of the particles of air or earth give off rays for only a few minutes. Then they stop and are just as harmless as before. Others emit rays for a few hours. Still others continue for days, and some go on radiating for months, and a few for years. But the intensity or the power of these rays is far greater from those particles which emit for only short periods. The longer a particle gives off rays, the less dangerous they are because they are weaker.

These rays work like getting wet with three glasses full of water, of equal size. The first glass is poured rapidly on your clothing until it is emptied in five minutes. The second is emptied a drop at a time over a period of a month. The third is emptied in tiny droplets almost too small to see, taking a year. The first would soak clothing much more than the other two, although the amount of water is the same. The harmful power of the rays is analogous to this kind of wetting. The long-lasting radiations are also very weak.

The morning after the explosion at Zero observers entered the crater in lead-lined Sherman tanks. The X-rays from the ground were so intense then that it would have been dangerous without this shielding. Six weeks later when General Groves led his party in, the X-rays were still being emitted, and there were enough of them so that had a human being remained in the crater continuously day and night for one month, and had kept moving around so that he would not miss any of the hot spots, the exposure would probably have killed him. But a few minutes or even a few hours in the crater at that time carried no serious risk.

The general's party remained about fifteen minutes without damage. Camera men ranged all through the crater with little or no fogging of their films. Photographic film is far more sensitive to X-ray damage than a human being is. Rays that come from particles in the air after an atomi : bomb explosion are scattered so far and wide that there is ordinarily no risk. Should an atomic bomb war be fought with many bombs, then here and there the air itself might be dangerous. However, that danger would be temporary and would be mostly over in the matter of a few hours.

If bombs are exploded on the surface of the earth or in the earth the way the V-2's detonated, greater radio activity and more X-rays from the earth itself would be expected afterwards. The bigger the bombs, the more there would be of this kind of earth X-ray. But these rays also would follow the natural law of the very rapid diminishing in intensity. The earth in the crater and its very immediate vicinity might be lethal to human beings for a short time, and then dangerous for more than brief occupancy for a period of months.

THE ATOM'S 'SHADOW'

THIS New Mexico explosion brought something new in earthquake waves. These waves were made by the earth being pushed down instead of from a movement inside the earth. If atomic bombs are used in contact with the earth, or detonated at some depth, there will be serious damage from small earthquake waves. How far away these will be serious will depend on many factors, including the strength of the blasts and the character of the soil.

All explosions contain freak areas which for want of a better explanation are called "shadows." When General Groves was a young man, he and several others were close to an explosion of about two pounds of TNT. Most of the men were uninjured. Groves was badly hurt. The atomic bombs have the same shadows, but with an additional risk.

At Hiroshima ten Japanese soldiers were sitting on a bench on the parade grounds of the military headquarters. They were not far from the central part of the blast. They should have been killed almost instantly by the blast itself or by the terrific heat as were many other persons in their vicinity. But all of them were apparently uninjured. A day or two later one of them died, and within a few more days, others died. All these deaths were due to X-ray burns or burns caused by rays of neutrons. The symptoms of both burns are similar.

One after another these soldiers died until only one was left. Nothing happened to him. Whatever may have hit the other nine, this one escaped. That incident suggests that there may be the so-called shadows in the X-rays and neutron rays of an atomic bomb flash.

But those who escape the crushing blast and the heat familiar in ordinary explosions are subject to the added risk of flash atomic rays. The flash rays are not the same radiations that may linger in the crater, or in the air after the explosion, although they are the same kind. The flash rays last only a fraction of a second, and disappear as instantaneously as the blast of fire that they accompany. These quick rays do not apparently extend much farther from the center of an atomic explosion than do the fire and blast effects. But within these limitations, they are a new and vicious form of death by explosion.

It was an engineering and scientific miracle that the first atomic explosion was free from accidents. But it was a carefully calculated miracle, and as such is repeatable. However immense this nuclear energy may be, it is not beyond the control of man. It may be a monster, but it is not a Frankenstein monster.

ROLL YOUR OWN ATOMIC BOMB

MAKING an atomic bomb is in principle simpler than rolling a cigarette. The cigarette bomb would not be very effective, probably only a big fizz, likely fatal to you, but it illustrates the startling nature of an atomic bomb.

To roll this bomb, substitute for tobacco uranium of the atomic weight 235, or plutonium, the new synthetic metal. These metals are hard, like iron. Uranium's natural color is silvery. But because of tarnish it resembles the colors of very dark brown tobacco. It is nearly twice as heavy as lead.

The cigarette would have to be rolled with small strips of this heavy metal. When the roll reaches a weight that is a military secret, but that is something over two pounds, this cigarette will light and explode. No match is needed, nor any other lighter. There is no trigger mechanism required. In fact, nothing can stop the explosion. It is only necessary to bring together enough of the pieces of metal.

The situation is the same as if your tobacco cigarette would light itself. For an effective bomb, the weight of metal that must be brought together is much more than two pounds.

A cigarette burns because of the oxygen in the air. Shut off this oxygen, and the burning cigarette would be extinguished instantly. The atomic bomb does not use oxygen, but explodes on account of something else that, like oxygen, is present in the air.

The substitute for oxygen is neutrons. These are one of the three particles out of which all atoms of all kinds of chemical elements are formed. The others in the trio are protons and electrons. Look at your hand. Nearly half its weight is made of neutrons. More than half the weight of the uranium is made of neutrons. Everything in the universe, hydrogen alone excepted, consists of half or more of neutrons. Ordinarily these neutrons are so tightly bound in the cores of atoms that they never get out.

But the air always contains some free-flying neutrons. It is possible to listen to them, with an electrical instrument that clicks every time an electrified, that is to say ionized, atomic particle strikes the instrument's sounding board. The clicks average 30 to 100 a minute, and some are indirectly due to neutrons. The source of these free neutrons is cosmic rays, the mysterious, high-speed particles from space that drive completely through the earth's blanket of air and deep into the ground. The rays jar neutrons loose from atoms in the air. The neutrons are not as numerous as particles of oxygen. But they make up for that by getting around. Their initial speeds are about 9,000 miles a second.

Neutrons penetrate steel, lead and other heavy elemer s like a rifle bullet going through cheese. They pierce the metallic covering of an atomic bomb. When one of them hits an atom of uranium 235, that atom usually breaks in two. From the split several neutrons emerge. These hit other uranium atoms. In this way a chain reaction starts in the metal, like the chain reaction of a burning cigarette or that in the explosion of T.N.T.

There are enough free neutrons in the air to set off the atomic cigarette bomb, or a real bomb, instantly. There is also an additional guaranty of immediate explosion of the metal. The explosive atoms also split spontaneously from time to time. This happens often enough to light either the metallic cigarette, or an atomic bomb.

If for any reason the scientists do not wish to rely on the spontaneous explosion of an atomic bomb, a neutron trigger can easily be placed in the bomb. A very small amount of radium mixed with beryllium emits a constant stream of neutrons, and such a stream would be a good trigger.

URANIUM'S REALLY SAFE

IF URANIUM and plutonium explode so easily, why does not the uranium in the earth blow up, and why must there be more than two pounds of the metal gathered together before it will explode? Your cigarette will answer both questions. Unroll the cigarette and scatter the tobacco on a table. It is possible to burn this cigarette tobacco, but that will have to be done piece by piece. The burning will require many matches, and if the tobacco particles are well scattered, no burning particles will set fire to any other grain of tobacco. That is to say, there will be no chain reaction, and chain reaction is what happens in a burning cigarette.

The atoms of the explosive uranium 235 are scattered in minerals of the earth like a handful of tobacco thrown over a table. Really these atoms are scattered far more effectively. If a handful of cigarette tobacco were tossed into the air during a hurricane, the amber grains might not be separated by the wind as effectively as nature has scattered the explosive uranium. This scattering is, atom by atom, distributed throughout normal uranium, which has an atomic weight of 238, and which does not explode. In this normal uranium only seven-tenths of one percent is composed of atoms of the 235 variety.

Why must there be more than two pounds of uranium 235 before an explosion is possible? The cigarette gives the answer. Take a very small pinch of tobacco. Roll it in the paper. You can light it, but the tobacco will not continue to burn, because

Harnessing the Atom Ranks with Greatest Discoveries of Man

FIRE—Its initial use by man is shrouded in antiquity, but it is believed to have marked an important milestone in the change of status from mere animal to human.

AGRICULTURE—With the development of crops and the domestication of animals, man for the first time was able to set up cities and organized nations.

THE WHEEL—Prehistoric civilizations got along without it, but the wheel has been basic in the development of modern cultures. Without it industries are impossible.

POWER—Development of steam and internal combustion engines gave man time for cultural progress and made possible the industrial revolution.

ATOMIC ENERGY—This could step up man's potentialities to unguessed heights. It may revolutionize his way of living and permit him to explore earth's outer space.

there is not enough tobacco to maintain a chain reaction, that is, the ordinary fire.

Uranium requires more than two pounds for a somewhat similar reason. The large minimum weight appears surprisingly great to people not acquainted with atomic fire. In an ordinary fire, as in a cigarette, the heat spreads from one grain to the closest adjacent grain. Neutrons do not spread their atomic fire, that is their atom-splitting effects, by moving from one atom to the next closest atom. Instead, the neutrons travel quite a distance as a rule before they hit an atom. In some cases this average distance is about one inch before hitting and splitting a uranium atom.

But of the two, the cigarette which contains only a pinch of tobacco, or the atomic cigarette which contains too little metal, the atomic cigarette is much the safer. The abortive ordinary cigarette might start a fire. The atomic bomb that is too small is as safe as dirt. Nothing explodes it. Like dirt, this atomic bomb metal can be melted in a furnace, but even in a furnace the atomic bomb metal would not explode.

This cigarette bomb would be inefficient, actually only a big fizz, for a remarkable reason. The neutron explosion in uranium moves so fast that there are only a few millionths of a second between the start and the completion of the reaction. A very large part of the power of this explosion appears to be confined to the extraordinarily brief interval of one ten-millionth of a second. Human hands, going through the motions of rolling a cigarette, cannot move so fast.

As the cigarette bomb pieces are brought very close to each other, the atomic fire would start, and would spread so fast that much of the metal would be blown away before the explosion reached terrific proportions. In order to explode, the uranium metal must be packed together. Any pieces which do not explode during this packing become non-explosive as soon as they separate from the main mass.

How it is possible to assemble a few pounds of uranium, or many pounds, so rapidly that even a fair fraction of the metal has time to explode is one of the secrets of the atomic bomb. Perhaps this is the main secret, because most of the other secrets were about the application of techniques of manufacturing metal that men had done before. Not even the dreams of magic ever conceived anything as swift as the assembly of this atomic metal. The pieces of metal are set up at or near the center of the bomb, separated by distances, and other factors which make them safe from explosion. The real trigger of an atomic bomb is the mechanism which starts and completes the assembly of the explosive metal.

WELL-KNOWN PRINCIPLES

ALTHOUGH the assembly technique is a secret, the principles that were employed are not. They were released to the world in the official Smyth report six days after the first Japanese bomb was dropped. The report gives four principles. One is the use of a gun to shoot the pieces of uranium together. This gun is a small piece of artillery. The only facts revealed are that the principles of this piece are not very greatly different from those of more familiar types of guns. Inside the bomb, part of the explosive metal is fixed as a target. The other sections of metal are shot against this target. But even projectiles shot from a gun do not move fast enough for the assembly of an atomic bomb. For example, the bullet or shell from a gun of high velocity moves much less than an inch in one millionth of a second.

A second principle is the shape of the pieces of metal. To understand this, double both fists. The shape of a doubled fist is roughly that of a half sphere, like a baseball cut in two. Assume that each fist is made of uranium metal but not enough to explode. Bring the two fists together, knuckles touching, and they would instantly explode. Now repeat, but instead of doubled fists, open your hands with fingers stretched straight. In this shape your hands still represent the same weight. Now bring the palms together and, if they were uranium metal, they would never explode. They would be quite safe.

This analogy is over-simplified. Actually it would be probably necessary to iron out these two rounded pieces of uranium into thin flat plates. However, the fists and the palms illustrate the principle. In the flat shape, because neutrons have to travel so far before they hit an atom, only the neutrons traveling lengthwise in the plates could do much splitting. The neutrons flying in all other directions would nearly all escape without exploding an atom. This escape of neutrons is the explanation of the use of shape in pieces of metal in the bomb assembly.

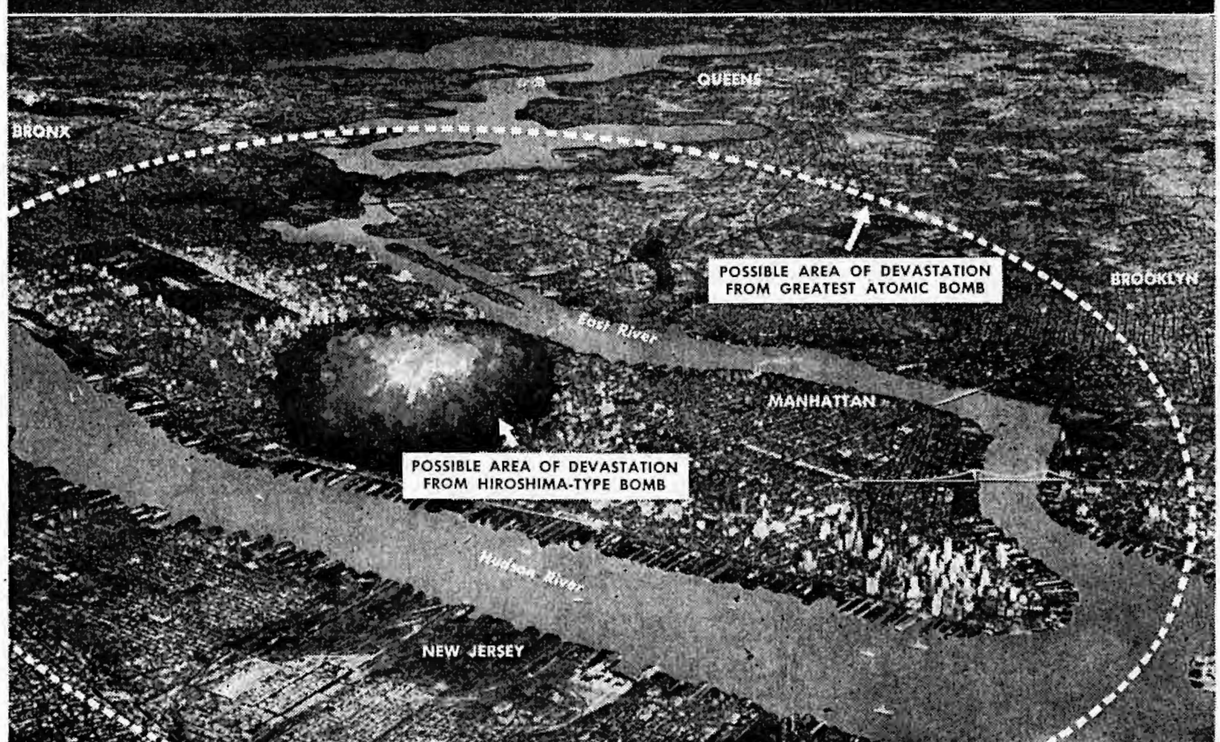
A third principle is the use of chemical elements which absorb neutrons. The white metal cadmium is one of these absorbers. Boron is another absorber.

When a neutron is absorbed in cadmium or boron it is completely finished. It does not move any further. It does not split the atom which absorbs it. It is no longer able to take part in the atomic explosion. Absorbers of these or other types are placed in the bomb assembly in such a way that they slow down the explosive chain reaction at its start. As the reaction approaches the climax, these absorbers are somehow neutralized or withdrawn. How that can be done so quickly is another feat that outdoes all the dreams of magic.

The fourth principle is to surround the assembly of explosive metal with a peculiar kind of mirror. This is a mirror which does not reflect light, but does reflect neutrons. In spite of everything that can be done, some of the neutrons escape from the metallic assembly without splitting any atoms. The mirror reflects these neutrons back into the uranium or the plutonium. This bomb mirror is made of a dense metal. There are a number of heavy metals which would make good neutron reflectors. The one chosen is a secret, but examples of what they might be, so far as density is concerned, are lead, platinum, gold, or osmium. The latter is the heaviest of all the naturally occurring metals.

The secrets of the atomic bomb are much like those of a sixteen-inch gun. All nations know how to make one of these weapons. But the formula used to produce the gun metal is a secret of each nation. So, too, is the precise pitch of the rifling in the gun barrel, and likewise other details. In the atomic bomb one of the secrets is the amount of metal used. There have been a number of published estimates of this weight of metal, apparently all of them guesses. For example, when President Truman announced the explosive power of the bomb dropped on Hiroshima as about 20,000 times that of TNT, many people were able to figure immediately how much metal was in that bomb, provided all of it

One Bomb Vs. New York—Now and in the Possible Future



—Photo by Curtiss-Wright Flying Service

An atomic bomb of the type dropped on Hiroshima, Japan, might devastate a New York City area two miles in diameter. But the most powerful bomb theoretically possible from present atom-splitting materials might destroy all Manhattan and much of Brooklyn, Queens and New Jersey.

exploded. The amount would have been between ten and fifteen pounds. However, it is impossible to believe that the very first bombs attained 100 percent efficiency. In fact, such rapid progress was made that when the third bomb was dropped on Nagasaki a few days later, it was, by official announcement, more powerful than the Hiroshima bomb.

There are other reasons than just how much metal can be exploded involved in producing more powerful bombs. However, the evident fact remains that the first atomic bombs were nothing like cigarette size or baseball size.

IF THE BOMB GOES THE LIMIT

THERE is no escape from the terrible destructiveness of atomic bombs. There is a theoretical limit—the most powerful atomic bomb that can be made with the present atom-splitting metals.

This limit is a single bomb that should completely destroy Manhattan, along with much of Brooklyn and Queens across the East River and some of the Jersey cities across the Hudson.

There is no early prospect that atomic bombs of this extreme power ever will be attained. In fact, nothing like that power should be necessary even though atomic bombs were used to devastate all the civilized nations. One of the most difficult facts to realize is that atomic bombs do not stop where other bombs leave off. The atomic weapons belong to a completely different range. Only one-tenth of one percent of the intrinsic energy in the explosive atoms is released by the splitting. Nevertheless, if only one percent of this sort of splitting is obtained, the resulting bomb is far more powerful than anything made by ordinary chemical explosives.

Fantastic stories that atomic bombs will destroy everything within forty to eighty miles radius are based on complete misconceptions of the laws of nature. When the explosive power of a bomb, atomic or otherwise, is doubled, the distance of destruction is not doubled. For example, if a certain bomb would destroy everything within a radius of one mile, a bomb one thousand times more powerful will have a destructive radius of only ten miles. The terrible fact is that at the very beginning of making atomic bombs, while they are still crude, it is not necessary for an aggressor nation to possess either the best bombs or the most bombs in order to destroy its enemy and a large part of the enemy population.

Uranium has been considered one of the comparatively rare minerals in the earth's crust. The prewar estimates will be revised for a number of reasons known to geologists, chemists, and mining engineers. But assuming that only the limited prewar amounts should ever be available, there is still enough of this fissionable material to destroy all the cities in the world.

The first atomic bombs were very expensive. But soon after the war ended, the bomb experts themselves said it would be possible before very long to make atomic bombs at about one-thousandth the cost of the first ones. There was no question but that atomic bombs could become both cheap and plentiful. There was no question that there would be improvements in all the techniques required to produce the material and make the bombs.

One of the destructive powers of atomic bombs at first little mentioned by the experts, particularly some who tried to belittle this weapon, is the incendiary effect. In World War II incendiary bombs did far more damage than high explosive. The atomic bomb is by far the most incendiary weapon ever invented. The heat of millions of degrees starts fires instantly. Fireproof walls are little protection. Concrete structures may stand without much apparent damage, and a few actually did so in Japan. But the blast broke windows and the flash of heat boiled and eddied throughout the buildings, starting fires wherever there was anything inflammable. A temperature which vaporizes steel and likewise vaporizes human beings close to the center of an atomic bomb flash is probably the most dangerous starter of fires that exists outside of the sun and the stars.

An example of fire damage was a military hospital at Nagasaki. This structure was concrete and stood on a hill bordering the atomic explosion area. Glenn Babb, Associated Press foreign editor, inspected this building after the explosion. He found the place more or less intact. The windows and doors were gone. But the walls looked good, floors seemed undisturbed and stairways were all in place and apparently undamaged. The hospital appeared as if it could be put to use again simply by renewing doors and windows, and moving in new furniture.

Mr. Babb was informed that there had been about 600 personnel in the building at the time of the explosion, and that all were dead. One room on an upper floor had been used for storage of papers. These papers had been piled flat, in tight bundles, an arrangement that makes paper difficult to burn. The piles of paper had reached half way to the ceiling. After the explosion nothing was left in that room except a foot-deep layer of very fine powder.

DEATH OVER THE POLE?

THE atomic power now being developed makes it virtually certain that V-2 types of weapons will drive atomic bombs, if they are used in the future. It is anybody's guess on how long it will require to make projectiles of this sort with ranges of thousands of miles and accurate enough to hit a city of 100,000. That much accuracy is well within the theoretical possibilities.

Almost as dangerous is a different method of attack that was perfected thousands of years ago and has been used ever since in varying forms, with its most famous example the Trojan Horse. Enemy agents might be difficult to detect coming from a supposedly friendly nation, and each one carrying a small amount of uranium. Due to its weight, the size of the pieces would be inconspicuous

Furthermore, the rays this explosive metal emits are not easy to detect. These rays are weak and are mostly heavy atomic things known as Alpha particles which do not travel far and are not detectable like the rays of radium. The presumed secret agents could assemble the necessary pieces of metal in a time bomb mechanism. Such a bomb big enough to destroy a large area would not be too conspicuous. Places like basements could be found in which to set it off.

With expected improvement in radio, bombs of that sort might be exploded simultaneously by pressing a key at some remote control point. There are also the possibilities of producing fairly destructive tidal waves against coast cities and of exploding atom bomb ships in harbors.

Atomic bombs will change some of the tactics of war. A few of these changes already are in sight. One will be what nations may call "Operation Polaris," meaning bombardment by atomic shells fired over the North Pole.

This Pole is on or near the shortest air route between some of the nations that in the past few centuries have initiated or waged the world's great wars. Looking down from on top of a mythical North Pole, an observer could see them all. There would be the European nations, particularly those northern countries that have been strong in war since the fall of the Roman Empire. There would be all of Russia and her Siberian possessions. Also bordering or within reach of this Polar Sea would be Japan, the United States and Canada.

To some of the military targets in these countries, the best route would be over the Polar Sea, sometimes over the Pole itself. Warplanes may some day fly those short routes. The Russians flew over part of the Polar Sea in one of their demonstration flights to America, before the war.

Atomic rocket bombs, of the future V-2 type, may find other advantages, in addition to shortened distance, over the Polar Sea routes. There may be less radar observation to detect them than when they cross other oceans. The Polar Sea, it is likely, will have fewer ships or bases capable of sniping at high-flying atomic rocket bombs with proximity-fuse weapons.

The point has been made that atomic bombs may not be particularly effective against armies deployed in field operations. Even the wide spread of destruction—a radius of miles in future atom bombs—might not put out of action a significantly large number of enemy troops. It must be remembered, however, that rocket bombs probably will be one of the cheaper forms of attack. Their devastation per square mile will cost less than that attained by saturation bombing with ordinary bombs.

There is a more important point in their use against troops in the field. This is based on the thing in atomic energy that is different from all other forms of bomb damage. That thing is the radioactive rays. These rays can be used against troops in the field in two ways. One is to explode the atomic bombs near enough to earth to render large areas temporarily radioactive. These areas would become untenable. For a time after the bombing they would be dangerous to life even for short stays.

Such an unheard of thing as a radioactive ray barrage has to be considered if atomic wars are fought.

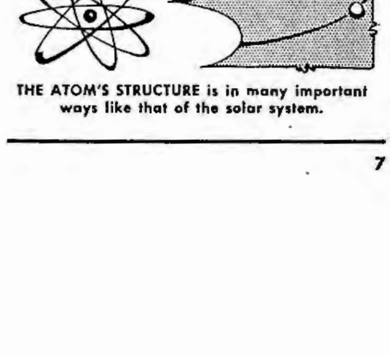
The second tactical use of the rays will be in the air itself, which is made radioactive, and in the dust and other impurities of the air that also emit dangerous rays after an atomic bomb explosion. Normally these particles are driven to altitudes of many miles, where they disperse with little risk to human beings. But winds affect this distribution. Heavy, rainy weather is likely to cause large quantities of the particles to be precipitated back to earth while they still are dangerous. Favorable weather conditions could be used to insure a dispersal of the ray-emitting particles over a large

Atomic Oddities

THE NAZIS drove out some of the scientists who might have produced bombs for them.

THE TEST BLAST in the New Mexico desert was felt 160 miles away.

DR. ENRICO FERMI, while working for the Axis, almost discovered how to split an atom. Only a strip of aluminum foil in his apparatus prevented success. He later served the Allies.



THE ATOM'S STRUCTURE is in many important ways like that of the solar system.

ALL MATTER IN THE UNIVERSE IS MADE UP OF ATOMS

territory, far in excess of the limits of damage from the direct atomic explosion.

ONE IN TEN MIGHT DIE

THE future defenses against atomic bombs are unlikely to be anything that will explode the bomb in the air before it reaches its destination. There will be many kinds of defense of the same kind that armies and navies always have used, if the world chooses to fight wars in the atomic age. But it is possible to foresee a sneak atomic bomb attack that deceives the defenders until the moment the bombs begin to explode. There have even been some guesses that the country firing the bombs might not be immediately identified. That guess seems far-fetched. But it is not too far-fetched to speculate on the sneak attack attaining complete surprise.

With that attack, in one hour, all the cities of a country like the United States with populations of 100,000 or more might be destroyed. And with the cities about ten percent of the people of the nation could be expected to be killed.

Without complete surprise, some protection is possible to minimize immediate loss of life and of injuries. Shelters some distance from the center of the atomic explosion would afford protection. They would save men, women and children from some of the destruction that happened in Japan.

There men and women who were not killed and not seriously injured became bald on the tops of their heads. The baldness was due to radioactive rays. It affected the tops of their heads because they were outdoors, without benefit of air raid warnings, and the atomic bombs were exploded high in the air above them. Three feet of concrete would have stopped these rays from doing damage. The concrete would also have saved many Japanese from more serious and often fatal radioactive burns that damaged bone marrow, caused teeth to loosen in a few days, and frequently resulted in death from anemia. Shelters of this sort would also afford some protection against the heat and blast effects of an atomic bomb.

Laying these speculations aside, it is apparent that with atomic weapons the world has reverted to the type of war common thousands of years ago. Then the victor often destroyed not only opposing military forces but the entire enemy population of men, women, and children. Women were spared often as prizes and men as slaves. But with atomic war there may not be even such diluted mercy.

The new weapons will certainly reach far over all military lines and all fixed defenses and fall upon the home folks, on mothers, fathers, and the children wherever they are. In fact, it is possible that in an all-out atomic war the military forces may be one of the comparatively safe occupations, because they at least will be dispersed to the best advantage to avoid atomic weapons. It appears certain now that one nation will be able really to destroy another nation, and that even a great nation may not be secure from this fate. Whatever may happen in the future, this inherent power of atomic weapons is real, and that is probably the most sobering fact in all human history.

THE SPLITTING ATOM

THE explosive uranium is not a scientific creation. It is like the discovery of coal and petroleum, just another natural resource in the earth. Nature created these uranium atoms with their ability to split, and they have been waiting for thousands of years for man to discover their peculiar qualities.

Plutonium, the new metal that is produced by alchemy in the state of Washington, is a scientific creation. But its properties are the same as those of uranium. In fact, after the war ended, the discovery was announced that plutonium exists in the earth. This new synthetic metal is, moreover, made out of uranium and therefore is limited in amount.

Uranium is mined like other minerals. Uranium ores are converted into metal much the same as other minerals. The first uranium metal appears to have been made immediately after World War I. No one then suspected its explosive properties. The metal was made in very small lumps about the size of buttons for experiment.

Actually this metal was non-explosive, because it was normal uranium—that is, a mixture of the atomic weights 238, the plentiful form of uranium, with a very small amount of the explosive 235 type. The first uranium metal made on a large scale came during World War II and cost at the rate of $1,000 a pound. In a year the price was reduced to $22 a pound. However, it is not necessary to use the expensive metallic uranium in order to obtain the 235 variety, either for bombs or for atomic fires. The 235 can be separated from compounds containing uranium.

The atoms of two other heavy metals split much the same as uranium. They are protactinium, which is so rare that it is not a present prospect, and thorium, which is three times more plentiful than uranium. These three atom-splitting metals hold the top places in mass among all the known natural elements. All three are slowly disintegrating. This does not mean that they are vanishing, but only that they are moving downward in atomic weights step by step until finally they become lead. This natural process of breaking down is, however, an important sign of the probability that no other atoms will split like these.

Little was said during the war about thorium. It was not then used for bombs or power. But the methods by which it can be used are known. When thorium is bombarded by neutrons, a new chemical element is created. This element is uranium 233. That is, the creation is a new metal with the atomic weight of 233. The atoms of this metal split the same as those of uranium 235. Thus for atomic energy the world possesses five metals, three of them natural, and the other two synthetic, namely, plutonium and uranium 233.

Except these five, the atoms of no other elements are known thus far to split in any way that yields either useful atomic power or bombs. The difference between these five and all the other elements is like the difference between coal and stones. When a fire is started in coal it continues by a chain reaction until the coal is consumed. Stones really can be burned, too, provided a fire is hot enough. But once started burning, stones do not continue by spreading fire from one stone to the next.

The talk about splitting atoms of other chemical elements is based on misunderstanding and wishful thinking. The others are wished for because they are cheaper and more plentiful. It is conceivable that more than forty of the other heavy elements may in theory be split like uranium. These are all the elements heavier than silver. They include tin, cadmium, iodine, tungsten, platinum, gold and lead. It is a fact that their atoms, if split, would each yield many million electron volts.

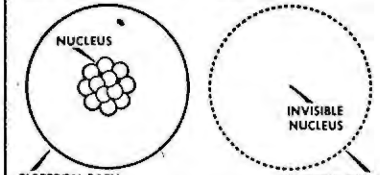
But the neutrons, or other particles, powerful enough to split these commoner elements are almost non-existent. The ordinary neutrons that split uranium have no such effect. Cosmic rays produce some particles with energies that might split gold or any of the other two score. But no one can make the equivalent of cosmic rays without prohibitive expense. And if they are made, there is still no chain reaction.

The cosmic ray projectiles have energies of many billions of volts. Contrast that enormous figure with the voltages of the neutrons that are most efficient in splitting atoms of uranium and plutonium. The latter carry only about one-fortieth of one volt.

Splitting an atom means that its core, or nucleus, breaks into two nearly equal pieces. That is all it means. What happens to the electrons circling around the core does not matter. When an atom splits, each of its parts becomes a complete new atom and both are among the known atoms of chemical elements.

The Misleading Atom

As usually pictured, the atom looks like this: **Actually, a picture of the atom should look like this:**



THE nucleus of an atom is invisible. Even if an atom were as big as this page, it would take a microscope to see the nucleus, for the nucleus is only one ten-thousandth of an atom's diameter. Yet it contains 99 percent of the weight.

ATOMS ARE EVERYWHERE

IT is difficult to be told that flesh and everything else in the universe is made of atoms so small that no microscope has ever been able to see one. After accepting that, the simplicity becomes astonishing. All these atoms, of whatever sort and without any exception, are composed of only three kinds of tiny particles. The three are neutrons, protons, and electrons. The first two are heavy, each about 1800 times the weight of an electron. The only difference between the atoms of one chemical element and another is in the number of these particles. For example, the difference between an atom that gives an eye its blue color, and an atom of mercury, is merely in the number of particles. Eighteen of these primary particles make a carbon atom in your body. Three hundred and twenty-seven of them make an atom of the explosive uranium 235.

Although neither atoms nor their component particles, the electrons, protons, and neutrons, ever have been seen, all will form tiny trails in water vapor that are visible to the eye without a microscope. These trails are produced in an apparatus named a Wilson cloud chamber. The trail of each kind of particle is distinctive; that is, by use of electric and magnetic forces, each one can be made to identify itself. The particles can be seen to emerge from atoms, and to reenter atoms, or to bounce against atoms or each other like little billiard balls. These pictures were part of the knowledge that laid the foundation for the atomic age. Scientists have been watching and photographing the vapor trails for years. But among laymen almost no one thought there was anything practical in this scientific pursuit. In fact almost everyone who stopped to look or listen said "So what?"

"What" is the atomic bomb.

All the familiar diagrams or drawings of atoms are misleading. The atom has not any skin as some diagrams would indicate. There is just a blur of electrons moving at speeds of probably hundreds of thousands of miles an hour around a central core. In the next place and much more misleading, the central core is always visible in the pictures. But the fact is, if an atom was enlarged to be as wide as the diameter of this page, the central core of nucleus would be invisible without a microscope.

This core is so small that its diameter is only one one ten-thousandth part of the atom. Yet in this core is concentrated virtually the entire weight of an atom. The core is made of the two heavy particles, neutrons and protons. What force squeezes down the atomic core and all its mass to this small compass is unknown. The size, however, has been measured accurately. The forces of electrical attraction and repulsion in the squeezed-down core are known, but they do not explain the small size. There is another force in this incredibly small atomic core, which has been calculated, although its nature is still unknown. This mysterious force is something about one million times stronger than the force of gravitation.

The small size of these atomic cores is the principal obstacle to splitting them and to obtaining atomic energies by the split of the plentiful atoms. The particles whose impact splits atomic cores, namely neutrons, are no bigger than the core.

There is no way of aiming these atomic bullets. Consequently it is a fact that out of every one hundred thousand neutrons or other particles fired at a single atom, only an average of one is likely to hit the core. And that is just about the most wasteful shooting that man ever tried. That is why it has cost far more for the atom-smashing apparatus than the value of the energy which came out. That is one reason why the present uranium, plutonium and thorium atoms appear to be in a class by themselves, a natural phenomenon which is not likely to be repeated with any other atoms. These very massive atoms split and furnish their own bullets for further splitting at a cost that is cheaper than burning coal, oil or gas.

DREAMERS AND THE ATOMIC FUTURE

ATOMIC bombs are only one step toward a future whose outlines already were taking form when the war ended. This future is mapped partly by the men to whom nobody listened, the theoretical physicists. These men were called in on the bomb project to take their places with practical engineers. One of them is Dr. Robert J. Oppenheimer, who was head of the Los Alamos, New Mexico, project known in code as the Y. His men were the fabricators of the bombs.

Before the war, Dr. Oppenheimer one day was reading a paper on theoretical physics to a group of his colleagues at the Massachusetts Institute of Technology, Cambridge, Mass. A severe thunderstorm came up. Presently the chairman interrupted and apologized to Dr. Oppenheimer, saying:

"We should take a brief recess until the storm abates so that you can be heard."

"Oh," replied Dr. Oppenheimer, "was anyone listening?"

That describes the prewar place of theoretical physicists. They were the men nobody listened to. Scarcely even their own colleagues. Even to most of the scientific world the ideas of these men were closed books and their comments were dream stuff.

Nevertheless when atomic fires and bombs were needed, these dreamers took many of the top jobs among practical men. They, and almost they alone, could foresee the shape of things to come, and how those things must be handled to avoid the risk of blasting the bomb project and much of its personnel into fragments so small that there would be no trace. The accident record of the entire bomb project is almost miraculous considering that some risks were previously entirely unknown and in some respects the greatest that were ever faced.

It should be noted that the theoretical physicists were by no means the only executives of the project to be credited with the safety record. All through, in every area where the Army, the scientists and big industry worked, the precautions taken against accidents were about ten-fold those of the best ordinary safety practices. One reason for this was that the atomic bomb project could not afford many serious accidents, because had such occurred no power on earth would have been able to keep the secret.

These men to whom nobody listened went safely in almost one single stride into the mysteries of an energy greater than the sun is known to use. In fact, when these men started on the bomb work, they already knew how the sun produces its energy, and that its method would not work for their purposes.

The sun uses the millions of degrees of temperature of its interior to change four atoms of hydrogen into one new atom of helium. Involved are six pieces of alchemy, in which the sun starts with common carbon, changing it into nitrogen, then into oxygen, and back down the scale until it has its original carbon again, plus the new helium atom. This takes a long time, and out of it all comes about thirty million electron volts of energy. That is less than one-sixth of the energy which spurts from a single split of an atom of uranium.

What these d-e ners know, and what their col-leagues have verified in laboratory experim ts, is a comforting guarantee that there is no way or man to explode the earth nor any part of it. They can and have demonstrated that it is not possible for the air to burn with atomic energy unless the volume of air should be as great as the entire mass of the sun at a sustained temperature of a million degrees or more. The total volume of air surrounding the earth would not make much more than one good tongue of flame of the sort that is continually shooting out of all sides of the sun.

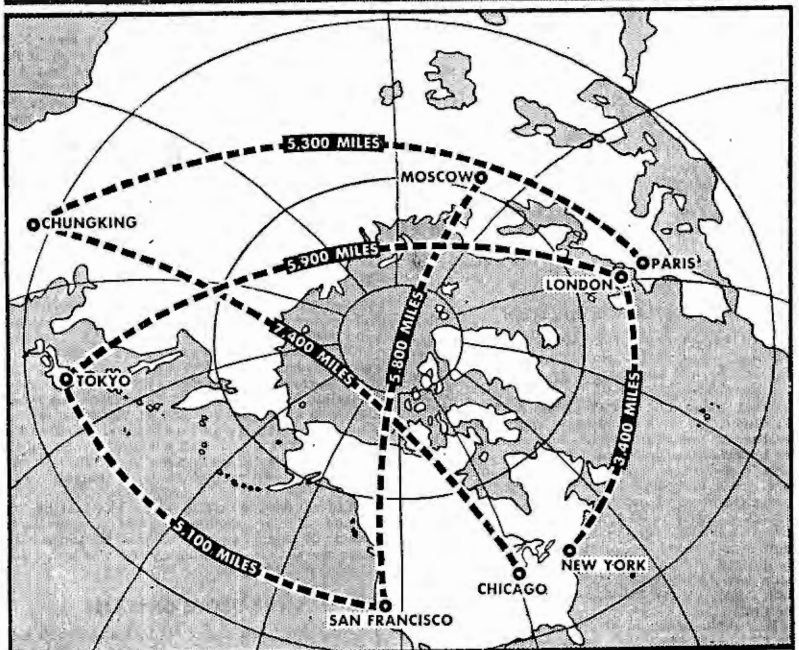
Although the temperatures created by the explosion of an atomic bomb are many millions of degrees, and are about as high as those which have sometimes been credited to the interior of the sun, they are gone in a flash. They are not sustained. It may be difficult to refrain from the fear that these scientists have missed something when they say the air will not burn with atomic fires, but what they did with the atomic bomb is a good guarantee that their predictions about the safety of the earth are correct.

The only place in the entire universe where there is any sign of atomic explosions of an earth-shattering scale is in the stars called Novae. These are the so-called new stars which telescopes discover about once each year on the average. Sometimes they appear where no star was seen before. At other times a small star flares up to become very bright.

Hundreds of years ago one of these new stars was so bright for a short time that it could be seen in the daytime. So far as telescopes can observe, all of these explosions occur in stars. They do not so far as the evidence goes occur in cold solid bodies like our earth and the other planets of the solar system. While it is possible that the earth may have been created partly as the result of some atomic explosion billions of years ago, it is virtually certain that the explosion took place as a result of chemical reactions going on in millions of degrees of heat, and that by cooling down the earth lost the energy by which it could destroy itself, or by which man could blow up the world.

But it can be confidently expected that stories and theories about blowing up the world, or parts of it, will plague people for many years. The theories are not scientific. They are guesses, and are

The Arctic—Future Mediterranean Sea?



The atomic bomb, plus the development of long-distance airplanes and rocket ships, may make the Arctic militarily the most strategic region in the world, just as was the Mediterranean Sea in former times. This map shows how the earth's major cities all are relatively close to the north pole—all subject to atomic raids over the top of the earth. The figures shown are distances by air.

not made by scientists well founded in atomic work. One example is a proposal that the earth never lost its original heat, but that the high temperature retired into the supposedly molten interior. There it now awaits a deep enough crack in the crust, created by an atomic bomb, perhaps one exploded under water. Through this crack would issue the pent-up forces to blow the world apart.

REMAINING MYSTERIES

THE phrases "energy of creation" and "power of the sun," used to describe the tremendous force of atomic bombs, are in about the same class as the fairies, genii, ghosts and Olympic gods that earlier men used to explain natural events they did not fully understand.

Both explanations of the bomb mean that some of the forces of atomic energy are not yet understood. These mysterious forces are apparently some kind of attraction that takes place between very small particles when they are very close together. This is the force that has been calculated as a million times greater than gravitation. This force apparently does not apply in any large degree to objects as large as atoms. But it exists between the much smaller primary particles that form atoms, namely neutrons, protons, and electrons.

The existence of this odd force in the sub-atomic world is apparently the key that scientists expect to use to obtain atomic energies from elements that are more plentiful and less expensive than uranium and thorium. This plan will enable the investigators to bypass the difficult problem of trying to split other atoms in the same way that uranium and thorium divide. The theoretical physicists, the men who safely guided the atomic bomb development, already have definite plans for tapping the still unknown sub-atomic energies.

Cosmic rays have furnished the clues. These rays produce particles that are neither neutrons, protons, or single electrons. The particles are plainly visible in the vapor trails of cloud chambers. One of them has a mass equal to the weight of about two hundred electrons. It has been named meson and also heavy electron. The latter is a popular name which annoys the nuclear physicists, because it is an untrue description. Since the war mesons have been made in the laboratory by a 100,000,000-volt X-ray machine. Another particle that has been seen is made of two electrons, one negative and the other positive. This particular pair is probably the most amazing combination yet discovered. This one shows up as a result of a gamma ray converting itself into solid matter. A gamma ray is the same thing as an X-ray and as immaterial as light. This pair of particles appears to represent the creation of matter. Actually it is not creation, but only evidence of what scientists have long believed, that both matter and rays are merely two different phases of the same thing, that one is convertible into the other, and that both are indestructible.

Two other pieces of information about the sub-atomic particles have come to light, and have been emphasized by the atomic bomb work. These are that both of the heavy particles, neutrons and protons, probably are not units, but are assemblies of some sort.

The theoretical physicists already have predicted that still other sub-atomic particles exist, and have outlined the methods by which they may be discovered. Dr. J. A. Wheeler of Princeton University has sketched the picture of this futnre atomic energy trail. He is one of the younger theoretical physicists, whose ideas along with those of his former teacher, Professor Niels Bohr, the Danish scientist of Copenhagen, had much to do with initiating the atomic bomb project.

Wheeler likens the uranium discovery to Columbus landing on the islands of the West Indies. The uranium, protactinium, thorium, and plutonium atoms are only the outlying islands in the atomic age. He says the continent lies beyond. But this continent surely will be found and explored, and its resources are vast and unpredictable. He thinks that in the course of exploring this continent, man may find an explanation of an event that took place perhaps ten billion years ago. This event was the beginning of creation in its present pattern.

Scientists do not predict how much farther the atomic energy discoveries may lead man into the mysteries of creation, and in fact few of them venture as far as did Dr. Wheeler. But it is possible for speculations to go farther. The atomic predictions of today are not far out of line with some of man's age-long beliefs. As an example, *Genesis, 1-3*, reads:

"And God said, Let there be light; and there was light."

This sentence, if removed from the context, and considered by itself, comes close to one of the fundamental discoveries of physicists. It is only neces-

FOREIGN SCIENTISTS DID SPADEWORK IN ATOMIC RESEARCH

sary to substitute in the Biblical sentence the present day definition of light as verified in laboratory experiments.

In that new definition light is simply one of the forms of electro-magnetic radiation. It is one of the forms of energy. Light is the same sort of thing as heat, radio waves, X-ray, and the gamma rays of radium. The only apparent differences are in the wave lengths, or the frequencies of vibration. Some of these electro-magnetic waves have been seen to change into material particles in laboratory tests. If mass and energy are interchangeable, as the atomic bomb has proved on a big scale, then light also changes into matter.

Considered in this broad, although somewhat technical meaning, creation of light is the creation of matter and energy, and those two comprise all the material universe.

PIONEERS OF THE ATOM

MILLIONS thought Providence gave the Allies the secret of the atom. That is not true. If Providence had anything to do with it, she gave the secret to Germany.

What happened to this secret in the prewar thirties was something different than most people realize. An understanding of those events is almost as important to the world's future welfare as the atomic discovery itself. The atomic events of the five years preceding Hitler's invasion of Poland prove the impossibility of preventing further atomic energy discoveries. The world may be able to delay, but cannot stop the advance either in atomic power or bombs. Inevitably it will become easier to destroy with future atomic energies. Civilization may use intelligence to save or to advance itself, but cannot escape the discovery of more facts of nature.

Unveiling the secret of uranium began in Rome, in 1934, with some work by Enrico Fermi, now an American citizen. He is credited by many scientific leaders with inspirational insight. He was the first to use the then newly discovered neutrons to bombard uranium. He was seeking in this way to create out of uranium some elements that were heavier than this metal and not known to exist in nature. Fermi was not looking for the material to make atomic bombs. The evidence is he did not even think of that. What he discovered was a puzzle that interested scientists everywhere for the following five years.

Among those working on this problem were Madame Curie's daughter Irene, wife of Frederique Joliot. Both Joliots are in top ranks of physicists. They were not looking for atomic bombs. They found, in the uranium bombarded by neutrons, traces of chemical elements that ought not to exist there. But the identification was not clear.

Next, in Berlin, Otto Hahn, head of the great Kaiser Wilhelm Institute, undertook the investigation. He assigned the search to Lise Meitner. She is an Austrian. She had reason to fear the Nazis. Hahn protected her, but as the Nazi tyranny spread, she left Germany and went to Stockholm. Her work on the strange interlopers in uranium was unfinished. Hahn, who is himself a chemist, and his colleague F. Strassman, took over the Meitner data. Hahn noted some facts she had not finished interpreting and quickly made the discovery that one of the puzzling elements in the bombarded uranium was barium.

Barium is about half the weight of uranium. That was the all-important basic discovery. The barium meant that uranium atoms were splitting into two about equal-size atoms. That was the secret of the atomic bomb, although not apparently recognized at the moment.

Almost the first action Hahn took was to notify Miss Meitner in Stockholm. To do that was part of the code of scientists, and probably also involved a touch of chivalry, since Meitner, with the information, and what she might do with it, would be in a stronger position in her scientific career. The fact that Hahn's identification of the barium was the great discovery was recognized by the Nobel committee later in awarding him a Nobel prize, although not for this particular atomic discovery.

Perhaps it might be said that it was the work of Providence that Hahn and Strassman did not keep their discovery a secret for Germany alone. For, as will appear soon, when physicists in other countries heard of that barium discovery, they took only a few hours to discover the secret of bombs and atomic power. At any rate, Hahn and Strassman do not appear to have been looking for atomic bombs.

LISE MEITNER'S STORY

A WORLD-WIDE legend has grown up about Miss Meitner. She has been credited throughout the lay world with the inspirational insight that first explained what Hahn and Strassman discovered. But scientific reports never credited her alone. At the time, and before the world knew anything about it, she was credited jointly with her colleague, O. R. Frisch, who was another and earlier expatriate from Germany. Frisch later worked on the bomb project in England and then at Los Alamos, New Mexico, as part of the scientific team that made the bombs. Niels Bohr, of Copenhagen, in whose laboratory Frisch was working, urged Meitner and Frisch jointly to study the Hahn discovery.

Miss Meitner's own story, in a letter to The Associated Press, hitherto unpublished, gives joint credit. She writes:

"I want to establish the following points. Nobody had formed the uranium-splitting idea before the process actually had been found.

"When Professor Hahn and Dr. Strassman demonstrated that by irradiating uranium by neutrons, there were formed transformation products as low as barium, O. R. Frisch and I discussed this result and came to the conclusion that there was an absolutely new type of nuclear process, which on the basis of Bohr's liquid drop model of atomic nuclei could be explained as a division of the uranium nucleus into two smaller nuclei of roughly equal size.

"And we drew attention to the fact that by this division of the uranium nucleus a very large amount of energy will be set free. By rough estimates we showed that this energy was about two hundred million volts."

LITTLE DROPS OF WATER

IN their published report Meitner and Frisch said that the heavy nucleus of uranium would be expected to move in a collective way having some resemblance to a liquid drop.

There it was. Thinking in terms of little drops of

He Gambled on the Atom

FRANKLIN D. ROOSEVELT

liquid made clear the incredible thing that nobody had anticipated. Atomic bombs and atomic energy were clearly possible. But Meitner and Frisch had not been looking for any such outcome. Everyone is familiar with the model they had in mind. It is seen when water drips off an icicle, or off leaves. As the moisture extends down in a V-shape, the lower end pinches off, forming a drop. This pinching action is the way a drop of water breaks in two.

Bohr and other physicists had theorized that the core or nucleus of a heavy atom is not a hard, rigid ball, but is more like a mass of jelly. This core, Meitner and Frisch reasoned, might have a surface tension like a drop of liquid, and so would be capable of dividing in two.

Frisch and Meitner were the first to publish this finding. But even had they kept silent, the great atomic discovery would not have been delayed by one day. Bohr came to New York before Frisch and Meitner had completed their studies. One evening he called at Columbia University, upon his colleagues there, George B. Pegram, dean of physics, and John R. Dunning, who later became one of the foremost atomic bomb men, and others of the Columbia group. Bohr told them of Hahn's discovery. One of the group picked up an old envelope. A few calculations were quickly made on its back. These showed the splitting of uranium with release of far more than a million electron volts. Dunning and some of the colleagues went into a laboratory, and in two hours had the evidence verifying the great release of energy.

The discovery was stunning. The Columbia group talked it over and decided to maintain silence awaiting developments. Bohr a day or two later informed other colleagues gathered in Washington, who quickly arrived at the same results as Columbia. These men from other scientific institutions conferred with the Columbia group, and it was jointly decided to make public what had been found. All the parties refrained from claiming credit for priority in discovery. Bohr told them he felt sure, as later proved to be the fact, that Frisch and Meitner had done the same thing a little earlier.

SCIENTIFIC PROGRESS IS INEVITABLE

THE trails of great scientific discoveries are frequently like this one. In fact, the discovery of bombs and atomic energy became inevitable back in 1932, the year that J. Chadwick of England discovered neutrons.

Scientific progress is moreover inevitable. If one nation misses making the discovery, the scientists of another are sure to do so. The discovery of X-rays by Wilhelm Konrad Roentgen, the German, is an illustration. The very day that his discovery was cabled to American newspapers, American physicists looked in their own laboratories and realized that they had been seeing the evidence of X-rays in their own experiments.

Attempts to restrict this scientific progress has two perils to society. One is for the nation that restricts its scientists too much. In some other nation, there is certain to be a group not so restricted. This second group is more likely to make fundamental discoveries. Such a group need not be composed of evil men, and possibly never will be. But it may be easy for evil men to take over what such scientists have learned.

Another danger is that if the investigation of atomic energy is shackled by too rigid controls, most of the rest of scientific progress will also be shackled. For the energies in the atomic nucleus will soou be vital parts of the progress of many other branches of science, and already are exactly that in medicine and biology and nutrition. Atomic energy is the chemistry of the future. It will be important in some of the things that the great 200-inch telescope will see. It is true that trained physicists and chemists will make most of the atomic discoveries. But for some time physicists and chemists have been indispensable members of the research teams in other sciences. The discovery that means the next great step in atomic energy might come from a group working in cancer or synthetic rubber, to name but two of many possibilities.

In the days when the atom bomb was a great secret, an American rubber chemist, reasoning in terms of chemistry instead of physics, had the idea that the mysterious action between very small particles is the key to atomic energy that will not have to depend on splitting atoms. He did not then know that physicists were thinking about this same concept. He wrote a letter to a physicist of his acquaintance outlining his proposals. This happened in war time when the exchange of scientific thoughts was not one of the freedoms. The only reply he received was:

"How in the world did you manage to get that letter through the mails?"

Industry also will be hampered in its progress if controls on the study of atomic energy are made too severe. Not only in power, but in many other ways this new atomic energy will become useful in producing those things that the public needs. A nation that voluntarily restricts its own atomic energy progress without the certainty that other nations are doing the same in full measure, will risk its own industrial and economic future.

There is another important aspect. The great discoveries often appear so insignificant when first reported that no one suspects their significance. And this aspect of science may be a safeguard for those nations or groups who go too far in attempting to shackle knowledge. No one, for example, would have thought to interfere with Dr. Max Planck, the

The Search for Atomic Secrets Began in Ancient Greece

ANCIENT

DEMOCRITUS, 400 BC, proposed theory of invisible particles.

ARISTOTLE, 350 BC, rejected idea, said there were 4 elements in all matter.

ARAB thinkers about 1000 AD added three more basic elements.

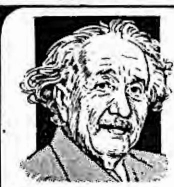
REBIRTH

DESCARTES, France, 17th century, said particle motion caused heat.

DALTON, England, 1808, established modern atomic theory in writings.

MENDELEEFF, Russia, 1869, set up periodic table of 92 elements.

MODERN



EINSTEIN, Germany, 1905, gave formula energy equals mass.

THOMSON, England, in early 1900's discovered electron.

RUTHERFORD, England, 1918, found proton, smashed first atom.

BOHR, Denmark, 1913, established electrons move in regular orbits.

FERMI, Italy, 1933, discovered neutron capture by nucleus, value of slow unit.

MEITNER, Austria, 1939, showed with Frisch that neutron splits U-235.

German physicist, in teaching his class of students about color temperature. Color temperature is a technical phrase. The light from a tungsten lamp is somewhat yellow, and the temperature of the tungsten filament is around 2500 degrees Fahrenheit. If a slightly blue-colored lamp bulb is used in place of the ordinary white glass, the light loses its yellow tinge and becomes more nearly white. This color, due to the blue glass, is the same shade that would be emitted by a tungsten wire heated to about 3600 degrees, that is, about 1000 degrees higher than the ordinary lamp temperature. That difference is the color temperature.

Professor Planck was teaching his students the mathematics by which such color changes can be predicted. He was using a new mathematical formula for this purpose. The new formula was only a fraction of a degree more accurate than the old, but scientists prefer to use the more accurate tools even though the differences are very slight.

Then the professor went on a vacation. While he was away he received a letter informing him that the new formula had worked very well in the temperature studies so long as it dealt with short wave lengths. But when applied to the longer wave lengths, the formula no longer had any agreement with the old one. Planck did not wish to interrupt his vacation. He wrote to the class telling them to multiply the last factor in the new color-temperature formula by —1. This was a shot in the dark by Professor Planck.

When he returned from vacation, he learned that the —1 had corrected the discrepancies. That minus factor, in fact, had worked far better than he had expected. So he was faced with the problem of explaining the realities behind this mathematical symbol. There just was no explanation in anything then known about the nature of light or of temperature.

But Professor Planck found one theory that could be an explanation. The trouble was that this theory was almost completely incredible. The theory was that light and temperature, instead of being smooth, uninterrupted streams of energy, as always had been thought, were broken up into small particles or packages that followed each other like the beads on a necklace. This was the now famous Quantum theory.

Professor Planck published it. No one really believed it at first. But after a time this Quantum theory explained so many things about energy that had previously been unsolved that the theory was accepted as a fact, and as the discovery of one of the great laws of nature. The Quantum theory became one of the corner stones in discovering atomic energy and making the bombs.

'SALESMEN' OF THE BOMB

A FLASH of intuition by President Franklin D. Roosevelt gave the atomic bomb and the atomic era their practical start. Without his early inspiration, the atomic age would hardly have dawned before the war ended, and possibly not for years.

One man who is not a scientist was, more than any other individual, responsible for the President's initial action. He is Alexander Sachs, New York economist, with offices in Wall Street. Sachs is Russian-born, but American by upbringing, education and career. Some acquaintances say he looks like Ed Wynn, the comedian. He had known Roosevelt since 1932, and had been an informal adviser. He had no official government position, but some of his ideas had been acted on by the President. Sachs proposed in 1933 the use of N.R.A. funds for reconditioning the Navy, mechanizing the Army and improving the national defense. In 1936 he proposed the idea of a power pool.

By the time of the atomic discovery, Sachs had come to be known as the Economic Jeremiah.

He was one of a small group, all the others scientists and interestingly enough all of them foreign-born, who more than anyone else foresaw the dangers from the first. American scientists at that time were not accustomed to working with the government. The foreign group had a different background and with it a perspective to see that the government was needed.

Professor Albert Einstein of relativity fame was one of this group. All except Einstein were comparatively young. Sachs then was 46. The others were Dr. Leo Szilard, 42, recently arrived from Hungary; Enrico Fermi, 39, from Italy, at Columbia University; E. P. Wigner, 36, from Hungary, at Princeton; Edward Teller, 32, from Hungary, at George Washington University; and Victor F. Weisskopf, 31, from Austria, at the University of Rochester.

The early attempts of scientists to interest official Washington had got nowhere. The first attempt came within three months after the German atomic discovery, when Dr. George B. Pegram, dean of physics at Columbia, sent Enrico Fermi to Washington. Fermi returned with the answer that the men he talked with were interested. That was all.

The motive of all the scientists was based on fear of what aggressor nations might do to the United States with atomic bombs. The small group of foreign-born stuck to their guns.

EINSTEIN LOOKS AHEAD

EINSTEIN discussed the prospects with Wigner and Szilard, and then with Sachs. The upshot was that in August, 1939, Einstein wrote a letter to Roosevelt and entrusted it to Sachs. The latter presented the letter to the President on October 11, along with scientific articles, a letter by Szilard, and his own observations. Einstein's letter read:

"Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore it is my duty to bring to your attention the following facts and recommendation.

"In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

"This new phenomenon would also lead to the construction of bombs, and it is conceivable — though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air."

Einstein's letter went on to point out what might become a precarious situation in a race for supplies of uranium with Germany sitting in the driver's seat. He said that Germany already had stopped sale of uranium from the then best known source of supply, in Czechoslovakia, and told of uranium splitting work going on in Berlin under close observation of the government.

Szilard's memorandum pointed out the possibility of using uranium to drive boats and airplanes. He forecast too how bombs might be made.

THE PRESIDENT'S FORESIGHT

SACHS gave the President the scientific manuscripts. But in his own discussion he emphasized the broad world trends. One was the possibility of the Nazis overrunning continental Europe and attacking England. If, he said, the Nazis succeeded in taking France, there would be no continental staging area for defense purposes. He remarked on the peril for England when only the English Channel stood between her and Germany.

"If," he added, "Hitler produces atomic bombs, the Atlantic Ocean will become only an English Channel for America."

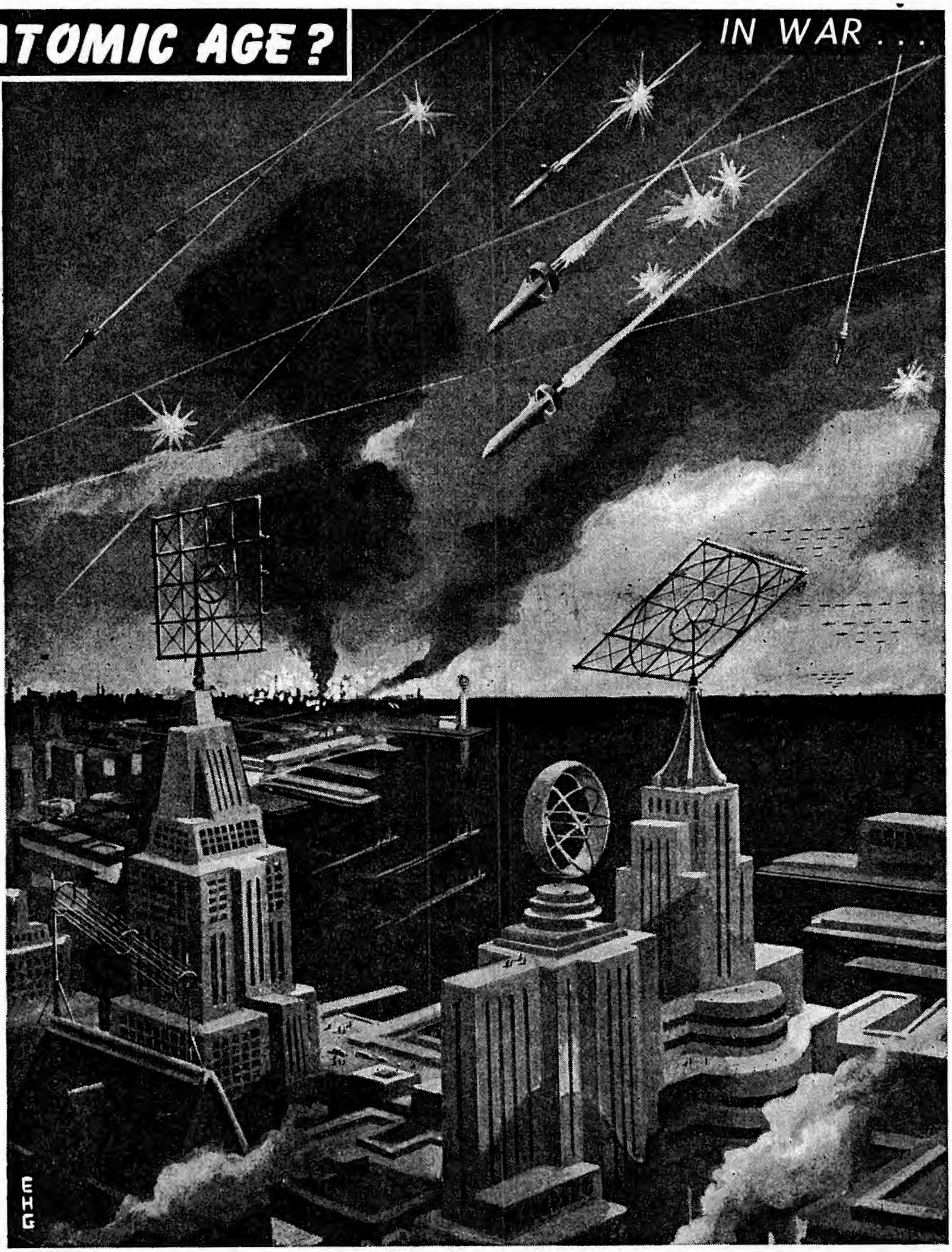
Sachs also read the President the following passage from F. W. Aston, British scientist, who discussed the opposition to atomic research, saying:

"There are those about us who say that such research should be stopped by law, alleging that man's destructive powers are already large enough. So, no doubt, the more elderly and ape-like of our prehistoric ancestors objected to the innovation of cooked food and pointed out the grave dangers attending the use of the newly discovered agency, fire. Personally, I think there is no doubt that sub-atomic energy is available all around us, and that one day man will release and control its almost infinite power. We cannot prevent him from doing so and can only hope that he will not use it exclusively in blowing up his next door neighbor."

"Alex," remarked the President, "what you are


IN PEACE . . .
THE COMING A
ROCKET SHIPS POWERED BY ATOMIC ENERGY MIGHT EXPLORE OUTER SPACE.
CITIES MIGHT BE LIGHTED BY ATOM-PRODUCED FLUORESCENT GLOWS IN THE SKY.
HUGE POWER PLANTS TO HEAT ENTIRE CITIES ARE POSSIBLE.
ARCTIC REGIONS MIGHT BE MADE COMFORTABLE FOR LIVING.
NEW RADIOACTIVE RAYS MIGHT ENABLE SCIENTISTS TO STUDY WHAT HAPPENS IN CANCER TISSUES.
NEW RAYS MIGHT PROVIDE A CHEAP WAY OF PROSPECTING FOR OIL.
ATOM-POWERED SHIPS COULD HAVE UNPRECEDENTED SPEEDS — AND SUBMARINES COULD REMAIN UNDER WATER LONGER AND TRAVEL MUCH FASTER.
.AKES MIGHT BE CREATED IN THE MIDST OF DESERTS.
MORRIS

G ATOMIC AGE ?



AMERICAN SCIENTISTS GAMBLED WITH THEIR OWN FUTURE

after is to see that the Nazis don't blow us up."

"Precisely," replied Sachs.

The President then called in his aide, the late General E. M. (Pa) Watson and said: "This requires action."

Sachs went out with General Watson, whom Roosevelt appointed as liaison for the White House. The President designated Dr. Lyman J. Briggs, then director of the National Bureau of Standards, to constitute a committee to consider the situation. This committee met at the end of October with representatives of the Army and the Navy as members, and a number of scientists. Some of the scientists were unconvinced. They suggested waiting and seeing, and said that lines of progress other than chain reaction might be more attractive.

"Let's wait" seemed to be the most frequent watch word during that first winter of the war. Military men would say to General Watson:

"Well, this is so remote. Let's wait and see."

General Watson sometimes replied, "but the Boss wants it, boys."

THE UNIVERSITIES GO TO WAR

MEANWHILE much scientific progress was under way in university laboratories, particularly at Columbia. But Einstein and Sachs remained dissatisfied through the winter. In the spring, before the fall of France, Sachs saw the President again to talk about the probable course of Nazi aggression. Einstein wrote another letter with further information about progress of German uranium work. Szilard wrote a letter suggesting that a bomb set off at sea near the coast might produce tidal waves that would destroy coastal cities. He told of the possibilities of a new poison gas made of neutrons that might kill a human being within a radius of one kilometer.

Sachs urged the President not to be misled by the reticence of scientists. He proposed that the time had come to telescope into a short space the developments that ordinarily would take many years.

In June, 1940, the President set up the National Research Defense Committee under Dr. Vannevar Bush. This later became the Office of Scientific Research and Development. The new committee took over the atomic project. There it remained until the middle of 1942, when the Manhattan District was formed and Major General Leslie R. Groves took over.

The President, when he created Bush's organization, had carried the ball for seven months. How much faith in science this required is shown in his word to Dr Briggs.

"This baffling and intricate matter," was the President's description.

Einstein shyly remained away from all the Washington conferences. His role was to point out the cloud on the horizon. Sachs was the catalyst.

Under the new scientific organization, something new in war developed. This was the voluntary linking of the nation's universities and colleges to do a military job. What they did is probably the greatest single military revolution of history. The chain of universities stretched from coast to coast and Canada to the Gulf of Mexico. Canadian and English universities joined in some of this work. Columbia did the path-finding research of this period.

In those days American colleges and universities were the ports of missing men. Professors and scientists were not to be found by visitors who asked for them. They had departed. Where to? War work was the answer. Occasionally a guess was added that they had gone into atomic energy projects.

American industrial laboratories also lost scientists to bomb work. A few of these laboratories became atomic energy centers. This nuclear energy snowball rolled and rolled until it became the largest single war project. The Navy was in almost from the start with a project of its own that finally became one of the four methods of obtaining explosive atoms.

From Denmark came Niels Bohr, the father of the present conception that an atom is a small central sun surrounded by electrons in orbits like the earth and the other planets. The figure of Bohr looms big. He had been the teacher of many of the physicists of all nations. These former students included some of the leaders in the atomic energy project both in the United States and abroad. Bohr was one of the first to predict that it was not common uranium that was splitting but U-235.

Later, after he escaped from Copenhagen to Sweden with Hitler at his heels, and then was flown by bomber by the British to London, Bohr came to the United States under the code name of Dr. Baker. Here he acted as an advisor on the atomic bomb.

The volunteer scientists included some of the world's greatest and most famous. For nearly all of them there was one great driving force—deadly fear. Almost to a man they regretted what they had to do. Probably unanimously they hoped the result would be not simply the use of atomic bombs and energy but the end of war.

ONE PANAMA A YEAR

IF RED grains of sand were scattered over all the seashores of the world, and each grain were on an average about 200 yards away from every other grain, that would parallel the spread of explosive uranium 235 atoms in the earth.

If these red grains would explode whenever a few pounds were gathered together, it would have been easier to make the first bomb by gathering such sand, by hand, one grain at a time, using as pickers the half million workers who at one time or another were on the bomb project, than it was to gather enough atoms of uranium 235 to make the first bomb. The tasks of engineers and scientists in designing plants to extract the explosive material almost surpasses imagination. What they did is a guarantee that many things which seem like dreams will come true in the atomic age.

The equivalent of one Panama canal a year was built for nearly three years at Oak Ridge, Tennessee, where the uranium 235 was produced, and at Hanford, Washington, where the new explosive metal, plutonium, was made. When these plants were completed, the output per day was in pounds. The exact amounts were military secrets. By all accounts, the uranium output was higher than the plutonium. Two great plants, each in a separate valley, were built at Oak Ridge to produce uranium 235. A third large plant was built in another Oak Ridge valley for experimenting with plutonium. Four huge plants were built at Hanford.

In the driver's seat for the two billion dollar project was Major General Leslie R. Groves, a six-footer, variously known in the Manhattan Engineer District by the code names of The Lone Ranger, The Headless Horseman, Gus, Gen, Ninety-Nine and other code names, less elegant, but intended affectionately. Ninety-Nine came from an airport messenger's mistake in copying the initials G.G., for General Groves, as 99.

General Groves is an Army engineer, fourth in his class at West Point in 1918, the son of a Presbyterian minister of Albany, N. Y., who was an Army chaplain. Groves is heavy-set, with thick, slightly greying black hair, blunt, firm and with eyes that usually twinkle. In taking over the atomic project, he gave up the chances for advancement that go with wartime military achievement for the greatest gamble in history. Could bombs be made at all? And, more critical still, would they be in time? Nobody knew.

If American science and industry failed the job might be the greatest hoax of all time. The American people might be so disgusted that the project could not be completed after the war. Science might be set back for years.

General Groves had a flare for saving difficult situations. In the early days, when the town of Oak Ridge was building a new dwelling every thirty minutes, on an eight-hour day, it became urgent to get the State of Tennessee to improve the roads to Knoxville, about twenty miles away. The situation was a bit embarrassing because the military authorities had not completed their liaison with Governor Prentice Cooper.

As the Governor tells the story, soon after the Manhattan District took over 59,000 acres of Tennessee, he received protests from about fifty families in the area who said they were being dispossessed from their homes hurriedly, and that it was up to him to do something about it.

A number of inquiries came from Tennesseans who said that their ancestors first brought fire into those valleys, where the families had continuously lived ever since. They asked why an outfit calling itself The Manhattan Engineer District should be taking such large quantities of Tennessee land from the tax rolls without identifying itself even by name or otherwise with Tennessee. Others pointed out that through the Tennessee Valley Authority's acquisition of land and otherwise the Federal Government had already deprived Tennessee of six per cent of its land as a tax source. Reports reached the Governor from Knoxville, from citizens ordinarily reliable, that the Oak Ridge development was not a military project at all, but had to do with a post-war social experiment and planned economy for some hoped-for ideal community.

At about this time an officer was sent to see Governor Cooper. This officer was under security restraint, and could not give the Governor any idea of the nature of the project, not even so much as a hint as to the general objective. This was not satisfactory to the Governor. General Groves then stepped in, along with Colonel Kenneth D. Nichols, the General's right-hand man. They invited the Governor to a meeting, offering to go to Nashville. The Governor suggested Knoxville, and the meeting was held there with the State Highway Commissioner attending, since the road situation was urgent. The Governor was satisfied with explanations, and the party started for Oak Ridge.

A state police car led the way. In the second car were the Governor and the General. While topping a hill, around a curve, the police car, with its siren blowing, passed a heavy truck loaded with a road scraper. The officer waved the truck to take one side of the road. The machine's startled driver swerved it completely over the edge of the road and down a precipice. The driver jumped to safety.

The Governor's car jammed to a quick stop, and he stood at the roadside looking down on about $4000 worth of ruined state machinery. General Groves went to see that no one had been hurt and then ranged himself beside the Governor, gazed down at the toppled machine and was the first to speak.

"You see, Governor," he said, "that's what we have been talking about. These roads are too narrow."

Later, at tea in Oak Ridge, Governor Cooper smiled—"General, it was not necessary to order a man killed and thousands of dollars of equipment damaged in order to impress us that a road was needed."

General Groves grinned, and throughout the project the Governor and the State granted every request of the District, starting with widening the roads.

"JULY 1ST NOTHING"

THE diplomacy of Colonel Nichols was an asset. He is a native of Cleveland, a graduate of West Point, in 1929, fifth in his class. Some of the younger scientists at Oak Ridge, immediately after the war, were debating how they should go about telling the country their opinions of the political implications of the atomic bomb, as they, and other scientists throughout the project, afterwards did. When it was suggested that they discuss the matter with Colonel Nichols, one of them replied, in effect:

"Not on your life. He will be so nice about it that he probably will persuade us to remain silent."

On many a day General Groves and Colonel Nichols sat for hours with scientists or engineers, or both, asking for the earliest possible date for completing a job. The scene often went like this:

"Well, General Groves, the best that can be done is July 1st."

And then from the General: "July 1st nothing. It will be done March 1st."

Time was running out, even when the great building projects started. One of these comprises about ninety buildings on the broad floor of a valley. These structures rise against a background of the Cumberland mountains looming six thousand feet high. But the mountains do not dwarf the great buildings of brick and concrete. The central building is U-shaped, each leg nearly a half mile long. The structure rises sixty feet. In this great building uranium that has been converted into a gas is strained through thousands of great barriers, containing billions of holes averaging a few millionths of an inch in diameter. These barriers are in the form of large, thin sheets. There are so many that if the sheets were set end to end, they would reach from New York to Tokio. This process separates atoms of weight 235 from the slightly heavier and far more numerous atoms of weight 238. The latter do not make bombs.

Nothing about this great plant now suggests the heartbreaking obstacles of its early days. A group of physicists at Columbia University in the early days were the plant's principal sponsors, under the leadership of John R. Dunning. Two of the head committees on the atomic bomb project were not favorable.

The project had a low rating until the DuPont Company was asked to build and operate the plutonium plant in Washington. The DuPont executives were granted the privilege of learning what the other projects were. They wanted to be sure that they were not undertaking something that would get them into trouble after the war.

They did not want to risk repeating their experience after World War I, when the company was accused of being one of the world's munition makers profiting from war. That accusation was made notwithstanding the fact that barely three percent of the company's business was munitions. When DuPont engineers and scientists went to Columbia and looked at the gaseous diffusion project they were impressed. Their backing gave this project real impetus.

But after the construction started at Oak Ridge General Groves received letters declaring that it probably would fail. As the last straw, after this plant was well under way a group of foreign engineers, collaborators on the bomb project, arrived in this country and urged abandonment of this great division. General Groves stuck, spending more and more money on gaseous diffusion. Harold Urey, who received the Nobel prize for discovering heavy water, headed the scientific group in the gaseous diffusion plan. Dr. Dunning had enthusiastic faith in the plan and drove it through. In the end this plant produced more of the explosive bomb materials than any other part of the project, either for uranium or plutonium.

This great plant developed an efficiency surpassing that of most industrial plants. The development engineer was P. C. (Dobie) Keith, of the Kellex Corporation. Keith was one of the brilliant workers. When the plant was completed, and in operation by the Carbon and Carbide Chemical Corporation, he took his leave of Colonel Nichols, the Oak Ridge commanding officer. What Keith said in that farewell was typical of the effort of all key men. "I'm leaving," he said. "My job is done. I have spent four years. I think I have done good work. I can't help but wonder whether I was right—whether it will be in time. Do you think I made a mistake?"

Colonel Nichols, under security restraint, replied simply "No." A few days later the first bomb was exploded and the atomic age dawned.

SEPARATING URANIUM

IN a second valley at Oak Ridge was another great plant where a different drama was played. This plant comprises one hundred and forty buildings, dominated by mile-long, parallel rows of great, red almost windowless structures. In these, uranium is separated in vacuum spaces between the jaws of electro-magnets, whose pole faces are as wide as a small room, and wide apart. Uranium in the form of a gas is driven in the vacuum at high speed into the magnetic field between the great pole faces. Being electrically charged, the atoms curve in the magnetic field. The heavier atoms travel in wider curves than the light and separation is obtained.

So great are the magnets in these plants that a large amount of United States Treasury silver was borrowed from its West Point storage place and converted into the necessary electrically conducting bars. Copper, which normally would have been used, was not available because of other war needs.

In the beginning this process was a poor relation among all the brilliant schemes. General Groves was advised it wouldn't work, that it was as foolish as picking a needle out of a haystack, magnetizing it, and using this magnetic needle to draw one needle out of a second haystack. Opponents were many, advocates few. The General spent a hundred million dollars in the face of a growing file of adverse reports from scientific and engineering authorities that would have been damning had the plan failed.

The military policy committee of the project gave the General full support in backing the brilliant young scientist, Ernest O. Lawrence, who headed the magnetic separation idea. Lawrence received a Nobel prize for his invention of the cyclotron. In his University of California laboratory, Lawrence and his associates dismantled their cyclotrons to obtain great magnets for their experiments.

The magnetic plant was the first to produce uranium 235 in quantity. Although the output was not as large as the gaseous diffusion production, it came in handy at a critical time when the high purity uranium 235 was badly needed for early developments. The Tennessee Eastman Corporation operated this plant with a personnel of about 24,000. Westinghouse and Allis-Chalmers supplied much equipment.

A third plant, in the same valley with the U-shaped building for gaseous diffusion, was sponsored by the Navy under direction of P. H. Abelson of the Naval Research Laboratory. Here uranium was used in liquid form. The liquid was heated so that one portion was hotter than another. The lighter weight atoms moved toward the hotter part of the liquid, and in this way the 235 was separated from the 238.

These Oak Ridge plants, in their know-how and the new devices employed in them, were the second secret of the atomic bomb.

COOPERATION PAYS OFF

ONE of the early decisions by General Groves was to set up a plant at Los Alamos, New Mexico, to manufacture atomic bombs. Here also there was difference of opinion. One of the American scientists, some of whose ideas were part of the main success of the atomic project, advised there was no hurry. The making of a bomb, he said, would be a small job that twenty scientists could do in three months. Others thought it a bigger job than that. General Groves chose an early date and the bomb-making required two-and-a-half years and about 4000 scientists and technicians.

The scientists were not the only important men in the atomic project. Industry did a job as big, and the American industrial system showed itself as a further guarantee of bringing about nuclear miracles of the future.

The cooperation of industry never ceased to intrigue Manhattan District officers. In all far more than ten thousand firms cooperated, directly or indirectly. Some of the more prominent were asked to do things or make things that had never been done or made before. Nobody replied, "It can't be done."

The usual reply was—"If it can be done, we'll do it." They always did. The head of a great corporation signed a contract to make something heretofore unknown in industry, without even inquiring what the new thing was to be. After the war, when the project came out into the open, Manhattan District officers expressed admiration for the ability of free American industry to get things done.

Labor was a part of the great cooperation. Unions refrained from sending organizers into the great plants, because of the risk to secrecy inherent in any contact that required talking with those workers. When Chicago had a truck-drivers strike in 1944, many shipments of the atomic bomb project would have been tied up. The agents of the Manhattan District knew always where every carload was every day. They went to union officials. Without being able to tell these officials anything about the nature of the project other than that it was military, the agents were able to drive trucks to transship all bomb materials. Picket lines offered no interference.

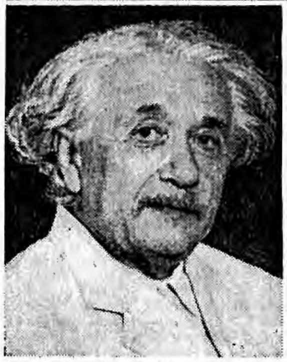
The men in the planning divisions worked as continuously as they could stand. Fatigue often became a serious problem. It did not help much that the men at Oak Ridge who knew what was going on refrained from talking even to their wives about their work. In theory the wives did not know. Nevertheless, it was the women of Oak Ridge, living in mud, queues, and often in cramped quarters the like of which they never had seen, who were given by the Army officers a goodly share of the credit for the success of the project.

The wife of a famous scientist, whose work involved the bringing in of many other scientists and their families, had a tactful formula. Frequently these scientists did not go first to Oak Ridge. The first move was to induce them and their wives to give up comfortable homes and move to the wartime uncertainties of another city where they had to do important atomic energy work. This lady would talk to the wives about the importance of getting their husbands to take the first move. Later, after they had been thus softened up, she would repeat the tactics when the men folks were needed in an unknown new town that in those days lacked almost everything a woman values in a home, except only her husband and children.

Most of the men carried through despite fatigue. Colonel Nichols and his officers made a point of watching for the signs of exhaustion. These were not greatly different from some of those apparent in battle fatigue. They were never allowed to go so far as that, since sharpness of judgment was essential to these men. When one of them began slowing down, the usual remedy was to take a few days rest in the attractive hospital that the Army erected for Oak Ridge.

Although it was not one of the aims to make Oak Ridge an example of a post-war community, this fifth city of Tennessee became in some respects a prototype of cities of the future. Its dwellings were spread along, around, and sometimes behind the hills that form the valley, which is the main town site. Oak Ridge has the dispersion that has been a dream of the city of the future. As one result of this, Oak Ridge would not be totally destroyed by one of its own atomic bombs.

Three Who 'Sold' the Atom to America



DR. ALBERT EINSTEIN

DR. ALEXANDER SACHS

DR. LEO SZILARD

ATOMIC FIRES

IN the atomic energy prospects the cheerful side far exceeds the gloomy aspects. Atomic energy will some day raise living standards so that man who now in industrial countries has the equivalent of 80 slaves may be served by the equivalent of 800 or 8000 slaves in the form of mechanical, industrial, and economic improvements.

Men always have possessed the means of killing each other. First perhaps were the stone axes. Later came bronze implements, then steel, then gunpowder. When Alfred Nobel invented dynamite, he and a good sized group of philosophers believed that this explosive was so terrible that it would end war. Men now possess pistols for almost personal use. Man has never yet destroyed himself, although with some of his weapons he might have come close to that. Good sense and increasing intelligence have saved him, and these same qualities certainly will be used again now to reap benefits, instead of destruction, from atomic energy.

For the good things in prospect in atomic energy man will use atomic fires. These are somewhat different from atomic bombs in their make-up. They use neutrons for their burning, but in a quite different way than do the bombs.

An atomic fire is simpler than a blaze of wood, coal, oil, or gas. This nuclear fire would be easier to build, except for the great weight of materials that have to be used. The first great atomic ovens were erected in the State of Washington in a subdivision of the Manhattan District known as the Hanford Engineer Works. The location is 400,000 acres in the central part of the state between the Yakima Range and the Columbia River. This area is on an undulating table land in a mostly uninhabited region of grey sand, grey-green sage brush and dried water courses. Colonel Franklin T. Matthias commanded this project.

Here are three atomic ovens. Each is an immense cube of graphite bricks. The cubes rest on concrete foundations. All around each are shielding walls three feet thick, and over them roofs of the same massive proportions. These ovens are called piles because their bulk is mostly the pile of graphite brick. Hundreds of horizontal holes pierce the graphite cubes. These holes are machined with the precision of rifle barrels. The holes are really the ovens. When an atomic fire is wanted, slugs or blocks of normal uranium metal are placed in the holes. At Hanford this uranium is enclosed in aluminum cans. The cans, however, are for a special purpose not related to making an atomic fire.

When a sufficient number of blocks of uranium is in the holes, the fire starts. No lighter of any

MODERN ALCHEMY MAKES PRODUCT WORTH MORE THAN GOLD

sort is applied. The fire starts spontaneously. Neutrons set free by cosmic rays or by radioactive impurities in the oven or its fuel initiate the fire.

But there is no flame, no smoke, no fumes. The blocks of metal simply get hot. How hot they become depends on the temperature that the operators want.

The controls for this nuclear fire are less complicated than the drafts and valves of many ordinary heating plants. The controls are long metal rods or strips. They are usually cadmium, a common silvery white metal, or boron steel. Either of these elements absorbs neutrons, and this absorption stops the neutrons from spreading the fire. To slow the atomic heat, the rods are pushed in. These rod controls are operated automatically, like a thermostat, to maintain any chosen temperature. The rods also control the time when an atomic fire starts. In the first ovens, the fires started when the last rod was pulled out the last foot-and-a-half.

The heat is due to the splitting of atoms of uranium 235. About five particles come out of each split. Two of them are the halves of the uranium atom, and the others are neutrons. The friction of these particles as they pass through solid matter or air creates heat. This heat can be calculated. It would be a temperature of trillions of degrees provided all the energy of the speeding particles turned into heat. But some of the energy is converted into motion, imparted to struck particles. Part of the energy is radioactivity. The actual heat becomes millions instead of trillions of degrees.

However there is no danger of atomic ovens flashing instantly into a lot of incandescent vapor. For the extremely high temperatures exist only very close to the atomic split and in minute particles. These temperatures drop very rapidly with distance. For that reason, atomic fires start with low temperatures the same as stoves burning ordinary fuels.

But because the temperatures of the atomic splits are so extremely high, the atomic fuel, when used for producing heat, lasts an almost incredible long time. Or to put it in another way, a mere pinch of this fuel will yield the heat equal to that from many pounds or tons of other fuels. While it is burning, this atomic fuel creates new fuel to replace that which has been burned. The replacement may be either partial or complete. How long a pile will continue to give useful heat with one loading depends on the percentage of uranium 235 or plutonium in the original fuel, and other factors not yet fully developed.

The first atomic fires burned normal uranium, that is, the metal composed of both 235 and 238 weight atoms. In this normal uranium the 235 is only seven-tenths of one per cent of the total. That percentage is one of the most interesting of all the atomic energy discoveries. Had the 235 amount been only a little less, no atomic fire would be possible in normal uranium. At a far earlier time in the earth's history, there was two or three times more of the 235 in normal uranium. This explosive material has since then disappeared due to slow disintegration. Man came along with his great discovery just in time to take advantage of the waning percentage of 235.

This fact is no insuperable handicap however. For the purposes of using atomic energy, more efficient fires will be built by using uranium 235, and other splitting atoms, that have been refined to the point where the percentage is higher than that in normal uranium. Meanwhile, the normal uranium used for the first nuclear fires is absolutely safe from dangers of atomic explosion.

The graphite bricks are used because of a peculiar characteristic of the splitting atoms. Neutrons that have lost about all their speed and nearly all their energy are far more efficient at splitting uranium 235 atoms than the 9000-mile-a-second neutrons and the neutrons carrying electrical charges of millions of volts each.

A neutron with very weak voltage, which means very slow speed, is the most efficient projectile for splitting an atom of uranium, or plutonium. The speeds of these slow neutrons are not given, but their energies are as low as one-fortieth of one volt. The carbon in graphite is a very good substance for slowing down the neutrons. These atomic particles when emitted are travelling at terrific speeds, and they have to be slowed down to make a fire efficiently. Carbon does not split when hit by the neutrons. The latter merely bump around from carbon atom to carbon atom, like a cue ball. Sometimes the neutron cue ball makes 200 hits on carbon atoms before it gets slow enough to be a highly efficient atom splitter.

Heavy water makes a very good atomic oven, or perhaps nuclear teakettle is a more exact description. The heavy water serves to slow down the neutron speeds until they become efficient in splitting the 235 atoms.

The Allies did not make large heavy water atomic ovens because they lacked sufficient quantities of this material. The Germans had heavy water and used it as the Allies would have liked to do. The Germans also used graphite for making atomic fire ovens.

THE THREE-YEAR FIRE

THE building of the first atomic fire in America took nearly three years. This was longer than any other single step. The reason for the delay was the difficulties inherent in making a fire in normal uranium that had so very little of the burning 235 materials. Much of this atomic fire work was done before any attempt had been made to extract the 235 and concentrate it in amounts that would have been much easier to burn.

Using normal uranium, the very first atomic ovens weighed six tons or more. These ovens were not intended to start fires, but only to discover principles. They were used much like taking a log of wood and holding a match to it. There is a slight fire until the match goes out. In place of matches, these early ovens used atomic blow torches, made of a little radium mixed with beryllium. This combination emits a stream of neutrons, and the neutrons in striking uranium showed what could be done.

The Germans, in their search for atomic bombs, went through this same stage of using atomic blow torches of radium and beryllium in small graphite ovens. They had also the advantage over the Allies of heavy water ovens. These comparisons are significant because they mean that had the Germans possessed the manpower they would very likely have produced atomic bombs. As far as their experiments proceeded, they duplicated the road travelled by the Allies. In addition to lack of manpower, the Germans lacked the spirit of free enterprise that drove the project to success in America, and the Nazis also persecuted and expelled some of the scientists who would have been able to help them make bombs.

By December, 1942, with the American phase of the war a year old, time was running perilously low for the Allies in their atomic bomb project. Enrico Fermi headed the group experimenting with atomic fires. By that December his associates had built more than two dozen atomic ovens. But there had been no real atomic fires.

Fermi set up his last oven on the floor of a squash court under the west stand of Stagg Field, at the University of Chicago. This pile of graphite bricks was shaped like a doorknob. It weighed many tons. The scientists still did not have enough uranium metal to fill this oven. They supplemented the metal with uranium oxide, a heavy, black salt. Each day a little more was added to the oven. Each day came closer to the load that was expected to take fire. Actually the scientists miscalculated this load. They figured on using more uranium than was needed. But they safeguarded their experiment with long strips of metal thrust into the doorknob oven like hatpins into a hat. The metal strips were neutron-absorbers.

On the morning of December 2, when the absorbing strips were partly withdrawn, the long-awaited fire started.

In Washington, Dr. James B. Conant, president of Harvard University and deputy for the atomic project under Dr. Vannevar Bush, was waiting for word from Chicago. A camouflaged message was sent to Conant, based on the fact that Professor Fermi was a native of Italy. The message read:

"Italian navigator has landed on the new world. He found the world somewhat smaller than he expected."

Conant replied: "Were the natives friendly?"

"Yes," was the answer.

The "yes" was assurance that no unforeseen difficulties had been found in the fire. The "smaller world" meant that the fire had started with less uranium than anticipated.

Present at this first atomic fire built by man was an observer for a commission upon whose decisions would depend appropriations for about one billion dollars. Because of secrecy restrictions, this commission member was not permitted to tell what he had seen. But by the shining of his eyes, his colleagues knew.

This first nuclear fire made by man, when compared with later steps, was utterly tiny. It would have taken this fire seventy thousand years to produce enough plutonium to make one bomb. Nevertheless, in the end, the fire proved to be the most valuable of all the war-time accomplishments for the progress of peace-time uses of atomic energies.

ALCHEMY AND PLUTONIUM

ALCHEMY and transmutation of the elements came true when the Hanford site atomic ovens were placed in operation. Of all the dreams realized in the atomic project, this one is perhaps the sweetest, safest and the most magical for future uses.

The great ovens were erected to make plutonium, a new kind of metal. Plutonium is the first synthetic or man-made metal. The manufacturing process is pure alchemy. Ordinary uranium, of the atomic weight 238, the non-bomb metal, is transmuted into an entirely new metal. This is plutonium, which has an atomic weight of 239. The plutonium atoms are heavier than anything else known in nature before the war started. They were first made for bombs because they explode like uranium 235.

The original alchemists of the middle ages wanted to transmute baser metals into gold. They were ridiculed. But now the world owes them a vote of thanks. Although they never succeeded, their work started the science of chemistry, with all its practical benefits to man. And the modern chemists who worked on the atomic bomb project were a very large factor in the success of the bomb and of the peace-time progress ahead.

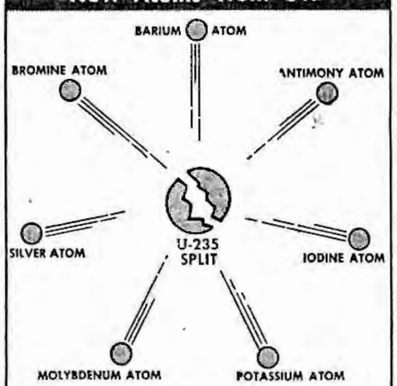
Long before the war, scientists knew the processes of transmutation. But little attention was paid to these modern alchemists. They were unable to make sufficient amounts of transmuted elements to be visible even under a microscope. Plutonium was the first visible and relatively large-scale achievement in alchemy. The value exceeds that of all the gold in the world. This is true not because plutonium can be used to make bombs, but because it is one of the great resources for atomic power.

When it was decided to transmute uranium into plutonium, the task of initiating the scientific work fell to Dr. Arthur H. Compton, Nobel prize winner in physics, who was then head of the metallurgical section of the atomic bomb work at the University of Chicago. He ran into difficulties. He went first to one of the great industrial corporations and asked that company to undertake the alchemy job. The executives said they had no experience in transmutation, and no personnel trained for it. Then Dr. Compton went to one of his friends, the president of a New England university. He asked whether that university would undertake the sponsorship.

"I don't believe," replied the President, "that my trustees would touch it with a ten-foot pole."

At that stage, for a university to stake its reputation on a plutonium project was somewhat like agreeing to back the world's potentially greatest boondoggle. The uncertainties were tremendous. Dr. Compton returned to Chicago. President Hutchins

New Atoms from Old



A TOTAL OF TWO ATOMS OF THESE TYPES IS FORMED WITH EACH URANIUM SPLIT.

TWO complete new atoms of ordinary chemical elements are formed from each split of a uranium or plutonium atom. The new atoms are temporarily radioactive and make up the ashes in an atomic oven. At least 25 such new atoms have been found Only two are formed by each split.

of the University was away. Time was pressing. Dr. Compton talked to one of the members of the University of Chicago board. He described the project and the risks. Then he remarked:

"———— University won't undertake it."

"Oh," mused the Chicago board member, "so ———— University won't."

Thereupon he called another member and they talked it over. The Chicagoans got together for a conference. Dr. Compton told them: "This is a gamble, but I think it is worth trying."

The Chicagoans decided to undertake the job. This may not have been the greatest gamble ever undertaken by any university. But it was the first time that a great university undertook the sponsorship of a new industry on a big scale. The university furnished members of its staff for the scientific planning.

The first alchemy plant was erected at Oak Ridge, Tenn., hidden in a valley. Although this structure rated only as a pilot plant, it was bigger than many a large industry. The DuPont Company set up and engineered the plant. Later Monsanto Chemical Company took over the Oak Ridge operation. The DuPont Company went to Washington, there setting up, engineering and operating the great plutonium ovens. Time was so urgent that completion of the Oak Ridge pilot plant was not awaited.

Dr. Compton's duties took him both to Oak Ridge and to the Hanford plant in Washington. Military secrecy required him to have two code names, one for each location. He was Mr. Comus in one area, Mr. Holly in the other. Sometimes the duality caused confusion. Once when flying between Oak Ridge and the west coast he got off the plane about midway for a bite of food. When he boarded the plane again, the stewardess, with a pencil poised over her passenger check list, said:

"Name, please?"

Dr. Compton was embarrassed. His name was on a slip of paper in his pocket, and he did not recall which one he had given when the flight started.

MAGIC IN METALS

IN the Hanford ovens, when an atom of uranium 235 splits, some of its emitted neutrons keep the fire going by breaking other 235 atoms. Most of the remaining neutrons hit atoms of the weight 238. In this second type of hit, the uranium nucleus does not split, but absorbs the neutron. A neutron weighs almost precisely one atomic unit. Thus when one neutron is added to uranium 238, the weight is raised to 239. This change in weight is transmutation. Alchemy is as simple as that. The difficulties in alchemy are not in the principle. They are in the expense of the very high energies required, and in the fact that transmutation takes place one atom at a time. The yield is low.

In the Hanford ovens, this new atom of the weight 239 emits some rays and starts rearranging the particles in its core. In a little more than two minutes on the average, this atom that was originally uranium is transmuted into an atom of a different metal, neptunium. This form of neptunium is not stable. It goes on emitting rays and finally one electron, and in the average time of two days becomes plutonium.

This new plutonium metal has a half-life of 24,000 years. This period of time means that in 24,000 years half of any given quantity of plutonium will emit enough rays to change itself into a different element. The change made by plutonium is back into uranium, but not the 238 kind. Plutonium becomes uranium 235. And here, using atomic fires, man has something that at first glance resembles perpetual motion. For the uranium 235 makes the plutonium that afterward reverts to uranium 235, which in turn can make more plutonium. However this is exceedingly slow motion, and of no practical use.

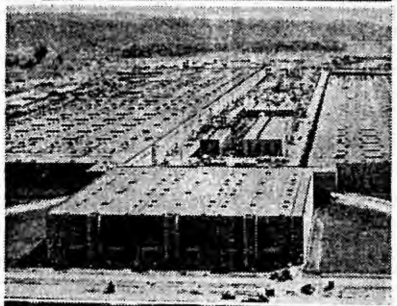
The new plutonium atoms remain in the uranium metal. As long as they are left there, they will split like the uranium 235, and these splits help to continue the atomic fire and also to make more plutonium. But the exploded atoms of either uranium or plutonium are of no further use for fire. Both, when they split, become two atoms of about half their original weights. These smaller atoms are not the kind that split.

Plutonium makes good bombs. Official reports have called plutonium super-bombs. The main military reason for making plutonium was the fact that it was thought easier to separate this metal from normal uranium than to extract the uranium 235. When this decision was made, there was no certainty that the 235 variety would be extracted in time for the war.

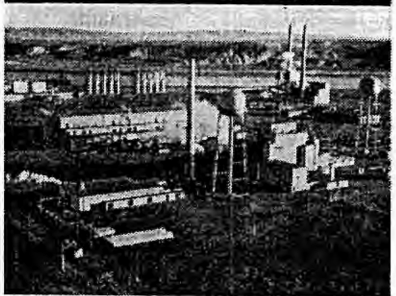
THE CHEMIST TAKES OVER

PLUTONIUM separation is by chemical processes that have been used in industry for many years, in contrast to uranium 235 extraction which was entirely new. Nevertheless how this chemical separation is done is in its detail the third secret of the atomic bomb. To effect the separation, the blocks of uranium are pushed out of the ovens and make an underwater journey of several miles to separation plants. Here is the reason for having the uranium in aluminum cans. The aluminum protects the metal from the water, which would otherwise partly dissolve it. The separation plants are three great man-made canyons. In the separation there are about thirty major chemical steps, and in addition several hundred lesser processes.

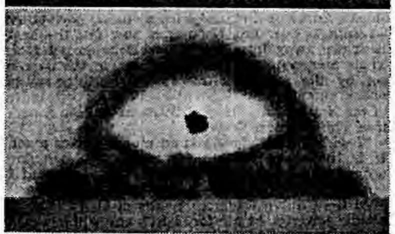
Landmarks of the Bomb



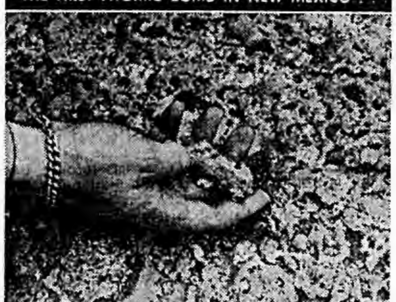
THIS PLANT WAS BUILT IN TENNESSEE . . .



AND THIS IN WASHINGTON TO ACHIEVE . . .



THE FIRST ATOMIC BOMB IN NEW MEXICO . . .



WHICH LEFT THE GROUND LIKE THIS . . .

AND LED TO THIS AT HIROSHIMA IN JAPAN.

Great cranes are used over these canyons. The cranes are run by remote control, by operators who look through a periscope thrust out above the shielding walls behind which the men hide from the canyon's atomic rays.

The yield of plutonium for each ton of uranium cooked in the ovens is a few grams, equivalent to the weight of a few nickel coins. However, the uranium can be cooked again and again, each time yielding its quota of plutonium. Nothwithstanding the low yield, and the size and expense of separation methods, the ease with which plutonium can be split with slow neutrons, and the 200,000,000 electron-volts of energy from each split, give plutonium good chances to compete, along with uranium 235, with coal, oil and gas.

Plutonium started as an idea, in mathematical symbols on paper. It was an unknown metal that should, in these calculations, make good bombs. Many scientists did the figuring. Among these groups were Dr. E. O. Lawrence and associates of the University of California and some of the British.

The Californians, with the aid of their cyclotrons, produced sub-microscopic amounts of plutonium. This was in 1940. But this first transmutation product was not the same kind of plutonium that makes bombs and that is produced in the Hanford atomic fires. This early plutonium has a half-life of only 50 years. It was useful in making some calculations of the chemistry of the explosive plutonium that came along later. It was discovered by G. F. Seaborg, E. M. McMillan, A. C. Wahl, J. W. Kennedy and P. H. Abelson.

Two years later the first atomic bomb plutonium was made at the University of Chicago by B. B. Cunningham and L. B. Werner. There for the first time ever a synthetic metal, plutonium, was made in sufficient quantity to be visible. The amount was only a few millionths of a gram, and a gram is only one twenty-eighth of an ounce. So tiny was this bit of plutonium that when the scientists called General Groves to view their achievement, he said "I don't see anything." His remark was justified. Nobody could be sure of seeing this bit of plutonium unless the guide put a finger almost on it.

Nevertheless with this, and some other equally tiny samples, the chemists did in a short time a job that ordinarily would take five years or more. The job was to learn the then unknown chemistry of plutonium. To succeed in this, the chemists extended the recent science of micro-chemistry that makes analyses with tools ranging in size from a grain of sand to a penny. They made micro-chemistry into atomic-chemistry, which went literally into the invisible. To weigh the bits of plutonium a new balance was invented. This scale was made of quartz fibers and some of its parts were so fine that they were visible only under microscopes.

One of the new transmuted metals produced in the Hanford ovens is a stable element that will last millions of years. It is neptunium, but not the same form of neptunium that changes into plutonium. The latter form lasts only about two days. Several other new metals, none of them known to exist in nature, can also be made by use of the nuclear fires. The uses of all these new metals except two are unknown. The exceptions are plutonium, and an entirely new form of uranium that can be made from the metal thorium. The new uranium is good for atomic power purposes.

But the new synthetic metals, whether their uses are known or not, open a field of alchemy that exceeds the wildest dreams of the original alchemists. More than 500 of these transmuted elements had been made before the war by cyclotrons and other high energy apparatus. The amounts in all cases were too small to be visible. Even so some of them were useful in medicine and biology.

The experiments on such minute quantities charted the way to the future. That future now becomes reality, made so by nuclear fires that can be used on an industrial scale for transmutation and alchemy.

INTO THE FUTURE

THE first practical industrial use for atomic energy was to see into the earth to look for oil. The request for atomic materials for this purpose was made a few weeks after the war ended in the Pacific.

This was about the last prospect that might have

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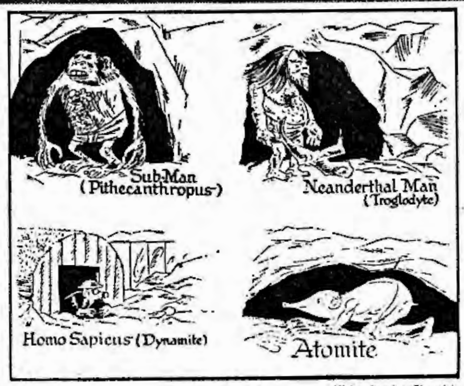


Vicky, London Chronicle

EVOLUTION

Justus, Minneapolis Star-Journal

HE MUST NEVER RISE AGAIN

been anticipated by a good prophet. It typifies the outstanding fact about atomic energy, namely that most of its peace-time uses are unpredictable.

The oil prospecting request is founded on no mere theory. It is based on a practice that was begun about the time the United States entered the war. When oil wells are about to run dry, a bit of radium mixed with the salts of beryllium is lowered down the well slowly. This combination emits neutrons. These particles penetrate the steel casing and concrete backing as easily as going through butter. They drive into the earth all around the shaft. There they hit cores of atoms, and transmute them. The transmuted atoms emit X-rays, some of which penetrate back into the well hole. An X-ray meter, lowered down the shaft, reads these radiations. By the volume or pattern of rays, experts can tell fairly well the location of any pool of oil that may have been missed in the original drilling. By this method, numerous by-passed oil pools were discovered during the war. Some of them produced from 200 to 1000 barrels a day.

Radium is very expensive. The atomic ovens produce radioactive materials that are comparatively cheap. The ovens make transmuted elements that may extend the oil prospecting to places where radium fails.

The first great energy application of uranium and plutonium is likely to be for large power plants. The atomic energies will give heat the same as coal, oil and gas. The heat will be used precisely like that of other fuels. It will make steam, or heat gas to drive a turbine, or use either steam or turbine to drive a generator to make electricity, or heat mercury as a substitute for steam.

The hot metal blocks of uranium or plutonium will substitute for furnaces. They can heat a liquid metal that in turn will heat boiler water. They may heat the water directly. Either method can be used to heat turbine gases. If heavy water is employed in place of graphite ovens, the water itself may be raised to steam super-heats, and then serve as the stove to heat water or gas. All these methods require few changes in design of existing power plants.

The splitting atoms do not give off electricity, despite the fact that their energies are measured in electron-volts. That electrical unit is used merely as a convenient yard stick. Nevertheless there is hope among scientists of discovering some way to take electricity directly from splitting atoms. Many of the splitting particles carry electrical charges. That fact is the basis for such speculations.

In the three atomic ovens at Hanford, Washington, that were built specially to make plutonium and not for power, the heat alone approaches the total power expected from Grand Coulee dam. If all this atomic heat were converted into electricity, there would be nearly as many kilowatts as are expected from the great dam. This Hanford heat is low-grade. That means that no one place in the ovens is excessively hot.

At Hanford the heat is got rid of by piping Columbia river water through the ovens. Never before was there such piping as this. The pipes are each only a few hundredths of an inch in diameter. But through them flows daily a volume of water that would equal the daily consumption of New York City. There is so much heat that even after the water has been cooled before returning it to the Columbia, the great river is warmed. But the warming of the river is only about one-tenth of a degree. For practical purposes the Columbia is not warmed at all. But if ever warming a whole river should become a worth-while job, atomic ovens might do it.

"TROUBLE-LESS" POWER PLANTS

THE heat in the Washington atomic piles comes entirely from normal uranium, which is the ordinary metal made from any uranium mineral. This normal uranium is burned without any attempt to refine or enrich its content of uranium 235. Far more intense and concentrated temperatures would be available with enriched uranium.

These blocks of metal that get hot without flame, smoke, fumes or dirt, and with no noise, have other advantages over fire. No matter how fast the heat is drawn away from them, the blocks do not cool. Their temperatures remain uniform, at the degree set by the automatic controls. Describing these ovens, an enthusiastic scientist said to his colleagues of the National Academy of Sciences and the American Philosophical Society:

"I wish I could show you an atomic power plant. It is the sweetest operating machinery, running with the least trouble, of any power plant that I know."

At the Clinton Engineer Works at Oak Ridge an atomic power plant ran for eight hours without need for an operator to make any adjustments. At the Ardennes laboratory of the University of Chicago, one of the very first power plants ran three years without serious difficulties.

An inherent advantage of the metal blocks is that a relatively small-size heater may give a lot of power. Another advantage is less corrosion of the sort due to excessive heating. The metal blocks are readily controlled against heat fluctuations.

With ordinary fuel, the amount of heat is limited by how fast the fuel burns. That is not true of atomic fuel. In an atomic oven the limit of the heat is the melting point of the materials forming the oven. A present disadvantage of uranium is the melting point of that metal. This is about 2100 Fahrenheit. Melted uranium however can theoretically be made to continue giving heat, and scientists expect to learn how. When that is done, atomic fires can be run up to thousands of degrees as soon as metallurgists discover alloys to make ovens that will not melt.

The wartime fission fires used many tons of uranium for a single oven. The tonnage will be sharply reduced when enriched uranium 235 or plutonium or thorium are used. For power purposes 100 pounds of plutonium is equal to 100 tons of normal uranium.

When the cost of fuel alone is considered, uranium is more efficient than coal, oil or gas. Compare, for example, the 200,000,000 electron-volts coming from one splitting atom, with the four electron-volts that come from two carbon atoms separating in ordinary fire, or about 35 electron-volts given off when an entire molecule of T.N.T. is consumed. It should be noted that fuel costs, in efficient power plants, are not a high percentage of total expense.

An interesting angle of atomic fuel is its peculiar ashes. They are invisible. This atomic ash is the split atoms of uranium or plutonium, two of which form at every split. Both remain inside the metal. Their volume is slight.

The atomic ash that would form in one day in a ton of uranium at Hanford might be no larger than a few thin dimes. But some of these new atoms have the ability to absorb neutrons. That means that the peculiar ash would ultimately extinguish the fire, since the margin of neutrons to keep the fire going is not large. Ultimately the atomic ashes have to be removed, a process more expensive than cleaning a furnace. But once the atomic fuel has been purified it can be burned again. That can't be done with ordinary fuel. Furthermore, with enriched uranium or plutonium, the ash problem is easier. Finally, these atomic ashes are valuable by-products, being useful minerals of two dozen varieties, and having useful radioactive properties.

The great handicap to atomic power is the rays from the nuclear fires. These are so intense and dangerous that about fifty tons of steel, or its equivalent, would be needed to shield a hundred horse-power atomic fire. That is not more power than the rating of many automobiles. No shields of less weight, or bulk, are likely to be possible. The laws of nature are against discovery of better shields. For the penetrating power of these rays has been tested for virtually every element in nature. One ray or another pierces every type of barrier. The atomic fires emit all kinds of rays simultaneously.

The world did not realize that man has had atomic energy at his disposal, in small amounts, ever since Becquerel discovered the slight radioactivity of uranium, and the Curies discovered radium. The new atomic energies are either the same as the pioneer rays or are more dangerous, because they are more intense. In addition the atomic fission releases rays that neither Becquerel nor the Curies knew.

The rays make it necessary to confine atomic power plants to projects where safe shielding is feasible. There are many of these. Shielding is feasible for plants making light, heat and power for cities. Atomic plants would do well in areas where no other power is available cheaply. This would apply especially to dry areas with no water power, and remote areas where hauling in of fuel is expensive. A few hundred pounds of atomic fuel could replace millions of tons of coal or many trainloads of oil.

The graphite brick used for the first American atomic ovens is neither the only nor the best material to make the moderator for a power plant. Graphite was used because it could be had more quickly. Heavy water has advantages. The Allies were experimenting with heavy water during the war. A drawback to heavy water has been the great expense of making it. There are other chemical elements that may be used advantageously. The prospects for power improvements are unlimited.

Because water is one of the good shields against neutrons, most dangerous of all the atomic rays, use of atomic plants to drive ships is a favorite early objective. One plan is for submarines. The U-boats might travel at high speeds under water, submerge to depths that may be safe even from atomic bombs, and remain under indefinitely. These speculations are based on having a great excess of power that would do everything including making available large oxygen storage space.

LAKES IN THE DESERT?

AMONG the dreams that appear to have possibilities, the British have offered some based on use of atomic materials for blasting. Even with ordinary explosives, the greatest uses have been as "blasting agents," a term preferred by manufacturers for avoiding the unpopularity attached to munitions-making. Without these agents many automobile roads and magnificent buildings would not have been constructed nearly so soon. These blasting agents did much to take the world out of the pyramid-building stage.

Tha British vision forecasts blasts that will transform landscapes, dig great holes and trenches for lakes and canals. Lakes may become possible in the midst of deserts. Some of the world's worst places may be converted into oases and fertile countries. There may be immense and constant sources of heat to make Arctic regions comfortable. At this point in the forecast the British prognosticator apparently made a slip. He said that the North Pole might very well make a resort. The South Pole might make a resort, but the North Pole is covered by deep ocean water and floating ice, and drying up oceans is not an atomic energy project.

Nevertheless, the conversion of ocean or other salt water into fresh water for irrigation is by no means beyond the scope of the foreseeable atomic age. Conversion of ocean water would be facilitated by cheap power. Many long-time dreams of engineers and scientists can be made to come true whenever power becomes sufficiently plentiful and inexpensive. These include lighting the night sky with radio waves to give a fluorescent glow that will substitute for street lighting. Others are harnessing the tides; many projects of irrigation; raising some agricultural crops outdoors, out of season, with the aid of artificial heat; and many ways of making hot weather more comfortable both by cooling and by the more difficult task of controlling humidity.

Pilotless rocket or jet propulsion ships, radio controlled, may be the first atomic-powered vehicles. As long as they have no human beings aboard, these ships require no shielding from their own atomic rays. Shielding set up about the take-off sites would be sufficient.

The main engineering obstacle to space ships of the sort that might fly to the moon has been the weight of fuel required. With atomic energy metals this weight problem can be solved. Atomic fuels, such as uranium 235, will be small and concentrated. But before atomic-powered air ships are possible, it will be necessary to solve the problems of applying atomic energy in small amounts. Much study is needed to learn how the few pounds of metal that can blow up a city may be scaled down to emit just a little of its force at a time.

One of the serious obstacles to space ships is expense. This may be relieved to some extent by experiments likely to be made for military defense purposes. Rockets that could be fired into space if anybody wished are likely to become possible early in the atomic age. This is due to the compelling necessity of learning quickly how to shoot atomic rockets that will at least span oceans. Any nation that develops atomic-powered rockets, while its neighbors have none, is well on the way to having the rest of the world at its mercy. In fact the rocket, with atomic power in its tail and an atomic bomb in its head, appears to be the supreme weapon of all time.

Pilotless radio-controlled ships, flying to altitudes of 100 miles or more, could obtain scientific information that will be needed before human beings can venture outside the stratosphere. One question is the effect of meteors or "shooting stars" on space ships. Astronomers estimate that probably twenty million meteors fall into the earth's atmosphere daily. It is likely that the number is far larger. These meteors are mostly small, a great many of them about the size of grains of sand. But these grains sometimes have velocities of 40 miles a second, and much faster meteors have been clocked. Even the small grains at such speeds would be expected to penetrate any kind of space ship armor that can be devised until stronger alloys are made.

How high above the earth's surface the thinning atmosphere and the strong electrical forces up there influence the weather can be learned by pilotless atomic ships. The air currents at 50 miles altitude, and higher, have been recorded by good evidence as running close to 200 miles an hour.

One fact that appears to tower over most of the others at the start of the atomic era is that coal, oil, gas and other natural fuels will not be abandoned. They will continue to be useful, even though they may someday be only supplementary fuels. The history of scientific progress runs that way. Old resources are not abandoned. They find new uses, and more uses, in the new era than in the old.

NEW SOURCES OF URANIUM

THE atomic age began with some limitations in the resources of uranium that were more apparent than real. In the known pre-war resources, the total uranium 235 available was apparently not more than enough to produce the electrical power of the United States for two years. This moreover was at the prewar rate of electrical power production. By using atomic ovens with U-235 to make plutonium, this American electric power figure might be multiplied by 50 times or more. But it appears that far more uranium will be available fairly soon than was dreamed of before the war. This extra supply is not alone from the possibility of discovering new deposits.

The new sources will be in the so-called low grade uranium minerals. There are at least 115 different known minerals that contain uranium in one or more of 500 different compounds. Of all these, before the war, only two, pitchblende and carnotite, were considered commercially useful sources. The 235 uranium is distributed all through the low grade minerals the same as in the pitchblende and carnotite. And this U-235 can be burned without the necessity of first reducing the minerals to the metallic form of uranium that was used for bombs and for the first atomic ovens in Washington.

In thorium there is a possibility of atomic power resources that will exceed the making of plutonium. This is in the transmutation of thorium into uranium 233. The latter is a form of the metal not known to exist in natural uranium. This new form of uranium has one apparent advantage over both uranium and plutonium for power purposes. It may not react fast enough to make atomic bombs. This slower reaction time may well be used to produce power more efficiently.

There are further possibilities in the non-explosive uranium 238. Although this common form of uranium does not split to any extent in the chain reactions developed during the war, it nevertheless possesses the peculiar splitting ability of the other forms of uranium. This U-238 actually splits spontaneously. These splits are comparatively rare. But they may furnish a clue to a chain reaction that was unknown in the early developments.

By the time the war ended, a great amount of information already had been collected about the peaceful applications of atomic energy. Several different kinds of atomic power fires were known and more than one had been experimented with. They were merely stepping stones. There were so many of these, however, that there was no question of ultimate success.

THE 'NEW' RAYS

THE radium-like chemical elements created by the atomic ovens, had they not been overshadowed by the atomic bomb, well might have been rated as the greatest scientific discovery of the century. These ovens are the sources for making rays that will do everything radium accomplishes, and much more.

For the first time, with the aid of the nuclear fires, man can cause any and all kinds of matter, including his own body, to emit radioactive rays. For the first time he can do this at reasonable costs.

None of these rays is new. All have been produced in laboratories, or foreseen as possibilities in laboratory experiments. But they were seldom useful, because they were too weak and too costly.

There are six kinds of these rays. Two of them are immaterial, like light. The other four are streams of particles that are so tiny they pierce solid matter easily. The immaterial rays are X-rays and gamma rays. The distinction between the two is artificial. X-rays are made by power tubes. Gamma rays come from radium and other radioactive, natural chemical elements. In the early days, the gamma rays always penetrated farther than the X-rays, hence the two names were used. Today, with new electrical apparatus, X-rays can be made that are more penetrating than any gamma rays.

The particle radiations are beta, alpha particle, proton and deuteron. Beta rays are streams of electrons or of positrons. Positrons are positively charged particles of the same weight as electrons. The latter carry negative electrical charges. Alpha particles are the heaviest of all the rays. They are the cores of atoms of helium, having each an atomic weight of four. Protons are heavy, positively charged particles, with an atomic weight of one. Neutrons are about the same in weight, but have no electrical charges. Deuterons are the cores of heavy hydrogen, and have an atomic weight of two. Proton and deuteron rays are not common in natural radiations. All the other four appear in large amounts in nuclear fires and their by products.

The source of the new rays is the splitting of the metallic atoms, whether of uranium, plutonium or of the thorium-uranium kind. The splits themselves emit rays far more intense and powerful than anything previously known.

These rays directly from the nuclear fires also

.....And Has Given Rise to Some of His Brightest Hopes

Alexander, Philadelphia Bulletin

RESHAPING THE WORLD

Hungerford, Pittsburgh Post-Gazette

. . . GOD'S ATOMIC POWER

Fitzpatrick, St. Louis Post-Dispatch

A NEW ERA IN MAN'S UNDERSTANDING

ATOM MAY FIND ITS BIGGEST USE IN PEACETIME POWER

render any kind of matter that they strike temporarily radioactive. It is these temporary rays that promise great advances in medicine, biology and industry.

The atomic piles can make the equivalent of tons of radium. The entire world supply of radium is only two pounds. Still smaller has been the supply of radium-like elements that now become available. The nuclear ovens produce, as regular byproducts in the uranium metal, about thirty temporarily radioactive chemical elements, each one about half the weight of uranium. A score of these are made in fairly large quantities. The temporary rays are emitted over periods ranging from a few minutes to years.

In addition to all these, virtually any ordinary chemical element, placed inside the nuclear ovens, will become temporarily radioactive. Some will emit one type of rays, others a different kind.

BLOCKING THE RAY KILLERS

THE intensity of the new sources of rays is appalling. If the Hanford ovens were not shielded by tons of material, any human being approaching them closely when they were in operation would be instantly killed. There never have been rays of such intensity on earth. The shielding of the ovens even has to be air-tight. For the air itself inside the shields becomes dangerously radioactive, and leaks would be unsafe to those outside.

When the canyons were built at Hanford to separate plutonium from uranium, the question arose as to whether the canyons needed roofs to prevent radioactive rays from shining up against the sky and reflecting back to earth. The canyon rays are emitted mostly by the thirty by-product elements. The canyons were built with roofs. There was no sky shine. Whether there might be a dangerous reflection from the sky is probably an academic question. But it gives an idea of the amazing power of the nuclear rays and of the pains taken to shield human beings.

In an experiment on mice, a single exposure to the beta rays of some pile elements caused skin cancer. Beta rays are streams of electrons or positrons. It was known previously that these rays could cause skin cancer. But single-shot skin cancer was new.

When chemists were weighing a quantity of the new metal plutonium so tiny that part of the scales was invisible to the eye, the study was done under remote control. The rays from even the tiny bits of elements on the scales were so powerful that shielding was required.

When uranium and plutonium are fully purified then rays are not dangerous to human beings, unless they get into the blood. These rays are alpha particles, which are heavy, and do not travel far in air. Plutonium appears to emit the alpha particles faster than uranium. When taken into the blood these particles get into the bones. They are the same sort of particles that caused the deaths of the women in New Jersey who had the habit of moistening with their tongues the tips of brushes to put radium paint on watch faces.

When the atomic energy work began, uranium was believed to be one of the most poisonous elements. Great was the astonishment when mice, on a diet containing uranium oxide, got fat and healthy. Investigation revealed that uranium taken by mouth in small quantities passes through the digestive system without being absorbed into the body. But uranium in a body cut is highly dangerous.

The first job with the rays was to learn safety measures. Since all forms of matter may become temporarily radioactive when too close to the ovens, there were daily checks for signs of rays of various sorts coming from desks, pens, pencils, clothing, hair and skin of scientific and technological workers. When some workers left their jobs, ray counters tested the front of their clothing, and a couple of steps farther, another counter figuratively felt their backs. Some stepped on a ray meter built into the floor to detect rays from shoes. The air was checked by a counter named "Sneezy." There were also blood tests. Before the war ended, the safety limits were well charted, and the control of the rays sufficient so that science and industry could go ahead with their uses.

RAYS ON THE ASSEMBLY LINE

THE industrial possibilities of using rays are numerous. Some of the intense radiations alter the properties of solid materials. One change is in elasticity, another in electrical conductivity. But it is not true that these rays disintegrate solids. Except for the disintegration by heat and pressure, the true disintegrator ray has yet to be discovered. The alterations in solids caused by the rays appear only after long exposure. These effects are also slight.

Nevertheless the changes in structure offer possibilities for industry. It may be possible to improve some materials for special purposes. X-rays already have been used to alter the colors of gem stones.

One of the astonishing things about alloys and plastics is the exceedingly small amount of some chemicals that cause great changes in properties. One thousandth of one per cent is sometimes enough. The reasons seldom have been completely understood. The new rays will cast light on these puzzles. This will be done by exposing the alloying element, or a small fraction of it, to the rays of the atomic ovens. The exposure causes temporary radioactivity in the alloying element. Then, by the rays that the compound emits, every step taken by the added fraction can be traced. This can be done with amounts too small to be seen in microscopes.

There are puzzles about the flow of liquids and gases, whose solutions would be useful for industry. This sort of flow can be followed by use of radioactive tracers.

The atomic ovens do not manufacture radium. But they can make a substitute much like radium, and as useful for many purposes. The substitute is antimony, a hard, brittle, tin-white metal. Placed in the plutonium-making ovens, antimony would become radioactive. In this way the equivalent of many times the radium stocks of the United States can be made in less than one year. Antimony can be used the same as high voltage X-rays to look through metals and see flaws.

RAYS VS. CANCER

BIOLOGY and medicine, and cancer especially, are the first major patrons of the new ray sources. There are many angles in the proposed cancer attack. One is to use nuclear rays the same as X-rays and radium—to burn away the malignant growths.

The new rays offer a variety of methods, some of which may do more effective cancer tissue destruction. These variations are not new shots in the dark. They have been tried before the war with the radioactive products of cyclotrons. But there was never enough radioactive material for widespread experiments.

Cyclotrons, for example, make radioactive strontium. This chemical element concentrates in the hard portion of bones. In the few experiments tried before the war, the radioactive strortium appeared to concentrate on the type of cancer that attacks the hard part of bones. More valuable than strontium would be radioactive calcium, since this is the natural element in the hard portion of bone, and strontium is only an unnatural substitute. The cyclotrons also produced radioactive phosphorous. This element concentrates in the soft portion of bones, and so has hoped-for usefulness for the sort of cancer than grows in bone marrow.

Also before the atomic age, cyclotrons made radioactive iodine. This form of iodine may be made by the atomic ovens. This iodine did the equivalent of clean surgery, without knife or blood, on toxic goiter in experiments at the University of California school of medicine. The radioactive iodine was simply taken in a drink of water. Nearly one hundred percent of the iodine concentrated in the thyroid gland, seat of the goiter.

This same iodine was not found, before the war, useful for treating cancer, because it failed to concentrate in any malignant growth. But the iodine discovery is one of the brilliant advances in medicine. It is the beginning of a new field of treatment. For this field the atomic ovens could supply most of the materials.

There is another broad attack on cancer. This is to attach radioactive elements to chemical compounds injected directly into a malignant growth. This has been hampered by difficulties in finding suitable radioactive compounds. Now virtually all compounds can be made radioactive, with the promise of enough intensity in the rays for cancer treatment.

The variations possible in this form of experiment seem endless. One of them, tried before the war, is to inject compounds of beryllium into a malignant growth. When X-rays are turned onto this compound in the cancer, the beryllium emits neutrons. The neutrons are one of the rays with high destructive power for living tissues, cancer included. They are too dangerous to be allowed to continue for a long time. But in this experiment, the neutrons appear only as long as the X-rays are on. They stop when the X-rays are turned off.

A most promising type of investigation is the use of radioactive tracer compounds to study the metabolism of cancers. These malignant cells use sugar in a different way than normal cells. They use oxygen differently. And there are other differences. These differences, it is hoped, will some day reveal how malignant cells are able to grow so much more rapidly than normal. If that is discovered, it may prove to be the long sought key to the cause of cancer. Certainly the irradiated tracers will permit many experiments to learn how the metabolism of malignancy is different.

The radioactive tracers used in this way do not destroy or harm tissues. For tracing, very small quantities of the ray-making chemicals are added to drugs, food or other chemicals taken into the body. Because of their intense rays, these tracers can be followed, even when they form only one millionth of the tissues under investigation.

Tracers will aid in making drugs with specific effects on cancer. There have been numerous drugs of this sort. A few of them have temporarily stopped the growth of cancers; sometimes even caused temporary disappearance. But the malignant growths returned, and were fatal. What caused the temporary improvement is still unknown. Radioactive tracers will help in studying this puzzle.

WHERE DO THE DRINKS GO?

OF broader importance to human beings is the tracer work to be done on living tissues in normal health and in diseases of all kinds. This tracer technique, too, was well outlined before the war, but sufficient materials were lacking.

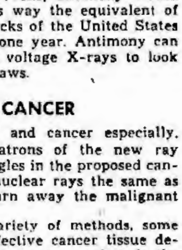
The common elements in living tissues are carbon, hydrogen, nitrogen, oxygen and often sulphur. Carbon is so universal in tissues that it has been said to form the molecules of life. These common elements, exposed to the rays in atomic ovens, become temporarily radioactive. Actually they may not all become radioactive, but each element has more than one weight, called isotopes. One of the forms usually becomes radioactive.

An easy example of the action of tracers would be a drink of whiskey, spiked with a strongly radioactive chemical. This might clear up the debate as to why a couple of drinks cause signs of intoxication in one person, while another can take many without showing effects. There are popular theories, such as that the drinker who can tolerate a lot gets rid of some of the alcohol by changing it into water and carbon dioxide. However the physiologists have not had satisfactory proof. They have suspected that a shot of alcohol gets distributed differently in the body of the fellow who can drink a lot with little apparent effect.

If a swallow of the spiked whiskey is taken, a ray counter will trace the drink by the noise it makes. This noise is a rattle, sometimes as fast as a machine gun. When the liquor gets into the stomach the rattle will be concentrated there. It can be heard by holding the counter close to the midsection and using amplification to step up the clicking sound.

Later, as the alcohol goes into the blood, the

The Atom Also Brought . . .



THE atomic bomb put a shiny new adjective into America's lexicon. Since Hiroshima, the words atom and atomic have been worked and reworked and then worked some more.

Things no longer are colossal — they're atomic. They are as world-shaking as the atomic bomb, and anyone courting danger is "fooling with the atom."

The first atomic bomb was an inspiration to the nation's gagsters and advertising geniuses. There soon was an atomic cocktail, an atomic breakfast food, an anatomic blonde and also an atomic magazine.

Within six months, 22 atom-derived company names were listed in the Manhattan telephone book alone. They dealt with everything from chiropody supplies to pleating and stitching. There were atomic lighters, atomic food products, atomic handbags and clothes.

noisy drink can be picked up all over, Still later comes the period when much of the alcohol concentrates in the brain. This is the time when the drinker feels the effects. During that stage the rattle should come most strongly from the drinker's head. If the rattle should be just as loud from the head of a teetotaler, who made a mistake and got a good-sized drink, as from a fellow who can drink a pint with impunity, that might be evidence that the grey matter in the brain possesses the secret of tolerance to alcohol. But if the heavy drinker's head does not rattle as much as the teetotaler's, then the alcoholic noise can be sought in other parts of the body. The location may explain tolerance.

THE ADVANCING MEDICAL FRONT

THE great radioactive tracer studies concern nutrition, metabolism, growth, the action of many medical remedies and the mystery of growing old. Nutritionists would like to know precisely where different chemical elements in a meal go, how quickly they get there, and how long they stay. More difficult to learn, but more important, is how these elements of nutrition split up after they reach their destinations in the body Tracers will give some of the answers.

Some of the elements taken in food act as living catalysts, enabling the body to manufacture some of its own needs. Vitamins and hormones are among the catalysts of living tissues. There is in addition a great class of catalysts known as enzymes. Some enzymes are just as important as vitamins and hormones. But how these catalysts, of any sort, do their jobs is not yet clear. It is known that when the catalysts get out of balance a person's health begins to fail. But what makes this unbalance is mostly unknown.

One such unbalance is the hormones of the adrenal glands, that lie near the small of the back, and sometimes cause women to grow beards. In experiments with mice, these adrenal hormones are known to be directly involved with the onset of one type of mouse cancer.

Radioactive tracer studies in animals are likely to be as useful as in man, not only for the health of the beasts, but for the production of better food.

Animals will be used for much of the tracer work done for human benefit, and the tracers themselves will be harmless to the animals. Plants will serve as guinea pigs to some extent. Tracer work in them will be useful to agriculture, and for the discovery of new plant drugs and the improvement of old plant drugs, More nutritious plant foods may be another tracer goal.

One of the mysteries of penicillin and the sulfa drugs may be clarified by tracers from the nuclear ovens. Scientists know how both of these drugs act in test tubes. They know also that the action is not the same in living tissues. Apparently both drugs form combinations with some chemical compound already present in a living body. This combination seems to account for the remarkably fast curative effects.

Almost completely unknown are the reasons for natural growth. Likewise mysterious are the mechanisms that stunt normal growth. And why a thumb does not grow as big as a foot is still less understood. Other than the effects of time, the reasons for growing old are unknown. Even the changes in nutrition in ageing are not clear. The tracers used to study metabolism and nutrition are new tools for understanding both growth and ageing.

In fact, there is no illness or annoyance of mankind, from heart disease or infantile paralysis to baldness, greying hair or infertility, that can in advance be counted out from benefits of tracer investigation. Some will fail to benefit, but many biological and medical puzzles will be clarified.

Beyond the uses of the rays in industry and in medicine there is still a broader field, namely as tools for investigating the structure of matter. The results of that are unpredictable. But they are worth while because in that field will come some of the fundamental discoveries of the future.

TRAILING THE CONFLIGULATOR

WHILE the World War still was at its height the Security Department of the atomic bomb project was disturbed by an article that appeared in a Texas newspaper. It read like this:

NEW AND TERRIBLE WEAPON FOR USE AGAINST JAPS HAS OUTER FLAGELLA BIFID AND ALSO PERCOPODS CHELATE

A new and terrible weapon is to be turned against the Japs in the near future, the manager of the Du Pont nylon salt plant now under construction said yesterday.

He recently made a tour of the company's Richland plant where the weapon is being made and is familiar with the details of the death-dealing apparatus.

The plan has been in operation about two years, according to the manager, but only now can the story of the weapon be released.

"Shortly after the war began," he said, "the entire production of the E. I. Du Pont de Nemours company was switched to materials vital to the war effort.

"Of course, the company started making many things which were entirely new to us. Some of the things will be a great boon to the civilian after the war. We are even hoping we can find some peacetime use for our latest device, Configulator T-1."

"Configulator T-1 is the newest weapon ordnance has under consideration," he continued. "Tactical uses are still secret, but it can be safely said the art of warfare will be revolutionized by it.

"Briefly and in nontechnical language, Configulator T-1 is a combination of totalizer wheels arranged to be propelled through multiple predetermined circumferential superpositions and an intrinsically heterogenous precomputed taxonomy of abutments controlled by nonconsecutive monodromic sequences of denominational seriatim concatenation.

"One subassembly consists of an alkalitrachyte with phenocrysts of ancthoclase and aegirite in a tarchytic to hyalopilitic groundness of alkali-feldspar laths and grains of pyroxene and amphibole. The monocarpidean macrurans have antennules with outer flagella bifid and percopods chelate."

Aw, nuts—let's give the damn thing to the Japs!

Richland is the name of a small town near the atomic ovens in Washington. The Du Pont Company erected the plants there. Configulator obviously was a joke, and so the investigation proved it to be. But Configulators and their like all had to be investigated, not so much on account of the danger of spies, as because they started people to talking.

Anything printed about secret weapons, even those reported from Germany by the war correspondents, started conversation in America. These conversations frequently led to discussion of atomic bombs. This job that Security did of investigating even innocent conversations as much as possible was one of the reasons for success in keeping the atomic bomb secret. Security investigated about 2500 cases of publication or conversation.

Without this secrecy, the Allies might have faced a different situation in atomic bomb progress in Germany. After the war a letter was found in Germany, mailed from a Teutonic research center to Hitler. This letter indicated that German espionage on atomic projects in America had failed. It stated that although the Americans were working on an atomic project, the United States had not been able to get beyond the early stages.

Had Hitler possessed correct information, it is anybody's guess what Germany might have attempted. But what happened in Japan is a good guide. The Japanese had their own atomic project. They calculated that it would not be possible to make an effective bomb. This was an error in calculation. The Japanese scientists thereupon dropped the bomb idea and concentrated on trying to make uranium a substitute for coal. The empire was short of fuel of all sorts. The Japanese had barely more than twenty pounds of metallic uranium, but they were hunting for deposits in Manchuria and elsewhere.

Their uranium laboratory had been destroyed by bombs some time before the end of the war. Nevertheless, the day after Hiroshima received the first atomic bomb, Japanese scientists went to work again to see if they could make one.

TIGHT TALK KEEPS THE SECRET

THE F. B. I. cooperated with the Manhattan Engineer District. But the maintenance of secrecy and safety was principally the work of an undercover army organization known as the Security Department. The personnel was about 450 men and 35 Wacs. They served under Colonel W. Budd Parsons, who in civil life was a Seattle manufacturer.

Most of the men of this force went through the war without uniforms. They could not explain to their friends. Most of them were college graduates. Many were professional men. They were picked for known qualifications. Some were doctors in physics or chemistry. Others had industrial investigation experience. Some worked in plants where they had to refuse promotion because of their under-cover responsibilities. Few could be promoted to the grade of officers, but many of them received technical ratings.

Among the investigations were fifteen hundred cases of loose talk. The agents tried to stop such talk without telling the real reasons to the speakers. Sometimes the speed with which they caught up with the talker had the desired effect.

Persons who made a remark on a Wednesday about atomic energy were likely to be startled at a visit on a Saturday by an agent who said the

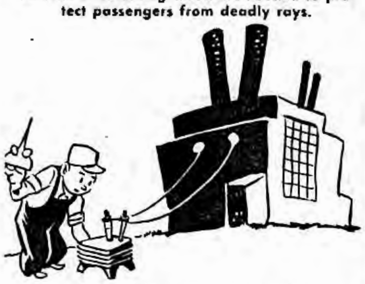
Limits of the Atom

WHILE the harnessing of atomic energy opens great new fields for peacetime development, there are many things that atoms cannot do. For instance, atomic energy . . .

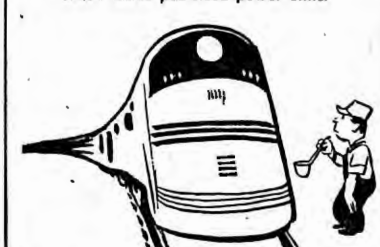
CAN'T substitute a block of uranium for the household furnace or kitchen range.

CAN'T change the cycle of the seasons.

CAN'T provide power for small cars, since 50 tons of shielding would be needed to protect passengers from deadly rays.



CAN'T make pea-sized power units.



CAN'T drive streamliners across the continent on a thimbleful of water.

ATOMIC ENERGY WILL SHAPE THE FUTURE OF THE WORLD

authorities would like to know the source of the conversation. Mostly the sources proved to be speculation. Sometimes agents learned what they wanted to know without revealing their identities.

Such a case concerned a waitress who had talked frequently about the routes of some truck drivers who made her lunch stand a regular stop. These drivers were atomic project men. When an agent, in the guise of a customer, asked how she knew the routes, she pointed to the drivers' equipment for certain kinds of weather. She could, she said, put two and two together and figure where they went.

"Sure," said the agent. "But did you ever stop to think that if you put two and two together too often, you may get behind the eight ball?"

Bouncing putty, a new synthetic plastic that made its appearance a year before the war ended, caused one of the longer investigations. This one started when a young man living in the south called Dr. Arthur H. Compton in Chicago, long distance, and asked him for information about uranium 235. At that time Compton was supposed to be a complete secret so far as atomic energy was concerned. Security agents learned that the young man was connected with a Farm Cooperative, and that as a side line he gave lectures on electricity. He got hold of a piece of bouncing putty and found it so fascinating that he got the idea of broadening his lecture subjects. In particular he wanted to add a lecture on another subject, the research on atomic bombs. The head of the Farm Cooperative knew Dr. Compton. The would-be lecturer got Compton's name, but not his address. He thought the doctor was in Kansas City. He tried to telephone the scientist in that city, and gave as an address a university that is not located in Kansas City. He put in a long distance call. The operator did the rest. She identified the right Compton and found him in Chicago.

A number of investigations were due to men seeking jobs, who wrote letters or sent telegrams asking for work connected with an atomic project in some city whose location was a secret for atomic purposes. The explanations found in these cases usually were a long chain of tips, sometimes crossing the United States and back, passed along by one person to another, without any of the informants knowing about atomic bombs. But the last informant would innocently give the location of a city where he knew some men had been getting jobs. This last city would be the pipe line to an atomic bomb job.

The Security Department read four hundred newspapers daily. Hundreds of scientific publications and magazines were read and checked. A number of young scientists received Ph.D. degrees on the basis of scientific papers they wrote, but which Security forbade to be published.

Security agents had to do much talking with draft boards. For there were 50,000 deferments on the atomic bomb projects, and no one could be told the real reason. The Manhattan District was one military organization that made good use of an enlisted man's previous qualifications. In this way about twenty-five hundred young chemists and physicists were obtained for the atomic projects.

An aid to secrecy was the innate good sense of Americans. Many men made shrewd guesses as to the nature of the work at Oak Ridge, Tennessee and elsewhere. But they kept their mouths shut. Oak Ridge workers, in response to questions as to what they were doing, sometimes made replies such as:

"This is something Eleanor thought up. It is something Franklin wants. We make the heads of horses to be sent to Washington to complete the animals."

These replies were not intended disrespectfully or politically, but as polite ways of getting over the idea that the job is "none of your business." Security and the great industrial organizations gave many carefully planned lectures and objective aids to employees, all based on patriotism and the need of keeping silent. These were given to more than 100,000 persons who might have access to enough unusual information to do some unwise talking. The way these Americans cooperated was an example of democracy in action.

SECURITY GOES TO CHURCH

EARLY in the war a religious publishing company issued a tract based on a sermon about the great things of life. Among these were startling powers, like the power of the universe typified by atomic energy. The author of the tract placed God above all these powers. One Sunday at church service an Illinois manufacturer picked up this tract. He took it home and read it. He got the idea that maybe there was something in industrial science and he wrote to the University of Chicago for information.

The same tract came up again as the source of information when a Knoxville pastor preached a sermon saying that the power of uranium 235 is the greatest thing man has discovered. But he added that this power cannot comfort man in his hour of trouble. Only God can do that. Security agreed that the sermon was splendid, but asked the minister not to repeat the uranium section. In Maryland another pastor preached a sermon enunciating the same principle and with the uranium from the tract as his source. This tract blazed a five-year long trail before the war ended.

Poison ivy, cleaning acids, and heat rashes gave Security many headaches. Workers knew they were dealing with unusual compounds and that precautions were taken for their safety. Skin troubles alarmed them. Security had to deal with the skin rashes because an alarmed worker might talk. One case of skin rash was followed to South America to make sure no atomic secrets were leaking. All sorts of precautions were taken for all phases of the atomic bomb work. Waste baskets were collected daily under supervision of an armed guard and their contents were burned with the guard still watching. Used typewriter ribbons were destroyed because a spy might be able to read a few words on them.

The briefcases of scientists and the representatives of industry on the job were objects of solicitude. The cases sometimes contained clues to atomic secrets. There are stories that the bodyguards, who were regularly assigned to the principal scientists, were there primarily to prevent absent-minded loss of briefcases. The fact is that business men forgot briefcases too.

A high point in briefcase etiquette was inaugurated one day by a scientist. He was making a trip accompanied by his bodyguard. With them went a technologist from an atomic laboratory. The scientist and the technologist each had a briefcase.

The rules required the guard to carry the briefcases of scientists. On this trip the guard could carry only one briefcase, because another rule that was seldom if ever broken required the guard to keep one hand free to use his gun. None of the trio knew what was in the technologist's briefcase. The contents might include secret documents. The dilemma was solved by the scientist giving his own case to the guard, and himself carrying the case of the technologist, who was left with nothing to carry.

Many incidents of keeping the secrets of atomic bombs made laughable stories afterwards. But the precautions brought success beyond expectations. There never was any known attempt at sabotage of the atomic projects by enemy agents, although there were a few cases of minor sabotage due to personal quarrels among the working forces. There were attempts at espionage during the war. These attempts continued at least for a time after the war ended. But enemies did not profit by them.

THE SCIENTISTS SPEAK

PEACE or suicide are the alternatives frequently presented as the only choice offered civilization in dealing with the atomic bomb. And new horrors are predicted.

The horrors probably will come true, at least in possibilities. But the suicide may be doubted. Men always have been able to commit suicide individually. Few did so. Now there is the ability to commit universal suicide. But it is unlikely that men will do so, any more than most of them will kill themselves individually.

Two months after war ended in the Pacific scientists, most of whom never before had stepped out of their own fields, began speaking through newspapers, magazines, radio, lectures, and Congress. They had several important messages for the public. But they concentrated mostly on one of these. That message was the horrors. They did this because the public did not fully realize the tremendous forces discovered, nor the ease with which these forces could be used for destruction. These scientists believed that the best way to avoid the perils was to make it clear that the horrors surpass anything that has been imagined.

Almost without exception they offered a general principle of action. This principle was abolition of war. To this end they proposed international agreements, and many of them said the nations would have to give up some sovereignty.

Whether nations will choose to fight another war using atomic bombs is unpredictable. How war may be changed is also unpredictable. But Professor Niels Bohr, of Copenhagen, the father of the idea that an atom is a small solar system, stated a principle that is certain to apply, both to wars of the future, and to maintaining peace if wars are abolished.

"We have," he said, "even reached the stage where the degree of security offered to the citizens of a nation by collective defense measures is entirely insufficient."

Another principle, which defines the goal that in the end will be inevitable, was stated by Dr. Arthur H. Compton, who now is Chancellor of Washington University, St. Louis. He said:

"The release of atomic energy is merely the most recent important step of that steady progression that is compelling man to become human."

There has been unanimous agreement by scientists, industry and the military authorities that other nations can make atomic bombs. The only differences of opinion have been as to how long this will take in other countries. The disagreements were wide, running from two years to more than twenty. In reality two years or twenty makes little difference. Twenty years is only a brief moment in the face of the certainty that everyone who wants the bombs may have them.

But no scientist, industrialist or military authority believed that America's initial methods would remain unchanged. Here again there was wide difference in opinions. These ranged from the belief that atomic energies, whether for bombs or power, will be difficult to attain, anywhere, for at least ten or fifteen years, to discussions of "kitchen sink" methods of making atomic bombs. "Kitchen sink" means almost literally that—that it can be done secretly in a house. There are now no such methods. Probably no one believes there ever will be any atomic power that can be produced in the kitchen sink. But there is no doubt whatever that at some unpredictable date, much easier methods of making atomic bombs will be perfected. In the long run, this attainment cannot be prevented even though attempts are made to curb the progress of bombs.

This prospect of future bombs is one reason why many scientists, as well as others familiar with atomic energy possibilities, have taken the stand that agreement to stop making atomic bombs would be risking the destruction of the United States. Agreement to stop would result merely in making it possible for some ambitious nation to develop bombs with the hope of gaining mastery of the world.

THE ONE WAY OUT

THE United States appears to have the choice of ending wars, or to change its character and become aggressive, in order to survive. There is no sign that Americans intend to change their character. All signs since the war point just the other way.

If the nations fail to abolish war, then Americans have to think about reverting to environments that were left behind with the cave man and medieval castles. People who want a measure of safety from atomic bombs will not live on stately hilltops, as did the medieval barons. They will hide their homes behind hills, and the more hills the better. They will have caves into which they can take their women and children. The United States is more vulnerable to atomic bombs than some of the other great nations, because of her great development of cities and concentration of industry in or near them.

There is no present sign that Americans will take to the hills. That is contrary to American character.

The hope that science in the future will find an effective defense against atomic bombs is not well founded. The bomb is simply a collection of metal. This metal does not deteriorate for practical purposes. Plutonium, it is true, deteriorates in 24,000 years. The stuff explodes automatically merely on being brought together. No principles of nature are known to stop this explosion.

Armies, navies, air fleets, pilotless ships, rocket weapons and even radar control as far as the moon, offer no complete defense. Whether such defenses will be effective will depend on many things, including luck, politics and preparedness. There will be chances that they fail, with national destruction the penalty.

Whatever angle of approach is chosen in atomic bomb discussions, at the end of the argument the one way out appears to be abolition of war. No one has a sure formula for that.

No matter what happens, the best guarantee of the future of the United States is a great, free, peacetime atomic energy industry. If war comes, only this peacetime industrial potential can make the speedy conversion that will be essential for atomic defense. This atomic potential will furnish the same sort of protection as did the industrial power of the United States in 1941.

R. F. BACHER of the Massachusetts Institute of Technology had a big role in making the atomic bomb. His specialty is atomic structure.

KENNETH T. BAINBRIDGE of Harvard worked on the bomb. He specializes on electromagnetic forces and the weighing of atoms.

GREGORY BREIT of the U. of Wisconsin is a theoretical physicist. He calculated the force that is present in the nucleus of the atom.

L. J. BRIGGS, head of the U. S. Bureau of Standards, insisted on continuing bomb research after some said it would take too long.

SOME OF THE ATOMIC PIONEERS

VANNEVAR BUSH, president of Carnegie Institution, headed U. S. scientific war work and encouraged the early research on the bomb.

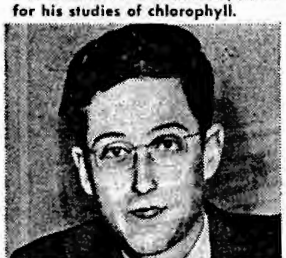
A. H. COMPTON, a Nobel winner who is now chancellor of Washington U., sponsored the work on plutonium for Chicago U.

J. B. CONANT, president of Harvard University, had an administrative role. He is a chemist, noted for his studies of chlorophyll.

JOHN R. DUNNING of Columbia was active from 1939 throughout in the discovery of uranium's qualities and in its production.

ENRICO FERMI, a former Italian, is a research wizard. First to bombard uranium with slow neutrons, he made the first atomic fire.

GENERAL LESLIE R. GROVES was the head of the bomb project. He supervised plant construction, operation and the scientists' work.



J. W. KENNEDY of the University of California, hardly known nationally before the war, is a chemist who helped on the bomb.

E. O. LAWRENCE contributed to the development of magnets that separated uranium. He also was an administrator in the bomb project.

J. R. OPPENHEIMER headed the Los Alamos New Mexico plant and laboratories that made the bombs. He is an administrator-scientist.

GEORGE B. PEGRAM made some of the early moves to interest the U. S. in atomic bombs. He knew of Germany's work on the atom.

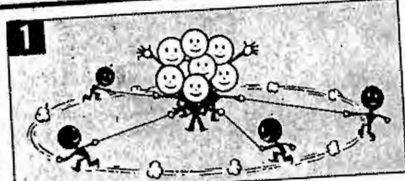
G. T. SEABORG of the U. of California is a chemist, radiologist and has the unique position of co-discoverer of four synthetic metals.

HAROLD C. UREY, a Nobel Prize recipient, headed research done at Columbia to extract U-235 by the gaseous diffusion method.

HENRY T. WENSEL, a physicist, became chief of the research control division of the Manhattan Engineering District at Oak Ridge.

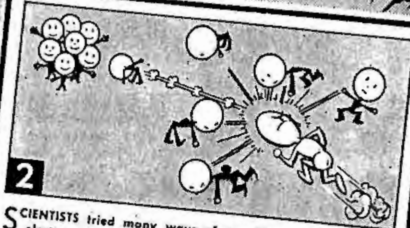
EUGENE WIGNER of Princeton is a theoretical physicist, born in Budapest, who has made studies on the structure of the nucleus.

ATOMIC PRIMER

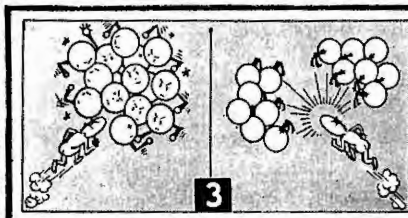


LIKE our solar system, an atom is made up of a central sun (nucleus) around which one or more planets (electrons) rotate. Protons (positive electric charges) in the nucleus hold electrons (negative electrically) from flying out of orbits.

The number of electrons in natural atoms range from 1 to 92 and determine what the substance is: gold, lead, uranium, etc. A nucleus also contains neutrons, which have neither a positive nor negative electrical charge. But keep your eye on the neutron. They are the key to the mystery of the atomic universes which are so small that millions of them are needed to make a speck of matter.

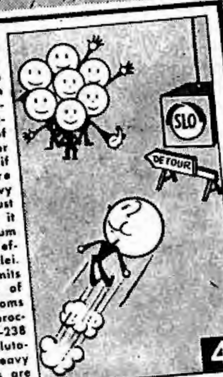


SCIENTISTS tried many ways of smashing atoms. Knocking electrons out of their orbits was easy but the energy released was small compared to what could be done if the nucleus, which contained nearly all the mass of the atom, could be split. In 1932 the neutron was discovered and in 1939 it was found that a neutron, fired like a bullet, could split the nuclei of some atoms. In some other atoms it would lodge in the undivided nuclei and start a remarkable chain of events. When nuclei in the first type of atom fly apart, they give off blasts of energy like toy balloons popped by a pin, but the atomic force is billions of times greater.



EXPERIMENTS disclosed that different atoms, like people, react in various ways when shot at. If a neutron hits the nucleus of that type of uranium which has 143 neutrons in its nucleus in addition to 92 protons (U-235), the nucleus splits and releases energy. If the external neutron hits a uranium nucleus that contains 146 neutrons in addition to 92 protons (U-238), the nucleus doesn't split but instead absorbs the neutron. The atom's weight is increased from 238 to 239, and then, in a mysterious series of processes, the atom changes into two new elements, first neptunium and then plutonium. Further, it was found that the final plutonium was just as nervous and as readily split as U-235 if it was hit with a neutron bullet.

AFTER scientists found the atomic bullet they learned that if it was fired too rapidly it had less effect on nervous nuclei than one moving at a slower speed. (Neutrons can travel at a speed of several thousand miles per second.) They learned that if islands of uranium were placed in graphite or heavy water, the neutron lost just enough speed by the time it reached another uranium island to have the desired effect of splitting U-235 nuclei. The newly split nucleus emits several neutrons, some of which hit other U-235 atoms to continue the splitting process, while the rest hit U-238 and converted it into plutonium. The graphite or heavy water slow-down cops are called moderators.



BECAUSE U-235 (the type of uranium which man found gives off atomic energy most readily) is only seven-tenths of one per cent of ordinary uranium, U. S. scientists developed huge centers for concentrating usable quantities of the element. In one process, uranium gas is forced through strainers that pass U-235 more rapidly than the ordinary U-238. In a magnetic process, U-235 is trapped because its atoms curve through the electric field in a different manner than U-238. A third process obtains the element by diffusion in a liquid. The processes involve thousands of steps before workable amounts are obtained. The atomic bomb puts together facts described in this "Atomic Primer" series. A gun fires masses of uranium together and an explosion follows, with nearly all the atoms splitting in one-tenth of one millionth of one second.

From the Papers of Eleanor Roosevelt

Sachs

Sachs—
Many thanks for your
letter of June 1st. I was
very much interested & would
like to know just what
you think should be done
now

Dr. Alexander Sachs has written you, under date of June 1, the attached letter, enclosing a copy of his testimony, given last November before the Senate Committee on Atomic Energy.

I could wish that Dr. Sachs understood the value of clear and simple English! I have difficulty in making out what he is driving at.

I gather that he thinks that, in considering the future of atomic energy, we should go back to the kind of "synthesis" between "political and moral strategy and war technology" exemplified in a proposal he submitted in November, 1944. See Page 2 of his letter, at top of page, beginning "Following a successful test...."

Paragraph 4, Page 561 of his testimony, to which he refers in his letter, apparently refers to the circumstances under which his proposal was submitted in November, 1944.

Apparently his letter has not yet been answered.

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I gather [illegible] he thinks [illegible] concerning the future of atomic energy, we should go back to the kind of [illegible] synthesis of [illegible] and [illegible] strategy and war technology [illegible] memorialized in a proposal he submitted in November, 1944. See page 8 of his letter, [illegible] paragraph, beginning "Following a successful test...."

Many thanks indeed Mr. President

Paragraph 4, Page [illegible] of his testimony, to which he refers in his letter, apparently refers to the circumstances under which his proposal was submitted in November, 1944.

[illegible]

Apparently his letter has not yet been answered.

ALEXANDER SACHS
72 WALL STREET
NEW YORK 5, N.Y.

June 1, 1946

Dear Mrs. Roosevelt:

In the thought that you may be interested in it, I am transmitting herewith a copy of the just released revision of my Testimony which opened the hearings before the Senate Committee on Atomic Energy. For the perspective drawn therein of the crisis and the challenge that have confronted the Great Community of Western Civilization applies, with variations, to the present short-of-peace sequel to the combat war, so out of key with the apocalyptic politics that under the "fear and trembling" impact of the atomic bomb on our fissionized mentality have come to be advocated by many scientists and publicists. Accordingly, for their bearing on the complex problems in national and world security and in economic development of atomic energy, it seems advisable to feature the major themes that I sought to telescope in the account given of the "Background and Early History of the Atomic Project":-

1. The timely acceptance and inauguration of the Project by President Roosevelt stemmed from the cumulative development in the period prior to the outbreak of combat war in 1939 of a concerted attitude and concern as to the implications of the international crisis of the interwar decades; and

2. The foreshortening of the opportunity for time-borrowing under heightened war technology required then, and correspondingly requires now, a new organizational framework characterized by initial and progressive adequacy and flexibility of scale and acceleration of coordinated stages and alternatives in the fundamental research and applications.

In view of the controversy that developed over the use of the bomb, the present occasion may also be utilized to spell out, in response to inquiries, the reference to that subject given on page 561, paragraph 4, of my Testimony. The consideration in connection with my analysis of the Finale of the War in November 1944 to "the form of the use of the bomb" was related to a series of recommendations made to and favorably received by President Roosevelt. The recent disclosure of the petition submitted in June 1945 to President Truman by a committee of seven representing sixty-four scientists at the Chicago Project contains a similar emphasis on the need for warning, but the committee appears to have shrunk from military use save upon agreement by all the other United Nations. Specifically, the earlier and different proposal that I submitted in November 1944 was as follows: Following a successful test, there should be arranged (a) a rehearsal-demonstration before a body including internationally recognized scientists from all Allied countries and, in addition, neutral countries, supplemented by representatives of the major faiths, (b) that a report on the nature and the portent of the atomic weapon be prepared by the scientists and other representative figures, (c) that thereafter a warning be issued by the United States and its Allies in the Project to our major enemies in the war, Germany and Japan, that atomic bombing would be applied to a selected area within a designated time limit for the evacuation of human and animal life, and finally (d) in the wake of such realization of the efficacy of atomic bombing, an ultimatum demand for immediate surrender by the enemies be issued, in the certainty that failure to comply would subject their countries and peoples to atomic annihilation.

The conjuncture under that proposal of international auspices with advance warning and provision for evacuation of the areas to be subjected to atomic bombing, while it would have reduced the surprise impact and destruction of life, would not, save for a minor delay, have diminished the military effectiveness of the threat of total annihilation in bringing about unconditional surrender. Furthermore, by enhancing our political and moral position, it would have etched in on the conscience of mankind and history the "no escape from retribution" to the aggressors.

In the unfolding of events, neither the originally recommended course nor the variant proposal urged many months later by groups from the Chicago Project was implemented, presumably due in part to the difficulties of the transition in the wake of President Roosevelt's death and the pressures upon the new Administration from the onrushing finale of the Far Eastern war.

Thus, towards the end there reemerged the need for a synthesis, corresponding to what was provided at the beginning of the Project, between political and moral strategy and war technology. Such a synthesis has become indispensable for the effectuation of civilian developments under adapted democratic economic enterprise - with due mindfulness of the dangers both from totalitarian control and anarchic exploitation - that will usher in the greater industrial revolution of nuclear energetics.

Sincerely yours,

Alexander Sachs

Mrs. Eleanor Roosevelt
29 Washington Square
New York, N. Y.

Revised Transcript

BACKGROUND AND EARLY HISTORY ATOMIC BOMB PROJECT IN RELATION TO PRESIDENT ROOSEVELT

OPENING TESTIMONY BY ALEXANDER SACHS

IN HEARINGS BEFORE THE SPECIAL COMMITTEE ON ATOMIC ENERGY
UNITED STATES SENATE

SEVENTY-NINTH CONGRESS
FIRST SESSION

PURSUANT TO

S. RES. 179

NOVEMBER 27, 1945

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BACKGROUND AND EARLY HISTORY ATOMIC BOMB PROJECT IN RELATION TO PRESIDENT ROOSEVELT

REVISED STATEMENT OF DR. ALEXANDER SACHS

Dr. SACHS. I am by profession, gentleman, a practical economist, economic adviser, and industrial consultant. I was previously economist and vice-president of the Lehman Corp., of which I am still a director and a special economic adviser in my new capacity. Throughout the decade prior to the war I was associated with them.

I have also been interested in the problems of our national economy and national welfare as affected by international conditions and problems. From its advent phase on, the Great Depression of 1929–33 struck me as fraught with greater gravity and deeper portent than prior depressions in our business cycle history. For I felt that its roots lay in the untenability of the whole postwar reconstruction of the twenties that was effected on a world scale, and furthermore, I felt with growing concern that the financial and economic collapse would engulf the political order that was established by the peace treaties. Thus imbued, I came to be known or nicknamed as the "Economic Jeremiah." In the course of that depression I had gone to Europe to observe on the spot the financial crisis of 1931 and my advice came to be sought by leading figures. In particular I was a special adviser in an informal capacity to Lord Reading and Lord Lothian, who as members of the new National Government formed in the summer of 1931, were concerned with the impact of the world depression on England.

From that trip I came back with a sense of foreboding as to the further repercussions of that depression upon the United States, holding that the break-down of the postwar monetary and economic reconstructions was bound to aggravate the spiraling depression in the United States as it was undermining the political and economic order of the world. The fulfillment of successive analyses and forecasts regarding the depression led to my being introduced in 1932 to Mr. Roosevelt. Thus began an association which continued from then through this war as an informal adviser without any special label. In that work I tried to live up to a concept that President Roosevelt had formulated in his message of January 1937 on Government reorganization. He described therein that men who are to serve a President as assistants and advisers should not only command personal confidence but: "They should be possessed of high competence, physical vitality, and a passion for anonymity." In particular I tried to live up to the last requirement, a passion for anonymity, and throughout have avoided any public self-referentialness, feeling that my job was to be on tap to and for the President without trying to influence the course of events beyond trying to point out advance implications and consequences to those who were shaping the course of events.

As to the interaction between the economic and political forces that produced the world crisis, I had in 1932 submitted to the President-elect this summary: "The statesmen of the world have continued to be overtaken by a sort of high-tension paralysis—like the trivial oscillations of the trench war battlefronts up to America's entrance in the great war—only to find that the imperious and menacing march of events swept aside the half-willed and half-thought schemes, and even attacked improvised defenses that were resorted to too late, as in the German case to save Germany for democracy. The outstanding feature of this great depression is that the economic order developed since the Reformation and the great society developed since the fall of the Roman Empire have come to be threatened not by the destructive impact of external or natural forces, but by a disintegration from within because of an incipient failure of concerted will and political wisdom."

Thus imbued, I came to suggest early in 1933 in connection with the formulation of the National Recovery Act—for which I was called in in my capacity as an economist—that an important use for public-works funds to be provided was the reconditioning of the Navy, the mechanization of the Army, and the improvement of national defense. General Hugh Johnson, who during the depression was an assistant in an economic capacity to Mr. Baruch and had thus become interested in my interpretations and forecasts of economic developments, was given by the President a leading role in the NRA and he and the President asked me to serve as organizer and first head of NRA's Division of Economic Research. In the drafting phase of the act, I at first urged upon them the inclusion of those national defense provisions.

Senator AUSTIN. What year was that?

Dr. SACHS. That was in 1933, in the legislation of April and May. Hugh Johnson in the Blue Eagle, pages 197–198, credits me with having suggested that this provision about making available funds for naval construction and other defense be written into the NRA bill. Hugh Johnson was a little bit too generous in thinking that I had sole responsibility for the idea. The fact was that in a patient argument with the President the conclusion was reached that the advent of Hitler to power boded ill for all democracies, and that it was necessary that we take time by the forelock.

I have always been of the view that the real warmongering, combined with defeatism, is done by the pacifists, and that one who is concerned about the protection of national interests without aggressive aims is the real practical pursuer of peace.

Later on—and I had been in the habit of reporting to the President regarding the progress of international developments—in 1936 he called me in to help in working out a solution for the problem of public utilities and electric power. I had proposed the idea of a power pool, and even then we discussed that in the event of war danger we would want to have a mechanism for the coordination of private and public power. The distinguished figures representing the public at that White House Conference in September 1936 were Mr. Owen D. Young and Mr. Lamont, and I had been another one that was selected alongside those representing the public-utility interests and the governmental authorities concerned with power. The international situation was a subject of discussion a year later with the renewed outbreak of Japanese aggression on China.

After Munich I had begun to send the President a series of memoranda. It was at the turn of the year in January 1939, that I had sent in a very long study on the international situation. In the preface to it I described the attitude underlying that memorandum and the predecessors on problems that had been discussed with him in 1936, and also in 1937 prior to the quarantine speech. My role was, if you will, to be a resonator for ideas that he had and also as a humble submitter of ideas of my own. In that preface I wrote:

"The orientation towards the world crisis that has been developed in prior reports and needs to be borne in mind continually is that we are already in what Thomas Hobbes, who lived through the British civil war 300 years ago, justly called 'war time tract' and 'war weather.' 'For war consisteth not in battle only but in a tract of time wherein the will to contend by battle is sufficiently known * * *. For as the nature of foul weather lieth not in a shower of rain but in an inclination thereto of many days together; so the nature of war consisteth not in actual fighting but in the known disposition thereto during all the time there is no assurance to the contrary.' "

The thesis then was that the aggressor powers, the Nazis and their allies as well, for Japan had begun its aggressions in 1931 and expanded them in 1937, were passing from the state of "white war" and limited war to totalitarian war.

On March 10, 1939, when I had been asked by St. John's College to deliver a talk on the world situation, I prepared certain notes of which I had sent the President a copy. Those were entitled "Notes on Imminence World War in Perspective Accrued Errors and Cultural Crisis of the Inter-War Decades." That memorandum dated March 10, 1939, had this opening sentence:

"This interwar generation has been living on the edge of a smoldering volcano; and the predominant attitudes among both what is called the 'right' and what is called the 'left' have been variants of escapism, very much like peasants situated on the edge of a volcano who go on cultivating the slopes in the hope that the eruptions will not take place in their lifetime."

Then I reviewed the errors of the interwar period. Toward the end I said:

"The present period is too late for that reversal of error which prevents the consequences of error. The real 'Munich' took place in 1936, in connection with the Rhineland. Then was the last opportunity missed for preventing that cumulative German aggression that was bound to culminate in a new and more terrible war by Germany. But what can and must be done for our salvation and safety is self-clarification and self-reorientation toward the onrushing dangers."

Then in the concluding sentence—and you must pardon the length, for I thought it was my business to try to think things out instead of trying to be popular—I urged preparedness:

"There is still time for western civilization, and especially for the exceptionally and fortunately situated United States, to use the time drafts that can still be made on the 'Bank of History' for the preparedness that has and will become more and more urgent and inevitable for all members of western civilization as a result of the past errors committed and in the course of the prospective unfolding aggressions of Nazi Germany."

It was in the following month, on April 15, 1939, that there was published in the Physical Review a note by Dr. Leo Szilard entitled "Instantaneous Emission of Fast Neutrons in the Interaction of Slow Neutrons with Uranium."

In keeping with the custom in scientific research, the date of its original sending was included, dated March 16, 1939. So it coincided with the time when Hitler seized Prague, and by seizing Prague became the controller of the crossways of the Continent.

The background of that article in the Physical Review was that at the turn of the year 1938 certain experiments had been concluded in Germany. These became known rather fully, thanks to Dr. Niels Bohr, of Denmark, who came to this country and reviewed them with his colleagues, for scientists are an international community. The word "international" in that connection is not as precise as it ought to be. Science rather is "trans-national"—moving across boundaries of nations—and progresses in terms of evolving common ideas. After all, our heritages of common moral, political, and intellectual ideas in their institutional forms date for our world from the Reformation and the Renaissance. That crystallization of Hebraic-Christian ideals, and that recovery of the Hellenic pursuit of science has functioned as a sort of spiritual and intellectual atmosphere for all nations of our civilization. The men of science depend upon the free flow of knowledge and ideas through that atmosphere. Through such personal communication as was provided by Dr. Bohr the refugee scientists working in this country were made aware more thoroughly than through the publications of the experiments by Drs. Hahn, Strassmann, and Meitner that had resulted in the fission of uranium.

What was subsequently done in this country represented a distinct advance. The work was by Dr. Szilard and, as independent confirmation, by Prof. Enrico Fermi, a Nobel Prize physicist from Italy. The Nazi contamination had advanced so far that return became difficult for him, as well as for all others who did not conform to the tribalistic notions of nazism. The mutual confirmatory work of Dr. Szilard and Dr. Fermi amounted to the suggestion that a chain reaction could be established in the process of atomic fission. Such a chain reaction had implications for war by reason of the kind of power that would be concentrated in and released by the process of atomic disintegration.

Because I had been imbued with the ideas already noted about the nature of the world crisis, I was concerned with what was happening to the victims of nazism and fascism, and I tried in my own small way to be helpful during the period when the scientists had to leave.

I gave you at first some high lights of the "Book of Genesis" of my concern, and after that came, if you will, the "Book of Exodus," the exodus of scientists who came to this country as a haven of refuge. Prior to that Dr. Szilard had worked in England at Oxford and Cambridge—at Oxford with F. A. Lindemann, who played toward Mr. Churchill a role analogous to the one concerning this project played by me toward Mr. Roosevelt.

In the wake of this phase of the exodus, the scientists settled in democratic countries like ours were concerned not only with the progression of a technical problem, but with its political and moral implications. Dr. Einstein was preeminent among them. Professor Einstein's theoretical work, while it antedated the First World War, received practical confirmation in the astronomical tests that, interestingly enough, came just in the closing phase of World War I, as Prof. A. S. Eddington, of Cambridge, showed in his early books on relativity and space, time and gravitation. There was another great physicist, who was a friend of Dr. Szilard and part of that group, Prof. E. P. Wigner, professor of theoretical physics at Princeton.

Einstein, Wigner, and Szilard discussed the problem. I want to impress upon you gentlemen—if a member of the cognate older faith may refer to the Gospel of St. John—that "in the beginning was the word," and the idea. In the beginning was a moral idea and a political concern on the part of the physical scientists and this social scientist whom they brought in. They brought me in because they had known of my interests and had heard that I was in a position to talk to the President and talk to him in terms of broad and fundamental concepts. The idea was, How can this be brought to the attention of the President?

The Germans were organized to carry on experimentation without limit. The Nazis were not at all concerned about the magnitude of expenditures. Ironically, despite all the beblinkered concern on the part of members of my own expertise, economics, as to the postwar problem of reparations, the fact was Germany was spending on armament in any and every year once it got going, more than was involved in the total amount of its remittances on reparations. Money was no object. They had the scientific governmental institutions. Many of the scientists who later led here and in England in this work had been carrying on such work at the Kaiser Wilhelm Institutes of Physics and Chemistry.

Our idea was that if they should be able to discover a concentrated power that could be used as an explosive, then the real safety of the United States and the rest of civilization would be gravely imperiled. For bear in mind that the essence of this period of foul weather internationally, to use Thomas Hobbes' expression for this wartime weather, was that the Nazis were rushing to conquer and not permitting others time for the organization of defense.

Therefore, these physical scientists and myself—I was brought into the picture in the summer of 1939 and was conditioned for what was taking place because I had for a long time been interested in theoretical physics and had followed the scientific publications—then felt that it was important to bring these matters to the attention of the President. In turn I felt that it was essential that an opinion should be written by the one man whom the world recognized as the preeminent scientist of our day, and not only the preeminent scientist, but, as the Senator this morning remarked, one of the greatest humanitarians because he had left nazism before expulsion orders were given to him. He had anticipated the trend of events. He did have the political foresight and did see what it implied. So after discussion Dr. Einstein wrote a letter regarding this, dated August 2, 1939. I had also asked Dr. Szilard to write a memorandum describing the significance of the current and evolving scientific research, which was written on August 15, 1939.

Then I sought and waited for a proper opportunity to see the President. I had been in touch with him through the summer, but I felt at the time that the mere delivery of memoranda was insufficient. Our system is such that national public figures—you gentlemen know it from your work as legislators, and it applies to the executive and the administrative in government—are, so to speak, punch-drunk with printer's ink. So I thought there was no point in transmitting material which would be passed on to someone lower down. This was a matter that the Commander in Chief and the head of the Nation had to know and act on. I could do it only if I could see him for a long stretch and read and discuss the material, so that it would come in by way of the ear and not as a sort of mascara on the eye.

Then, of course, with the outbreak of the war on September 1, 1939, the President had the problem of the existing neutrality legislation, as you recall. So only when that was solved did I accept an appointment, because it meant that then I could see him at leisure and present all the relevant material. I brought over the material to him, and met with him on October 11, 1939. I wrote the letter in anticipation of my seeing him so that I would be able to read it. The opening sentence was:

"With approaching fulfillment of your plans in connection with revision of the Neutrality Act, I trust that you may now be able to accord me the opportunity to present a communication from Dr. Albert Einstein to you, and other relevant material bearing on experimental work by physicists with far-reaching significance for national defense.

"Briefly, the experimentation that has been going on for half a dozen years on atomic disintegration has culminated this year (*a*) in the discovery by Dr. Leo Szilard and Professor Fermi that the element uranium could be split by neutrons and (*b*) in the opening up of the probability of chain reactions—that is, that in this nuclear process uranium itself may emit neutrons. This new development in physics holds out the following prospects:

"1. The creation of a new source of energy which might be utilized for purposes of power production.

"2. The liberation from such chain reaction of new radioactive elements, so that tons rather than grams of radium could be made available in the medical field.

"3. The construction, as an eventual probability, of bombs of hitherto unenvisaged potency and scope: As Dr. Einstein observes, in the letter which I will leave with you, 'a single bomb of this type carried by boat and exploded in a port might well destroy the whole port together with some of the surrounding territory.'

"In connection, then, with the practical importance of this work—for power, healing, and national defense purposes—it needs to be borne in mind that our supplies of uranium are limited and poor in quality as compared with the large sources of excellent uranium in the Belgian Congo, and, next in line, Canada and former Czechoslovakia. * * *"

I also informed him we had learned that in the wake of the successful experiments of Drs. Hahn, Strassmann, and Meitner, the last of whom afterward also joined the exodus, the Germans upon capturing Czechoslovakia and seizing Prague, had embargoed the export of uranium from Czechoslovakia.

I also mentioned the people who had been at work on this and who had been consulted.

"* * * Mindful of the implications of all this for democracy and civilization in the historic struggle against the totalitarianism that has exploited the inventions of the free human spirit, Dr. Szilard, in consultation with Prof. E. P. Wigner, head of the physics department at Princeton; and Prof. E. Teller, of George Washington University; sought to aid this work in the United States through the formation of an association for scientific collaboration, to intensify the cooperation of physicists in the democratic countries—such as Professor Joliot in Paris, Professor Lindemann, of Oxford, and Dr. Dirac, of Cambridge—and to withhold publication of the progress in the work on chain reactions."

The CHAIRMAN. Doctor, what was the date of the embargo on uranium?

Dr. SACHS. Right in April, right after the seizure of Prague on March 15, 1939. Bear in mind that the scientific world community was already astir and included Professor Joliot, married to a daughter of Madame Curie; Professor Lindemann, of Oxford, afterward Lord Charwell, who played this corresponding role to Winston Churchill.

"As the international crisis developed this summer, these refugee scholars and the rest of us in consultation with them unanimously agreed that it was their duty as well as desire to apprise you at the earliest moment of their work and to enlist your cooperation. * * *

"In the light of the foregoing, I desire to be able to convey in person, in behalf of these refugee scholars, a sense of their eagerness to serve the Nation that has afforded them hospitality, and to present Dr. Einstein's letter, together with a memorandum which Dr. Szilard prepared after some discussion with me and copies of some of the articles that have appeared in scientific journals. In addition, I would request in their behalf a conference with you in order to lay down the lines of policy with respect to the Belgian source of supply and to arrange for a continuous liaison with the administration and the Army and Navy Departments, as well as to solve the immediate problems of necessary materials and funds."

There are two more documents that are pertinent to the enlistment of the President's interest at the time. One of the things that I submitted to the President, in addition to the scientific material was, of course, this review of mine of the whole world situation on the imminence of war and the nature of this war, which is really a Thirty Years War from 1914 on, with only a brief interlude, a brief armistice, in the twenties. From 1931 on there was a resumption of war first by Japan in the seizure of Manchuria, and then came the succession of wars, the Italian war against Abyssinia, the interventionism by the Axis Powers in Spain, the war against Austria, and finally the seizure of Czechoslovakia.

In 1936 there were lectures delivered on the history of science, reviewing the progress since the turn of the century in the physical sciences. The book was published by Cambridge University Press after Munich in 1938. Due to the work that I had done in England and my relationship to leading figures, I used to get publications in a variety of fields, including science. This book published in 1938 contained two lectures on the history of recent developments in physics, and the development of the theory of atomic structure by Lord Rutherford, whose work initiated the technical side of the physical research since the turn of the century. Some of the greatest work of Lord Rutherford was done right nearby when he was professor of physics at McGill University, and it was for this work that he got the Nobel Prize.

There were these two lectures by the subsequently deceased Lord Rutherford which were revised by an assistant of his, and then there was a separate lecture in addition on Forty Years of Atomic Theory, by F. W. Aston, of Cambridge, who died only a few days ago, as you may have seen the notice. F. W. Aston, reviewing the work that had been done by 1936 and describing what was being done in England and elsewhere, ended up his lecture with a warning and a prophecy. I showed this book to the President with a view to high lighting that, as with other fruits of the tree of knowledge, there is an ambivalence to atomic power with poles of good and evil. The concluding paragraph is as follows:

"There are those about us who say that such research should be stopped by law, alleging that man's destructive powers are already large enough. So, no doubt, the more elderly and ape-like of our prehistoric ancestors objected to the innovation of cooked food and pointed out the grave dangers attending the use of the newly discovered agency, fire. Personally, I think there is no doubt that subatomic energy is available all around us, and that one day man will release and control its almost infinite power. We cannot prevent him from doing so and can only hope that he will not use it exclusively in blowing up his next door neighbor."

The President remarked, "Alex, what you are after is to see that the Nazis don't blow us up." I said, "Precisely." He then called in General Watson, lovable "Pa" Watson, another one of that period who has gone from us, and said, "This requires action." General Watson then went out with me, and the informal group was established.

Senator VANDENBERG. What was the date of this?

Dr. SACHS. October 11, 1939, sir.

He selected, with the approval of the President, one man representing the Army concerned with science, and one representing the Navy: Colonel Adamson for the Army and Commander (since Admiral) Hoover for the Navy.

Holding that as an expert I ought not to be injecting political views, I have throughout my work remained an associate regardless of party and other affiliations. I have the honor to know ex-President Hoover, and I was very pleased to find a namesake of his concerned with these scientific problems, as President Hoover during his incumbency as Secretary of Commerce did a great deal for the advancement of science and scientific research.

As the central figure, the President named a Government individual who was concerned with problems of science, the Director of the Bureau of Standards, Dr. Lyman J. Briggs, who rendered great service during the critical period.

I got in touch with Dr. Briggs that very night, before having to go again to the White House to report progress to the President. For the potentialities of this were very much in the mind of the President, and he had remarked, "Don't let Alex go without seeing me again."

I saw him later that night, and the resultant idea was to hold a meeting in the near future. A meeting was scheduled after this October 11 conference at the White House, for October 21.

I reported to Professor Wigner, who throughout this period occupied a pivotal role because he is highly esteemed and was perceptive on what you might call the political problems. I reported to him in a letter of October 17, and I sought throughout the interval to broaden the group of scientists who were to attend that conference.

Senator VANDENBERG. How about the Einstein letter you referred to?

Dr. SACHS. The Einstein letter of August 2, from which I quoted in part in my own letter, was left with the President, along with my letter.

The CHAIRMAN. Have you a copy of it?

Dr. SACHS. That is part of a record which I will leave with you gentlemen, which was a report I prepared immediately after the announcement about the use of the atomic bomb in August for the White House, for the Department of Commerce—Mr. Wallace as the successor in charge of the Department that had such an important role through the Bureau of Standards—and for the War Department.

The CHAIRMAN. Does that contain your letter?

Dr. SACHS. It contains all the documents, sir. It contains Einstein's letter, and it contains other memoranda.

I had throughout this period sought to be a historian, because the President said to me, "Pa Watson is going to be too busy to be a historian; you had better do that."

I made contemporaneous reviews, and would submit them as galvanizers of action.

I have a copy of Einstein's letter, a duplicate, which has his signature, and I will leave that copy with you.

Senator VANDENBERG. Could you state in a sentence or two the import of Einstein's letter?

Dr. SACHS. Yes, sir. [Reading:]

"Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which have arisen seem to call for watchfulness and, if necessary, quick action on the part of the administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendation."

He then describes the new phenomenon, and states that the sources of practical supply are outside the United States; that the United States has only very poor ores of uranium in moderate quantities, and that there is some good ore in Canada, and the former Czechoslovakia. As to that, he reports:

"I understand that Germany has actually stopped the sale of uranium from the Czechslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under Secretary of State, von Weizsaecker, is attached to the Kaiser Wilhelm Institute in Berlin, where some of the American work on uranium is now being repeated."

In other words, there was political interest being taken in the work. So Dr. Einstein said that one of the ways in which the administration could be helpful was to entrust this task to a person "who has your confidence and who could perhaps serve in an unofficial capacity." His task might comprise the following:

"(a) To approach Government departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States.

"(b) To speed up the experimental work, which is at present being carried on within the limits of the budgets of university laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the cooperation of industrial laboratories which have the necessary equipment."

These scientists, as you see, gentlemen, were no doctrinaires, but indicated a practical perceptiveness—ready to use whatever means were available so that the Government and the Nation secured a supply and funds for going ahead with this thing.

The next meeting that was held was on October 21 in Washington under the chairmanship of Dr. Briggs of the Bureau of Standards, and there was a survey made of the whole situation. Many scientists were there who were not as concerned as these refugee scientists, for, as I tried to explain, gentlemen, the latter, in addition to their interest in the advancement of science, were interested in the imperiled position of the United States and civilization. They were infused with a concern in the Quaker sense of the word of devoted interest and responsibility. Many of the other scientists said: "This is very remote; we have got to wait and see; there are other lines of progress rather than the chain reaction that may be more attractive." The discussion wandered all over attractive side issues.

The one who occupied the intermediary and catalytic role in behalf of the President had then to ask these American men of science and the Government officials, including the Army and Navy representatives, to indulge—and I remember using the phrase of the Irish poet Yeats, echoing Coleridge—in a "willing suspension of disbelief."

The issue was too important to wait, because if there was something to it there was danger of our being blown up. We had to take time by the forelock, and we had to be ahead of the Germans.

One great advantage that we had was that these refugees, these scientists themselves, responded to that very spirit of freedom that brought the Pilgrim Fathers over here, the search for the freedom of speech and religion and, if you will, free science and free thought. They were saturated by ideas and motives which the regimented scientists could not have, and so the transplanted and the American scientists, if given the means, would make advances much faster.

In the wake of that conference, a subcommittee was appointed, notwithstanding those expressions of doubt. The subcommittee was presided over by Dr. Briggs, and on behalf of the services, Keith F. Adamson, lieutenant colonel, United States Army, and Gilbert C. Hoover, commander, United States Navy. A report was written to the President dated November 1, 1939, on the stationery of the National Bureau of Standards of the Department of Commerce, which reviewed the situation technically and culminated with this observation:

"3. The energy released by the splitting of a mass of uranium atoms would develop a great amount of heat. If the chain reaction could be controlled so as to proceed gradually, it might conceivably be used as a continnous source of power in submarines, thns avoiding the use of large storage batteries for onder-water power."

(I would not have wanted to limit it to this form, but a continuous sonrce of power was the fundamental idea.)

"4. If the reaction torned out to be explosive in character it would provide a possible source of bombs with a destructiveness vastly greater than auything now known.

"The military and naval applications suggested in paragraphs 3 and 4"—in this case he was expressing the not quite suspended dishelief of the representatives of the Services; voicing their greater skepticism, Dr. Briggs said that the military and naval applications "must at present be regarded only as possibilities because it has not yet been demonstrated that a chain reaction in a mass of uranium is possible. Nevertheless"—and in this respect these representatives were willing to go ahead—"in view of the fundamental importance of these uranium reactions and their potential military value, we believe that adequate support for a thorough investigation of the subject should be provided."

There had been a previous adverse report that I had known about, which was given by a technical adviser of one of the Services in the summer, and it was because of that adverse report that they didn't see any reason for being interested, although they wanted to be kept informed, that I was brought in to go directly to the Commander in Chief.

So they conclnded:

"We believe that this investigation is worthy of direct financial support by the Government."

But, alas, we had no money.

"The Lea bill now before Congress if enacted would provide for carrying out important investigations of this kind in cooperation with the universities.

"We recommend the enlargement of the committee to provide for the support and coordination of these investigations in different universities. We suggest the following be invited: President Karl Compton, Massachusetts Institute of Technology; Dr. Alexander Sachs, 1 William Street, New York" (that was my address at Lehman Bros., who were very kind to let me devote time, and did not ask me to tell them what is was about. Mr. Robert Lehman is particularly to be thanked for this, and a man who afterward became an adviser of the War Production Board, and later Deputy Chairman, Mr. Arthur H. Bunker, who was then executive vice president of the Lehman Corp.)

The people who were asked to be added were Prof. Karl Compton, myself, Prof. Albert Einstein—I am reading this in the order given there; I belong very much at the foot of any such list—Prof. Albert Einstein of the Institute for Advanced Study, and Dean George B. Pegram, Columbia University.

As a sequel to the major finding and recommendation, the committee proposed that initial support take the form of:

(*a*) Supplying for immediate and experimental work four metric tons of pure-grade graphite; and

(*b*) If later justified, supplying 50 tons of uraninm oxide.

Later on there were all kinds of difficulties about getting the supply, to which I referred. Late that year and in the following year there was another newcomer, an industrialist-engineer by the name of Boris Pregel, who made available his very valuable supplies and experience to Columbia University for the experiments of Dr. Szilard and Professor Fermi, for which he was thanked by Dean Pegram.

The first phase was to coordinate the group of physical scientists for the purpose of presenting the idea to the President. The second phase was the securing of action by the Government, and that was climaxed by the report, which was a go-ahead signal, that Dr. Briggs wrote on November 1, 1939.

If you bear in mind how narrow has beeu the time, how correct was the concept of the memorandum from which I read of March 10, 1939, that the job was "time-borrowing, the issuance of drafts on the 'Bank of History,'" it becomes plain that if the work had not been thought through before the advent of the war, and if the President had not taken action immediately after, and if the report of the Bureau of Standards and its technical head had not come forth on November 1—the bomb could not have come when it did toward the end of the war to abbreviate the war in 1945. From all this you will realize that the time-borrowing was very essential, and along with it the finding and improvement of the organization media for the successive tasks of the year 1939 and the year 1940 and beyond. In the ensuing period I was an adviser of the President also on problems of strategy. I was also a special consultant to General Donovan, Director of the Office of Strategic Services, for whom I had written in 1941 the first report on the intellectual work that was being done in outside institutions on problems of totalitarian war economics, as well as strategy, before the organization of the Office of Coordinator of Information, that afterward became the Office of Strategic Services.

Through these connections I was able to keep in touch, and I was in turn kept in touch, on the basis of great confidence, with the White House on what was going on, so I knew what wos happening even to the very last. I discussed the problem of the form of the use of the bomb with the President early in November 1944, when I submitted a memorandum on the Final Phase of the European War and Emerging Phases of Far Eastern War Liquidation—which contained a forecast that the war would end in April or May, and that there would be no last-ditch stand, but the whole German system would collapse.

Though I have kept in touch, my official role as the representative of the President coutinued up to the time when, as you will see, I submitted to him the idea that it must be given over to an organization in charge of all scientific development, and suggested Dr. Bush, of whose keen interest and ready aid I had learned in the course of the difficult months of 1940.

Many of the pivotal figures are not now alive; the President is dead. General Watson, who rendered very great service, is dead. I well remember his report that in talking to military and naval men who had said, "Well, this is still so remote; what is this thing?—let's wait and see," "Pa" Watson would say, "But the Boss wants it, boys." That was the theme song of "Pa" Watson. He is dead, and the secretary who used to call me up and pass on White House messages is also dead.

These documents that fortunately were written represent the main available records of the flux of events, apart from scraps, and the scraps that are available in the files are insufficient to give a correct picture. One gets a picture from some of the things that have been published that there was a linear progression. Like all human undertakings, it was full of set-backs, difficulties, conflicts between perceptiveness and willingness on the one hand, and doubts and negations on the other, and it required continuous prodding. Such work as I was able to do, I was able to perform because everyone knew I was not concerned about anything but the progress of the work and had made myself anonymous. If I may again quote the New Testament, there is a verse in First Peter, "Be ready always to give answer to anyone that asketh of you the reason of the hope that is in you, with meekness and fear." I felt that I and the others had to go on with this work, and that it must go on, and so I sacrificed my time and concentrated on that. Later on, as a matter of fact, when the war broke out, I resigned from my administrative post and became a private economic adviser and was the better able to devote myself to war work to a considerable extent.

Prior to that, in the summer of 1941, I had given to the Navy a plan that was worked out with the aid of a great engineer, Dr. Emil Mayer, for the use of detector radiosonic buoys for the establishment of an Atlantic security lane originally for the lend-lease shipments. This substantially was afterward adopted by the Navy through technical work under Professor Hunsacker of MIT and the fostering concern from 1942 on of Mr. Lewis Douglas, then Deputy Administrator of the WSA.

Thus with regard to the adoption of all such technical devices I want to etch in this consideration: that in the beginning there had to be a political concept and a moral concern, and that later it was necessary to provide proper vehicles for action and also to induce acceleration of action.

The third stage in the atomic project was the coordination phase of the university researches with limited governmental aid and pressure—by Einstein and the speaker—for a new framework and an accelerated tempo for the project.

While a number of the university representatives were encouraged by the governmental interest, the fundamental tenor and the tempo of the work remained, on the whole, continuous with the past—that is, they were regarded as mere laboratory researches.

The time of this phase was approximately coincident with what was called then the "phony" war. This was the time of the war which embraced the period between the fall of Poland and the Nazi invasion of the Lowlands.

You can well realize that the President during this period was pressed by and preoccupied with numerous internal and international problems. Our liaison for the project, General Watson, orally conveyed the general tenor to the President of Dr. Briggs' report. While he had done that, he thought when, after an interval, he transmitted it to me on February 8, 1940, that a more pointed conclusion was still necessary. He added that he had asked for a special recommendation from Dr. Briggs.

Meanwhile, some progress was made in the coordination of the university researches by the Coordinating Committee mentioned in the concluding point 8 of Dr. Briggs' report. The appointment of Dean Pegram served to focalize activities in Columbia on this project and frequent conferences were held there by the speaker with Drs. Pegram, Fermi, and Szilard.

In mid-November of 1939, our group had projected an octet of experimental projects in the hope that the subsidiary questions could be cleared within a period of 6 months. In notes that were made at the time, I listed the nature and scope of these subsidiary problems and the recommended leading figures from nearby educational institutions working on these problems. Of the new men brought in the most important was Prof. Harold C. Urey, who had won the Nobel Prize for his work on heavy water.

After the turn of the year, the Columbia project became the recipient of governmental aid in the form of limited funds intended for the purchase of materials, as is borne out by the reply that Dr. Briggs made on February 20, 1940, to General Watson's note of February 8, 1940.

But Dr. Einstein and myself were dissatisfied with the scope and the pace of the work and its progress. The speaker conferred with Dr. Einstein at Princeton in February. I went out to see him there and developed an inquiry as to the importance of the work that was being carried on at the time in Paris, work that had been described in a contemporaneous issue of Science. While we felt that it was very important that this free trade in ideas—to use an expression of Justice Holmes in one of his great and discerning decisions—that this exchange of ideas among free scientists should be carried on because they served as links and as stimuli to future work, their accessibility through publications to Germany constituted an important problem. Nonetheless, it was advisable to secure comparative evaluations and in response to my question about the work of the French, Dr. Einstein said that he thought the work at Columbia was the more important. He further said that conditions should be created for its extension and acceleration.

Accordingly, I sent, on February 15, 1940, to General Watson a plea for larger aid and an intimation that presently Dr. Einstein would give a favorable evaluation of the work which had been completed at Columbia.

(The letter referred to is as follows:)

FEBRUARY 15, 1940.

Gen. EDWIN M. WATSON,
Secretary to the President,
The White House, Washington, D. C.

DEAR GENERAL WATSON: Thank you very much for your letter of the 8th and the accompanying report of Dr. Briggs to the President, both of which will be treated as confidential. Had the recommendations from the second part of point 5 through points 6 and 8 been placed ahead of the more technical points 1–4, the practical meaning of the letter would have been clearer and more forceful; namely, that in the opinion of Dr. Briggs and his colleagues it was distinctly worth while to go ahead. Due to too academic a presentation, I feel that that practical point was lost.

As the last issue of Science contained a quotation from Science Letters bearing on work in Paris, and as, since our meeting, there has been even more searching and significant work in this country, I shall take the occasion to submit within the next month an up-to-date appraisal of the situation which, according to Dr. Einstein in a recent conversation, holds forth even greater promise than we had thought.

With kind regards and appreciation,

Yours sincerely,

ALEXANDER SACHS.

Dr. SACHS. Ensuing conferences which I had with Dr. Einstein prompted the suggestion that he prepare another review of the situation for submission to the President. I had felt that Dr. Einstein's authority was such that, combined with his insight and concern, it would affect the tempo of the work. His review, which was dated March 7, was written as a letter to me. I will read the opening and closing paragraphs of this letter, addressed to me at my office at the Lehman Corp.

"In view of our common concern in the bearings of certain experimental work on problems connected with national defense, I wish to draw your attention to the development which has taken place since the conference that was arranged through your good offices in October last year between scientists engaged in this work and governmental representatives."

He also reported that he had learned of the further work that was going on in Germany since the outbreak of the war, the work on uranium. He pointed out that this work was being intensified in Germany. I shall quote a portion here:

"I have now learned the research there is being carried out in great secrecy and that it has been extended to another of the Kaiser Wilhelm Institutes, the Institute of Physics."

The sources of such information are not only personal communications but also scattered references in technical publications that can be made to throw light on what goes on. By this process even under the totalitarian system secrets come out. Similarly, under our freer system things can come out in an impersonal way. They did come out even while we were taking terrific measures, and very rightly so. Yet by inadequate attention to technical sources those measures proved in one not unimportant instance rather ineffective. I refer specifically to the unwitting disclosure by the Minerals Yearbook of 1943. On page 828 of that book, in the course of a very technical statement about uranium, there is such a reference to the use of uranium for potential war purposes in 1943.

Senator TYDINGS. Was that our book, or was it a German book?

Dr. SACHS. It was our book, the Minerals Yearbook for 1943, on page 828. At the very time that newspapers and editors were not even to breathe the word "atom," the Minerals Yearbook of 1943, page 828, said, with reference to uranium, "Uranium production in 1943 was greatly stimulated by a Government program having materials priority over all other mineral procurements, but most of the facts were buried in War Department secrecy." Then it goes on to say, "Most of the 1943 uranium supply was used by physics laboratories for research on uranium isotopes as a source of energy." These technical books went everywhere, they were available by the ordinary routine to the technicians who would not have to read between the lines.

Thus secrets leaked out. To a different degree this sort of thing obtained even in the hermetically sealed German system. It is inherent in the situation.

As I said, Dr. Einstein wrote me on March 7, 1940. He stated that research on uranium had intensified in Germany.

"Since the outbreak of the war, interest in uranium has intensified in Germany. I have now learned that research there is being carried out in great secrecy and that it has been extended to another of the Kaiser Wilhelm Institutes, the Institute of Physics. The latter has been taken over by the Government and a group of physicists, under the leadership of C. F. von Weizsaecker, who is now working there on uranium in collaboration with the Institute of Chemistry. The former director was sent away on a leave of absence apparently for the duration of the war.

"Should you think it advisable to relay this information to the President, please consider yourself free to do so. Will you be kind enough to let me know if you are taking any action in this direction?"

I shall skip the next paragraph. Then he wrote:

"I have discussed with Professor Wigner of Princeton University, and Dr. Szilard the situation in the light of the information that is available. Dr. Szilard will let you have a memorandum informing you of the progress made since October last year so that you will be able to take such action as you think in the circumstances advisable. You will see that the line he has pursued is different and apparently more promising than the line pursued by Monsieur Joliot in France about whose work you may have seen reports in the papers."

I had, throughout, followed the policy not only of being an expert on tap, but of going to other people's experts to see what they were doing. When it came to scientific work, I left that to the scientists. I did not presume, when I forwarded these memoranda written by Dr. Einstein, Dr. Szilard, and the others, to act other than as a synthesizer for them.

I passed on Dr. Einstein's review of the situation to the President on March 14, 1940, asking for an opportunity to confer with him on the latest phases of the experimental work.

(The letter referred to was entered in the record of the committee and appears below:)

MARCH 15, 1940.

The PRESIDENT,
The White House, Washington, D. C.

DEAR MR. PRESIDENT: As a sequel to the communication which I had the honor to submit to you on October 12, Prof. Albert Einstein sent me another regarding the latest developments touching on the significance of research on uranium for problems of national defense. In that letter he suggests that I convey to you the information that has reached me that since the outbreak of the war, research at the Berlin Institute of Physics, which has been taken over by the Government, was placed under the leadership of C. F. von Weizsaecker, son of the German Secretary of State.

In the realization that these further views of Dr. Einstein have a definite bearing on the favorable report submitted to you by Dr. Briggs as chairman of the committee which conferred with experimental scientists concerned and myself, I am enclosing his communication for your kind perusal. May I also ask whether and when it would be convenient for you to confer on certain practical issues brought to a focus by the very progress of the experimental work as indicated in the concluding paragraph of Dr. Einstein's letter?

In view of your original designation of General Watson in this matter, I am transmitting it through his good offices.

Yours sincerely,

ALEXANDER SACHS.

Dr. SACHS. The reply of General Watson on March 27, 1940, was to the effect that the governmental committee was awaiting "a report of the investigations being conducted at Columbia University" and hence "the matter should rest in abeyance." I did not feel that I could rest.

Senator TYDINGS. "In abeyance"?

Dr. SACHS. Yes. For the sense of foreboding about Nazi aggression that had been voiced before the outbreak of the war—as I disclosed previously—impelled me to relate the expectations of new invasions in the wake of spring to the instant project.

At the beginning of April, opportunity was afforded the speaker in the course of a visit to the White House to unfold views on the probable course of German aggression as encompassing in this war—as distinguished from the last war—the elimination of neutrals so as to secure complete control of the coast from Norway to France. It had this bearing on the uranium project: It was suggested that diplomatic arrangements be made for the shipment of uranium supplies from Belgium to the United States, instead of shipment on the eve of invasion to France, to avoid their probable capture by the Germans in their military onrush through France.

Taking the project as a whole, it was urged that instead of delimited aid in the form of specific material purchases or reimbursements for expenditures by universities, a fund be made available from governmental sources or by persuading foundations to allocate a fund in order that research could be planned on an adequate scale and on a long-term basis.

I had also another thought in mind in making that suggestion that the late spring months were not too early for the planning of the enlargement of the research personnel; to wit, around April and May the scientists were being booked up for the next year's work in the universities, and if we did not take them then, we were not going to have them later on. So, our job was to divert academic talent from teaching to research, to public research. Otherwise, the right kind of people, the people we wanted, would have completed their negotiations with faculties for the next academic year.

The tenor of these considerations and recommendations was embodied in an aide-memoire which I prepared in Washington and left with the President as a review of the situation: "Import of War Developments for and Application to Natural Defense of Uranium Atomic Disintegration," April 20, 1940.

The fourth phase was the phase which I have called in this report written immediately after the events, in the role of contemporaneous historian which the President assigned to me—"efforts by the originators of the project to gain the adherence of the governmental and advisory group to organizational changes needed to attune the research to the urgencies of unfolding World War events."

The representations made to the President at the end of March and early April, as just summarized, led him within a few days to revert to and act upon my preceding correspondence that had been pitched in the same key.

Accordingly, on April 5, 1940, he acknowledged what had been conveyed to him and proposed that a new conference be held in Washington between Dr. Einstein and the speaker on the one hand, and Dr. Briggs and the special representatives of the Army and Navy on the other hand.

The closing paragraph of that letter indicated that the President wanted the research continued: That is, the preliminary questions about which a few in the coordinating group still retained tints of doubt were in his mind disposed of.

To General Watson was delegated the making of arrangements for the conference, but the President wanted to be advised directly of the results of the conference.

Under even date, General Watson asked the speaker for a list of scientists to be invited, inclusive of suggestions by Dr. Einstein. The inquiries made by the speaker of Dr. Einstein and other members of the coordinating group led to the submission to General Watson of the requested list.

Throughout my work I was in touch with Dr. Wigner of Princeton, Dr. Szilard and Dean Pegram of Columbia and, later on, also Urey.

Following the receipt on April 13 of the two letters from the White House of April 5, Dr. Einstein was written to on April 15. My letter opened with a statement regarding the transmission to the President of Dr. Einstein's communication of March 7 to me. It referred to favorable action taken by the President upon his return from the Canal Zone trip where he had been on vacation. I had gotten in touch with him in the course of that trip, as he had given to this anonymous adviser the privilege of getting through with his messages, and the message so conveyed had contributed to the decision by the President "to adopt the procedure suggested" in the speaker's original communication.

Cognizant of the resistances in the group to the proposed enlargement of the organizational framework, the speaker urged Dr. Einstein to participate in person in the forthcoming conference. However, after a conference which the speaker had with Dr. Einstein at Princeton, it became clear that indisposition on account of a cold and the great shyness and humility of that really saintly scientist would make Dr. Einstein recoil from participating in large groups and would prevent his attendance. So, he delegated me to report for him, too.

As a substitute, I had asked him to enable me to record the consensus of our views in the form of a written communication to Dr. Briggs. That communication, dated April 25, 1940, to Dr. Briggs, which Dr. Einstein signed, referred to the discussions he had had with Dr. Wigner and myself on the progress of the work of Dr. Fermi and Dr. Szilard.

The purport and purpose of the letter was to impart a new impetus and to suggest an appropriate adjustment of the organization side of the research to the interlinked necessities of the emergent phase of the research and of the international situations.

I should like to quote from that letter.

"I am convinced as to the wisdom"—

The CHAIRMAN. Whose letter was that?

Dr. SACHS. This is Dr. Einstein's letter, which I brought with me, to Dr. Briggs

"I am convinced as to the wisdom and urgency of creating the conditions under which that and related work can be carried out with greater speed and on a larger scale than hitherto.

"I was interested in a suggestion made by Dr. Sachs that the Special Advisory Committee supply names of persons to serve as a board of trustees for a nonprofit organization which, with the approval of the governmental committee, could secure from governmental or private sources, or both, the necessary funds for carrying out the work.

"Given such a framework and the necessary funds, it (the large-scale experiments and exploration of practical applications) could be carried out much faster than through a loose cooperation of university laboratories and Government departments."

You must bear in mind that this was before the fall of France and the Government executives had no money.

We were trying to take this thing out of where it was. This was the viewpoint of those who, having made their venture of faith, sought assistance adequate to the need, as distinguished from other scientists who were content with what I called, in the memorandum to the President, a bit-by-bit procedure. Since we realized the import and pressure of international events, we wanted the thing lifted out of the somewhat monastic type of research that goes on in universities, a slow-motion process on very limited scale. We wanted both larger scale and much faster tempo.

Originally, the April meeting was scheduled by Dr. Briggs for April 22, and so far as nongovernmental people were concerned, was to be limited to Dr. Einstein, Dean Pegram of Columbia, and myself. Then by telegram of April 20, the meeting was postponed to the 27th. In the interim I sought to enlarge the group and I requested that an invitation be sent to scientists and executives in universities involved in the current uranium research.

That request was granted, as appears from my letter to the President of May 11, 1940.

(The letter referred to was entered in the record of the committee and appears below:)

MAY 11, 1940.

The PRESIDENT,
The White House, Washington, D. C.

DEAR MR. PRESIDENT: In furtherance of your kind letter to me of April 5, the conference suggested by you was arranged and held under Dr. Briggs' chairmanship on April 27, between the governmental and nongovernmental groups concerned with the bearing of uranium experiments on national defense. With the conclusion of the first experiment, which was conducted at Columbia University by Drs. Szilard and Fermi, with governmental aid, the whole project is now entering upon a new stage. Assuming that the governmental committee will now, upon your inquiry, report in favor of further and larger governmental action, may I, in accordance with your own gracious expression of a desire to be advised of developments, submit the following considerations and suggestions:

1. With the invasion of Belgium by the very power which has organized the residue of its scientists for uranium work, the danger—alluded to in my original letter to you of October 11, 1939—that America may be cut off from uranium supplies of the Belgian Congo has increased. In addition, the successful completion of the above-mentioned preliminary experiment renders it practicable and advisable that the action to be taken shall be adequate and comprehensive.

2. Such action inherently involves not only larger financial support to be accorded by the Government but also the formation of an organizational framework under which the work can proceed with the flexibility required for a going enterprise. Interestingly enough, the latter practical aspect has been emphasized by Dr. Einstein in conversations with myself and was communicated by him in a letter to Dr. Briggs, of which I am enclosing a copy for your kind perusal and attention. In this connection you might find of interest the enclosed copies of two communications which I have received from Dr. Szilard, the first of which contains a synoptic statement of the implication of the work for national defense that was made orally at the above-mentioned conference of April 27, and the second an outline of the next tasks to be undertaken.

3. The resultant requirement for forming an organization for directing the work outside of governmental institutions and for assuring that work by scientists in the universities is carried out with due secrecy has to be dovetailed with the designation of persons to serve as trustees of a nonprofit organization that is to supervise the allocation of funds and to coordinate the various branches of the work.

4. These interlinked needs suggest to me that it would be desirable to bring one of your legal aides into the circle of discussion, along with General Watson, who is now serving so efficiently as a liaison for the representatives of the service departments and the Bureau of Standards.

In view of the urgency of a decision on these points, I should greatly appreciate conferring with you in the course of next week, at your convenience.

Yours sincerely,

ALEXANDER SACHS.

Dr. SACHS. That, then, is the background against which the conference was held, a background which was lit up by portentous international events. The second week of the month opened with the German invasion of Norway and Denmark on April 9; the third week witnessed counter operations by the British, the landings in Norway on April 16 and April 18.

Since the concern for national defense and the survival of civilization motivated my mediation of the project between the scattered scientists and the President, it is understandable that in the flux of erupting international forces I should seek to transpose the laboratory questions to the larger theater of international policy and military operations.

Two contemporaneous crystallizations of that preoccupation are available. The first is a memorandum-letter prepared at my request by Dr. Szilard under date of April 22. The second is the already referred to memorandum for use with the President, dated April 20, 1940, and bearing the title "Import of War Developments for and Application to National Defense of Uranium Atomic Disintegration."

Skipping the very technical side, I want to mention the——

The CHAIRMAN. Doctor, I am sorry, but we have to recess at 12 o'clock. So, if you will, we would like to have you bear that in mind.

Dr. SACHS. All right, sir. I will pick an appropriate place.

The memorandum-letter by Dr. Szilard aimed to describe the next phase of the research and its dual alternatives and their respective applications to national defense. The first case deals with chain reactions in which the neutrons are slowed down so only a small fraction of uranium can be utilized. In the second case, the neutrons are not slowed down and so the bulk of the ordinary uranium can be utilized. It is the latter case which has the greatest significance for national defense and particularly for the production of atomic bombs. The former significance would appear to lie in power production. Both would also present the complication that personnel handling such atomic engines would be exposed to the radiations.

The second alternative also presented a dual utility for concentrated power and concentrated explosives. As to the second use, the concluding paragraph of that memorandum constitutes a most illuminating formulation:

"A chain reaction of this second type would make it possible to bring about explosions of extraordinary intensity. If, for purposes of aggression, a bomb based on such a chain reaction were set off at sea near the coast, tidal waves brought about by the explosions might lead to the destruction of coastal cities."

The coincident memorandum of the speaker was concerned with high lighting the bearing of the war developments on the organizational aspects of the uranium research, and evoking applications for naval warfare with a view to throwing into sharper relief the urgencies of providing more central direction and greater adequacy of scope and speed in the prosecution of the project.

I had previously been called in to discuss what would be the results if control of the Mediterranean was achieved by the aggressor. In that connection there was a coincident idea advanced by a person who had been in the Army and who was concerned about this problem, a very great authority and friend of mine, General Donovan. General Donovan and myself had independently perceived that the Mediterranean would for war prosecution against Germany be significant north-south, as distinguished from east-west. We saw that the democracies would be pushed out from the Continent, that the next war phase would push France out as a major belligerent power.

This conclusion did not require so much foresight, as it required a memory with which I happen to be endowed. For the French military people engaged in the last Peace Conference had seen that and stated it. Furthermore, in the book on the Peace by André Tardieu to which Clemenceau wrote an introduction, there is a prevision of the 1940 plight and defeat of France. Clemenceau was a layman who had his own views about military strategy: You will remember he was the man who had remarked that war is too serious a thing to leave it solely to the military—Clemenceau had seen that development and he expressed himself on it as an insighted layman, who while entertaining complete respect for the performance of the military, can synthesize the military considerations with the political considerations.

Clemenceau had insisted at the Peace Conference, "If you do not give the French the protection at the Rhine, then the other democracies will have no base of operations, no base of support, no jumping-off place for operations by the overseas democracies." Thus mindful of the last war, we agreed we would not even have a base on the Continent. Therefore, the significance of the Mediterranean was going to be north-south and not east-west.

In the light of and following such discussions on the fate of our access by sea to the Continent, I broached the problem of the supply of uranium for the United States. I pointed out that the biggest supply of uranium was in the hands of the Belgians. I pointed out that even if in anticipation of invasion they were to send it to France, it would not come to us. Hence we ought to open, ahead of invasion, diplomatic negotiations.

Incidentally, that industrialist-scientist I mentioned, Boris Pregel, who at the outbreak of the war was in France and was a French citizen, had, it later appeared, asked the French Government in 1939 to make arrangements with the Belgians.

That prescience on the part of these newcomers and refugees, gentlemen, was operative in our cause because they were united by a political sensitivity along with their specific expertise as scientists and technologists.

Now, the memorandum which I submitted to the President opened with a description of the meetings and the work that was being done by other scientists; by the scientists in England, men like Drs. Chadwick and Lindemann, and so on. That work would be available for coordination with research in America. In other words, there was suggested at that time the idea of Anglo-American collaboration. In that already alluded to Cambridge lecture in 1936, it was foreseen that there would eventually be developed a new source of energy; and that lecturer was also aware, profoundly and humanly aware, of the dualism, the good and evil, in such development.

The memorandum then dealt with the tendency to reservations and understatement of the results of research and their implications, the effect of which on governmental representatives was to cause them to recoil from the very suggestions that were being pressed by Dr. Einstein and myself for providing a larger and more resourceful organizational framework for adequate and faster prosecution of the task.

In the effort to overcome the tempo dampening and scale dampening that the other attitude entails—the attitude of conservative hesitation, proper enough in an ordinary task but not for this kind of thing, which required the already designated "willing suspension of disbelief"—in that effort, the speaker submitted the following observations and considerations which in a later presentation to the President appeared to be contributive toward a resolution of the organizational difficulties:

"The present writer, as a nonphysicist"—this is a quotation from my memorandum—"would not of course venture an opinion alongside those cited. But as an economic historian and as a practical economist versed in the conduct of technological research, he has ventured to convey to the scientists mentioned and to the governmental authorities his hypothesis that the difficulties which loom so large now might well arise from the characteristic physical limitations of the pre-prepilot plant operations that are carried on in the typical university laboratories. If the project is fraught with promise and importance for national defense, then it seems to him worth while to approximate very soon the conditions of industrial pilot-plant operations. This might entail the building of equipment, machinery, and even the construction of adequately scaled and adequately protected physical plant.

"Once we relate the uranium research to national defense, it should be regeared in type and tempo to the most advanced technological research that has been carried out by the American chemical and electrical companies."

I need hardly insert parenthetically that it was this scale of operation which was carried out with such distinction later on by General Groves. Returning to the memorandum:

"What has taken place in Poland, Denmark, and Norway, and will doubtless go on through other European countries that will be invaded, is that the pacific-minded countries have not brought their national defense up to the quantity and

quality required for technological warfare. When the import of the European war is assimilated by the American people and national defense is undertaken as a national enterprise, then we may be confident that we will match in war with the progressiveness of our civilian technology and come to surpass it, which means surpassing the German military technology."

In the conviction, then, that "an adequate organizational framework is itself the precondition for the ascertainment and effectuation of the value of nuclear research for national defense," the speaker proceeded to sharpen the possible applications of that research for naval operations——

Senator RUSSELL. What was the date of that?

Dr. SACHS. April 20, 1940, before the invasion of France.

As I say, I proceeded to point out the possible applications for naval operations, on the assumption that the war would in time become global on the part of the Axis, inclusive of Japan, against the democracies, inclusive of the United States.

In that event, the applications in the dual form of telescoped power drive and magnified explosives should aid the United States to overcome "the disadvantage under which we labor due to the enormous distances between continental United States and our possessions, and between our possessions and the Japanese homeland."

This was not warmongering, this was adjustment to the import of events as I saw them, as I followed the phenomenal developments.

If I may quote again from the Bible, from the Twenty-fifth Jeremiah: the nations were successively "taking the winecup of this fury at the Lord's hands and drinking it." I could see that we would all be engulfed; that on the Continent, only Great Britain would be left; and that we would be the only major continental-insular power left in the universe and that then we would have to take action. I saw that we must not let Germany get ahead with atomic research on the kind of weapon they were working on, a weapon whose essence is the elimination of time for the defense, the elimination of that borrowed time that we all needed so badly in this war.

Inasmuch as the attempt to relate the applications to strategic and logistic configurations presupposed naval data, Dr. Briggs' good offices with Admiral Bowen and Commander Hoover brought answers to questions I submitted in a letter. I did not have a copy of that letter for inclusion in my report.

As the sequel to my April 1940 activities was to place the atomic project on a new plane, this new stage of the work in progress provides the occasion for drawing attention to a needed revision in the fast-crystallizing misconceptions of the project's history. The historical review I have given from the contemporaneous record that I kept for the President as a guide to his decisions and actions shows that the development of the atomic bomb was not the linear progression from a single decision that people have spoken and written about. You will remember the story in Alice in Wonderland about the Queen and Bill Lizard: how the Queen started with the end, or the sentence to be imposed, and then worked back. So there is a tendency when it comes to writing history for people to say in the instant case: We have got the bomb and we used it; therefore, the order of development must have been present throughout. Actually there was no such straight line, but rather a zigzag of lines. Moreover, every bit of effort that was applied to evolve and effectuate the eventual right policy was indeed indispensable. Every right effort, however apparently infinitesimal, becomes in retrospect infinitely important for what gave us not only the weapon but the timely use for shortening the war.

As to the role played by the bomb, while it assuredly shortened the war, it must also be recognized that Japan had already been, on normal military calculations, beaten. The timing was so right because of what had been done toward beating Japan by the Navy, the Air and other military power, and also by the economic and other factors. We must not in our concern with the new weapon tend to eliminate all the other elements that constitute the whole organization of our national defense and offense. Thus we needed those bases protected by the Navy and the Air Forces to use for the bombing and so the application of the bomb was conditioned by the success of the other war operations with the other war technologies.

All the same, the bomb presents a new factor—a most vital factor. But I cannot now go into those questions and instead I must return to the history in the crucial phase.

The conference of April 27, 1940 on organization framework and the inadequacy of what we had then, resulted in new submissions to the President for a resolution of the difficulties.

The conference that was held on April 27 at the Bureau of Standards under Dr. Briggs' able and conciliatory chairmanship did serve to dispel doubts that had been entertained by some members. It also marked further progress in evoking a willingness to entertain consideration of large-scale expenditures that might run up to six figures. That was fantastic, alongside the cost theretofore—the thousands that were being spent and the money that was being furnished by those who were on the margin, who were spending out of their own pockets in connection with this work in corresponding amounts. Yet the majority, accustomed to the small scale of physical laboratories at the universities and the correspondingly reduced scales of the budgets of governmental scientific laboratories, did not appear ready to design a large-scale and comprehensive program, and instead insisted on "bit-a-bit" procedures with ranked preferences and time deferments.

By the beginning of May the uranium research at Columbia, which was the pathfinding research, had reached the point where expansion was deemed advisable and desirable by the whole quartet of scientists concerned—that is, by the direct experimenters, Drs. Fermi and Szilard, and by Dean George Pegram and Prof. Harold Urey.

After a number of conferences by the speaker with the Columbia group, a sort of minute was drafted as of May 10 embodying the consensus as to the successive stages. In this case, I myself did the secretarial work.

The first point in this minute was:

"The first large-scale experiment would have as its aim to demonstrate beyond any doubt whatever that a nuclear chain reaction could be maintained in a system composed of carbon and uranium. This would require about 100 tons of graphite and some 10 to 20 tons of uranium metal. It would also be necessary to design a rather elaborate mechanism to stabilize the chain reaction and to safeguard against overheating as well as the possibility of an explosion."

The second point was:

"The next stage is to carry out a general survey of all nuclear constants in order to confirm the values previously obtained and to narrow down the limits of experimental error beyond observed values of the constants. This would strengthen the assurance of the group in the ultimate success of the experiment.

"Then as preparatory ground for that experiment would come the advancing of structural details and the carrying out of technological tests on samples of materials which have to be used in large quantities in the ultimate experiment. This in turn would require getting bids for the manufacturing of the material in needed quality and quantity."

As to quality, the problem of refinement was throughout a very grave one: it was the industrial know-how which had to be acquired, as well as the fundamental scientific research.

In financial terms, the first stage would require expenditures of $30,000 to $50,000; the second stage would require from $250,000 to upward of $500,000.

It was the speaker's view that in the interest of time-efficiency and even of economy, the second could be prepared for while the first was going on, providing that adequate funds were made available to begin with. The proposal which had been submitted for a nonprofit organization directed by a mixed board of trustees seemed, under the conditions antedating the prospect of large defense appropriations, particularly suited to methodical and economical direction of the work.

The lack of resolution of the organizational difficulties led the speaker to submit an analysis of the situation and resultant recommendations in a communication to the President dated May 11, 1940, together with a note of transmittal to General Watson of even date.

The point of departure was—I am coming to the end of this section, that may serve as a terminal point.

The CHAIRMAN. Very well, Doctor.

Dr. SACHS. The point of departure was that, according to the advices given to the speaker by Dean Pegram, the graphite experiment, which had been partly financed by the Government, was a success. As the communication was coincident with the German march through Belgium, the invasion having begun on May 10, the situation adumbrated in the initial presentation of October 11, 1939, had come to pass. I mean the situation I had presented when I stated that we should acquire uranium supplies from all Belgian sources had come to pass. A problem of access to uranium supplies that would be needed on a larger and larger scale had been thrust forward. This in turn threw into sharper relief the previously described need for that change in the organizational framework "under which the work could proceed with the flexibility required for a going enterprise."

The President was therefore requested to designate a legal aide to facilitate the establishment of a nonprofit body which would secure the resources for carrying on the work under conditions where the tenure of the research posts would be secure and their equipment and material be amply provided for. I had in mind that large group of scientists that would have to be brought in at that period when they were looking for other university posts. Along with that there should be provision for the necessary secrecy as distinguished from the normal eagerness and competitiveness in early publication of indicated results.

You must see that the job was to transform the conditions and to anticipate the time-order in normal use. Even for getting the scientists, you had to take into account the fact that we were preventing them from having what is the biggest asset to the scientist—the knowledge that the results of their research will get published when they do important things. So you have to give them adjustments in salaries. There was no time to delay. If we delayed, then we would be losing the scientists. Additionally, at that time—this was before the invasion of France—you would have to see to it that all this work, in view of its potential value and its potential danger, was not made known to the potential enemy through the scientific magazines, such as Science and the Physical Review, and related foreign publications.

Is this a good stopping point, Mr. Chairman? I could go on. What do you say, sir?

The CHAIRMAN. Doctor, the Senate meets at 12 o'clock.

Dr. SACHS. All right, let me go on, then. This is a very short section.

The CHAIRMAN. All right.

Dr. SACHS. This is part 6 of my history, assembled at the end, in August, from the notes and reviews that were made contemporaneously with the developments. The heading is: Resolution of the Difficulties and Resetting of the Uranium Project into the New Organization Established by the President on June 15, 1940, for the Direction of All Scientific Developments Related to National Defense.

The CHAIRMAN. What was the date that the small-scale stage ended and that you were to go forward on the large scale?

Dr. SACHS. Between May and June it was decided that we needed to go forward on the larger scale. The appointment of a new organization, the Office of Scientific Research and Development, came, I think, on June 15, having been preceded by suggestions of such a scheme that I transmitted to General Watson.

Senator AUSTIN. This was 1940?

Dr. SACHS. This was 1940.

In keeping with the practice of full knowledge and cooperativeness with the Presidential representatives from the Government services to direct the joint committee on the uranium project, the letter to the President of May 11 was given a counterpart in the communication to Dr. Briggs of May 13, 1940. That is, I did not do anything with the President without sending a copy or speaking about it to Dr. Briggs, as the administrator-scientist, or to General Watson, as aide to the President.

My letter to Dr. Briggs drew attention to Dean Pegram's favorable report on the graphite experiment and inferred that the governmental committee would report favorably to the President on the project. That would be reported directly to the President and I was convinced enough that it would be certain to be recommended.

Recognizing that university research is inherently characterized by what I called a "traditional discursive attitude and leisurely tempo," the contemporaneous facts of the invasion of Belgium threw into sharper relief the requirements of national defense. Applied to this project, those requirements were for a resourcefulness of operation and an acceleration of pace, and also a secrecy that could not be had in the university projects, generally carried on with limited means and in an atmosphere of mutual interchange. And I want to say here that the scientists, Dr. Szilard, Dr. Wigner and Dr. Einstein, were all of the same view, that there had to be secrecy against leaks to the enemy.

In furtherance of the foregoing, another letter was written to General Watson on May 15, the second and revised version of which is included here.

(The letter referred to was entered in the committee's record and appears below:)

MAY 15, 1940.

Gen. EDWIN M. WATSON,
Secretary to the President,
The White House, Washington, D. C.

DEAR GENERAL WATSON: Confirming the intimation that I had the honor to convey in my letter to the President and in my covering note to you, I have just received a letter from Dean Pegram, of the department of physics of Columbia University, stating that the initial experiment "has now been concluded with satisfactory result," and that "the absorption cross-section of carbon was found to be encouragingly small * * * only about one-third of the upper limit previously reported in the literature." The detailed meaning of that has been set forth in the letters of Dr. Szilard of May 10 and of April 22, which I forwarded to the President; a copy of the latter was also sent to you. Please advise me before any conference on this is arranged.

In connection with an independent matter having to do with economic and fiscal policies for effectuating national reconstruction and defense, I should appreciate your expressing to the President my readiness to submit certain social-minded economic ideas that had interested him in 1936 and 1934, as to incentive devices for evoking large-scale plant investment for national defense and the training and reconditioning of the requisite skilled labor. To the original proposals drafted in 1932, there was added in early 1933—when submitted for the National Recovery Act—a provision authorizing public-works expenditures for national defense, in view of the altered international situation. The ideas and proposals in connection with the original FHA plan submitted in 1933 were later expanded in the second FHA plan that, at the President's behest, was worked out for Governor Eccles' advisers. In keeping with the pattern of these earlier plans, the role of government can be adjusted to specific requirements.

For the instant purpose, the organizational instrumentality proposed is the establishment of a Scientific Council of National Defense, composed of executives, engineers, and economists, acting in behalf of the Government, who should be invested with administrative powers for the testing and execution of technical projects of utility for national defense.

Yours sincerely,

ALEXANDER SACHS.

Dr. SACHS. The main communication of the speaker contains the first adumbration of a plan similar to that later developed by the President for the direction of the scientific work related to national defense. The new suggestion was made in the settling of proposals which the speaker was evolving for submission to the President with respect to amortization and other incentive-tax devices for national defense plant construction. It was my belief that industry had to be related to and integrated for national defense and I had been asked to submit some suggestions. I made many suggestions in my professional capacity as an economist with reference to these problems, apart from my interest in this uranium research.

In respect to the specific problem of an organizational framework that would carry forward uranium research on a bigger scale and at a faster tempo, the new conclusion and recommendation of the writer was as follows, against the background that the Government was then thinking of going to the Congress with a request for bigger appropriations:

"For the instant purpose, the organizational instrumentality proposed is the establishment of a Scientific Council of National Defense, composed of executives, engineers, and economists, acting with administrative powers for the testing and execution of technical projects of utility for national defense."

In acknowledging that letter, General Watson on May 16 added an observation regarding the broader suggestion for a mixed executive and administrative group for scientific phases of national defense.

The CHAIRMAN. Was that group formed?

Dr. SACHS. That group was formed on June 15. There was an intervening communication and I had received an authorization after an O. K. and an encouraging word from the President to represent the Government in negotiations with the Belgian company representatives here for the acquisition of uranium.

The CHAIRMAN. Doctor, there has just been a quorum call from the Senate and I think we will have to stop at this point.

Dr. SACHS. May I complete that phase of the story?

The culmination of the foregoing phases of the uranium project came on the day following the Germany Army's entry into Paris. On June 15, the President

established a new committee for the correlation of the scientific efforts of the country concerned with problems of national defense and placed that committee under the chairmanship of Dr. Vannevar Bush, President of the Carnegie Institution of Washington, whose name I have mentioned in the course of my discussion here. This committee included representatives of the Army and Navy and distinguished scientists and, initially, was to be attached to the Council of National Defense, in keeping with the suggestions I had made.

Accordingly, the President advised Dr. Briggs on June 15 that "since the problem on which you are engaged is part of this larger picture," Dr. Bush was requested by him to take over the uranium project and to reconstitute the committee.

Now, I make my summary: Thus was found a larger framework in accordance with the tenor of the speaker's recommendations. Dr. Bush's committee after our entry into the war became the Office of Scientific Research and Development. Associated with him and with Dr. James B. Conant, of Harvard, was the General Policy Committee, which included the then Vice President, Henry A. Wallace, Secretary of War Stimson, Gen. George C. Marshall, and Army and Navy representatives. The other group of the Army came in 1942.

The uranium project as initially presented by Dr. Einstein and the speaker in October 1939, having by the spring of the next year been reported on favorably by the testing and coordinating committee that the President had appointed under Dr. Briggs' chairmanship, was thus launched on a permanent and progressive career in the wake of our decision after the fall of France to embark on expanding defense.

From then on it became invested with the importance, the resources and the secrecy available to the Government of the United States in defense and later in war for the translation of an idea into a reality and into an instrument of national policy in war and peace.

The CHAIRMAN. Thank you very much, Doctor.

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(Corresp. Finney)
[Ec. Ext.]
[Subj File Atomic]

Look
VOLUME 14, NUMBER 6
MARCH 14, 1950

How F.D.R. planned to use the A-BOMB

Here, for the first time, a secret wartime adviser reveals that President Roosevelt planned a "warning" demonstration to show the world what the bomb could do—and shock our enemies into surrender

THIS ARTICLE ANSWERS ALL THESE QUESTIONS:

- How did a secret memorandum influence a vital A-bomb decision?
- What story about Napoleon influenced F.D.R. to commit the U. S. to the bomb?
- Why did the President listen to Alexander Sachs?
- What nations would have witnessed a test of the atom bomb's destructive power?
- Did F.D.R., in his last months, change his mind about how to deal with Russia?

By NAT S. FINNEY LOOK WASHINGTON BUREAU

WHAT did President Roosevelt intend to do with the atomic bomb?

It is a strange fact that the biographies and memoirs of Roosevelt's official associates supply no answer to this question.

Dr. Alexander Sachs, recognized in the famous Smyth report as the man who persuaded Roosevelt to launch the atomic-energy project, has now come forward with an answer.

The President, he says, planned to demonstrate the bomb before international representatives of governments, science and religion, before he ordered it dropped on America's wartime enemies.

Dr. Sachs, a New York economist and student of the history of science, bases his assertions about what was in F.D.R.'s mind when he died on conversations he had with Roosevelt as late as December, 1944.

A memorandum advocating a new political strategy to bring about the surrender of Japan without the long, to-the-last-man struggle foreseen by the War Department General Staff was read by him to President Roosevelt immediately before the 1944 elections, Dr. Sachs says. F.D.R. expressed agreement with the ideas contained in the memorandum, and told Major General Edwin (Pa) Watson, his aide, about his views. This memorandum contained an idea Dr. Sachs submitted in a letter of May 8, 1944, which the President acknowledged by a letter to Dr. Sachs. In this May, 1944, letter it was urged that "victory over Germany would accelerate the defeat of Japan" far earlier than the military believed.

A Plan to End the War with Japan

"Final Phase European War and Emerging Opportunity for Liquidating Far Eastern War," was the title of this memorandum. It refers to the atomic bomb only in the code words "exponential weapon." But the meat of the policy it put forward was that with use of the atomic bomb in a series of dramatic warnings, Japan's Ruling House, along with groups that could point to a record of resistance to the Japanese militarists, could regain control of Japan. And that, in view of the utter hopelessness of the outlook of Japan from the spring of 1945 on (with Germany defeated) the Japanese Emperor would accept surrender terms. These terms, Dr. Sachs says, aimed at a "constructive use of the institution of the Emperor, with safeguards."

The memorandum in which Dr. Sachs says he stated the detailed plan for use of the bomb was separate from the one analyzing the opportunity for ending the Far Eastern war. Roosevelt told Dr. Sachs to leave his copy of this separate memorandum with him, and to destroy other copies.

Dr. Sachs says the broad plan, in which use of the bomb was an integral part, had been set in motion before Roosevelt's death at Warm Springs, Ga., in April, 1945. James V. Forrestal, then Secretary of the Navy, had recalled Captain (now Admiral) Ellis M. Zacharias from the West Coast to prepare the series of broadcasts in Japanese that played their part in Japan's ultimate surrender.

Editor's Note—Henry L. Stimson, Secretary of War in 1945, has described the War Department General Staff's estimate of the Far Eastern war situation in July, 1945 in a way that pictures the alternative to Dr. Sachs'

(Continued on next page)

How F.D.R. planned to use the A-BOMB

Adviser says F.D.R. planned expert commission to draft new policy toward an expanding Russia

suggestions for ending hostilities: "The strategic plans of our armed forces for the defeat of Japan, as they stood in July, had been prepared without reliance upon the atomic bomb. . . . We were planning an intensified sea and air blockade, and greatly intensified strategic air bombing, through the summer and early fall, to be followed on November 1 by an invasion of the southern island of Kyushu. This would be followed in turn by an invasion of the main island of Honshu in the spring of 1946. The total U. S. military and naval force involved in this grand design was of the order of 5,000,000 men; if all those indirectly concerned are included, it was larger still. We estimated that if we should be forced to carry this plan to its conclusion, the major fighting would not end until the latter part of 1946, at the earliest. I was informed that such operations might be expected to cost over a million casualties to American forces alone. Additional large losses might be expected among our allies and, of course, if our campaign were successful and if we could judge by previous experience, enemy casualties would be much larger than our own."

A sidelight of Dr. Sachs' story, not directly related to the atomic bomb, is that he urged Roosevelt to revise America's wartime policy toward Russia. Sachs says that at the time he died, Roosevelt was considering appointing a three-man "Colonel House commission" to draft a new Russian policy based on the Kremlin's apparent intention to seize control of Europe.

The relationship between Dr. Sachs and President Roosevelt was known to close mutual friends. But the extent of Dr. Sachs' activities as a personal, nonofficial adviser on atomic energy and grand strategy is little-documented, except in Dr. Sachs' own files. The President's executive officer on some matters of atomic energy was General Watson. Forrestal, who Dr. Sachs says returned from the Pacific in a state of emotional shock that impelled him to reach for any honorable way to end the war, was intermediary with Zacharias. Roosevelt, Watson and Forrestal are dead.

Now It Can Be Told

Dr. Sachs' lips were sealed by a pledge of secrecy to Roosevelt himself. He did not feel himself released until the Smyth report disclosed how he labored to persuade F.D.R. to undertake the atomic energy project, and even then he felt doubt about describing his association with the project during late phases of the war. He has discussed this association with acquaintances in conversations and letters, but the public has not heard the story.

I have examined Dr. Sachs' records of his conversations, and copies of the memoranda he used as the bases of his discussions with President Roosevelt. Here is Dr. Sachs' version of the last chapter of President Roosevelt's life:

Its roots go 12 years deep in time, back to 1932 when F.D.R. was still governor of New York and campaigning against Herbert Hoover for the Presidency. Dr. Sachs, then, and up to the war, with Lehman Corp., and since an independent consultant and director of Lehman Corp., had won himself a reputation in England and the United States as an economist of unusually deep grasp of monetary matters. Through mutual friends, Roosevelt asked Sachs' advice on a projected campaign speech on the gold standard. Sachs tells how he responded with a suggestion that, instead of making a derivative speech, the subject be assigned to the late Senator Carter Glass, who was a master in his own right. F.D.R. heeded Dr. Sachs' counsel, and appreciated the refreshing candor with which it had been given. Thus began as unusual an association of two men as American history records.

Reviewing Our Russian Policy

Its culmination came in February of 1945, just before the failing President left Washington for Warm Springs. In the course of a long, relaxed conversation at the White House, President Roosevelt accepted a view of world events Dr. Sachs says he first put forward in April of 1943—the view that American policy could not be based upon expectation of a friendly and co-operative Soviet Union. The President undertook to reconsider the philosophy underlying his administration's expectation of a postwar era of one-worldism, and to take under serious advisement the revision of the policy he theretofore had followed.

He agreed, says Dr. Sachs, with the contention that the ordinary state and military agencies of the Federal Government were so fixed in the patterns of the old policy that they could not hope to develop a new one. They suffered, Dr. Sachs explains in his own phrases, from hardening of the categories, blinkered thinking, encrusted ideas. Roosevelt planned to name Lewis Douglas, Dr. Sachs and one other man, not designated when F.D.R. died, to a special Presidential commission that would make a fresh review of the facts and present fresh conclusions so forcibly as to command the change F.D.R. might seek.

Plans for using the bomb had an earlier culmination. This occurred after the 1944 elections, during the first week of December to Dr. Sachs' recollection. Roosevelt and Sachs met at the White House where Sachs says he read what is here called his lost memorandum. At the conclusion of the two men's long conversation, the President nodded his agreement to Dr. Sachs' proposals for the use of the atomic bomb.

"For God's sake tell someone," Sachs pleaded.

The President agreed to "tell Pa," (General Watson). Dr. Sachs is satisfied that General Watson was told. His plea to President Roosevelt that someone be told was prompted by his own observation that F.D.R.'s powers were overstrained, and his anxiety that he, who had been insistent upon holding no official position whatever, might not be sole possessor of such a secret. The President, in Dr. Sachs' poignant phrase (he thinks it comes from Shakespeare but cannot find the line) was becoming "yonderly minded." Lengthening pauses spaced F.D.R.'s conversations with Dr. Sachs, pauses during which the President was there, yet in a sense not there. The line and coherence of F.D.R.'s thought was not broken by these pauses, which Dr. Sachs respected in silence, but the continuity of the President's on-pressing drive was momentarily suspended as if he listened inwardly to another, private harmony.

Our Enemies Would Be Warned

Here, as recaptured later by Dr. Sachs in a letter to Secretary of War Robert P. Patterson, is the proposal for the atomic bomb's use with which F.D.R. expressed agreement in December, 1944:

"Following a successful test, there should be arranged (a) a rehearsal demonstration before a body including internationally recognized scientists from all Allied countries and, in addition, neutral countries, supplemented by representatives of the major (religious) faiths; (b) that a report on the nature and the portent of the atomic weapon be prepared by the scientists and other representative figures; (c) that, thereafter, a warning be issued by the United States and its allies in the Project to our major enemies in the war, Germany and Japan, that atomic bombing would be applied to a selected area within a designated time limit for the evacuation of human and animal life, and, finally (d) in the wake of such realization of the efficacy of atomic bombing, an ultimatum demand for immediate surrender by the enemies be issued, in the certainty that failure to comply would subject their countries and peoples to atomic annihilation."

(Dr. Sachs' recommendation that representatives of the major religious faiths attend the atomic-bomb demonstration called for something more than Catholics, Protestants. . . . He wanted representatives of Judaism, Mohammedanism and Buddhism.)

Facts Have Been Twisted

This was the understanding in early December of 1944, and so far as Dr. Sachs can recollect or was informed, it remained the understanding until President Roosevelt's death on April 12, 1945. Yet a simple restatement of the plan as put down by Dr. Sachs in July, 1946, from his memory of the memorandum, can lead to profound misunderstanding of what was in the minds of Dr. Sachs and President Roosevelt when they last discussed their shared secret of the vast atomic project that was then approaching fruition. Indeed, incomplete information about the plan on which the minds of Dr. Sachs and Franklin Roosevelt then met has already been tortured and twisted to make it appear that had Roosevelt lived Hiroshima and Nagasaki would never have occurred. **(Editor's Note—This is not, as might appear to some, a denial that F.D.R had *planned* to demonstrate the bomb before using it as a military weapon. Dr. Sachs is simply making it clear that neither he nor anyone else can be sure of what F.D.R. might have done had he lived to face the situation existing in August, 1945. The Roosevelt plans called for more atomic bombs than actually existed in August, 1945. Obviously, Dr. Sachs**

Dr. Alexander Sachs

To close friends who know the quality of Dr. Alexander Sachs' mind only one word adequately describes him. The word is genius. A story about how he helped President Roosevelt to understand the atomic energy problem in 1939 throws light on why Dr. Sachs is so described. It shows how he thinks.

F.D.R. was worried whether an atomic weapon could be ready in time to decide the outcome of the war. Dr. Sachs had estimated the project might cost two billions, and honestly told the President that, ordinarily, it would take 25 years to do the job. He explained to F.D.R. that he had searched the history of human thought for an example of how time could be telescoped.

He found the example in music, he says. The composer of music has ways of making time three-layered. Remember the old round you used to sing:—"Are you sleeping, etc?" Three tunes going at once, harmoniously overlapping each other. This, he advised, was what must be done with the atomic project:

"When you start one part of the project, assume you have finished it successfully, and start the next as if you had." That is exactly what was done, probably for the first time with such a huge undertaking. It worked.

This man who makes a lifework of thinking in such unusual patterns was born 56 years ago at Rossien in Czarist Russia. He came to the United States in 1904. He was schooled at Columbia University and Harvard, but has never left the school of self-education.

Dr. Alexander Sachs' career has been in economics, with special emphasis on the mathematics of statistics. But the range of his intellectual interests embraces religion, science, history and politics. America is his home but he is well-connected in England and on the Continent.

Dr. Sachs was a special consultant to Gen. William J. Donovan, chief of the Office of Strategic Services, and economic adviser to the Petroleum Industry War Council during the war. These were his formal jobs. His relations with President Roosevelt were informal, unofficial and, until now, anonymous.

could not know how this and other technical facts might have caused F.D.R. to change his plans.) It has been whispered that President Truman knowingly brushed this plan aside in favor of the actual use of the bomb decided upon by an interim committee headed by Secretary of State James F. Byrnes and Secretary of War Henry Stimson. This committee, Secretary Stimson records, submitted its conclusions to a panel of distinguished scientific advisers who, partly because they could not, in the light of the facts, suggest an alternative, raised no objection to the way in which the bomb was used.

Dr. Sachs emphatically disagrees with those who argue that the American-British-Canadian team of nations that made the bomb is morally guilty for the use made of it. While he continues to believe that the broad sense of his proposal for a demonstration under international, inter-religious auspices of the weapon's powers could have been made when the bomb was tested at Alamogordo, N. M., he is convinced that the essential features of President Roosevelt's plans for using the bomb were actually carried out. Dr. Sachs decries the kind of "apocalyptic thinking" that makes the precise use of the atomic bomb the central overshadowing item in the unfolding of the President's much-more-comprehensive plan to bring about the surrender of Japan through negotiations with Hirohito after our facilitating a political coup d'état.

He points out that there was a warning to Japan—numerous warnings culminating in the ominous Potsdam Declaration. He continues in the belief that, had these warnings been sharply dramatized by such a disclosure of the bomb's awful powers as he conceived, Hirohito might well have been able to regain control earlier. Yet, he emphasizes, it was the bomb's terrific impact that sealed victory in the psychological war President Roosevelt had set in motion by having Captain Zacharias recalled to Washington to speak to Japan in Japanese that forethoughtfully included ceremonial and archaic language to appeal to the court and high naval and other officials. Dr. Sachs has only praise for the responsible men who made the fateful, final decisions in carrying through broad plans that were never seriously questioned by Roosevelt's successors, despite the great unpopularity of all suggestions that a deal should be made with the Japanese emperor.

History Teaches F.D.R.

He has a sharp word for persons who now give currency to an American "guilt complex" at the use of the bomb. He compares this "self-denigration" to the soft-thinking about Germany which followed World War I, and he warns that the upshot could be similar.

His story of the conversation with President Roosevelt, during which a decision was reached on use of the bomb as an integral part of ending the slaughter in the Pacific, suggests that Roosevelt may have been weighing in his mind all the political and moral implications of the use of the bomb. (It must be remembered that in December, 1944, there was no certainty the weapon could be made or would be ready in time to provide a sign or shocking accent to hasten the end of the mounting horror by other weapons of scientific killing.) Dr. Sachs says his way of dealing with President Roosevelt was to prepare a careful memorandum and read it aloud, pausing to discuss any fact or concept that raised a question in F.D.R.'s mind. Sachs would then attempt to support a crucial point by a story drawn from history—Roosevelt was an avid, ranging reader of history with relish for a telling passage, particularly when it was new to him. The discussion on this December day revolved about the subtle point of a stateman's responsibilities to history, and the rightness or wrongness of visiting the world with a new agent of destruction. Dr. Sachs was ready with a story.

You Can't Bury a Discovery

Toward the end of the sixteenth century, John Napier, the Scotsman who invented the logarithmic tables, became greatly interested in engines of war because of his Protestant zeal that Britain should never fall to such a threat as the Spanish Armada. Napier's biographer and descendant, Dr. Sachs told the President, learned that the Scotch mathematician had not only devised such weapons as sets of burning mirrors and primitive tanks, but had come upon an invention which succeeded in annihilating all animal life in an area of a square mile. His biographer, Sachs told President Roosevelt, recounted that Napier was "so disquieted that he buried the machine," feeling that "mankind had many engines with which to destroy each other and that . . . he would never willingly increase them."

With this story as his key, Dr. Sachs says he convinced President Roosevelt that it was neither possible nor desirable to suppress such a discovery as was being brought to birth within the Manhattan District. He saw the bomb as the climax of human technological

(Continued on next page)

How F.D.R. planned to use the A-BOMB

With the support of an Einstein letter and a story, Sachs induced F.D.R. to launch A-bomb project

achievement, linked to the most fundamental forces of nature. Its use would be a readily readable sign to the whole of humanity, and would, therefore, foreshorten the war and save millions of lives of our own and the allies, and our enemies as well. But that the weapon must, at the very least, be demonstrated so that the complexities of its impact upon human development would be felt. This, in its strange and somewhat indirect way, was the crux of the President's decision—a decision with an elaborate background that can be understood only by some grasp of the relationship between F.D.R. and Dr. Sachs, his most unusual confidential adviser.

Sachs Spoke Out

The beginning of this relationship has been described. At their first meeting, President Roosevelt found in Dr. Alexander Sachs an enormously well-informed man who preferred complete anonymity and had no hesitation whatever about differing with the President when he believed him to be in error. Few who knew Roosevelt well can be surprised that he formed an attachment to Dr. Sachs. The attachment grew through the years. It grew for reasons that are clearly on the record. In his own and related fields—modern economics—Dr. Sachs has a startling record of having been right when the pack of more orthodox thinkers was wrong. He foresaw that the National Recovery Administration would be a failure and be held unconstitutional, and very frankly advised F.D.R. of what he anticipated. Yet he back-stopped the late Hugh Johnson through the NRA days. There are numerous other instances of the sort.

President Roosevelt valued the advice of Dr. Alexander Sachs, his least-known aide, on economics and, later, atomic energy.

One central belief held steadily by Dr. Sachs in the years when World War II was gathering was the key to his peculiar helpfulness to Roosevelt. Sachs demonstrated historically that the Great Depression was something more profound than a collapse in the economic sphere. It was a collapse of the Great Culture of Western Europe. During the 1932 campaign, Dr. Sachs asked F.D.R. whom he considered his principal opponent. "Why, Herbert Hoover, of course," the New Deal candidate replied. "You are wrong, Mr. Roosevelt," Sachs says he told his friend. "Your enemy is Adolf Hitler."

He Saw War Coming

Long before other advisers to F.D.R. warned him that the great threat was aggressive war by the dictators, Dr. Sachs was correctly interpreting events in Europe and Asia. Partly because of his deep feeling of alarm about the oncoming war, Dr. Sachs kept a sharp eye on unfolding events in the scientific world. As the 1930's drew toward their end, a providential combination of circumstances made Dr. Sachs perhaps the only man who could have advised President Roosevelt about atomic energy.

His long record of giving the President sound advice in economic matters caused F.D.R. to rely upon him. His steadfast refusal to accept any public favor or assignment convinced Roosevelt he had discovered a counselor who genuinely desired anonymity. Dr. Sachs' lifelong interest in fundamental science (he is reputedly a first-rate mathematician) caused him to follow and understand the emergent possibility of unlocking the huge energies inside the atom. He attended a series of lectures in England in 1936-37 at which Lord Rutherford and F. W. Aston clearly forecast atomic energy. At the beginning of 1939, he secured one of the few careful translations made of the historic Hahn-Strassmann report on atomic fission.

During the latter phases of the Nazi purge of non-Aryan members of the great German scientific community, Dr. Sachs became interested in helping those who needed to be rescued. He got acquainted with some of these émigré scientists in the course of his professional trips in England. Others came to the United States and Canada. Through them, Dr. Sachs got the most expert, personal advice. Thus, in the summer of 1939, when the Navy Department flatly turned down proposals for an atomic project, Dr. Sachs was being told by such men as Drs. Leo Szilard and Eugene Wigner that the possibility of atomic weapons could not be neglected.

1939: Year of Decision

Dr. Sachs says he undertook to familiarize President Roosevelt both on the scientific possibilities of atomic energy, and the political possibilities if Germany became able to terrorize the democratic world with an atomic devastator. It is hard now to recall what things were like in early 1939. Austria had been swallowed by Hitler in 1938. Czechoslovakia, deserted by shock-sick England and France, had been taken over without a shot. The United States had no means for offensive war. Dr. Sachs says he became F.D.R.'s personal Jeremiah on the subject of technological warfare because of real fear that Germany might succeed in terrorizing the whole world.

During the late summer of 1939, Dr. Sachs says he broached the subject with President

Military observers view stark, granulated ruins

Roosevelt about starting an atomic project. The President was so preoccupied with problems of the neutrality act that he could not then give the matter attention. The story of how Dr. Sachs enlisted Dr. Einstein to contribute a supporting letter to the dossier of material he used to convince the President is told in the Smyth report, and Dr. Sachs' testimony before the Congressional atomic energy committee fills in a good deal of detail. But Dr. Sachs has never publicly told the story of the crucial meeting at which President Roosevelt decided to commit himself to making an atomic weapon.

On October 11, 1939, Dr. Sachs read a long letter-memurandum of his own to President Roosevelt along with the letter signed by Dr. Einstein and a joint memorandum signed by Dr. Szilard and himself. The President was impressed and willing tu help, but not convinced he should embark on such a costly course of action under government auspices. (Dr. Sachs later advised him that producing an atomic weapon might well cost two billion dollars on the basis of the telescoped cost of electrical power in the generation before World War I.) Dr. Sachs says he asked President Roosevelt if he could see him the next day. The President invited him to come to breakfast.

Dr. Sachs tells how he spent most of that night either at his room at a Washington hotel, or in nearby Jackson Park trying to think of

of Hiroshima, a year after the atom bomb blast. A "warning" demonstration of the bomb's power might have averted the destruction of this city and Nagasaki.

something he might say that would bring the President to order a study of the feasibility of atomic weapons. He recalls returning to his hotel room at dawn, and of dozing in a chair while waiting the operator's wake-up call. He did not go to bed for fear he would lose the thread of what he wished to tell the President.

He came back to the White House, he says, to find Roosevelt seated alone at his breakfast table while a servant attended him. As he sat down, the President said:

"What bright idea have you got now? How much time would you like?"

Dr. Sachs says he replied that he would not take long. "All I want to do is tell you a story." This is Dr. Sachs' recollection of the story.

Lord Acton and the Atom Bomb

He told the President that many years before, while he was in his final year at Columbia University, he had become acquainted with a philosopher and theologian, Prof. Dickinson Sergeant Miller. Later, in 1913, through this friendship, he met and talked to a visiting British divine, the Rev. John Neville Figgis. Father Figgis, he explained to President Roosevelt, had written a book on political theory entitled *From Gerson to Grotius*. This interest in European politics caused Father Figgis to be chosen as literary executor and editor of the lectures and writings of Lord Acton, a famous English political historian with whose work President Roosevelt was acquainted.

Father Figgis, Dr. Sachs told President Roosevelt, discovered that Lord Acton had been asked an unusual question about English history. Could Lord Acton mention an outstanding instance of England being saved from national peril, not by its own efforts, but by the failure of an enemy to seize advantage of an opportunity to destroy England? Dr. Sachs explained that, according to Father Figgis, Lord Acton asked a day to consider the question.

Napoleon Blunders

The next day, Dr. Sachs told President Roosevelt, Lord Acton was ready with his answer. There was an outstanding example of how England had been saved by an enemy's mistake. During the Napoleonic Wars, after Bonaparte had tried to land his armies on England's shores and failed because of the English Channel's tricky tides and currents, a young American inventor came to the French Emperor with an idea.

The inventor was Robert Fulton, and his idea was that Napoleon build a fleet of steamships that could overpower the channel's currents. Then Napoleon would be able to land his armies, and a helpless England would be at his mercy.

Dr. Sachs repeated Lord Acton's story of how Napoleon scoffed at Fulton's idea. And he told President Roosevelt how Lord Acton held that if the French Emperor, then at the zenith of his power, had only had the humility and the imagination to entertain a new idea the nineteenth century history of England might have been far different.

Dr. Sachs says President Roosevelt sat silent when he had finished his story. "That seemed like a very long silence to me," he recalls. "I suppose it was two or three minutes, but it seemed like half an hour." The servant, Dr. Sachs remembers, was clearing away the dishes and, without saying anything, President Roosevelt scribbled something on a piece of note paper and handed it to the servant. A moment later the servant returned with a tall package. When he unwrapped it, Dr. Sachs saw it was a magnum of Napoleon brandy. The servant drew the cork, and not until then did Mr. Roosevelt speak. He ordered the servant to pour.

A Toast to the Future

When each man, President Roosevelt and Dr. Sachs, held a pony of the old brandy, the President clicked his glass with Dr. Sachs and drank. Then, with a friendly gesture, he told Dr. Sachs he would take action on atomic energy. General Watson was directed to follow through.

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