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NARA RG 77, Entry UD-22A, Box 169, Folder 32.32 Germ. Incl. TA

- 3 -

Mr. Frank Hodson July 29th, 1942.

Italy

There are three commercial electrode plants in Italy.

S. A. Elettrografite di Forno Allione, which is owned by us, is located at Forno Allione about fifty miles north of Brescia, and some six miles south of the town of Edolo. It is fairly close to the Swiss border. At the time our manager left in January, 1941, the capacity was rated at 4,800 metric tons.

Another graphite electrode factory is operated by S. A. Talco e Grafite Val Chisone at the town of Pinerolo, which is south-west of Turin. Their electrodes are made from natural graphite and we estimate their capacity at about 4,000 tons per year.

A carbon electrode plant is operated by Elettrocarboni (owned by Siemens-Planiawerke) at Ascoli Piceno, a town north east of Rome not far from the east coast. We estimate this plant to have a capacity of about 5,000 tons.

There is also a carbon plant at Narni, almost due north of Rome, which we understand is operated by Montecatini to produce anodes for their aluminum plants.

France

The graphite electrode plant in which we are interested is operated by Compagnie Industrielle Savoie-Acheson at Notre Dame-de-Briancon in the Department of Savoie. It is about four miles north-west of Moutiers. The plant has a rated capacity of about 7,000 metric tons of graphite electrodes a year.

At the same location a separate company, Societe des Electrodes de la Savoie, operates a carbon electrode plant estimated to be capable of producing 5,000 to 7,000 metric tons per year.

The latter company also has a coal carbon electrode plant at Venissieux, a town southeast of Lyons. The capacity is estimated at 5,000 to 6,000 metric tons per year.

In none of the above have we attempted to include electrode plants for the manufacture of aluminum anodes except the one at Narni, Italy. As you know, these electrode plants are generally located close to the aluminum plants.

Hoping that this information will be of some value, I am,

Yours very truly,

/s/ H.P. Martin
Vice President

SECRET

H.P. Martin
wg

Figure D.546: Acheson Graphite Corporation to Frank Hodson. 29 July 1942. [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32 Germ. Ind. TA]

FIAT 397. *Survey of the Carbon and Graphite Electrode Industry of Germany.* With two supplements. pp. 6, 11.

[...] The discussions with the SIEMENS technical organization showed the possession of the extensive empirical know-how needed for successful operation in this industry, compounded as it must be of experience and science. Thus, as respects empirical know-how, the German industry could be rated as perhaps about equal to the U.S.

As far as scientific know-how and study of the fundamentals of carbon technology are concerned, the German industry has depended very largely upon collaboration with academic researchers, mainly with Prof. ULRICH HOFFMANN. The German industry has directed its technical work more along development lines. [...]

The following tabulation shows the total German production capacity for the baked basic stock for either carbon or graphite electrodes, comparing the installed capacity near the end of the war with that now available in the U.S. Zone [of Germany]. There is no other baked electrode capacity except at some of the aluminum plants which produce their own special electrodes.

The tabulation is in terms of baked weight. The indicated tons are of 1,000 kg. = 2,200 lb.

Firm	Location	Installed	Production	Capacity
		Total at End of War	Now in U.S. Zone	
SIEMENS	RATIBOR	60,000	–	t/yr.
”	BERLIN	30,000	–	”
CONRADTY	NÜRNBERG	19,000	19,000	”
I.G.F.	GRIESHEIM	15,000	15,000	”
		124,000	34,000	”

[See document photos on p. 4153.

Note that this postwar U.S. survey found that by the end of the war, the actual German annual production of graphite was even larger than what the United States had estimated during the war.

Conventional historians often claim that the German nuclear program foolishly rejected graphite as a reactor moderator, instead focusing only on heavy water. Heavy water has many advantages over graphite (p. 4063), yet there is evidence that the German nuclear program used graphite too. I.G. Farben's Bitterfeld facility was mass-producing both graphite (p. 4148) and heavy water (p. 4086) as well as other nuclear-related materials (pp. 4166, 4171, 4174). Similarly, Griesheim plants were producing both graphite (pp. 4152–4154) and heavy water (pp. 4102–4103), with other nuclear-related facilities such as Degussa in the same area [Hayes 2004; Nagel 2016]. Graphite was also mass-produced at the Siemens Plania Werke in Racibórz/Ratibor, Poland (pp. 4148–4152), near a reported heavy water plant at Auschwitz (pp. 4105, 4496) and reported uranium enrichment plants at Opava and Ostrava (p. 3783).]

GENERAL COMPARISON OF GERMAN AND U.S. CARBON AND GRAPHITE ELECTRODE INDUSTRIES

In order to give an over-all perspective of the technological comparison of the German and U.S. carbon and graphite electrode industries, the following summary briefly compares the major aspects of this type of process industry.

Materials:

When the war shut off their U.S. supplies of petroleum coke, the German electrode industry had to develop European materials. The principal substitute was pitch coke, which made acceptable quality graphite, and which did not cost appreciably more than the former price of U.S. petroleum coke.

Another substitute was an "extract" coke resulting from the synthesis of gasoline from coal. The quality of the graphite made with this coke was good, but the quantity available was relatively small, and the price about twice that of pitch coke. However, future developments in this field may make this a feasible material for electrode production.

Other electrode materials developed by the German industry were a metallurgical coke purified to an ash content of about 1% and an anthracite purified to an ash content of around 2.5%.

Processes:

The processes, equipment, and production methods of the German industry are essentially similar to those of the U.S. industry. The disparity in labor effectiveness typical of the German carbon brush and arc carbon industries is not the case for the electrode industry, which is about on a par with the U.S. industry in this respect.

Product Quality:

The many variations in metallurgical practices make it extremely difficult to draw accurate comparisons of the actual performance quality of German and U.S. electrodes. Further, the effects of air raids make the German figures even more difficult to interpret.

Based on a survey of representative electric furnace operators, considering both electrode usage figures and actual appearance after use, it seems evident that the performance quality of German electrodes made during the war ranged from perhaps nearly equal to definitely inferior to U.S. quality.

In very general terms, the consumption of graphite electrodes per ton of good ingots ranged from about 16 to 20 lb. in GERMANY, as compared with 9 to 18 lb. in the U.S.

Know-How:

Among the electrode users the general quality reputation of SIEMENS electrodes was better than CONRADTY. The discussions with the SIEMENS technical organization showed the possession of the extensive empirical know-how needed for successful operation in this industry, compounded as it must be of experience and science. Thus, as respects empirical know-how, the German industry could be rated as perhaps about equal to the U.S.

As far as scientific know-how and study of the fundamentals of carbon technology are concerned, the German industry has depended very largely upon collaboration with academic researchers, mainly with Prof. ULRICH HOFFMANN. The German industry has directed its technical work more along development lines. Based on the U.S. organization of direct industrial research in this field, it would seem that the U.S. industry has a definitely better scientific know-how than that of the German industry.

FIAT 397. *Survey of the Carbon and Graphite Electrode Industry of Germany*

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PART III

PRODUCTION CAPACITIES

A.) CAPACITY FOR THE MANUFACTURE OF BASIC STOCK FOR EITHER CARBON OR GRAPHITE ELECTRODES

The following tabulation shows the total German production capacity for the baked basic stock for either carbon or graphite electrodes, comparing the installed capacity near the end of the war with that now available in the U.S. Zone. There is no other baked electrode capacity except at some of the aluminum plants which produce their own special electrodes.

The tabulation is in terms of baked weight. The indicated tons are of 1,000 kg. = 2,200 lb.

Firm	Location	Installed Production Capacity: Total at End of War	Installed Production Capacity: Now in U.S. Zone	
SIEMENS	RATIBOR	60,000	-	t/yr.
"	BERLIN	30,000	-	"
CONRADTY	NÜRNBERG	19,000	19,000	"
I.G.F.	GRIESHEIM	15,000	15,000	"
		124,000	34,000	"
Equivalent lb. per yr.		273,000,000	75,000,000	
% of war capacity			27%	

It will be noted that the capacity for basic stock has been reduced by 73% by the elimination of the plants in the Russian Zone.

The following tabulation gives some information regarding the sizes of the largest presses and dies at the two plants now in the U.S. Zone.

Firm	Largest Press: Total Pressure	Largest Press: Max Cyl. Dia.	Largest Dies: Round	Largest Dies: Rectangular
CONRADTY	5,000 t	1,600 mm	700 mm.	500x750 mm
I.G.F.	2,800	800	500	350x350

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B.) CAPACITY FOR GRAPHITIZING OF GRAPHITE ELECTRODES

The following tabulation shows the total German capacity for the graphitizing of graphite electrodes, comparing the installed capacity near the end of the war with that now available in the U.S. Zone. The tabulation covers all of the graphitizing plants of GERMANY.

The tabulation is in terms of finished graphite weight. The indicated tons are of 1,000 kg. = 2,200 lb.

In order to figure the weight of basic stock required for a given finished graphite weight, it is necessary to allow for the machining and process losses. Add about 25% to the finished weight to obtain the basic stock weight required for steel electrodes; add about 10% for electrolytic anodes.

Firm	Location	Installed Production Capacity: Total At End of War	Now Available U.S. Zone	Available After Repairs U.S. Zone	
SIEMENS	MEITINGEN	20,000	20,000	20,000	t/yr.
CONRADTY	NÜRNBERG	4,800	2,400	4,800	"
"	KOLBERMOOR	3,000	2,400	3,000	"
" (allowing 50% of production for Swiss)	AFFOLTERN, SWITZ.	2,200	-	-	"
I.G.F.	BITTERFELD	9,000	-	-	"
		39,000	24,800	27,800	"
Equivalent lb. per yr.		86,000,000	54,000,000	61,000,000	
% of war capacity			63%	71%	

There is evidently a considerable excess of graphitizing capacity still available in the U.S. Zone. The most efficient graphitizing plant is the SIEMENS plant at MEITINGEN, but it is designed for large scale production. The advantages of the CONRADTY plant at NÜRNBERG are that it is well adapted for smaller rates of production, and that it is a complete plant combined

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Figure D.547: FIAT 397. *Survey of the Carbon and Graphite Electrode Industry of Germany.*

For more information on wartime graphite production and applications, see:

BIOS 258. *Carbon Electrodes, I.G. Farben, Griesheim.*

BIOS 337. *German Graphitising Furnances at Meitingen (Siemens Plania).*

BIOS 338. *German Carbon Electrode Manufacture at Griesheim (I.G.F.).*

BIOS 533. *Electric Furnace Design. Manufacture and Application in Germany.*

BIOS 715. *The Microanalytical Methods Employed in the Analytical Laboratories of I.G. Farben, Elberfeld-Wuppertal, Germany.* [Micro-analytical measurement of carbon at I.G. Farben.]

BIOS 819. *Blast Furnaces. Notes on German Practice.* [Carbon hearths to blast furnaces; carbon paste and bricks.]

BIOS 845. *Constructional Details of Chlorine Plant at Hoechst and Gendorf.* [Carbon anodes for chlorine cells.]

BIOS 895. *Aluminium Production at Vereinigte Aluminiumwerke (V.A.W.), Lünen.* [Carbon paste for Soderberg electrodes manufacture.]

BIOS 1181. [Graphitising of carbon electrodes: graphite brushes.]

BIOS 1230. [Carbon rocket rudders]

BIOS 1338. *Developments in Magnesium Production and Fabrication.* [Beryllium, zirconium at Degussa; also fluorine and carbon at I.G. Farben.]

BIOS 1399. *The Production of Carbon Black from Carbon Monoxide.*

BIOS 1596. *Carbon Electrodes. Report on the Interrogations of Dr. Diederich Wilm.*

BIOS 1823. *German Carbon Industry and Hydraulic Press Manufacture.*

CIOS XVII-2. *Englebert Factories—Liege and Aachen Kabelundgummiwerke-Eupen.* [Carbon black.]

CIOS XVIII-1. *Chemical Installations in the Cologne Area.* [Carbon black.]

CIOS XXVI-51. *Plant of Chemische Werke, Huls.* [Carbon black.]

CIOS XXVII-84. *I.G. Farben AG, Ludwigshafen and Oppau Wehrmacht Items.* [Carbon black.]

CIOS XXIX-14. *I. G. Farbenindustrie A. G., Leverkusen, Germany.* [Carbon, activated, production.]

CIOS XXIX-19. *Aluminum Reduction and Scrap Recovery at the Erftwerk of the Vereinigte Aluminum-Werke AG, Grevenbroich.* [Carbon anode plant.]

CIOS XXXIII-31. *Investigation of Certain Chemical Factories in the Leipzig Area of Germany.* [Artificial gems, graphite at I.G. Farben]

FIAT 104. *Survey of the Arc Carbon Industry of Germany.*

FIAT 105. *Survey of Manufacture of Graphite Rudders for V-2 Rockets.*

FIAT 115. *Survey of the Carbon Brush Industry for Electrical Equipment in Germany.*

FIAT 408. *Metallurgical Coke.*

FIAT 524. *Production of Aluminum.* [Carbon paste for Soderberg electrodes.]

FIAT 617. *The Electrical and Technical Ceramic Industry of Germany.* [Graphite resistors.]

FIAT 732. *Electrochemical Operations at I.G. Farbenindustrie A.G., Bitterfeld.* With 30 supplements.

FIAT 816. *Horizontal Mercury Chlorine Cells, I.G. Farbenindustrie, A.G.* [Graphite anodes.]

FIAT 817. *Vertical Mercury Chlorine Cells, I.G. Farbenindustrie, A.G.* [Graphite anodes.]

FIAT 863. *Activated-Carbon Production at I.G. Farbenindustrie, Leverkusen.*

FIAT 986. *Carbon Electrodes in Germany for the Aluminum Reduction Industry.*

FIAT 993. *The Aluminum Reduction Industry in Germany.* [Carbon electrodes for aluminum production.]

FIAT 1052. *The High Current Carbon Arc.*

G-35. Wilhelm Hanle. *Investigation of Cadmium Content of Carbon.* 1940.

G-46. Georg Joos. *The Production of Extremely Pure Carbon.* 1940.

G-85. Wilhelm Hanle. *The Determination of Boron and Cadmium in Carbon.* 1941.

G-153. Wilhelm Hanle. *Spectroscopic Analysis of Carbon, Aluminum, and Beryllium.* 1942.

F. Fluorine

[Fluorine was used for various industrial chemical production processes, but it also would have been essential for producing uranium hexafluoride for the enrichment of uranium-235. The following documents demonstrate large-scale production of fluorine.

For information on wartime German production of uranium hexafluoride for uranium enrichment, see pp. 3496–3511.]

Philip Morrison to Samuel K. Allison. 20 December 1943. Report on Enemy Physics Literature: Survey Report P. [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)]

The nearly unique position of fluorine in most successful separation schemes leads to an interest in the state of fluorine chemistry. (The examination of this point is the work of Dr. J. Katz of Seaborg's division.)

The general interest of German chemical industry in inorganic preparations, and probably also early preparation for chemical warfare, has put German fluorine chemistry considerably ahead of our own. In 1939 it was possible to procure fluorine gas in bombs(18) from the inorganic section of the I.G. at Leverkusen, near Frankfurt a. M. It is still not easy to do this in the United States. The number of trained inorganic chemists and even of fluorine workers in Germany was greater then than the number now available to the three projects in this country. A few of the leading men and institutions are:

H. v. Wartenberg	Göttingen
Wilhelm Klemm (Klemm has been interested in the chemistry of 93.)	Danzig-Langfuhr
Wilhelm Biltz	Hanover u. Göttingen
Eduard Zintl	Darmstadt

There is little doubt that the I.G. would be the constructor of any large-scale separation plant. Such a plant would probably be at Leverkusen, near Frankfurt. Frankfurt a. M. is the center of the German chemical industry; the Deutsche Gold- und Silber-Scheide-Anstalt A.G. is there as well. One might speculate that Bothe's and Rajewsky's groups form the physics staff—with the K.W.I. f. Physik the Y [Los Alamos] equivalent—for a Leverkusen or Frankfurt plant.

(Can the information bearing on this region be especially searched for clues?) [...]

(18) Z. anorg. allg. Chem., 242, 406 (1939)

[See document photo on p. 4157.]

DECLASSIFIED
Authority NND 917017

NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944), Philip Morrison to Samuel K. Allison, 20 December 1943, Report on Enemy Physics Literature: Survey Report P.

SECRET

S. K. Allison - 5 - December 20, 1943

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There is little doubt that the I.G. would be the constructor of any large-scale separation plant. Such a plant would probably be at Leverkusen, near Frankfort. Frankfort a. M. is the center of the German chemical industry; the Deutsches Gold-und-Silberscheideanstalt A.G. is there as well. One might speculate that Bothe's and Rajewsky's groups form the physics staff--with the K.W.I. f. Physik the Y equivalent--for a Leverkusen or Frankfort plant.

(Can the information bearing on this region be especially searched for clues?)

(18) Z. anorg. allg. Chem., 242, 406 (1939)

Figure D.548: Philip Morrison to Samuel K. Allison. 20 December 1943. Report on Enemy Physics Literature: Survey Report P. [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)]

J. A. Lane. 5 April 1945. SUBJECT: Interrogation of Doctor Halberland. [NARA RG 77, Entry UD-22A, Box 166, Folder 32.22-1—GERMANY—Research—TA—(1943–June 1946)]

1. Doctor Halberland, technical director of the lower Rhine division of the I. G. Farben Company, was located at I. G. Farben's plant at Uerdingen on the Rhine. [...]

3. [...] Large quantities of fluorine are produced at Leverkusen as well as Germany's major production of titanium. [...]

5. [...] In his opinion, eight days only would be required to bring the plant to 70 per cent production. [...]

6. [...] Halberland was questioned about I. G. Farben's relation with other companies such as DeGussa, Auer, Roges, etc., but no positive answers were obtained. When questioned about the sources of interests in rare materials, he was very vague but mentioned that rare earths come from the Black Forest region. [...]

[See document photos on p. 4159.

I.G. Farben produced large quantities of fluorine. DeGussa, Auer, Roges, and other companies produced uranium. To produce uranium hexafluoride, it would have been necessary for I.G. Farben to collaborate with those companies. When the I.G. Farben director, Dr. Halberland, was interrogated about such collaborations, he refused to provide answers, but apparently indicated that they did exist.

Notes from this interrogation were considered so important regarding Germany's nuclear program that they were placed in the files of Leslie Groves's Foreign Intelligence Unit of the U.S. Manhattan Project.]

NARA RG 77, Entry UD-22A, Box 166, Folder 32.22-1—GERMANY—Research—TA—(1943–June 1946)

SECRET

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HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
Alsos Mission
APO 887

5 April 1945.

SUBJECT: Interrogation of Doctor Halberland.

1. Doctor Halberland, technical director of the lower Rhine division of the I. G. Farben Company, was located at I. G. Farben's plant at Uerdingen on the Rhine. Uerdingen is one-half mile northeast of Krefeld. He is at present undetained but is living in Uerdingen in an air raid shelter across the street from the main entrance of the I. G. Farben Company plant. He is a chemist of eighteen years experience and technical director of four large I. G. Farben Company plants, among which are the large Levurkusen plant and that at Uerdingen. He also supervised the work at the Knapsack plant. He went to the United States in 1937 where he visited the duPont Company, Bayer Company, and other companies.

2. The Uerdingen plant produces various inorganic chemicals such as sulphuric acid, sodium dichromate, hydrochloric acid, chlorine (10,000 tons per month) as well as various organic chemicals such as acetanilide, benzene, toluene, nitrobenzene and previously produced war gas (adamsite) but this production has been discontinued. When questioned further on war gas production, Dr. Halberland indicated that most of war gas production in Germany is now centered at Durenfort. The four major research centers of I. G. Farben Company are located at the plants at Levurkusen, Bitterfeld, Ludwigshafen and Höchst.

3. Dr. Halberland being scientific director of Levurkusen knows a great deal about research work done there. The key personnel at Levurkusen are: Dr. Burgenmann, director; Dr. Beyar, scientific laboratory director; Dr. Klebert, inorganic chemicals; Drs. Wink, Ludwig, Bömmer, organic chemicals; Dr. Albers, photographic materials; Dr. Conrad, rubber plant. Large quantities of fluorine are produced at Levurkusen as well as Germany's major production of titanium.

4. Dr. Halberland knew of no special research station operated by I. G. Farben which would have been under government supervision. When questioned about university connections, Dr. Halberland stated that research work was placed in various universities. Professor Alder of Cologne was one consultant of which Halberland knew.

5. It is believed that a great deal more information about I. G. Farben organization, etc., may be obtained from Halberland. According to him, the administrative papers and files of the Uerdingen plant are still intact and under lock and key. His secretary, Fraulein Klein, Uerdingstr. 374, Krefeld, knows of the filing system and location of all documents and has the keys to the files. Troops are billeted in the lower part of the administrative offices and the building has suffered no noticeable bomb damage. We checked with the troop commander and discovered that he had been instructed not to disturb files, etc., in the upper offices. The building overlooks the Rhine and therefore must be exploited with caution. Questioning of Dr. Halberland seemed to bring very cautious answers. Further interrogation should be carried on with some tact. Dr. Halberland is keenly interested in seeing that files are undisturbed, so that the plant may reopen with the least difficulty. In his opinion, eight days only would be required to bring the plant to 70 per cent production.

6. Dr. Halberland is convinced that Germany has lost the war and thinks it foolish for the Germans to continue fighting. He therefore might reveal more information if interrogated by the proper personnel. Halberland was questioned about I. G. Farben's relation with other companies such as DeGussa, Auer, Roges, etc., but no positive answers were obtained. When questioned about the sources of interests in rare materials, he was very vague but mentioned that rare earths come from the Black Forest region. An immediate survey of the files at Uerdingen plant seems advisable. Such a survey might provide information for further interrogation of Dr. Halberland.

J. A. LANE
Expert Consultant

Figure D.549: James A. Lane. 5 April 1945. SUBJECT: Interrogation of Doctor Halberland [NARA RG 77, Entry UD-22A, Box 166, Folder 32.22-1—GERMANY—Research—TA—(1943–June 1946)].

BIOS 1595. *German Fluorine and Fluoride Industry.* pp. 5–7.

The first system has been developed by Dr. Siemans of Riedel de Haen. This has been installed at Vereinigte Flusspatgruben where six sets of retorts were erected complete with absorption systems and redistillation equipment and a further six in process of erection. The completed factory would have been capable of producing at least 6000 tons of pure anhydrous hydrofluoric acid per year. [...]

The completed plant at Leverkusen Works is capable of producing hydrofluoric acid at 80% strength equivalent to 9,600 tons per year, of which 960 tons per year would be 98–100% without redistillation. [...]

An unique system has been installed at the I.G. Oppau Works for the production of cryolite from low grade feldspar. The process is cyclic and appears very efficient. [...]

The production of fluorides from hydrofluoric acid (aqueous) and the corresponding metallic salt followed the conventional procedure. In the older plants the processes were very crude, but in the new plants, particularly at Leverkusen, sufficient plant of suitable design has been installed for the production of all the fluorides, bifluorides, fluoborates and silica fluorides. [...]

At Falkenhagen, Berlin, plant had been erected for the production of 720 tons fluorine per annum. When the Russian Army was approaching the Works, the entire plant was dismantled and despatched to Stulln in Bavaria, where it was hoped to re-erect on the site of the plant producing anhydrous hydrofluoric acid. [...]

During discussions with Prof. Helfrich and Dr. Schmidt-Dupont at Bonn University, information was obtained indicating that I.G. at Leverkusen had produced fluorine and other fluorine compounds for general use and that in conjunction with the University of Göttingen, investigations had been conducted into the problems of fluorine production, together with those associated with metallic fluorides of the earths and rare earths. [...]

[See document photos on p. 4161.

Metallic fluorides could have included uranium hexafluoride.]

BIOS 1595.
German Fluorine and Fluoride Industry

5.

Riedel de Haen System

The first system has been developed by Dr. Siemans of Riedel de Haen. This has been installed at Vereinigte Flusspatgruben where six sets of retorts were erected complete with absorption systems and redistillation equipment and a further six in process of erection. The completed factory would have been capable of producing at least 6000 tons of pure anhydrous hydrofluoric acid per year.

Since there are available 18 redistillation equipments, each capable of distilling approximately one ton of 92-95% HF in 6 hours, adequate plant was provided for repeated distillation in order to obtain a very high grade anhydrous hydrofluoric acid. It was anticipated that a purity of 99.99% HF would be obtained after redistillation.

I.G. Farben Industries System

The system developed at the I.G. Works was a relatively long rotating kiln, gas-fired, with a worm as agitator. The completed plant at Leverkusen Works is capable of producing hydrofluoric acid at 80% strength equivalent to 9,600 tons per year, of which 960 tons per year would be 98-100% without redistillation. The acid strength was guaranteed not less than 98% and contained approximately 1% as fluosulphonic acid and 0.10% silica, presumably as H_2SiF_6. Detailed analysis and methods are attached as appendix.

Oppau Works, Ludwigshafen

An unique system has been installed at the I.G.Oppau Works for the production of cryolite from low grade fluorspar. The process is cyclic and appears very efficient. The process proceeds according to the following reactions :-

1. $3\,CaF_2 + Si0_2 + 3H_2SO_4 = H_2SiF_6 + 3CaSO_4 + 2H_2O$
2. $H_2SiF_6 + 6NH_3 + 2H_2O = 6NH_4F + SiO_2$ (Solid)
3. $6NH_4F + Na_3AlO_3 = Na_3AlF_6 + 6NH_3 + 3H_2O$

6.

Fluorides

The production of fluorides from hydrofluoric acid (aqueous) and the corresponding metallic salt followed the conventional procedure. In the older plants the processes were very crude, but in the new plants, particularly at Leverkusen, sufficient plant of suitable design has been installed for the production of all the fluorides, bifluorides, fluoborates and silica fluorides.

At the Saline Ludwigshalle Works, hydrofluoric acid was purified from silica and H_2SiF_6 by the precipitation of sodium silico fluoride by sodium carbonate and the sodium silico fluoride recovered and sold for use in the manufacture of ceramics.

Fluorine and Fluorine Compounds

The production of fluorine and fluorine compounds with Cl_2 and other elements was proceeding rapidly and on a large scale when the war terminated. At Falkenhagen, Berlin, plant had been erected for the production of 720 tons fluorine per annum. When the Russian Army was approaching the Works, the entire plant was dismantled and despatched to Stulln in Bavaria, where it was hoped to re-erect on the site of the plant producing anhydrous hydrofluoric acid. There were 60 cells available, together with spares and all the electrical equipment to provide each cell with 12 volts D.C. and 2500 amps each.

Chlorine Trifluoride

The reaction vessels for the production of chlorine trifluoride were around the factory and a detailed description of the process was obtained, this, together with sketches, are included in the account of the processes.

Fluorine at Leverkusen

During discussions with Prof. Helfrich and Dr. Schmidt-Dupont at Bonn University, information was obtained indicating that I.G. at Leverkusen had produced fluorine and other fluorine compounds for general use and

7.

that in conjunction with the University at Gottingen, investigations had been conducted into the problems of fluorine production, together with those associated with metallic fluorides of the earths and rare earths. The fluorine cell at Leverkusen was of approximately the same capacity as those erected at Falkenhagen operating at 2500 amps and 11-12 volts with an output of 1 kilo per hour. By using special electrodes they had overcome the polarisation troubles which had been experienced at Falkenhagen. The electrolytes employed in the cells, however, were very different. At Falkenhagen the ratio of 1KF to 1 HF was employed together with the graphite anode. At Leverkusen 1KF to 2.5 HF was employed, utilising a petrol coke anode. The use of these different electrodes necessitated independent cell design.

Figure D.550: BIOS 1595. *German Fluorine and Fluoride Industry.*

For more information on wartime fluorine production and applications, see:

BIOS 261. *Hydrofluoric Acid Vereinigte Flusspathgruben G.m.b.H. Stulln.*

BIOS 714. *The Development of New Insecticides and Chemical Warfare Agents.* [Fluorine compounds.]

BIOS 764. *Production of Aluminium Compounds in Germany.* [Fluoride of aluminum manufacture.]

BIOS 785. *The German Mica Industry.* [Fluorine-phlogopite (synthetic mica) manufacture and properties.]

BIOS 896. *The Manufacture of Zirconium-Potassium Fluoride, Zirconium Oxide and Zirconium Oxychloride.*

BIOS 1095. *Developments in Methods and Materials for the Control of Plant Pests and Diseases in Germany.* [Fluorine compounds.]

BIOS 1335. *The Fluorspar Industry in Germany. Mines and Treatment Plants in the Nabburg and Regensburg Districts, Upper Palatinate (Bavaria).*

BIOS 1338. *Developments in Magnesium Production and Fabrication.* [Beryllium and zirconium at Degussa; also fluorine and carbon at I.G. Farben.]

BIOS 1433. *I.G. Farbenindustrie, A.G. The Manufacture of Triphenylmethane Dyestuffs at Hoechst, Ludwigshafen and Leverkusen.* [Fluorol 5G manufacture at Ludwigshafen.]

BIOS 1480. *The Manufacture, Formulation and Application of the Major Pest Control Products in the British, U.S. & French Zones of Germany.* [Fluorides.]

BIOS Misc. 14. [Fluorine organic compounds.]

CIOS XXIX-14. *I. G. Farbenindustrie A. G., Leverkusen, Germany.* [Fluoride production.]

FIAT 524. *Production of Aluminum.* [Fluoride recovery from aluminum furnace gases.]

FIAT 747. *The Synthesis of Fluorine-Mica of the Phlogopite Group.*

FIAT 838. *Elemental Fluorine, I.G. Farbenindustrie—Leverkusen.* [potentially nuclear-related]

FIAT 1114. *Recent German Research Work on Fluorine and Fluorine Compounds.* [W. Kwasnik and P. Scherer—nuclear-related!]

[For information on wartime German production of uranium hexafluoride for uranium enrichment, see pp. 3496–3511.]

G. Aluminum

[Aluminum was used for fabricating a wide variety of metal structures and packaging. On the other hand, aluminum could have been quite useful as cladding around fission fuel in a reactor, or as spherical pusher and casing shells in an atomic bomb as described on p. 4530. The following documents illustrate that wartime production of aluminum was widespread and sophisticated.]

For information on wartime aluminum production and applications, see for example:

BIOS 127. *The Aluminum Fabricating Plant of Aluminium Wals-on Persbedrljvon N. V., Utrecht, Holland.*

BIOS 144. *Wrought Light Alloy Plants in North-West Germany.*

BIOS 151. *German Aluminum and Magnesium Melting and Rolling Practices.*

BIOS 179. *German Cable Industry.*

BIOS 214. *Non-destructive Testing of Materials, Siemens-Werner Werk "M", Berlin/Siemenstadt.*

BIOS 229. *Wrought Light Alloy Plants in Southern Germany.*

BIOS 264. *German Brass and Copper Wire Industry.*

BIOS 279. *German Technique in the Production of Light Alloys.*

BIOS 288. *Aluminium Hydrate and Alumina Production in German Factories.*

BIOS 316. *German Light Alloy Foundry Industry.*

BIOS 374. *German Aluminum Foil Industry.*

BIOS 376. *Recovery of Aluminium Alloys from Aircraft Scraps.*

BIOS 392. *Welding of Aluminium and Aluminium Alloys with Particular Reference to the Manufacture of Pressure Vessels.*

BIOS 462. *Impact Extrusion.*

BIOS 465. *High Temperature Refractories and Ceramics.*

BIOS 470. *Specialized Ceramic Materials with Particular Reference to Ceramic Gas Turbine Blades.*

BIOS 504. *Visit to Metallgesellschaft A.G., Frankfurt a.M.*

BIOS 527. *Iron, Steel and Non-Ferrous Metal Works Plant and Machinery.*

BIOS 533. *Electric Furnace Design. Manufacture and Application in Germany.*

BIOS 605. *Some Marine Applications of Light Alloys in Germany.*

BIOS 643. *German Anodising Practice.*

BIOS 681. *German Cold Rolled Strip Industry.*

BIOS 693. *Investigation of the Light Alloy Forging Industry in Germany.*

BIOS 720. *Metallurgical Research and Testing Laboratories in the Stuttgart Area.*

BIOS 724. *Electronic Principles as Applied in Germany to the Testing of Materials.*

BIOS 764. *Production of Aluminium Compounds in Germany.*

BIOS 766. *The Manufacture of Pharmaceuticals and Fine Chemicals in the U.S. and French Zones of Germany.*

BIOS 895. *Aluminium Production at Vereinigte Aluminiumwerke (V.A.W.), Lünen.*

BIOS 974. *Alumina and Aluminium Production at the Lippewerk of the Vereinigte Aluminium-Werke A.G. Lünen.*

BIOS 975. *Alumina Production at Martinswerk Bergheim/Rhineland.*

BIOS 976. *Electro-Thermic Production of Aluminium-Silicon Alloys at Lurgi-Thermie G.m.b.H., Horrem.*

BIOS 981. *Light Alloys. Notes on German Technique on Continuous Casting and Extrusion of Aluminium Alloys with Particular Reference to Tube Extrusion, Tube Reducing Machines and Vertical Extrusion Presses.*

BIOS 982. *Light Alloy Rolling, Osnabrück Kupfer and Drahtwerke Osnabrück.*

BIOS 995. *Hot-Dipping and Electro-Deposition of Tin and Tin Alloys in Germany.*

BIOS 1084. *German Aluminium Fabricating Equipment.*

BIOS 1089. *Aluminium Refining and Scrap Recovery at V.A.W. Erftwerk Grevenbroich.*

BIOS 1099. *Survey of Secondary Aluminium Industry in Germany.*

BIOS 1100. *German Aluminium Foil Industry.*

BIOS 1165. *Aluminium Holloware Industry in the British Occupied Zone of Germany.*

BIOS 1190. *German Cable Industry.*

BIOS 1205. *Chemische Fabriken, Oker and Bramschweig. Aktiengesellschaft, Oker and Harz. Manufacture of Aluminium Hydroxide Pigment (Tonerde-Gel) and Aluminium Sulphate.*

BIOS 1215. *German Methods of Rhodiumizing, Aluminizing, Anti-Reflection Surface Coating and Allied Subjects.*

BIOS 1231. *The German Container and Canning Industries.* [Aluminum cans]

BIOS 1271. *Food Preparing Machinery.* [Aluminum cans]

BIOS 1295. *The Production of Certain Types of Phosphor Bronze, Brass and Light Alloy Castings in Germany. Composite Report of Interrogations of Dr. Heinrich Bauer, Dürener Metallwerke, Düren.*

BIOS 1342. *German Optical Mirrors and Reflectors.*

BIOS 1366. *The Production in Germany of Extruded Sections and Tubes in Aluminium and Magnesium Alloys.*

BIOS 1405. *Impact Extrusion. German Practice. 1946.*

BIOS 1409. *Cold Impact Extrusion of Aluminium, Etc.*

BIOS 1423. *The Application of Aluminium and Its Alloys in Germany.*

BIOS 1454. *Aluminium Pressings.*

BIOS 1467. *German Methods of Production of Aluminium Coated and Continuous Electroplated Steel Strip.*

BIOS 1535. *Report on Investigation of Methods of Gaseous Metal Treatment.*

BIOS 1550. *Sheathing of Cables with Aluminium.*

BIOS 1567. *Manufacture of Aluminium Clad Steel Strip by Wickede Eisen und Stahlwerke.*

BIOS 1595. *German Fluorine and Fluoride Industry.* [Aluminum fluoride manufacture and analysis.]

BIOS 1656. *Extrusion of Light Alloys at I.G. Farbenindustrie, Bitterfeld. Interrogation of Herr K. F. Brauninger.*

BIOS 1660. *A General Survey of the German Non-Ferrous Industry.*

BIOS 1667. *Some Notes on Open Hearth Furnace Design and Operation.*

BIOS 1703. *Manufacture of Aluminium at I.G. Farben Factory, Bitterfeld.*

BIOS 1757. *Manufacture of Super-Purity Aluminium at the Vereinigte Aluminium Werke, Erftwerk, Grevenbroich.*

BIOS 1770. *High Strength Aluminium-Zinc-Magnesium Alloy Development in Germany.*

BIOS 1861. *Light Alloy Foundries in Germany.*

CIOS XXII-4. *Aluminum Woerwerke, Erftwerke, Gravenbroich.*

CIOS XXIV-22. *The Electrochemical Industry, Bitterfeld Area.*

CIOS XXV-17. *The Electrochemical Industry, Burghausen Area.*

CIOS XXV-30. *Felten and Guilleaume Carlswerke, Cologne.*

CIOS XXV-31. *Suddeutsche Kabelwerke, Mannheim.*

CIOS XXV-32. *Hackethal Draht Und Kabelwerke AG, Hanover.*

CIOS XXVI-47. *Gelr. Guifine G.m.b.H., Ludwigshafen Am Rhein.*

CIOS XXVI-60. *Light Metal Production and Development for Aircraft, I.G. Farben.*

CIOS XXVII-9. *Kupfer U Drahtwerke, Osnabruck.*

CIOS XXVII-94. *Vereinigte Deutsche Metallwerke AG.*

CIOS XXIX-14. *I. G. Farbenindustrie A. G., Leverkusen, Germany.* [Aluminum fluoride production.]

CIOS XXIX-18. *Metal Fabrication at Mansfeld AG Kupfer Und Messing Werke, Hettstedt.*

CIOS XXIX-19. *Aluminum Reduction and Scrap Recovery at the Erftwerk of the Vereinigte Aluminum-Werke AG, Grevenbroich.*

CIOS XXX-72. *Aluminum and Magnesium Fabrication, Leipziger Leichtmetall, Werk-Rackwitz, Rackwitz.*

CIOS XXX-73. *Aluminum Fabrication, Osnabrucker Kupfer and Drahtwerk, Osnabruck.*

CIOS XXX-85. *A Survey of the German Can Industry During the Second World War.*

CIOS XXXI-57. *Hugo Schneider AG, Messingwerke Aluminum Werke, Leipzig.*

CIOS XXXI-73. *Vereingte Leichtmetall Werke G.m.b.H., Hannover Linden.*

CIOS XXXII-21. *Aluminum from Clay.*

CIOS XXXII-55. *Recovery of Metals from Scrapped Airplanes.*

CIOS XXXII-59. *Aluminum and Magnesium Production and Fabrication.*

CIOS XXXIII-31. *Investigation of Certain Chemical Factories in the Leipzig Area of Germany.*

CIOS XXXIII-32. *The Vereinigte Leightmetall-Werke, Hanover.*

CIOS XXXIII-59. *The Vereinigte Leightmetall-Werke, Hanover.*

FIAT 395. *Metallurgical Practices in Germany. The Fields of Non-Ferrous Melting and Casting.*

FIAT 406. *Non-ferrous Metal Rolling Mill Practice in Germany.*

FIAT 417. *"Press-Welding" Aluminum for Aircraft Radiators.*

FIAT 501. *The German Aluminum and Magnesium Industries.*

FIAT 516. *Report on Recent Cable Development in Germany.*

FIAT 522. *The Beryllium Industries of Germany and Italy (1939 to 1945).* [Alloys of beryllium with Al, Cu, Ni, Mg, etc.]

FIAT 524. *Production of Aluminum.*

FIAT 569. *Manufacturing Bronze, Aluminum or Other Flake Metal Powders.*

FIAT 602. *Aluminum Pistons for Automobile and Aircraft Engines.*

FIAT 686. *Casting Methods for Aluminum and Aluminum Alloys Billets.*

FIAT 699. *Magnesium Determinations in Aluminum.*

FIAT 731. *Technology of Aluminum and Aluminum Alloy Production in Germany Including Early Fabrication and Recoveries from Scrap.*

FIAT 754. *Vibrating Ball Mill for Pulverizing Fine Materials.*

FIAT 787. *Precious Metal Refining and Fabrication by W. C. Heraeus and G. Siebert Platinschmelze of Hanau.* [Aluminum and rhodium mirrors]

FIAT 805. *German Research on Experimental Aluminum-Base Bearings.*

FIAT 829. *Non-ferrous Metal Production Processes in the Hamburg District.*

FIAT 876. *Continuous Casting of Metals in Germany.*

FIAT 907. *Review of Recent Developments in Aluminum Refining.*

FIAT 927. *Production of High Alumina Slags in Blast Furnaces and Allied Processes for Recovering Alumina.*

FIAT 980. *German Aluminum Industry.*

FIAT 986. *Carbon Electrodes in Germany for the Aluminum Reduction Industry.*

FIAT 989. *Alumina Production in Germany.*

FIAT 992. *The Electrothermal Production of Aluminum Silicon Alloy.*

FIAT 993. *The Aluminum Reduction Industry in Germany.*

FIAT 997. *German Research in the Light Metals Industry.*

FIAT 1011. *Fabrication of Aluminum in Germany. A Study of Some Specialized Practices and Techniques Employed in the Industry.*

G-80. Rudolf Fleischmann. *The Capture Cross Sections of Aluminum for Thermal Neutrons.* 1941.

G-153. Wilhelm Hanle. *Spectroscopic Analysis of Carbon, Aluminum, and Beryllium.* 1942.

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SECRET

MBC/fil/2764

SPCWN
(19 Oct 44)

19 October 1944

SUBJECT: German Aluminum, production and fabrication; German Magnesium.

TO: Chief, Chemical Warfare Service, Washington 25, D. C.

THRU: G-2, War Department General Staff.

1. There is reported herewith information concerning the production of aluminum and fabrication of aluminum in Germany, supplied from the following two sources, both considered reliable.

a. Compagnie de Produits Chimiques et Electrométallurgiques, Alais, Froges et Camargue, Paris.

b. Dr. G. Chaudron, Faculté des Sciences, Universite de Paris, in collaboration with Dr. Hérenguel.

2. Raw materials. Most of the bauxite was imported into Germany from Hungary and Yugoslavia. The ordered stocks are in considerable quantity and are estimated to cover the needs for several years.

3. In general, all electric power is supplied by power houses with the exception of plants located on Inn, an affluent of the Danube, and on the Rhine, which are supplied by hydroelectric power.

4. Alumina Works. The total capacity is estimated at 700,000 tons a year, distributed over five principal factories as follows:

Lautawerk, situated in Saxony between Kottbus and Bautzen on the Leipzig to Breslau line, at 20 Kilometers from Ruhrand and 60 Kilometers from Horka . . . . 140,000 tons

Bergheim/Erftwerk, west of Cologne . . . . 150,000 tons

Mundenheim, near Ludwigshafen . . . . 200,000 tons

Lünen, in Westphalia, at 17 Kilometers northeast of Dortmund on Lippe . . . . 90,000 tons

Schwandorf, in Bavaria, at 42 Kilometers north of Ratisbonne . . . . 125,000 tons

SECRET

~~ALSOS dist: Major Smith~~

Returned by Major ~~Smith 11-9~~

Figure D.551: M. B. Chittick. 19 October 1944. Subject: German Aluminum, production and fabrication; German Magnesium [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL].

NARA RG 77, Entry UD-22A,
Box 165, Folder ALSOS MATERIAL

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SPCVH
(19 Oct 44)

Two other factories were reported but the French have no recent information on them.

A factory located on Höchst a/Main, which belonged to I.G. Farben-Industrie, and made 5000 tons of alumina in prewar years.

A factory at Dölau which was owned by Zeschimer & Schwarz Company and was making at that time 2000 tons.

5. Aluminum Works. The total German capacity is estimated at 300,000 tons a year as follows:

Lautawerk (see above) . . . . 60,000 to 70,000 tons

Lünen (See above) . . . . 45,000 tons

Erftwerk (Grevenbroich-Rhenanie of the north, at
25 Kilometers southwest of Dusseldorf).. 30,000 tons

Mattiwerk on Inn, in Bavaria . . . . 66,000 tons

Bitterfeld, near Hall . . . . 60,000 to 70,000 tons

Rheinfelden (Duchy of Baden on the Rhine, near
the city of same name. Factory owned by
a Swiss company of Nenhausen). . . . . . 39,000 tons

Mattiwerk is the most recent. It was built in 1940, occupies an area of 150 hectares, and employs 3000 people. Its power installations must be of the order of 150,000 KW.

6. Further information on concerns which produce aluminum and half-and-half light alloys. The combined output of two companies, Dürener Metallwerke A.G. and Vereinigte Leicht Metallwerke G.m.b.H., amounted in 1943 to about 70% of the total German half-and-half light alloy production.

Information about these two concerns follows:

Dürener Metallwerke A.G., Berlin

Works: Düren (Station: Düren - North)
Waren (Mecklembourg)
Wittenau (Station: Berlin - Reinickendorf)

-2-

Figure D.552: M. B. Chittick. 19 October 1944. Subject: German Aluminum, production and fabrication; German Magnesium [NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL].

H. Calcium

[Calcium was used in making certain metal alloys, but it also would have been extremely useful in key steps of the purification of thorium, uranium, and/or plutonium. The following documents demonstrate large-scale production and use of calcium, and even methods of utilizing calcium to purify thorium and uranium.]

BIOS 236. *Developments in Pure and Applied Microbiology (American, British and French Zones) During World War II.* [Calcium gluconate from hydrolysis of starch.]

BIOS 489. *Chemische Fabrik Joh. A. Benckiser, G.m.b.H. Ladenburg Works. Manufacture of Calcium Citrate.*

BIOS 636. *Mineralölwerke F. Harmsen, Kiel—Germany: Lubricants.* [Calcium soap greases.]

BIOS 675. *The Production of Thorium and Uranium in Germany.* [Using calcium to process thorium and uranium—see pp. 4172–4173.]

BIOS 798. *The German Ferro-Alloy Industry.* [Calcium silicide manufacture.]

BIOS 883. *Notes on Casting and Fabrication of Lead and Production of Bahnmetall.* [Calcium-lead alloy manufacture.]

BIOS 1044. *German Carbide and Cyanamide Industry. Carbide Production.* [Calcium carbide manufacture.]

BIOS 1045. *German Carbide and Cyanamide Industry. Handling of Carbide in Bulk.* [Calcium carbide, bulk transport of.]

BIOS 1046. *German Carbide and Cyanamide Industry. Manufacture of Calcium Cyanamide.* [Calcium cyanamide manufacture from carbide.]

BIOS 1385. *The German Hard Metal Industry.* [Electron microscope, zirconium, uranium, thorium, calcium tungstate manufacture, etc.]

BIOS 1443. *The German Nitrogenous Fertiliser Industry (Excluding Cyanamide) in the Western Zones.* [Calcium nitrate manufacture for fertilizers.]

BIOS 1480. *The Manufacture, Formulation and Application of the Major Pest Control Products in the British, U.S. & French Zones of Germany.* [Calcium compounds.]

BIOS 1490. *German Gypsum Industry (British, American and French Zones).* [calcium sulfate mining]

BIOS 1539. *German Chlorate Industry.* [Calcium chlorate manufacture.]

BIOS 1700. *The Manufacture of Glycerophosphates and Hypophosphites in Germany.* [Calcium glycerophosphate and calcium hypophosphite manufacture.]

CIOS X-1. *Caves at Bad Mor Mories, Near Vaas Used for Storage of Peroxide.* [Calcium permanganate underground tank storage.]

CIOS XVIII-1. *Chemical Installation in the Cologne Area.* [Calcium carbide.]

CIOS XXV-17. *The Electrochemical Industry, Burghausen Area.* [Calcium cyanamide production.]

CIOS XXVII-83. *AG für Stickstoffdünger, Knapsack.* [Calcium carbide production.]

CIOS XXVII-85. *Miscellaneous Chemicals, I.G. Farben AG, Ludwigshafen and Oppau.* [Calcium carbide.]

CIOS XXVII-92. *German Carbide, Cyanamide and Cyanide Industry.* [Calcium carbide.]

CIOS XXXIII-31. *Investigation of Certain Chemical Factories in the Leipzig Area of Germany.* [Calcium manufacture at I.G. Farben, Bitterfeld.]

CIOS XXXIII-47. *Manufacture of Sodium and Calcium Permanganate.*

FIAT 229. *Copper, Lead, Zinc, Tin, and Antimony Smelting and Refining in Northwestern Germany.* [Calcium-lead alloys.]

FIAT 431. *A Survey of the Chlorine and Caustic Plants in Western and Southern Germany.* [Calcium chlorate production.]

FIAT 665. *German Fertilizers and Soil Fertility.* [Calcium magnesium phosphate fertilizer.]

FIAT 728. *AG für Stickstoffdünger, Knapsack.* [Calcium cyanamide.]

FIAT 732. *Electrochemical Operations at I.G. Farbenindustrie AG, Bitterfeld.* [Calcium manufacture.]

FIAT 750. *Rare and Minor Metals.* [Calcium production.]

FIAT 756. *Calcium Metal and Calcium Hydride.*

FIAT 859. *Continuous Chilling and Cooling of Calcium Carbide.*

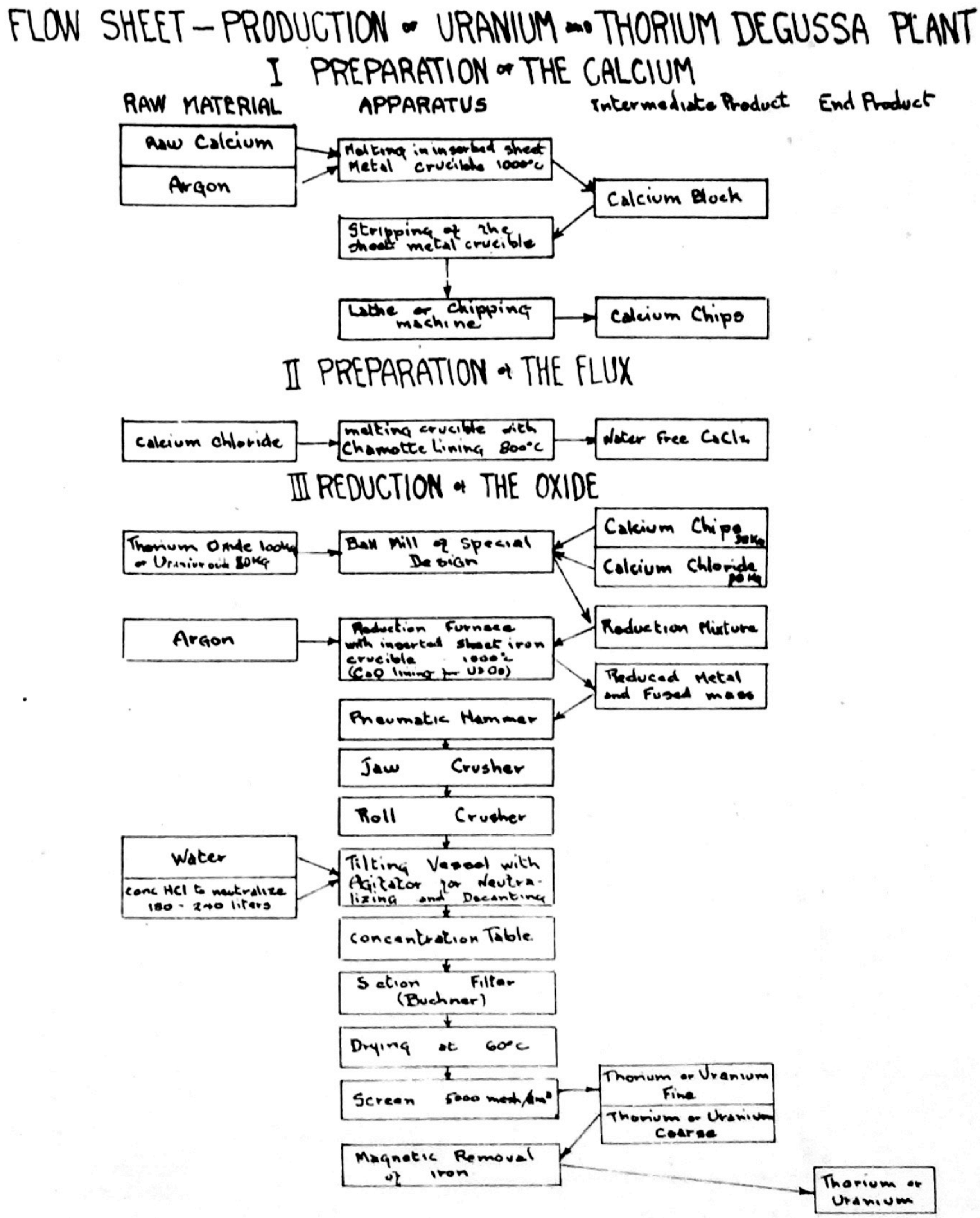

Figure D.553: Flowchart of German methods of using calcium to process uranium and thorium [BIOS 675].

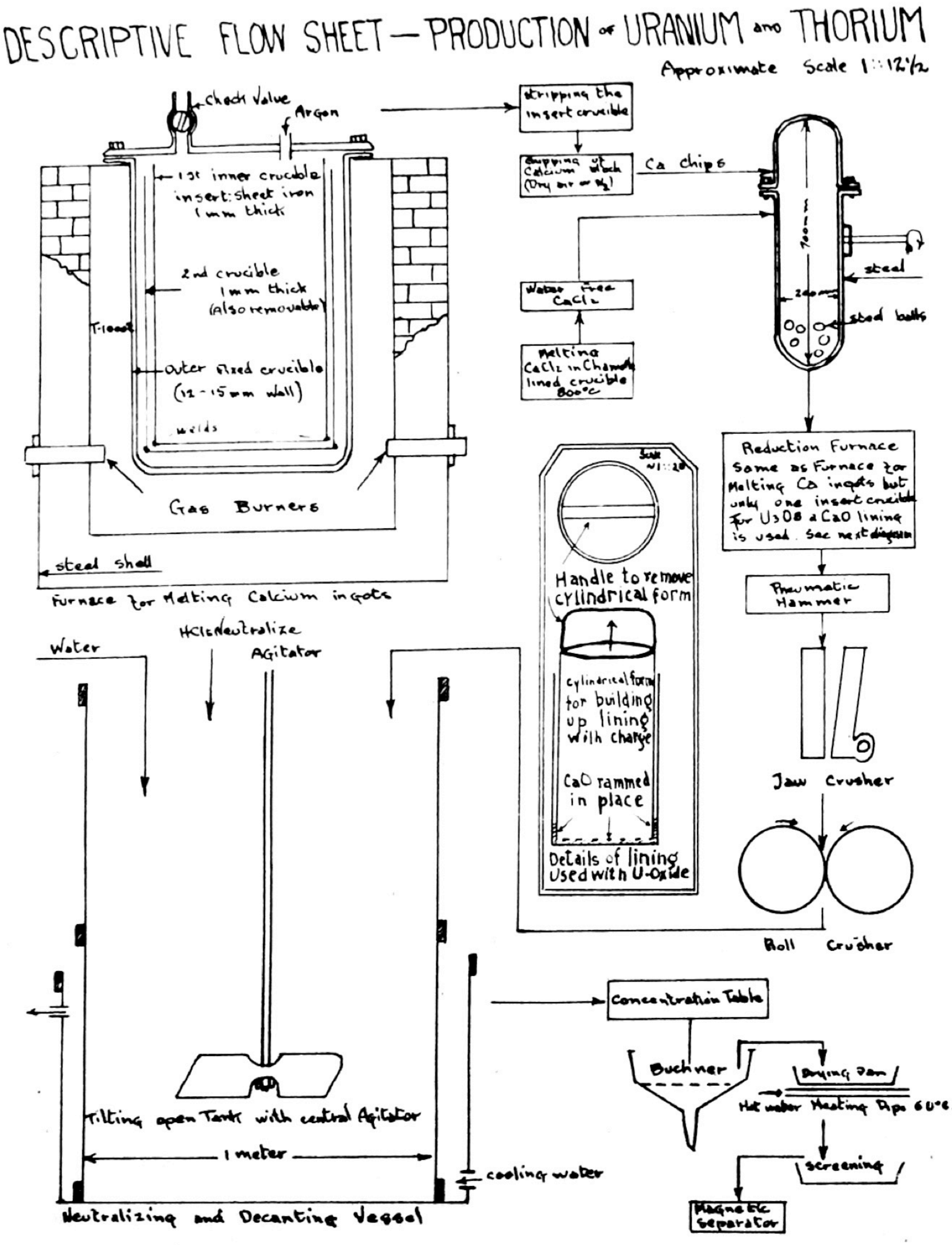

Figure D.554: Flowchart of German methods of using calcium to process uranium and thorium [BIOS 675].

Henry S. Lowenhaupt. 1996. Chasing Bitterfeld Calcium. CIA Historical Review Program. https://www.cia.gov/static/Chasing-Bitterfeld-Calcium.pdf

In December 1946 a chemical engineer from the former I. G. Farben plant at Bitterfeld in East Germany volunteered in Berlin that this plant "had started in the past few weeks producing 500 kilograms per day of metallic calcium. Boxes of the chemical are sent by truck every afternoon to Berlin, labeled to Zaporozhe on the Dnieper. Calcium is believed to be used as a slowing agent in processes connected with the production of atomic explosive."

This was the lead we in the Foreign Intelligence Section of the Manhattan District Headquarters had been waiting for. We had read the technical investigation reports from FIAT (Field Information Agency /Technical) on the production of uranium at the Auergesellschaft Plant in Berlin/Oranienburg. We also knew that Dr. Nikolaus Riehl—with his whole research team from Auergesellschaft—had met the Russians, volunteering to help them make uranium for their atomic bomb project. We knew from intercepted letters that the group was still together, writing from the cover address PO Box 1037P, Moscow. We knew Auergesellschaft during World War II had made the uranium metal for the German Uranverein—the unsuccessful German atomic bomb project—by using metallic calcium to reduce uranium oxide to uranium metal (not as "slowing agent"). We had analyzed the two-inch cubes of uranium metal from the incomplete German nuclear reactor which the Alsos Mission had found in the minuscule village of Stadtilm in Thuringia. We knew German uranium was terrible—full of oxides and voids, though it was fairly pure otherwise by non-atomic standards. The files also disgorged that in 1945 the Russians had started to dismantle and take to Russia the small calcium plant at the enormous Bitterfeld Combine, in addition to the big magnesium facility.

Cables went out immediately to the European Command in Germany via G-2 and directly to Col. Edgar P. Dean, Manhattan District representative in London, to locate and interrogate all engineers who had fled Bitterfeld to the West or were currently willing to sell information on their unloved masters. We wanted to know how much calcium was to be produced, what its specifications were, and where it was to be shipped. We wanted to know what non-atomic normal German industries used calcium, and in what quantities. We wished Col. Dean to keep our British colleagues in the Division of Atomic Energy, Ministry of Supply, informed.

At home, the Scientific Division of the Office of Special Operations in the newly-formed Central Intelligence Group was also apprised of our needs. Col. Frank A. Valente of our section was asked to take time out from his task of organizing an atomic detection system to talk to the U.S. Atomic Energy Commission in depth about the use in the U.S. program of calcium to reduce uranium salts to uranium metal. Major Randolph Archer, also of our office, was asked to talk to U.S, firms making calcium metal, and find out what it was used for and in what quantities.

As so often happens, the people involved and their experience were crucial ingredients. On the American side was the Foreign Intelligence Section of the Washington Liaison Office of the Manhattan District, then in the process of transferring as a unit to the newly formed Central Intelligence Group. It was headed by Col. L. E. Seeman, a career Corps of Engineers officer who had run the American engineering forces of the CBI theater during World War II and would go on to become major general. The section was staffed with a few career Corps of Engineers personnel, several officers and civilians trained in science, and the remainder trained in investigative procedures in the Counter Intelligence Corps.

The orientation toward engineering on the part of our management led directly to a pragmatic approach—do what works, and get on with the job. The engineering orientation also led materially toward the estimative method of technical evaluation. Engineering officers are accustomed to laying out engineering tasks to find out how long they will take at a minimum—and then to evaluate likely slippage. They think in quantitative terms—man days, truckloads, cubic yards. The scientific side of the section, Col. Valente, Mr. Charles Campbell, Mr. Donald Quigley, and I learned gradually to ferret out the crucial technical facts, the bottlenecks as it were, that could be used in these engineering-type evaluations.

A remnant of the wartime cooperation in the atomic field was the direct liaison at that time with the Intelligence Section of the British Division of Atomic Energy of the Ministry of Supply. Col. Dean, Assistant Military Attaché, was our representative in London. This cooperation was normalized gradually into more regular country-to-country liaison channels after our section was deployed to the newly formed CIG early in 1947. The Atomic Energy Act of 1946, which restricted much atomic data to "cleared" U.S. personnel, also tended to perpetuate differences between the U.S. and UK intelligence efforts already in being in 1946 because of the "nationalistic" policies on the parts of both General Leslie R. Groves, Manhattan District Commander, and Sir John Anderson, head of the UK atomic effort.

The British office was staffed with technical personnel, much as our own was. Mr. David Gattiker, their liaison to our section, had been a chemical engineer with Imperial Chemicals Incorporated before World War II. Mr. Kenneth Townley, one of the London members, was a geologist by profession with some experience in uranium prospecting. Its leader, Commander Eric Welsh, however, was also a career member of MI-6. Commander Welsh had masterminded the sabotage of Norsk Hydro in Norway in 1943 to prevent the Germans from getting heavy water and completing an operating reactor at Stadtilm. In 1940 he had been instrumental in smuggling the great nuclear physicist Niels Bohr out of occupied Denmark. And in the thirties he had been a chemist at Bitterfeld.

Returning to the calcium problem, by mid-January 1947 the Bitterfeld activity was definitely confirmed, and indeed amplified: Russian requirements were for 30 tons of metallic calcium per month, and distillation was needed to achieve adequate purity. A number of former Bitterfeld engineers were soon interviewed, especially by Major Paul O. Langguth working for Col. Dean in London. As we learned more, some were even re-interviewed. I remember, for instance, flying to Wright Patterson Airbase in late 1947 to talk once again to a Bitterfeld metallurgist whom Langguth had previously interrogated, and who had in the interim come to the U.S. as a member of the Air Force's Operation PAPERCLIP. [...]

[During the war, German industry produced calcium and used it to purify uranium and thorium (pp. 4172–4173). After the war, German industry continued to produce calcium for nuclear purposes—for the Soviet Union, as shown by the above document.]

I. Nickel

[Nickel was used for nickel-cadmium batteries and certain alloys. Yet because nickel is much more resistant than other metals to corrosion by uranium hexafluoride (used in uranium enrichment), it would have been invaluable in a nuclear program. The following documents demonstrate large-scale production of nickel.]

For information on wartime nickel production and applications, see for example:

BIOS 26. *Copper Smelting and Refining, Together with Related Metallurgical Activities at Nord Deutsche Affinerie, Hamburg.* [Nickel ores (Petsamo) treatment.]

BIOS 263. *Part I. I.G. Farben Industrie-Oppau Works, Ludwigshafen (Report on Nickel and Iron Powder Plants. Part II. Nord Deutsche Affinerie, Hamburg (Report on the Treatment of Nickel-Copper Ores and Residues).*

BIOS 358. *Acrylic Esters, Synthesis from Acetylene and Nickel Carbonyl.* [Nickel carbonyl regeneration from nickel salts.]

BIOS 371. *Regeneration of Nickel Carbonyl (from Aqueous Solutions).* [Nickel carbonyl regeneration from nickel salt solutions.]

BIOS 511. *Ruhr-Chemie A.G. Sterkrade Holten. Interrogation of Dr. O. Roelin.* [Nickel catalysts in Fischer-Tropsch process.]

BIOS 681. *German Cold Rolled Strip Industry.* [Nickel plated steel strip manufacture.]

BIOS 708. *German Alkaline Accumulator Industry.* [Nickel for alkaline accumulators: nickel carbonyl]

BIOS 755. *Manufacture of Butanol, Methoxybutanol, Butyraldehyde, Glycerogen at I.G. Hoechst.* [Nickel catalyst preparation for glycerogen manufacture.]

BIOS 778. *German Manufacture of Wires and Strips for Electrical Heating.* [Nickel-chromium and Ni-Cr-Iron alloys for heating.]

BIOS 779. [Nickel-chrome alloys for pyrometers.]

BIOS 1003. *Some Aspects of Copper, Nickel and Cobalt Production in Germany.* [Nickel, nickel sulfate, and nickel carbonate.]

BIOS 1009. *A Survey of German Electro-Plating Methods.* [Nickel plating methods.]

BIOS 1241. *The Manufacture of p:p' Diaminodicyclohexyl Methane (Dicykan).* [Nickel oxide catalyst manufacture.]

BIOS 1323. *The Production of Powdered Iron and Sintered Iron Driving Bands in Germany.* [Nickel-iron sheets from sintered metal.]

BIOS 1372. *German Silver & E.P.N.S. Holloware Industry.* [Nickel-silver holloware manufacture.]

CIOS XXXI-20. *Refining of Cobalt, Nickel, Zinc and Cadmium.*

CIOS XXII-15. *I.G. Farbenindustrie Plant, Frose, Germany.* [Nickel production.]

CIOS XXIV-12. *I.G. Farben—Oppau Works, Ludwigshafen.* [Nickel production.]

CIOS XXXIII-59. *German War List for Ferrous Materials (Kreigsliste).*

FIAT 422. *Manufacture and Regeneration of Catalysts at I.G. Farbenindustrie, Ludwigshafen Oppau.* [Nickel sulfate.]

FIAT 522. *The Beryllium Industries of Germany and Italy (1939 to 1945).* [Alloys of beryllium with Al, Cu, Ni, Mg, etc.]

FIAT 879. *Notes on the Peeling of Nickel Deposits.*

FIAT 800. *Nickel Cadmium Storage Batteries in Germany.*

FIAT 881. *Contribution to the Production of Cast Nickel Anodes.*

FIAT 882. *Anodes.* [Nickel anodes in electrolytic processes.]

German Nickel Refineries. Undated but probably 1944. [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32 Germ. Ind. TA]

Information from Section H of Economic Survey of Germany.
The Metal Industries, Ministry of Economic Warfare.

CONCERN	LOCATION OF PLANT	ESTIMATED PRODUCTION (Tons)
I. G. Farben	Oppau, Piesteritz	5000–2500
Sacksische Blaufarben Nickelwerke AG	Aue and Oberschlema	2500
Vereinigte Deutsche Metallwerke AG (Basse und Selva)	Altena	2500
Norddeutsche Affinerie	Veddel—Harburg near Hamburg	500
		Total 13,000

[See document photos on pp. 4178–4179. This U.S. intelligence document was considered so important with regard to Germany's nuclear program that it was placed in the files of Leslie Groves's Foreign Intelligence Unit of the Manhattan Project.]

Ylem.

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GERMAN NICKEL REFINERIES

Information from Section H of Economic Survey of Germany.
The Metal Industries, Ministry of Economic Warfare.

CONCERN	LOCATION OF PLANT	ESTIMATED PRODUCTION (Tons)
I. C. Farben	Oppau, Piesteritz	5000 - 2500
Sacksische Blaufarben Nickelwerke A.G.	Aue and Oberschlema	2500
Vereinigte Deutsche Metalkwerke A.G. (Basse und Selve)	Altena	2500
Norddeutsche Affinerie	Veddel - Harburg near Hamburg	500
	Total	13,000

Hareaus Vacuumschmelze A G at Hanau on Main is only concern directed to wire drawing-1938 capacity 106 tons.

Rolled nickel used principally in the manufacture of anodes, sheets, rods, bars, and tubing made by:

FIRM	LOCATION	NICKEL CONSUMPTION 1938 (Tons)
Vereinigte Deutsche Nickelwerke A.G. (Bosse und Selve)	Schwerte/Ruhr	150
Hiller u Muller Nickel-Fabrik A G	Dusseldorf	?
Deutsche Edelstahl Werke A G	Krefeld	250
Vereinigung Deutscher Drahtwebereien A G	Berlin	?
Montangesellschaft A G	Berlin	200
Fried Krupp Grusonwerk A G	Magdeburg	?

SECRET

NARA RG 77, Entry UD-22A, Box 169, Folder 32.32 Germ. Incl. TA

Figure D.555: German Nickel Refineries. Undated but probably 1944. [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32 Germ. Ind. TA]

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The bulk of German refined nickel production is delivered to the following consumers, who are mainly concerned with the production of alloy steels and nickel alloys.

FIRM	LOCATION	CONSUMPTION 1938 (Tons)
Fried Krupp A G	Essen	318
I G Farben A G	Oppau	4,500
Basse u Selve (VDM)	Altena in Westphalia	1,572
Robert Basch GmbH	Stuttgart	?
Gebr. Boehler A G	Dusseldorf	?
Vereinigte Stahlwerke A G (Bockumer Verein)	Bockum	?
Klockner Eisen A G	Duisburg	?

The following copper producers and fabricators are concerned with the production of nickel-copper products and steel alloys containing nickel:

FIRM	LOCATION	PRODUCTION CAPACITY (Tons)
Hirsch Kupper u Messingwerke A G	Finow, near Eberwalde	?
F A Lange Metallwerke A G	Auerhammer	?
Erkenzweig u Schwemann	Hagen	?
Mansfeldscher Kupferschieferbergbau A G	Mansfeld	?

SECRET

Figure D.556: German Nickel Refineries. Undated but probably 1944. [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32 Germ. Ind. TA]

J. Zirconium

[Zirconium was used for high-temperature metals and ceramics in non-nuclear applications, but its high temperature resistance and other properties also would have made it ideal as a fuel cladding material in fission reactors.]

FIAT 750. *Rare and Minor Metals.* p. 16. [See document photos on p. 4181.]

[...] The element is imported principally in the form of zircon mixed with monazite. In 1936 the production of metallic zirconium was 2,000 kg. and the pre-war price (1938) was RM 35 per kg. There are three producers of the metal:

Deutsche Gold- und Silver-Scheideanstalt[...]

I.G. Farbenindustrie A.G.[...]

I. D. Riedel—E. de Haen A.G.[...]

These documents also demonstrate commercial production and use of zirconium:

BIOS 276. *Telefunken Gesellschaft für Drahtlose Telegraphie m.b.h., Berlin; Special Materials for Radio Valves.* [Zirconium for radio valves, treatment of.]

BIOS 896. *The Manufacture of Zirconium-Potassium Fluoride, Zirconium Oxide and Zirconium Oxychloride.*

BIOS 1338. *Developments in Magnesium Production and Fabrication.* [Beryllium, zirconium at Degussa; also fluorine and carbon at I.G. Farben.]

BIOS 1385. *The German Hard Metal Industry.* With Addenda. [Electron microscope, zirconium, uranium, thorium, etc.]

CIOS XXIX-14. *I. G. Farbenindustrie A. G., Leverkusen, Germany.* [Zirconium compounds, production.]

FIAT 89. *Metallurgical and Industrial Developments in Magnesium.* [Zirconium alloys]

FIAT 617. *The Electrical and Technical Ceramic Industry of Germany.* [High temp zirconium ceramics]

FIAT 774. *Anhydrous Chlorides Manufacture.* [Zirconium chlorides.]

FIAT 785. *Electrical Contacts.* [Zirconium alloys for electrical contacts.]

FIAT 1048. *The Production of Zirconium Oxide.*

[For documentation of the shipment of zirconium to Japan, along with other apparently nuclear-related materials, see p. 4132. This evidence suggests that at least some of the zirconium produced in Germany during the war was intended for nuclear applications.]

FIAT 750. *Rare and Minor Metals*

TITANIUM

Interesting developments have been reported in the titanium industry in Germany. A preliminary investigation has been made by one BIOS team and a second BIOS team was in the field as this report was written. A statement from Metallgesellschaft merely mentions the employment of the metal as a "getter" in vacuum tubes and for gas free copper and iron alloys. Ferro-titanium, of course, is used in steel refining and titanium tetra-chloride in smoke screens. Before the war about 5000 to 7000 tons of titanium were imported in the form of titanium ores, most of which went into the manufacture of pigments; probably not to exceed 100 kg. were needed to produce the small amount of metallic titanium required. However, there are three producers of the metal:

Deutsche Gold- und Silber-Scheideanstalt, previously Roessler, Frankfurt a/M, Weissfrauenstr. 7-9

I. D. Riedel-E. de Haen A.G., Berlin-Britz, Riedel-str. 1-32

Titangesellschaft G.m.b.H., Leverkusen/Rhein

The metal is made from the tetrachloride by sodium reduction.

URANIUM

Metallic uranium was virtually a laboratory curiosity outside of atomic bomb experiments. Attempts to use uranium carbide of sintered hard carbide tool tips in Essen failed. The principal use of uranium salts is in ceramics. The latter are produced by the following firms:

Auergesellschaft A.G., Berlin N. 65, Friedr. Krause-Ufer 24

I. D. Riedel-E. de Haen A.G., Berlin-Britz, Riedelstr. 1-32

As reported in the Stars and Stripes (February 9, 1946, p. 4), valuable data on uranium, vital to atom bomb production, was recently seized by American military authorities along with thousands of business records belonging to Auer Gesellschaft, Inc. These records were viewed by a FIAT representative (Smatko) but contained no information pertinent to the present report.

ZIRCONIUM

Metallic zirconium sheet and powder are used for

photo flashlights, usually in combination with magnesium and aluminum foil. Additional uses are found in the radio industry and as minor additions in certain alloys. An alloy of gold with 3 percent Zr, employed as contact material, is probably the hardest gold base contact alloy (hardness 200 Brinell). In Germany, as elsewhere, the principal use of zirconium is in the form of oxide for refractories. Zirconia is also an opacifier in the enamel and glass industry and zirconium carbide is a commercial abrasive. The element is imported principally in the form of zircon mixed with monozite. In 1936 the production of metallic zirconium was 2,000 kg. and the pre-war price (1938) was RM 35 per kg. There are three producers of the metal:

Deutsche Gold- und Silver-Scheideanstalt, formerly Roessler, Frankfurt a/M, Weissfrauenstr. 7-9

I. G. Farbenindustrie A.G., Berlin-Halensee I, Kurfürstendamm 142-143 (80-85 percent metallic zirconium for flash photo bulbs)

I. D. Riedel-E. de Haen A.G., Berlin-Britz, Riedelstr. 1-32.

Figure D.557: FIAT 750. *Rare and Minor Metals*.

Frederic A. C. Wardenburg and Samuel A. Goudsmit. 18 November 1944 [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-1 GERMANY: Personnel (Mar 43–Dec 44)].

In our investigations of the Soc. de. Terres Rares (STR) in Paris we uncovered the following information, as reported in part before: [...]

Dr. Jansen worked with Ford in Cologne until the end of 1942. He was then hired by Auer and sent to Paris in January 1943. He returned to Germany only for occasional visits. [...]

After reporting to Dr. Ihwe, he was sent back to Saarbrucken to start a search for a lost railroad car loaded with zirconium and other products of the STR. [...]

According to Jansen, Dr. Ihwe is about 50 years old. He studied at Darmstadt and has been with Auer probably five or six years. He is very ambitious, a "Streber." Dr. Ihwe is in complete charge of the department of Rare Earths of the Auer Company. This department has all its facilities at Oranienburg. He is in charge of research as well as applications and some commercial matters. [...]

Jansen had only a very superficial knowledge of the materials produced by STR. He asked Ihwe what it was used for, but received the answer that it was secret. [...]

Jansen said that the Germans removed the electro-magnetic separator and classifier from the STR plant at Serquigny.

[See photos of the first two pages of this document on p. 4183.

The same Auer Oranienburg plant that spent the war acquiring and processing uranium for secret programs was also acquiring railroad cars worth of zirconium for secret programs, and its officials were eager to make sure that no zirconium went to waste. This evidence suggests that some if not all of the zirconium was intended for nuclear applications.]

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HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
ALSOS Mission

18 November 1944

SUBJECT: Dr. Jansen, Auer representative in Paris.
Information about Dr. Ihwe of Auer.
Information about Hechingen, Württ.

* * * * * * * * * *

In our investigations of the Soc. d. Terres Rares (STR) in Paris we uncovered the following information, as reported in part before:

Dr. Ihwe of Auer was officially put in charge of the STR. He is the chemist who was connected with the removal of stocks from Belgium for Auer. Dr. Ihwe travelled much and visited Paris only at regular intervals.

Dr. Jansen, an insignificant law graduate, was the representative of Ihwe at the Paris office of the STR.

Jansen's confidential secretary was a Miss Ilse Hermanns.

Very few papers were left behind at the office of the STR. Among those was a listing of registered mail sent by Dr. Jansen. Almost all of this mail was addressed to Auer. However, the last letter was addressed to Miss Ilse Hermanns at Eupen.

As we are especially interested in the movements of Dr. Ihwe, while in occupied territory, we considered it advisable to attempt to locate Miss Hermanns, on the chance that she might still be at Eupen, which is now in American hands.

As inquiries through channels failed, Lt. Colonel Pash and Pfc Leonard went to Eupen and succeeded in finding Miss Hermanns. Thanks to Colonel Pash's alertness he discovered that Dr. Jansen himself was there too. Informing us by telephone of his discovery it was decided that he bring Dr. Jansen to Paris for questioning. Colonel Pash also discovered several papers belonging to Dr. Jansen and Miss Hermanns.

Among the papers were documents and letters indicating that both Dr. Jansen and Miss Hermanns had visited Dr. Ihwe at Oranienburg early in September.

It was also revealed that Dr. Jansen's mother lived in Hechingen Württ. and that Jansen visited her for three days before going to Berlin.

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By CD/SE NARS, Date 24 FEB 1976

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Authority NND 917017

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Subject: Dr. Ihwe, Jansen, Hechingen. (cont'd) 18 Nov 1944

Dr. Jansen worked with Ford in Cologne until the end of 1942. He then was hired by Auer and sent to Paris in January 1943. He returned to Germany only for occasional visits. In the spring of 1943 he visited his mother at Hechingen. He left paris, after some difficulties with the German authorities, in August 1944 and returned to Berlin stopping over at Hechingen again.

After reporting to Dr. Ihwe, he was sent back to Saarbrucken to start a search for a lost railroad car loaded with Zirconium and other products of the STR. He used this occasion to visit Miss Hermanns at Eupen, where the front overtook him and he was cut off.

Interrogation of Dr. Jansen about Dr. Ihwe and Auer:

According to Jansen, Dr. Ihwe is about 50 years old. He studied at Darmstadt and has been with Auer probably five or six years. He is very ambitious, a "Streber". Dr. Ihwe is in complete charge of the department of Rare Earths of the Auer Company. This department has all its facilities at Oranienburg. He is in charge of research as well as applications and some commercial matters. Ihwe complained that lately administrative duties distracted him too much from his technical work. He told Jansen, who doesn't know any chemistry at all, that Rare Earths chemistry is a very difficult highly specialized subject, that very few chemists know anything about it, that Ihwe never was trained for it and had to acquire all this knowledge after joining Auer.

Jansen had only a very superficial knowledge of the materials were produced by STR. He asked Ihwe what it was used for, but received the answer that it was secret. Jansen heard that it was used for search light carbons and colored lenses. The zirconium oxychloride was used for waterproofing uniforms. Mesothorium was used for luminous dials. According to Gregory it was probably exported again to Switzerland in exchange for watches or similar instruments or for foreign exchange. The STR produced a few grams for them during the occupations. We also found documents indicating some shady black market deals in Mesothorium.

Jansen said that the Germans removed the electro-magnetic separator and classifier from the STR plant at Serquigny. ~~Answered that it was a secret and that he couldn't tell Jansen what it was for. Jansen gathered from hear say that it was used for search light carbons and for colored lenses. The Zirconium oxychloride is used for waterproofing uniforms.~~

Dr. Ihwe visited Paris about every six weeks. He traveled much, also to Southern France, looking for material. Jansen knew no details about his movements. He believed that Ihwe was looking for monazite which had not reached its destination, STR, when France was occupied. Jansen told about a shipment of monazite which was destined for France but which was diverted by the French so as not to fall into German

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NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-1 GERMANY: Personnel (Mar 43-Dec 44)

Figure D.558: Frederic A. C. Wardenburg and Samuel A. Goudsmit. 18 November 1944 [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-1 GERMANY: Personnel (Mar 43–Dec 44)]. "After reporting to Dr. Ihwe, he was sent back to Saarbrucken to start a search for a lost railroad car loaded with zirconium and other products of the STR."

[Further evidence of German zirconium production for nuclear purposes comes from a postwar shipwreck, as shown on p. 4185.

The SS *Flying Enterprise*, a commercial U.S. cargo ship, left Hamburg on 21 December 1951 with a variety of cargo headed for the United States. While passing near the southern coast of England, the ship was badly damaged in a storm on 25 December 1951. Despite extensive efforts by other ships to prevent the *Flying Enterprise* from sinking, it finally went down on 10 January 1952. (Everyone onboard was saved except for one person.)

In later interviews, the captain of the *Flying Enterprise*, Kurt Carlsen, stated that among the cargo was five tons of German-produced zirconium, left over from the wartime German nuclear program and destined to be used as cladding for the uranium fuel rods in the first U.S. nuclear submarine, USS *Nautilus*. Carlsen also stated that Navy divers salvaged the zirconium from the underwater wreck of his ship and took the zirconium back to the United States, causing a six-month delay in the launch of the Nautilus (finally launched in 1954).

This information confirms that some of the German zirconium that was being produced during the war was specifically intended for nuclear applications. It is not clear if those applications included submarine reactors, breeder reactors for producing plutonium, or other purposes. It is also not clear how far such nuclear work progressed in Germany during the war.

Any U.S. government documents on this shipment of zirconium or its origins in the wartime German nuclear program appear to remain classified and unavailable. This incident seems to confirm that the U.S. government has a much deeper knowledge of the wartime German nuclear program than it has admitted publicly, and that that knowledge shows the German nuclear program to have been more advanced than has been publicly stated.]

Bjarne Bekker. 2013. *Flying Enterprise & Kurt Carlsen.* Svendborg, Denmark: Bekker. p. 141. http://flying-enterprise.øavisen.dk

The reactor on "Nautilus" needed zirconium from "Flying Enterprise"

Kurt Carlsen spoke of it as if it were a story about onshore shooting in the Faroe Islands, water skiing on the lakes at Silkeborg or landing a sports plane on the beach on the west coast on a visit to his in-laws in Tane near Blavand. Quietly and matter-of-factly he sat in his retirement in Woodbridge and explained the cargo of zirconium. That the American military and secret service had found the material in West Germany. That Hitler was to use it in his nuclear program and that it was now to be used in the reactor of the first nuclear submarine "Nautilus".

"The launch was delayed six months, because divers had to enter the "Flying Enterprise" and retrieve the five tons of zirconium. Several idiotic reporters at the time wrote that my cargo was nuclear bombs. That was so wrong. My cargo was a material which encapsulates radioactivity".

[See also:
Deutsches Zirkonium war für erstes Atom-U-Boot der Welt bestimmt: Taucher bargen geheime Fracht des See-Helden Kapitän Carlsen. *Ruhr-Nachtrichten* (Dortmund). 24 January 1987.
https://www.youtube.com/watch?v=d99zNLh5E0U
https://www.youtube.com/watch?v=DzCOYlMcOiA
Lasse Spang Olsen and Emil Oigaard. 2002. The Mystery of Flying Enterprise. Copenhagen: Offshore Film Production.]

Sinking of the SS *Flying Enterprise* (10 January 1952)

Kurt Carlsen, captain of the *Flying Enterprise*

Journalist Bjarne Bekker interviewed Carlsen in 1976

First U.S. nuclear submarine, USS *Nautilus* (launched 1954)

Figure D.559: The SS *Flying Enterprise* sank on 10 January 1952 while carrying cargo from Hamburg to the United States. Its captain, Kurt Carlsen, later told interviewers such as Bjarne Bekker that the cargo included five tons of zirconium, left over from the wartime German nuclear program, which was salvaged from his sunken ship and used in the first U.S. nuclear submarine, USS *Nautilus*.

K. Cadmium

[Cadmium was used for nickel-cadmium batteries and soldering, but it also could have been extremely useful as a neutron absorber.

The following documents illustrate the production and applications of cadmium, as well as methods for electroplating thin layers of materials such as cadmium onto aluminum (which could be useful for nuclear applications).

German capabilities to electroplate cadmium on aluminum are potentially quite relevant for creating a neutron-absorbing cadmium layer on a spherical aluminum pusher as in the German fission implosion bomb described in March 1945—see p. 4530.

For a description of how cadmium was mined on a large scale with specific knowledge of its utility in atomic bombs, see p. 4293.]

English translation of Rudolf Fleishmann to Georg Stetter [both nuclear scientists]. 12 June 1942. [Deutsches Museum Archive, Munich, FA 002/0401]

[...] I am having thin cadmium sheets (foil) 0.5 mm and 1 mm thickness rolled out at the G. A. Scheid Co. refinery, Gumpendorferstrasse 85, Vienna VI. To be sure I must obtain the cadmium. I used to get it from the organization in Berlin you know about. [...]

English translation of Rudolf Fleishmann to Dr. Th. Schuchardt Firm, Goerlitz. 14 December 1943. [Deutsches Museum Archive, Munich, FA 002/0401]

[...] We require cadmium sheets for work with slow neutrons: 4 sheets 50 x 40 cm x 0.6 mm. [...]

For some examples of cadmium production and uses, see:

BIOS 264. *German Brass and Copper Wire Industry.* [Cadmium copper wire substitute production.]

BIOS 379. *The German Zinc Smelting Industry.* [Cadmium production.]

BIOS 708. *German Alkaline Accumulator Industry.* [Cadmium—iron "masse" for alkaline accumulators]

BIOS 813. *Zinc Works at Porto Marghera, Italy (Montecatini-Montevecchio, Soc. Italiana del Piombo e dello Zinco).* [Cadmium recovery in zinc refining.]

CIOS XIII-5. *Photo Lenses and Optical Instruments.* [Cadmium glass preparation.]

CIOS XXIX-14. *I. G. Farbenindustrie A. G., Leverkusen, Germany.* [Production of cadmium compounds.]

CIOS XXXI-20. *Refining of Cobalt, Nickel, Zinc and Cadmium.*

CIOS XXXI-56. *George Von Giesche's Erben, Magdeburg.* [Cadmium production.]

FIAT 733. *Vertical Retort Zinc and By-Products: Oker, Harz Mts.*

FIAT 800. *Nickel Cadmium Storage Batteries in Germany.*

FIAT 814. *German Production of Some of the More Important Inorganic Pigments.* [Cadmium pigments manufacture.]

FIAT 882. *Anodes.* [Cadmium anodes]

BIOS 1159. *The Uses of Zinc in Germany.*

[p. 27:] 3 CADMIUM—Supply and Consumption

SOURCES OF INFORMATION

The information on supply was obtained from the same sources as that on the supply of zinc, viz; the Reichsstelle Eisen und Metalle and the Metallgesellschaft. The production figures obtained from the former were said to be actual figures and not estimates; but it is thought that the export and import figures from the latter are estimates only.

TOTAL SUPPLY

The following table, in metric tons, shows German and Austrian production and includes that from Upper Silesia from September, 1939, from the following Smelters—Giesche (Kattowitz), Hohenlohe and Schlesag:

	1938	1939	1940	1941	1942	1943	1944
PRODUCTION	437	477	531	608	484	496	404
Imports	100	253	86	1	72	10	7
TOTAL SUPPLY	537	730	617	609	556	506	411
less exports	50	47	62	37	128	108	29
NET SUPPLY	487	683	555	572	428	398	382

[p. 28:] CONSUMPTION

No figures on consumption for various purposes could be obtained, but the team was informed that the main uses before the war were alkaline accumulators for mining lamps, cadmium pigments, cadmium plating instead of nickel for bearing alloys.

During the war the main uses were in accumulators [nickel-cadmium batteries] for the Forces—submarines, etc. and in cadmium alloy solders used as a substitute for tin-lead solders. [...] Other uses were severely curtailed, cadmium pigments being used only for military requirements.

[See document photos on p. 4189.]

BIOS 1159. *The Uses of Zinc in Germany*

only a general indication of the tonnage used in each.

	1938	1939	1940	1941	1942	1943	1944
Hot-Dip Galvanizing:							
Sheet:	13,000	10,000	10,000	10,000	12,000	15,000	13,000
Other:	65,360	83,020	97,670	107,490	85,900	67,250	60,430
Electro-Deposition:	1,400	1,700	2,000	2,150	1,800	1,500	1,350
Sherardizing:	120	140	165	180	150	125	110
Spraying:	120	140	165	180	150	125	110
Total:	80,000	95,000	110,000	120,000	100,000	84,000	75,000

3 CADMIUM - Supply and Consumption

SOURCES OF INFORMATION

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INDIVIDUAL SMELTER PRODUCTION

It will be observed from the above table that production rose rapidly in 1940 & 1941, but then fell again to the 1938-39 level. The following table

3 27

shows that the rise was due to the incorporation of the Upper Silesian Smelters in the Reich. The fall from 1942 onwards was due to the decline in the production of Giesche (Magdeburg) together with the decline and eventual extinction of Marquart for reasons unknown to the team. The Giesche (Magdeburg) smelter is believed to have been severely damaged in air raids.

	1938	1939	1940	1941	1942	1943	1944
Berzelius	44	48	37	54	44	64	62
Giesche (Mag.)	261	240	250	240	178	200	140
Marquart	132	113	9	88	22	-	-
Unterharzer	-	-	-	-	8	12	7
	437	401	296	382	252	276	209
Giesche (Katt.)		58	149	141	159	153	129
Hohenlohe		11	60	62	43	47	40
Schlesag		7	26	23	30	20	26
	437	477	531	608	484	496	404

In the case of the last 3 smelters, the figures for 1939 represent production subsequent to their incorporation in the Reich. The following table shows their production in January - August, 1939, before their incorporation:-

Giesche (Katt.)	102
Hohenlohe	15
Schlesag	28
	145

CONSUMPTION

No figures on consumption for various purposes could be obtained, but the team was informed that the main uses before the war were alkaline accumulators for mining lamps, cadmium pigments, cadmium plating instead of nickel for bearing alloys.

During the war the main uses were in accumulators for the Forces - submarines, etc. and in cadmium alloy solders used as a substitute for tin-lead solders. At first a solder containing 85% cadmium was used, but this was replaced later by one containing only some 17% cadmium. Other uses were severely curtailed, cadmium pigments being used only for military requirements.

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Figure D.560: BIOS 1159. *The Uses of Zinc in Germany.* 3 CADMIUM—Supply and Consumption.

BIOS 1009. ***A Survey of German Electro-Plating Methods.***

[p. 24:] CADMIUM.

A process of cadmium deposition by immersion was mentioned MR. MEYER but this was not seen.

[p. 67:] CADMIUM PLATING.

This was produced in small quantities but it appeared that zinc was used in practically all cases. This may have been due to shortage.

[p. 68:] CHROMIUM PLATING OF ALUMINIUM.

This had been done on a commercial scale but seemed to have faded out, due possibly to general disuse of decorative chromium plating during the war and the imperative saving of man power. One or two firms catalogued the finish. Interrogation brought little information.

[See document photos on p. 4191.]

BIOS 1615. ***The German Metal Finishing Industry.***

[p. 5:] Cadmium Plating

This is employed to a limited extent and the solutions are analogous to the higher current density type used in this country. [...]

[p. 8:] Plating on Aluminium and its Alloys

Although aluminium is widely used in Germany, no actual samples of nickel plus chromium plated aluminium were seen. Samples of lead plated battery lugs were encountered at Robert Bosch, Stuttgart and direct chromium plated aluminium at Blasberg's, Sollingen. Numerous references are made to the plating of aluminium and its alloys, however, and the most popular treatment for plating on this metal appears to be a primary application of a zincate dip followed by either a copper or brass deposit and then final plating.

[See document photos on p. 4191.]

For more technology for electroplating on aluminum, see:

BIOS 429. *German Electroplating Industry.*

BIOS 1009. *A Survey of German Electro-Plating Methods*

CADMIUM.

A process of cadmium deposition by immersion was mentioned by MR. MEYER but this was not seen.

HARD CHROME.

This was produced during the war, aluminium foil being used for masking, not lacquer or waxes.

24

CADMIUM PLATING.

This was produced in small quantities but it appeared that zinc was used in practically all cases. This may have been due to shortage. Mercury additions were strictly forbidden for aircraft work.

PHOSPHATE TREATMENT.

This was widely used during the war, both dyed and un-dyed.

CHEMICAL BLACKING.

The usual type of solution was used considerably for

67

producing armament components always with after oil-immersion.

SHOT BLASTING.

This was not seen, but it appears that sandblasting is the usual abrasive. The risk of silicosis is discounted.

CHROMIUM PLATING OF ALUMINIUM.

This had been done on a commerial scale but seemed to have faded out, due possibly to general disuse of decorative chromium plating during the war and the imperative saving of man power. One or two firms catologued the finish. Interrogation brought little information.

PLATING ON ZINC BASE DIE-CASTINGS.

In general, zinc base was used without plating; and this had been so for years. Certainly all zinc base components observed in use were unplated. It was however, agreed that zinc base could be plated with suitable solutions.

BARREL PLATING.

Barrel plating was not very common although a certain amount of work was produced by this method. The use of plated steel strip would necessarily reduce the quantity of barrel plating.

Barrels were of several types. Upright, immersed and special designs were used. Some of these are illustrated in this report.

SPRAYED FINISHES.

Utility finishes only in black, green, grey, and similar colours were seen. No attention apparently had been given to decorative or pastel shades, neither was anything seen in metallic or polychromatic colour. Cheap black japanning was fairly common.

BIOS 1615. *The German Metal Finishing Industry*

(A) Plating on Aluminium and its Alloys

Although aluminium is widely used in Germany, no actual samples of nickel plus chromium plated aluminium were seen. Samples of lead plated battery lugs were encountered at Robert Bosch, Stuttgart and direct chromium plated aluminium at Blasberg's, Solingen. Numerous references are made to the plating of aluminium and its alloys, however, and the most popular treatment for plating on this metal appears to be a primary application of a zincate dip followed by either a copper or brass deposit and then final plating.

(B) Testing of Plated Coatings, etc.

The testing of the plated coating for thickness, porosity, corrosion resistance etc., was apparently seldom done and the platers seemed to be little concerned about these points. Testing of solutions was equally haphazard. pH was rarely controlled except by litmus and pH papers; comparators were

- 8 -

B. CADMIUM

I. Firm: KAMPSCHULTE.

Solution:

47.5 g/litre	Cadmium Cyanide
42.5 g/litre	Sodium Cyanide
5.0 g/litre	Sodium Chloride
5.0 g/litre	Turkey Red Oil

Operating Conditions

Temperature:	25 - 30°C.
Current Density:	10 amps/dm^2
Voltage:	Not given

II. Firm: BLASBERG.

Solution:

50 - 120 g/litre	Sodium Cadmium Cyanide
20 - 60 g/litre	Sodium Cyanide
10 - 30 g/litre	Sodium Hydroxide

Nickel Salts as bright addition agents.

Operating Conditions

Temperature:	20 - 35°C.
Current Density:	0.5 - 1.2 amps/dm^2
Voltage:	Not given
Time:	10 - 60 minutes
pH:	12 - 13.5

Figure D.561: Top: BIOS 1009. *A Survey of German Electro-Plating Methods.* Bottom: BIOS 1615. *The German Metal Finishing Industry.*

D.8 Fission Bomb Design

[The following documents demonstrate that the German nuclear program had sophisticated implosion bomb designs that would be highly suitable for either a fission implosion bomb or a fusion-boosted fission implosion bomb, and moreover that the German program carried out serious experimental work on implosion bombs from an early date. The most important design details are summarized in Table D.2.

Adolf Busemann (German, 1901–1986), Rolf Engel (German, 1912–1993), Gottfried Guderley (German, 1910–1997), Walter Hantzsche (German, 19??–19??), Rudi Schall (German, 1913–2002), Hubert Schardin (German, 1902–1965), Erich Schumann (German, 1898–1985), Walter Trinks (German, 1910–1995), Hilmar Wendt (German, 1913–19??), and many others worked in teams that developed and demonstrated implosion bomb designs:

- H. Rausch von Traubenberg and other scientists in the German-speaking world began using neutron reflectors around their nuclear reaction experiments no later than 1936 (pp. 4196–4197).

- Herbert Wagner and other scientists at the Henschel aircraft company proposed nuclear weapons at the beginning of the war and apparently worked to develop them during the war (pp. 4198–4204).

- No later than 1940, the German mathematicians Walter Hantzsche and Hilmar Wendt predicted the pressure, density, and temperature in spherical and cylindrical implosion bomb configurations, mathematical solutions that are still used today (pp. 4204–4207).

- No later than 1942, Gottfried Guderley, a hydrodynamics expert working for the German military, performed very similar calculations for spherical and cylindrical implosions (pp. 4208–4209).

- 1943 U.S. intelligence reports stated that "several factories and hundreds of workers" just south of Hamburg were producing an unusual material that was a new type of explosive, that was so energetic that one kilogram of the new material would have a blast radius of several kilometers, and that would be placed into bombs of a highly unusual spherical design (pp. 4210–4220, 4446).

- Manfred von Ardenne worked throughout the war to produce fission bombs each containing a few kilograms of uranium-235 (pp. 3595–3651, 4218, 4221–4222). After the war he played a key role in the Soviet nuclear weapons program.

- Based on several inside sources, on 22 October 1944 the *New York Times* reported that Germany was developing an atomic bomb that simultaneously used high-voltage electricity (i.e., a high-voltage fusion neutron initiator) and the detonation of surrounding conventional explosives (i.e., implosion) to release large amounts of energy from fission fuel ("the force of the disintegrating atoms"). See p. 4223.

- In November 1944, *Time* magazine published an intelligence report that Germany was developing an atomic bomb with a spherical implosion design to cause uranium fuel to fission in an explosive reaction (p. 4223).

- A 23 March 1945 letter from General Ivan Ilyichev to Joseph Stalin reported that Germany had built and successfully tested an atomic bomb, and described it in considerable detail as a 2-ton, 1.3-meter-diameter spherical implosion bomb with multiple concentric layers and a uranium-235 core (p. 4529).

- Erich Schumann, the German Army Ordnance Office's head physicist, along with others on his staff, worked throughout the war designing and testing ever more sophisticated bombs that used an outer shell of conventional explosives to implode an inner core of various materials, including nuclear fuels (pp. 4225–4293). (Schumann was also Wernher von Braun's Ph.D. thesis advisor for the development of rockets, as well as a key figure in Germany's biological warfare program and several other advanced research programs. Yet Goudsmit testified to the U.S. Senate that Schumann was mainly interested in "the physics of piano strings.")

- In November 1945, the German economist Erwin Respondek wrote that Erich Schumann had been involved in the development of an atomic bomb that used uranium fuel and a neutron initiator (and apparently Schumann's expertise, conventional explosives for spherical implosion) (p. 4232).

- The implosion expert Walter Trinks worked closely with Schumann during the war. Trinks was imprisoned by the U.S. Army from June 1945 to June 1946, and he informed them that "At the end of the war I was occupied with experiments for... the initiation of atomic bombs" (pp. 4295–4297).

- A Top Secret U.S. cable from March 1946 stated that a "capable young engineer" in Poland knew that atomic bomb casings included a layer of cadmium, which was true for the implosion bomb designs described by both Ilyichev and Schumann (p. 4293).

- A 1946 U.S intelligence report (which was not declassified until 2006) stated that at the end of the war, General Hans Kammler's deputy Erich "Purucker was driving a large civilian car which contained many of the plans on the atom bomb. This car plus material fell into the hands of the Russians" (p. 4960).

- A U.S. intelligence card catalog shows that there were postwar reports giving details of the German atomic bomb plans, but those reports are still classified and unavailable to the public (pp. 5120–5120).

- After the war, Kurt Diebner discussed spherical implosion bomb designs, specifically showing a spherical core of fission fuel with a center of fusion fuel (pp. 4298–4305).

- German witnesses described secretive and mysterious work that had been conducted during the war to produce and test nesting aluminum spheres that apparently matched the description of those in the implosion bomb designs (p. 4308).

- Hubert Schardin led a Luftwaffe research group that also appears to have been developing fission implosion bombs during the war, and he aided the French nuclear weapons program after the war (pp. 4228, 4306–4307). [See also Krehl 2009, pp. 1160–1162; Nagel 2012, p. 149 ff.]

- In 2000–2002 interviews, Heinrich Himmler's chief adjutant, Werner Grothmann, mentioned the development of an atomic bomb that "would have possessed a spherical shape with a diameter of over one meter. It was very heavy, even though the bomb body itself was supposed to be out of aluminum. It was said, if one reduces the weight, the yield is not as high" (pp. 4309–4311).

- Werner Grothmann (pp. 4309–4311) and Erich Schumann and Walter Trinks (pp. 4225–4293) stated that there were actually several different versions of the implosion bomb design for different geometries (spherical vs. cylindrical), sizes, and fuels.

- German scientists also appear to have been aware of the gun-type fission bomb design [Karlsch and Walker 2005; Thirring 1946]. However, any development seems to have been focused on the implosion design, since it requires much less fission fuel and has a much higher efficiency than the gun design.

For sources describing weapon designs with a significant amount of fusion fuel as well as fission fuel, see Section D.9.]

Primary sources for fission bomb design

Component	Guderley 10/1942	Loofbourow 10/1943	*Time* 11/1944	Ilyichev 3/1945	Kurchatov 3/1945	Respondek 11/1945	Schumann 1945-1952	Polish eng. 3/1946	Diebner 1956-1962	Grothmann 2000-2002	König 2004
Neutron initiator				1. Internal high-voltage fusion neutrons 2. External gamma rays (via betatron)	1. Internal high-voltage fusion neutrons 2. External gamma rays (via betatron)	Neutron source	Fusion fuel	Neutron source (implied)	Fusion fuel	Ignition system	
Pit		High-density, high-energy new material, laborious to produce	Uranium	U-235	U-235	U-235	Uranium	Fission fuel	Uranium	U-235	
Reflector /tamper				``Delay mechanism" that was apparently also uranium			Uranium				
Neutron absorber				Cadmium	Cadmium		Cadmium	Cadmium			
Pusher				Aluminum			Aluminum				Aluminum
Explosive	Explosive designed for spherical implosion	Explosive designed for spherical implosion (implied)	Explosive designed for spherical implosion	Shaped segments of TNT with liquid oxygen, made lighter for rocket	Shaped segments of TNT with liquid oxygen, made lighter for rocket	Explosive designed for spherical implosion (implied)	Many shaped segments of TNT, RDX (explosive lenses) with simultaneous ignition		TNT and RDX	Complex explosive system with simultaneous ignition, made lighter for rocket	
Explosive case	Spherical case	Spherical case	Spherical case	Spherical aluminum	Spherical case	Case	Spherical aluminum	Case	Spherical case	Spherical aluminum	Spherical aluminum
Ballistic case				Steel case for rocket			Iron/ steel			Part of rocket	
Position for test				Positioned in a test area	Positioned in a test area		Suspended a few meters above the ground			On metal scaffold	

Table D.2: Details about fission implosion bomb design from primary sources.

H. Rausch von Traubenberg and H. Adam. 1937. Über die Rückstreuung von Neutronen und die Herstellung von Räumen mit erhöhter Neutronenkonzentration. *Zeitschrift für Physik* 104:442–447.

Wir beabsichtigen, unsere Versuche mit schwerem Wasser als bremsender Substanz fortzusetzen, da bei diesem eine geringere Absorption von Neutronen (Tritonenbildung) zu erwarten ist.

We intend to continue our experiments with heavy water as a moderating substance, since a lower absorption of neutrons (triton formation) is to be expected with this.

Zum Schluß haben wir noch Versuche über die Richtungsverteilung der an Eisen gestreuten Neutronen angestellt. Zu diesem Zwecke wurde ein Eisenstab von 3x3 cm als "Reflektor" benutzt und die Aktivierung des Rhodiumzylinders in verschiedenen Orientierungen zum Eisenstab ermittelt. Jedoch konnte die Frage bei der Schwäche unserer Neutronenquelle trotz langer Meßreihen noch nicht eindeutig beantwortet werden und wir beabsichtigen daher, das Problem der Richtungsverteilung mit stärkeren Neutronenquellen erneut in Angriff zu nehmen.

Finally, we performed experiments on the directional distribution of neutrons scattered by iron. For this purpose an iron rod of 3x3 cm was used as a "reflector" and the activation of the rhodium cylinder in different orientations to the iron rod was determined. However, given the weakness of our neutron source, the question could not yet be answered unambiguously, despite long series of measurements, and we therefore intend to tackle the problem of directional distribution again with stronger neutron sources.

Zusammenfassung. In der vorliegenden Untersuchung wurden die Resultate von Mitchell und Mitarbeitern über die starke Rückstreuung langsamer Neutronen an Eisen und Blei bestätigt. Es gelang in geschlossenen Hohlräumen (bis zu 9 Liter) durch Verwendung von reflektierenden Eisen- bzw. Bleiwänden Neutronenkonzentrationen herzustellen, die die Werte ohne reflektierende Wände um ein Vielfaches übertrafen. Auf diese Weise wurde erstmalig eine gewisse Anreicherung von Neutronen (Kernbestandteilen) in leeren Räumen erreicht und so die Möglichkeit gegeben, mit einem reinen "Neutronengas" ohne Anwesenheit von störender Materie zu arbeiten.

Summary. In the present investigation, the results of Mitchell and coworkers on the strong backscattering of slow neutrons by iron and lead were confirmed. It was possible to produce neutron concentrations in closed cavities (up to 9 liters) by the use of reflecting iron or lead walls which exceeded many times the values without reflecting walls. In this way, for the first time, a certain enrichment of neutrons (nuclear constituents) was achieved in empty spaces, thus making it possible to work with a pure "neutron gas" without the presence of interfering matter.

[German scientists began using neutron reflectors around their nuclear reaction experiments no later than 1936. See Fig. D.562. Neutron reflectors are important for both fission reactors and fission bombs.

H. Rausch von Traubenberg also did important very early work on tritium production and fusion reactions. See p. 4319.]

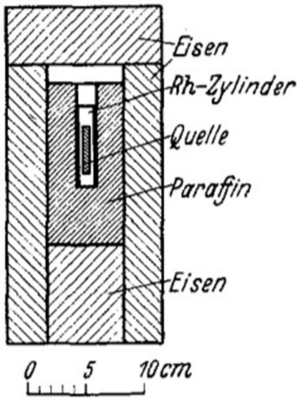

Fig. 1. **Konzentrische Anordnung von Neutronenquelle, Detektor und Paraffin im Eisengehäuse.**

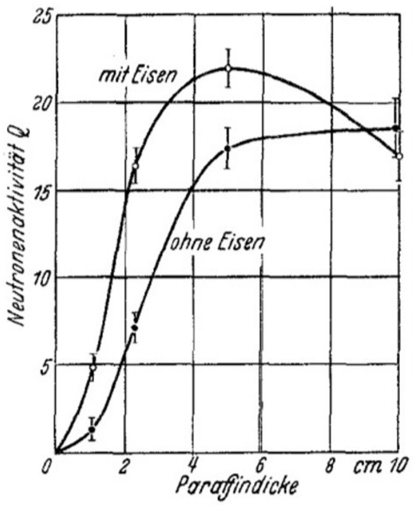

Fig. 2. **Abhängigkeit der Neutronenaktivität von der Paraffindicke mit Eisen als Rückstreuer, bzw. ohne Eisen.**

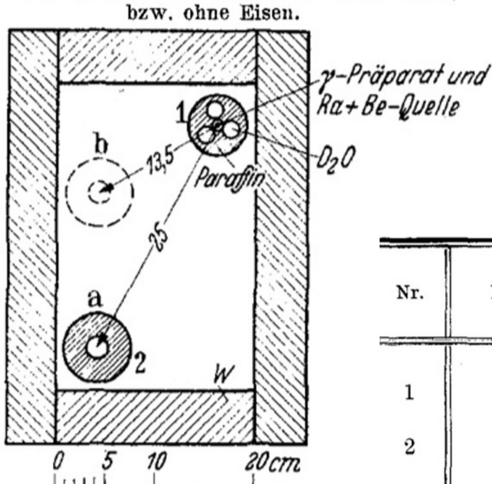

Fig. 3. **Schema der Anordnung von Neutronenquelle und Detektor im Eisenhohlraum.**

Über die Rückstreuung von Neutronen und die Herstellung von Räumen mit erhöhter Neutronenkonzentration.

Von **H. Rausch von Traubenberg** und **H. Adam** in Kiel.

Wir beabsichtigen, unsere Versuche mit schwerem Wasser als bremsender Substanz fortzusetzen, da bei diesem eine geringere Absorption von Neutronen (Tritonenbildung) zu erwarten ist.

Zum Schluß haben wir noch Versuche über die Richtungsverteilung der an Eisen gestreuten Neutronen angestellt. Zu diesem Zwecke wurde ein Eisenstab von 3×3 cm als „Reflektor" benutzt und die Aktivierung des Rhodiumzylinders in verschiedenen Orientierungen zum Eisenstab ermittelt. Jedoch konnte die Frage bei der Schwäche unserer Neutronenquelle trotz langer Meßreihen noch nicht eindeutig beantwortet werden und wir beabsichtigen daher, das Problem der Richtungsverteilung mit stärkeren Neutronenquellen erneut in Angriff zu nehmen.

Zusammenfassung. In der vorliegenden Untersuchung wurden die Resultate von Mitchell und Mitarbeitern über die starke Rückstreuung langsamer Neutronen an Eisen und Blei bestätigt. Es gelang in geschlossenen Hohlräumen (bis zu 9 Liter) durch Verwendung von reflektierenden Eisen- bzw. Bleiwänden Neutronenkonzentrationen herzustellen, die die Werte ohne reflektierende Wände um ein Vielfaches übertrafen. Auf diese Weise wurde erstmalig eine gewisse Anreicherung von Neutronen (Kernbestandteilen) in leeren Räumen erreicht und so die Möglichkeit gegeben, mit einem reinen „Neutronengas" ohne Anwesenheit von störender Materie zu arbeiten.

Kiel, Institut für Experimentalphysik, 23. November 1936.

German scientists began using neutron reflectors around their nuclear reaction experiments no later than 1936.

Zeitschrift für Physik
104:442–447 (1937)

Tabelle 1.

Nr.	Material	Volumen	Neutronenaktivität Q	Verstärkung $\frac{Q}{Q_0} = V$
1	Eisen	$20 \cdot 30 \cdot 15$ cm³ = 9 Liter	$15{,}5 \pm 1{,}1$	2,8
2	Eisen	$15 \cdot 20 \cdot 15$ cm³ = 4.5 Liter	$21{,}5 \pm 1{,}3$	3,9
3	Eisen	$7 \cdot 20 \cdot 15$ cm³ = 2,1 Liter	$23{,}0 \pm 1{,}2$	4,2
4	Blei	$15 \cdot 20 \cdot 15$ cm³ = 4,5 Liter	$16{,}1 \pm 1{,}2$	2,9

Figure D.562: German scientists began using neutron reflectors around their nuclear reaction experiments no later than 1936 [*Zeitschrift für Physik* 104:442–447 (1937)].

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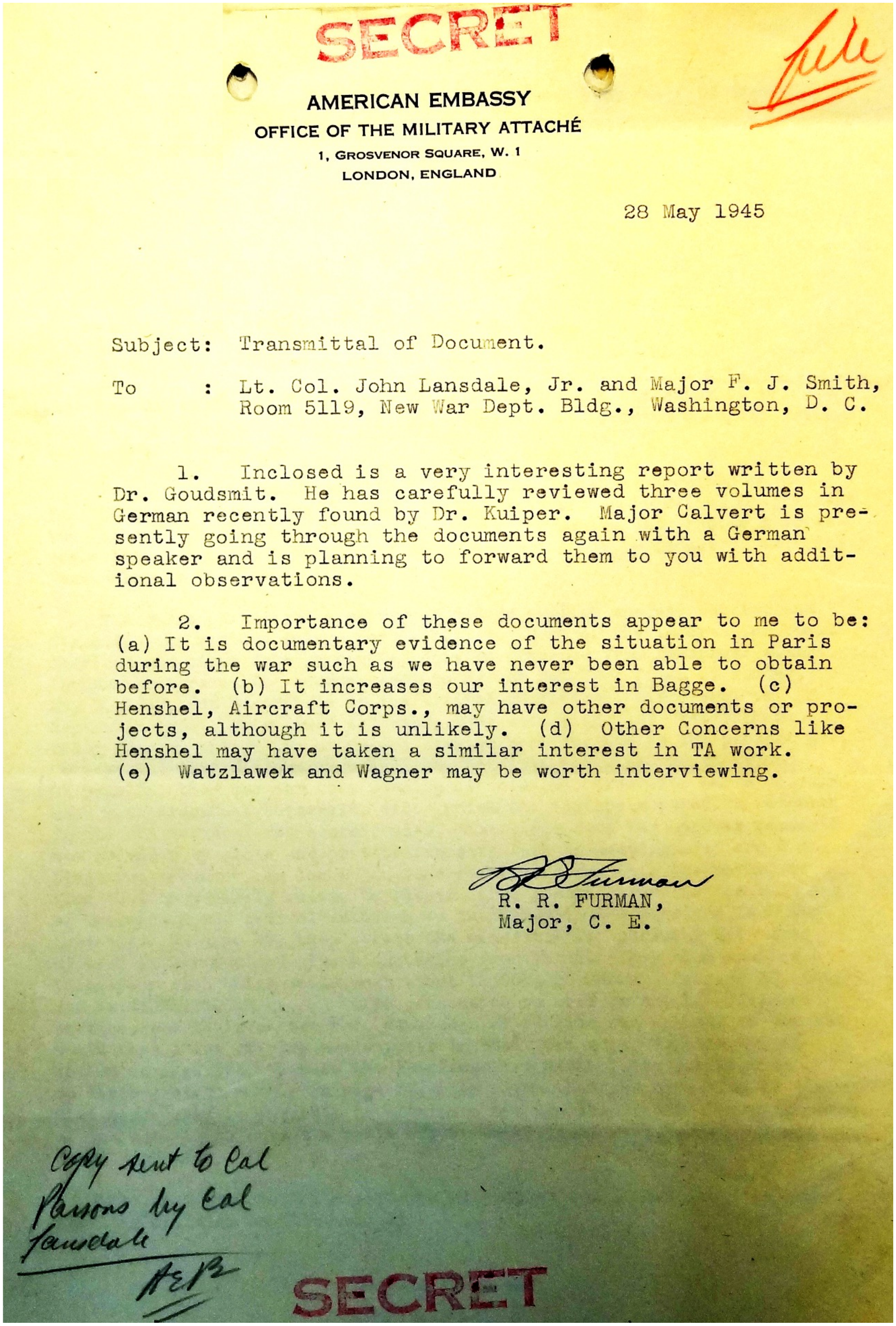

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AMERICAN EMBASSY
OFFICE OF THE MILITARY ATTACHÉ
1, GROSVENOR SQUARE, W. 1
LONDON, ENGLAND

28 May 1945

Subject: Transmittal of Document.

To : Lt. Col. John Lansdale, Jr. and Major F. J. Smith, Room 5119, New War Dept. Bldg., Washington, D. C.

1. Inclosed is a very interesting report written by Dr. Goudsmit. He has carefully reviewed three volumes in German recently found by Dr. Kuiper. Major Calvert is presently going through the documents again with a German speaker and is planning to forward them to you with additional observations.

2. Importance of these documents appear to me to be: (a) It is documentary evidence of the situation in Paris during the war such as we have never been able to obtain before. (b) It increases our interest in Bagge. (c) Henshel, Aircraft Corps., may have other documents or projects, although it is unlikely. (d) Other Concerns like Henshel may have taken a similar interest in TA work. (e) Watzlawek and Wagner may be worth interviewing.

R. R. Furman

R. R. FURMAN,
Major, C. E.

Copy sent to Col Parsons by Col Lansdale

AEB

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NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA

Figure D.563: Robert R. Furman to John Lansdale, Jr. and Francis J. Smith. 28 May 1945. Subject: Transmittal of Document [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA].

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HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
ALSOS MISSION
APO 887

26 May 1945

SUBJECT: Henschel Interest in TA

A very interesting document has just been found by Dr. G. P. Kuiper of Alsos. It was fished out of a well near Göttingen. It is a three hundred page report written by Dipl. Ing. Watzlawek under the direction of Prof. Dr. Ing. H. Wagner of the Henschel Airplane Works. It is dated 5 August 1941, Berlin, Marchstrasse 10.

The purpose of the report is to alert the German authorities to the fact that nuclear physics can have war and economic applications of greatest importance. They point out that Germany is far behind and propose a large-scale plan for nuclear physics to be taken up jointly by industry, especially Henschel, and the German Air Ministry.

The first part gives a survey of modern applied nuclear physics and discusses the various future possibilities. Most of the information about American and other foreign developments is obtained from newspaper clippings. The two most revealing sources seem to be the New York Times of Sunday, May 5, 1940, and an article in the British periodical, Discovery, of September 1939. From these articles, they deduce (p. 18) that work is being done in the USA to produce a uranium bomb for use in the present war. On page 19, they discuss in detail the possible technical applications. On page 38, they mention that Dunning of Columbia University had a conference with President Roosevelt, after which the isotope separation research in the USA was declared secret; also, that large sums for nuclear research are provided by state and private industry such as Westinghouse and General Electric. However, in looking up the references for this statement, we find that they merely relate to rather large grants given for the building of cyclotrons and medical research as ~~published in~~ the American technical journals. On page 29, they stress the necessity for pursuing this type of work in Germany and give a quotation from Fermi. They then propose a three-year plan which would cost about 13,000,000 Marks. On page 33, they set aside 35,000 Marks for three persons to be used in the intelligence service, and it is stated that knowledge of results and methods in the USA would save a lot of time and expense in their own work, especially, as stated on page 252, because the Americans are withholding publication on their present work. On page 37, they claim that the execution of their plan might make it possible to eliminate the American lead. The main point of the plan is to have the whole effort centralized with industrial and state support.

The next part contains photographic copies and German, English and American articles on this subject.

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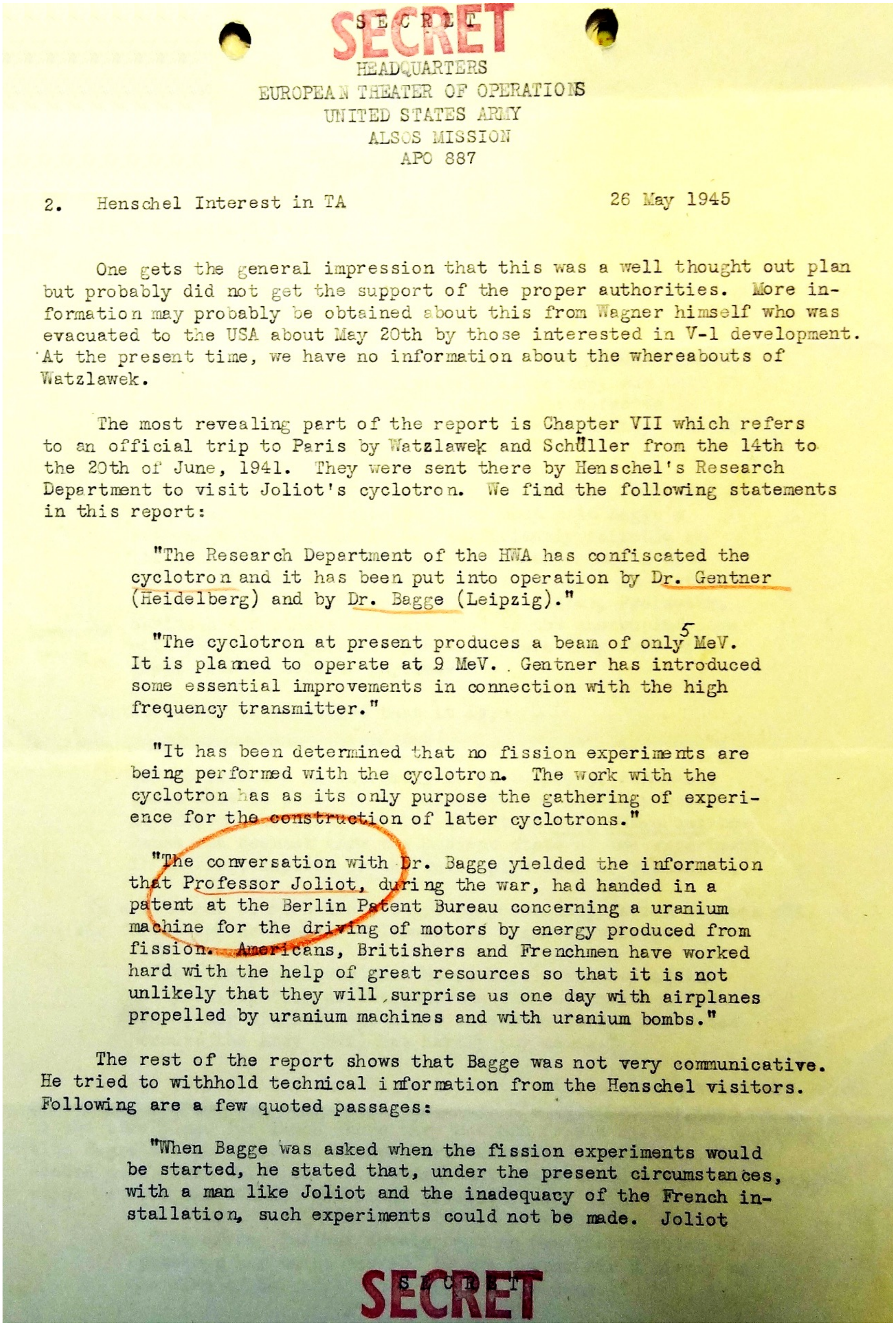
Figure D.564: Gerard P. Kuiper and Samuel A. Goudsmit. 26 May 1945. SUBJECT: Henschel Interest in TA [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA].



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HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
ALSOS MISSION
APO 887

2. Henschel Interest in TA 26 May 1945

One gets the general impression that this was a well thought out plan but probably did not get the support of the proper authorities. More information may probably be obtained about this from Wagner himself who was evacuated to the USA about May 20th by those interested in V-1 development. At the present time, we have no information about the whereabouts of Watzlawek.

The most revealing part of the report is Chapter VII which refers to an official trip to Paris by Watzlawek and Schüller from the 14th to the 20th of June, 1941. They were sent there by Henschel's Research Department to visit Joliot's cyclotron. We find the following statements in this report:

"The Research Department of the HWA has confiscated the cyclotron and it has been put into operation by Dr. Gentner (Heidelberg) and by Dr. Bagge (Leipzig)."

"The cyclotron at present produces a beam of only 5 MeV. It is planned to operate at 9 MeV. Gentner has introduced some essential improvements in connection with the high frequency transmitter."

"It has been determined that no fission experiments are being performed with the cyclotron. The work with the cyclotron has as its only purpose the gathering of experience for the construction of later cyclotrons."

"The conversation with Dr. Bagge yielded the information that Professor Joliot, during the war, had handed in a patent at the Berlin Patent Bureau concerning a uranium machine for the driving of motors by energy produced from fission. Americans, Britishers and Frenchmen have worked hard with the help of great resources so that it is not unlikely that they will surprise us one day with airplanes propelled by uranium machines and with uranium bombs."

The rest of the report shows that Bagge was not very communicative. He tried to withhold technical information from the Henschel visitors. Following are a few quoted passages:

"When Bagge was asked when the fission experiments would be started, he stated that, under the present circumstances, with a man like Joliot and the inadequacy of the French installation, such experiments could not be made. Joliot

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NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA

Figure D.565: Gerard P. Kuiper and Samuel A. Goudsmit. 26 May 1945. SUBJECT: Henschel Interest in TA [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA].

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APO 887

3. Henschel Interest in TA 26 May 1945

always acts very secretive, and his German colleagues get very little out of him."

"He (Bagge) mentioned further that such fission experiments were being done secretively in Germany and that it was also certain that many places were interested in it, principally industries, because he received many requests for visitors from industrial centers."

"As far as Joliot is concerned, to whom we (Henschel visitors) were not introduced, we must note Bagge's statement that Joliot is not sufficiently reliable so that one can perform uranium fission experiments with him. Furthermore, Professor Joliot is still in contact with Paris physicists such as Adler, Halban, Preiswerk, Savitsch and others who have fled to the unoccupied zone with the most important apparatus where they work with great zeal on nuclear physics."

Further down, it is stated that it is

"Dr. Bagge's opinion that cooperation with other German enterprises and an extremely large supply of resources could make it possible to eliminate the American lead. At present, he considers the situation very dangerous because one doesnot know the present state of the experiments in America, England or the unoccupied zone of France...."

In a luncheon conversation, Bagge proposes cooperation between HWA, the air forces and Henschel. Following is a quoted passage:

"Watzlawek believes that he is merely interested in the participation of the generous firm of Henschel and of the Air Ministry which has access to larger resources because the Army (HWA) has hardly any means."

On page 251, we find that Bagge tried to get rid of his visitors, pretending that he was very busy. However, his visitors happened to go to the same place for lunch where they saw him from a distance, together with Bagge's superior, a Lieutenant Dr. Suhnckel. Apparently, Bagge evaded them, from which they concluded that there could be no real cooperation between the HWA and the other groups.

"Therefore, further development in the construction of a cyclotron has to be carried by the German Air Ministry and the firm of Henschel alone without the Army!!"

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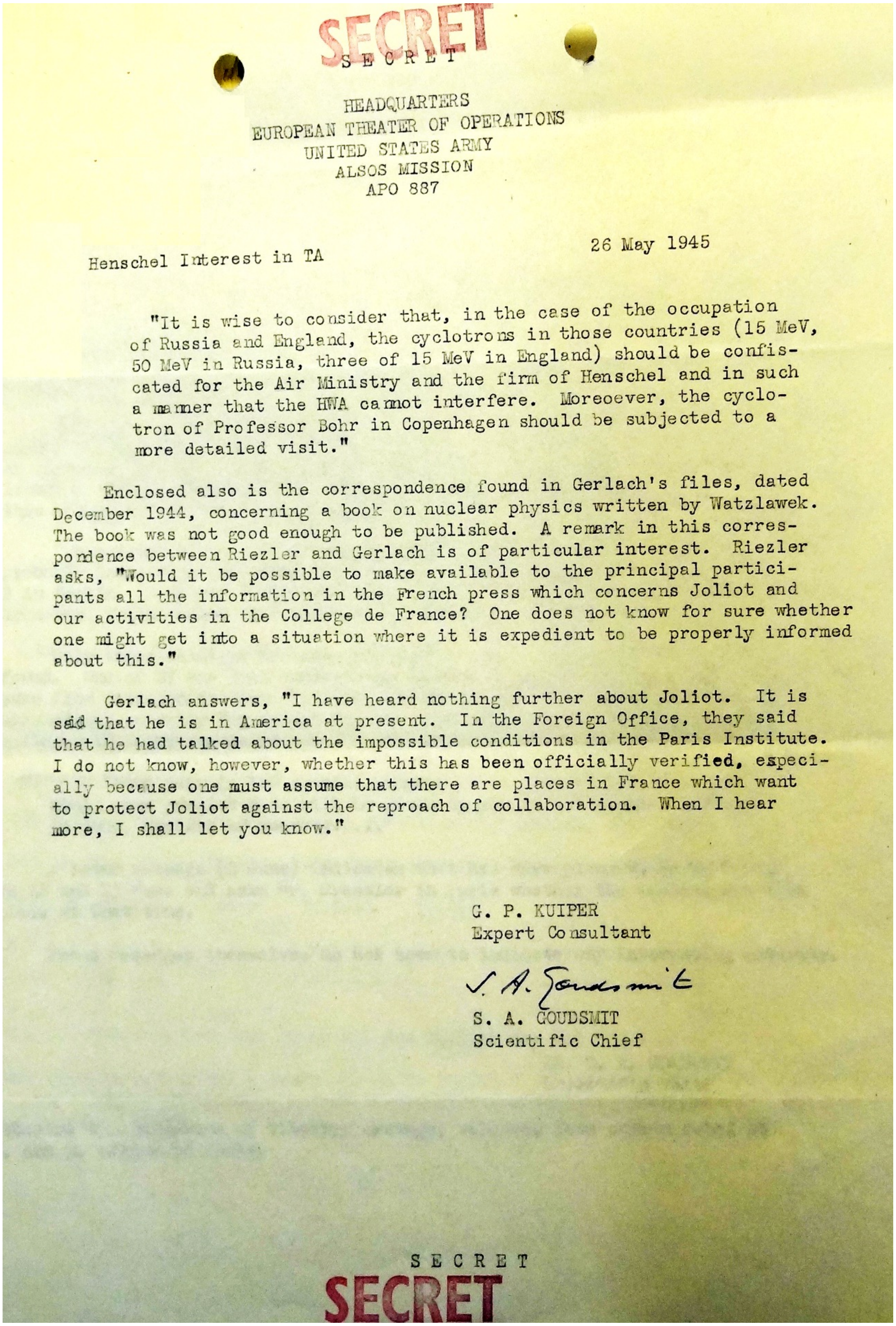
NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA

Figure D.566: Gerard P. Kuiper and Samuel A. Goudsmit. 26 May 1945. SUBJECT: Henschel Interest in TA [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA].



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EUROPEAN THEATER OF OPERATIONS
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APO 887

26 May 1945

Henschel Interest in TA

"It is wise to consider that, in the case of the occupation of Russia and England, the cyclotrons in those countries (15 MeV, 50 MeV in Russia, three of 15 MeV in England) should be confiscated for the Air Ministry and the firm of Henschel and in such a manner that the HWA cannot interfere. Moreoever, the cyclotron of Professor Bohr in Copenhagen should be subjected to a more detailed visit."

Enclosed also is the correspondence found in Gerlach's files, dated December 1944, concerning a book on nuclear physics written by Watzlawek. The book was not good enough to be published. A remark in this correspondence between Riezler and Gerlach is of particular interest. Riezler asks, "Would it be possible to make available to the principal participants all the information in the French press which concerns Joliot and our activities in the College de France? One does not know for sure whether one might get into a situation where it is expedient to be properly informed about this."

Gerlach answers, "I have heard nothing further about Joliot. It is said that he is in America at present. In the Foreign Office, they said that he had talked about the impossible conditions in the Paris Institute. I do not know, however, whether this has been officially verified, especially because one must assume that there are places in France which want to protect Joliot against the reproach of collaboration. When I hear more, I shall let you know."

G. P. KUIPER
Expert Consultant

S. A. Goudsmit
S. A. GOUDSMIT
Scientific Chief

S E C R E T

SECRET

NARA RG 77, Entry UD-22A, Box 169,
Folder 32.32. Germ. Ind. TA

Figure D.567: Gerard P. Kuiper and Samuel A. Goudsmit. 26 May 1945. SUBJECT: Henschel Interest in TA [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA].

Thomas Siemon. 24 July 2014. *Hessen-Niedersächsische Allgemeine.* https://www.hna.de/kassel/henschel-wollte-atombombe-kriegseinsatz-bauen-3727289.html

Pläne aus Zeiten des Zweiten Weltkrieges

Plans from the times of the Second World War

Schriftsatz aufgetaucht: Henschel wollte Atombombe für den Kriegseinsatz bauen

Written brief found: Henschel wanted to build a nuclear bomb for war use

Kassel. 1945 sorgten die Atombomben auf Hiroshima und Nagasaki für zehntausende von Opfern und furchbare Zerstörungen. Bereits vier Jahre zuvor gab es bei der Kasseler Firma Henschel konkrete Überlegungen für den Bau einer Nuklearwaffe. Das belegt ein Schriftsatz aus dem Jahr 1941, der jetzt aufgetaucht ist.

Kassel. In 1945, the atomic bombs on Hiroshima and Nagasaki caused tens of thousands of victims and terrible destruction. Four years earlier, the Kassel-based company Henschel had already given concrete consideration to the construction of a nuclear weapon. This is documented in a document from 1941, which has now appeared.

Er hat 260 Seiten und liegt der HNA vor.

It has 260 pages and is available to the HNA.

Mit ganzer Kraft müsse an der Erforschung der Kettenreaktionsvorgänge gearbeitet werden, heißt es da. Zwar wird auch die Nutzung der Atomenergie für den Antrieb von Kampfflugzeugen, U-Booten, die Medizin und zur Stromerzeugung erwähnt. Das klare Ziel der Entwicklung ist aber die "Herstellung einer Uran-Bombe für den jetzigen europäischen Krieg als furchtbarste Waffe".

It says that the research of chain reaction processes has to be done with all one's strength. The use of atomic energy for the propulsion of combat aircraft, submarines, medicine and power generation is also mentioned. But the clear goal of the development is the "production of a uranium bomb for the current European war as the most terrible weapon."

An der Echtheit der handgebundenen Dokumente besteht kein Zweifel. Helmut Weich, der ehrenamtliche Leiter des Kasseler Henschel- Museums, hat die erwähnten Namen und Örtlichkeiten überprüft. Demnach hat der damalige Chefentwickler der Henschel-Flugzeugwerke in Berlin-Schönfeld, Professor Herbert Wagner, das umfangreiche Dossier mit Unterstützung von weiteren Fachleuten erstellt.

There is no doubt about the authenticity of the hand-bound documents. Helmut Weich, the honorary director of the Henschel Museum in Kassel, has checked the names and locations mentioned above. Accordingly, the then chief developer of the Henschel-Flugzeugwerke in Berlin-Schönfeld, Professor Herbert Wagner, prepared the extensive dossier with the support of other experts.

Henschel war damals nicht die einzige Firma, die sich intensiv mit den Möglichkeiten der Atomenergie beschäftigte. Auch Siemens, die IG Farben und Degussa hatten großes Interesse an diesem Thema.

In der gedruckten Ausgabe am Freitag lesen Sie außerdem:

- Es blieb bei Plänen für die Bombe: Nach 1941 keine weiteren Aktivitäten zur militärischen Nutzung der Kernenergie bei Henschel bekannt

Bekannt ist, dass eine Delegation von Henschel in Paris war, um sich dort über die Forschung zur Kernspaltung mit einem sogenannten Zyklotron zu informieren. Nach Einschätzung von Fachleuten waren weder Henschel noch die anderen Firmen in der Lage, die Bombe wirklich zu bauen. Nach dem Krieg sprachen alle Beteiligten davon, lediglich Grundlagenforschung betrieben zu haben.

Henschel was not the only company at the time to be intensively involved with the possibilities of nuclear energy. Siemens, IG Farben and Degussa were also very interested in this topic.

You can also read in the printed edition on Friday:

- It remained with plans for the bomb: After 1941 no further activities for the military use of nuclear energy known at Henschel.

It is known that a delegation of Henschel was in Paris to inform themselves about the research on nuclear fission with a so-called cyclotron. According to experts, neither Henschel nor the other companies were able to really build the bomb. After the war, all those involved said that they had only carried out basic research.

Walter Hantzsche and Hilmar Wendt. 1940. HEC 10722. *On Shock Waves from Cylindrical and Spherical Waves of Compression.* [U.K. Imperial War Museum, Duxford Archive, Halstead Exploitation Centre reports]

We utilize only the equations of motion of an unsteady gas flow, and consider, in the following, a plane, cylindrical and spherical compression wave with a steep velocity front. In the case of the plane wave, a shock wave appears following continuous steepening of the velocity front. For cylindrical and spherical waves, on the other hand, it can happen that a steepening of the velocity front only takes place after a given time. Previously the front becomes flatter, the diminishing of the amplitude through the spreading of the wave, outweighing the steepening caused by the compression. A criterion is established for the onset of a shock wave, which, in the case of the spherical wave, agrees with Burton.

[This report demonstrates that by no later than 1940, German scientists had carried out calculations applicable to both spherical and cylindrical implosion bombs. Gottfried Guderley's more famous 1942 paper with similar calculations is shown on pp. 4208–4209. See also pp. 2139–2141 and 5056.]

H. E. C. 10722/1

Copy No. 4

L. F. A. Voelkenrode

Translation

M. O. S. No. 114

On shock waves from cylindrical and spherical waves of compression

by

Hantzsche and Wendt

German reference: Jahrbuch 1940 der deutschen Luftfahrtforschung.
"Zum Verdichtungsstoss bei Zylinder- und Kugelwellen".

June 1946

Figure D.568: By no later than 1940, Walter Hantzsche and Hilmar Wendt had carried out calculations applicable to both spherical and cylindrical implosion bombs [Halstead Exploitation Centre (HEC) Report 10722, English translation, U.K. Imperial War Museum, Duxford Archive].

Imperial War Museum, Duxford, HEC 10722

H. E. C. 10722/3

wave), that in spite of the reduction of amplitude, a shock wave occurs for the sperical case also. He gives an expression for the time of the progress of the wave up to the occurrence of the shock.

We utilize only the equations of motion of an unsteady gas flow, and consider, in the following, a plane, cylindrical and spherical compression wave with a steep velocity front. In the case of the plane wave, a shock wave appears following continuous steepening of the velocity front. For cylindrical and spherical waves, on the other hand, it can happen that a steepening of the velocity front only takes place after a given time. Previously the front becomes flatter, the diminishing of the amplitude through the spreading of the wave, outweighing the steepening caused by the compression. A criterion is established for the onset of a shock wave, which, in the case of the spherical wave, agrees with Burton.

In a rectangular coordinate system x, y, z, with u, v, w the velocity components, t the time, p and ρ the density and pressure, the Eulerian equations of an unsteady gas motion are:-

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial w}{\partial y} + w\frac{\partial u}{\partial z} = -1/\rho\, \partial p/\partial x \quad ---- \quad (1)$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z} = -1/\rho\, \partial p/\partial y \quad --- \quad (2)$$

$$\frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + v\frac{\partial w}{\partial y} + w\frac{\partial w}{\partial z} = -1/\rho\, \frac{\partial p}{\partial z} \quad --- \quad (3)$$

We add the equation of continiuty

$$\frac{\partial \rho}{\partial t} + u\frac{\partial \rho}{\partial x} + v\frac{\partial \rho}{\partial y} + w\frac{\partial \rho}{\partial z} + \rho\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}\right) = 0 \quad --- (4)$$

We shall assume a velocity potential ϕ (x,y,z,t) for the flow.

Then:-

$$u = \frac{\partial \phi}{\partial x}, \quad v = \frac{\partial \phi}{\partial y}, \quad w = \frac{\partial \phi}{\partial z}$$

Figure D.569: By no later than 1940, Walter Hantzsche and Hilmar Wendt had carried out calculations applicable to both spherical and cylindrical implosion bombs [Halstead Exploitation Centre (HEC) Report 10722, English translation, U.K. Imperial War Museum, Duxford Archive].

Imperial War Museum, Duxford, HEC 10722

H. E. C. 10722/7

plane are: $\dfrac{dR}{dt} = \phi_R \pm a$

Since on the curve the first derivatives $\partial\phi/\partial R$, $\partial\phi/\partial t$ are zero, $\phi_R \pm a = \pm a_o$, which is a constant. C is therefore a straight line. If the head of the wave at time T has the coordinate d, its equation is $R_o = d + a_o(t - T)$. (The positive sign must be taken because we are discussing a diverging wave.) The section $\phi = \phi(R, t)$ in the neighbourhood of the head of the wave can now be written

$$\phi \; \frac{k(t)}{2}\left\{R - [d + a_o(t-T)]\right\}^2 + \qquad (9)$$

The terms omitted consist of higher powers of $\left\{R - [d + a_o(t-T)]\right\}$ than the second.

Put the expression (9) for ϕ in (7c) and evaluate this equation at the head of the wave $R_o = d + a_o(t - T)$; one the obtains for $k(t)$ the differential equation

$$\frac{dk}{dt} + \frac{a_o k}{d + a_o(t-T)} + \frac{\gamma+1}{2}k^2 = 0 \quad ---- \quad (10)$$

This is an equation of Bernoulli's type which can be transformed into a linear differential equation of the first order by the substitution $\eta = 1/k$. If $k(t)$ has the value K for $t = T$, then one obtains for the solution of (10), when one further replaces t by means of $R_o = d + a_o(t - T)$,

$$k(t) = \frac{K}{\frac{R_o}{d}\left\{1 + \frac{\gamma+1}{2a_o} K d \log_e \frac{R_o}{d}\right\}} \quad --- \quad (11c)$$

In an analogous manner one obtains for the cylindrical wave

$$k(t) = \frac{K}{\sqrt{\frac{r_o}{d}}\left\{1 + \frac{\gamma+1}{a_o} K\sqrt{d}\left[\sqrt{r_o} - \sqrt{d}\right]\right\}} \quad -- \quad (11b)$$

and for the plane wave

$$k(t) = \frac{K}{1 + \frac{\gamma+1}{2a_o} K (x_o - d)} \quad -- \quad (11a)$$

The function $k(t)$ represents the gradient of the velocity front at the head of the wave. For the case of the plane wave, and $\gamma > -1$, we see from (11a) that, since the curvature $K = -$ is negative, $(k(t))$ increases continuously

Figure D.570: By no later than 1940, Walter Hantzsche and Hilmar Wendt had carried out calculations applicable to both spherical and cylindrical implosion bombs [Halstead Exploitation Centre (HEC) Report 10722, English translation, U.K. Imperial War Museum, Duxford Archive].

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL MEMORANDUM

No. 1196

NONSTATIONARY GAS FLOW IN THIN PIPES

OF VARIABLE CROSS SECTION

By G. Guderley

Translation of ZWB, Forschungsbericht No. 1744, October 1942

NACA

Washington

December 1948

Figure D.571: English translation of 1942 paper by Gottfried Guderley (1910–1997), a hydrodynamics expert working for the German military, predicting the pressure, density, and temperature of highly compressed and accelerated matter in both spherical and cylindrical geometries for power-law equations of state, as would be directly applicable to implosion bombs.

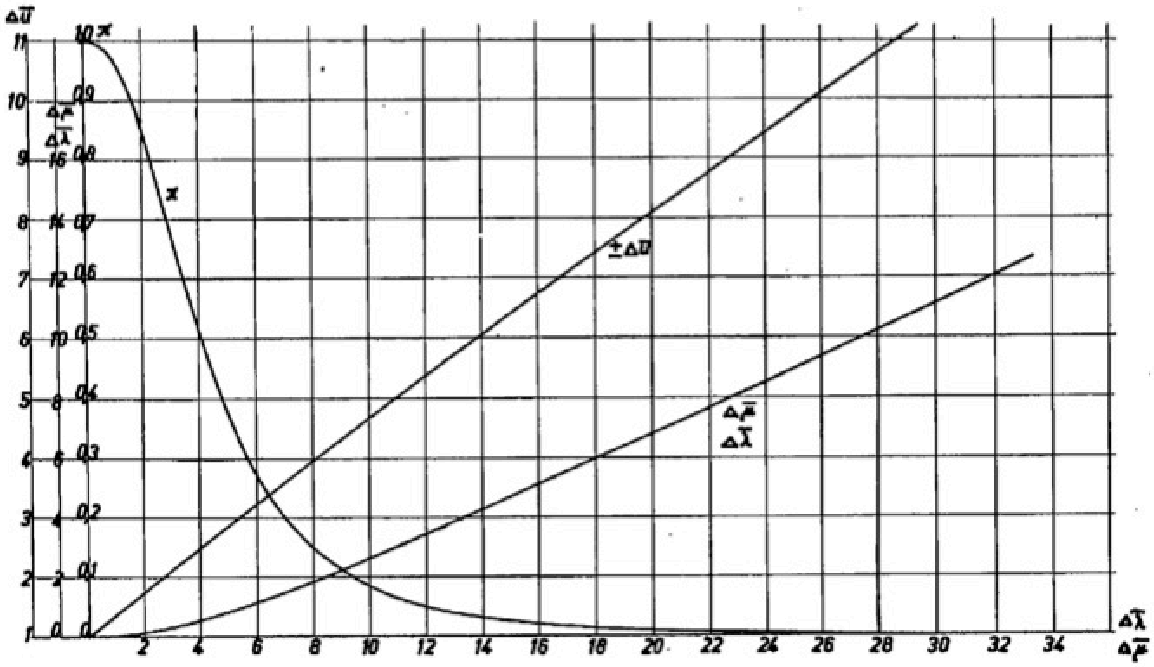


Figure 12a.- Characteristics of compression shocks K = 1.405.

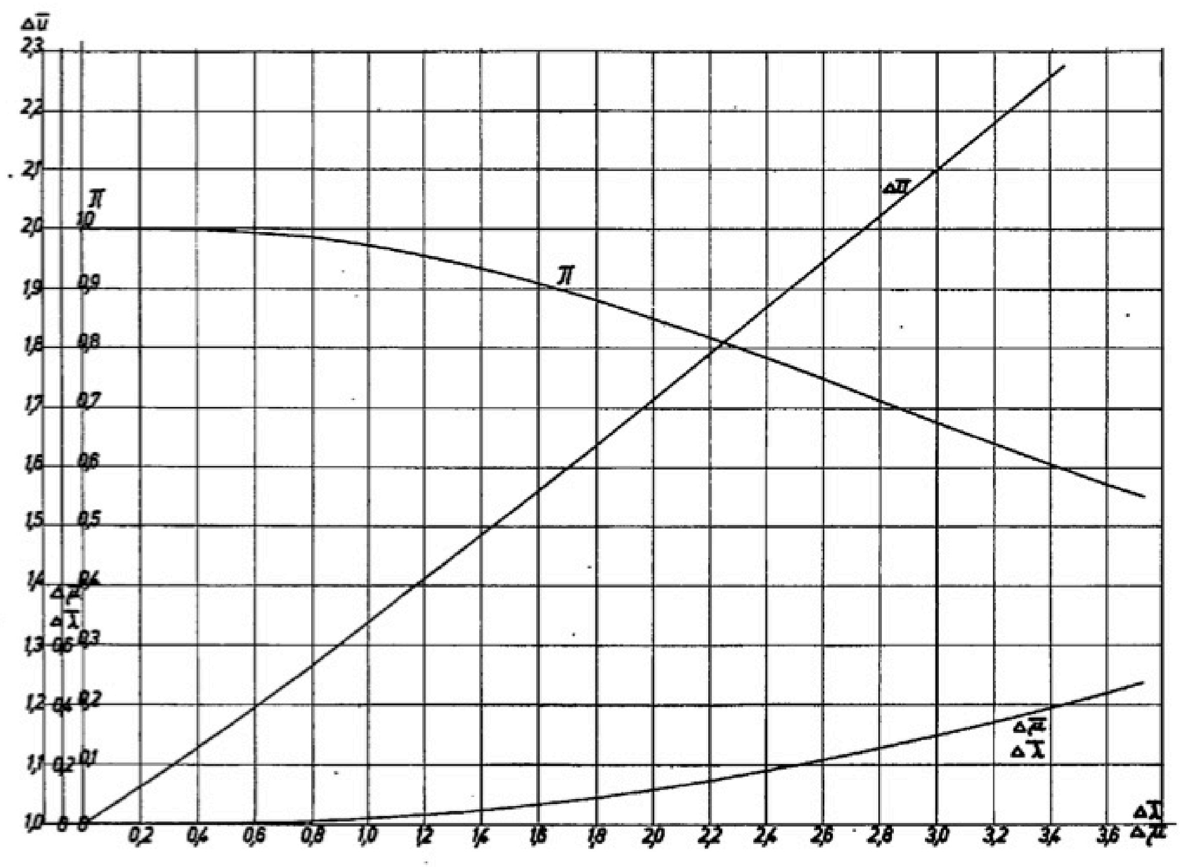
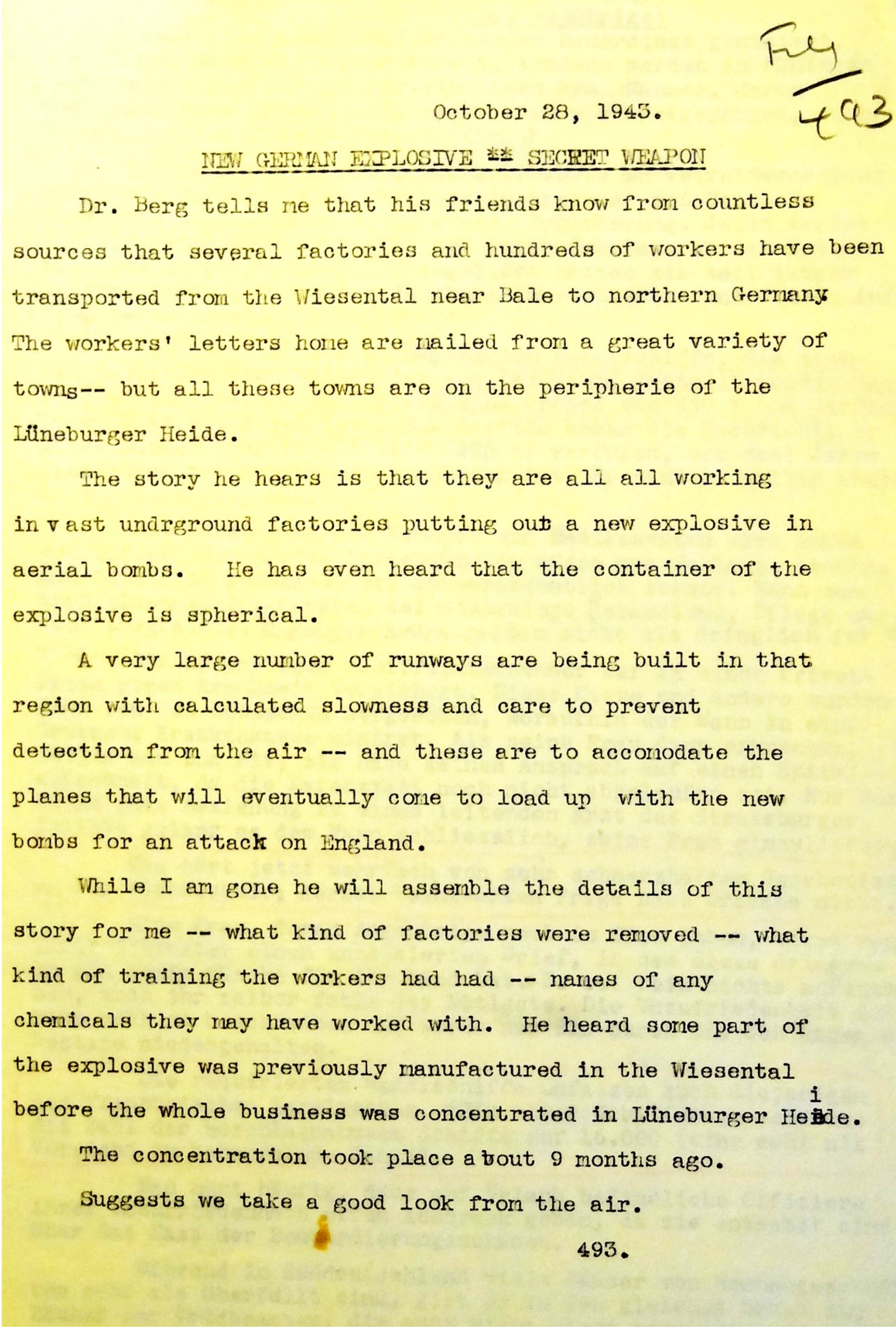


Figure 12b.- Characteristics of compression shocks K = 1.405.

Figure D.572: Detailed 1942 calculations by Gottfried Guderley predicting the pressure, density, and temperature in a spherical implosion bomb (without explicitly calling it that in public).



Fry
493

October 28, 1943.

NEW GERMAN EXPLOSIVE ** SECRET WEAPON

Dr. Berg tells me that his friends know from countless sources that several factories and hundreds of workers have been transported from the Wiesental near Bale to northern Germany. The workers' letters home are mailed from a great variety of towns-- but all these towns are on the peripherie of the Lüneburger Heide.

The story he hears is that they are all all working in vast undrground factories putting out a new explosive in aerial bombs. He has even heard that the container of the explosive is spherical.

A very large number of runways are being built in that region with calculated slowness and care to prevent detection from the air -- and these are to accomodate the planes that will eventually come to load up with the new bombs for an attack on England.

While I am gone he will assemble the details of this story for me -- what kind of factories were removed -- what kind of training the workers had had -- names of any chemicals they may have worked with. He heard some part of the explosive was previously manufactured in the Wiesental before the whole business was concentrated in Lüneburger Heide.

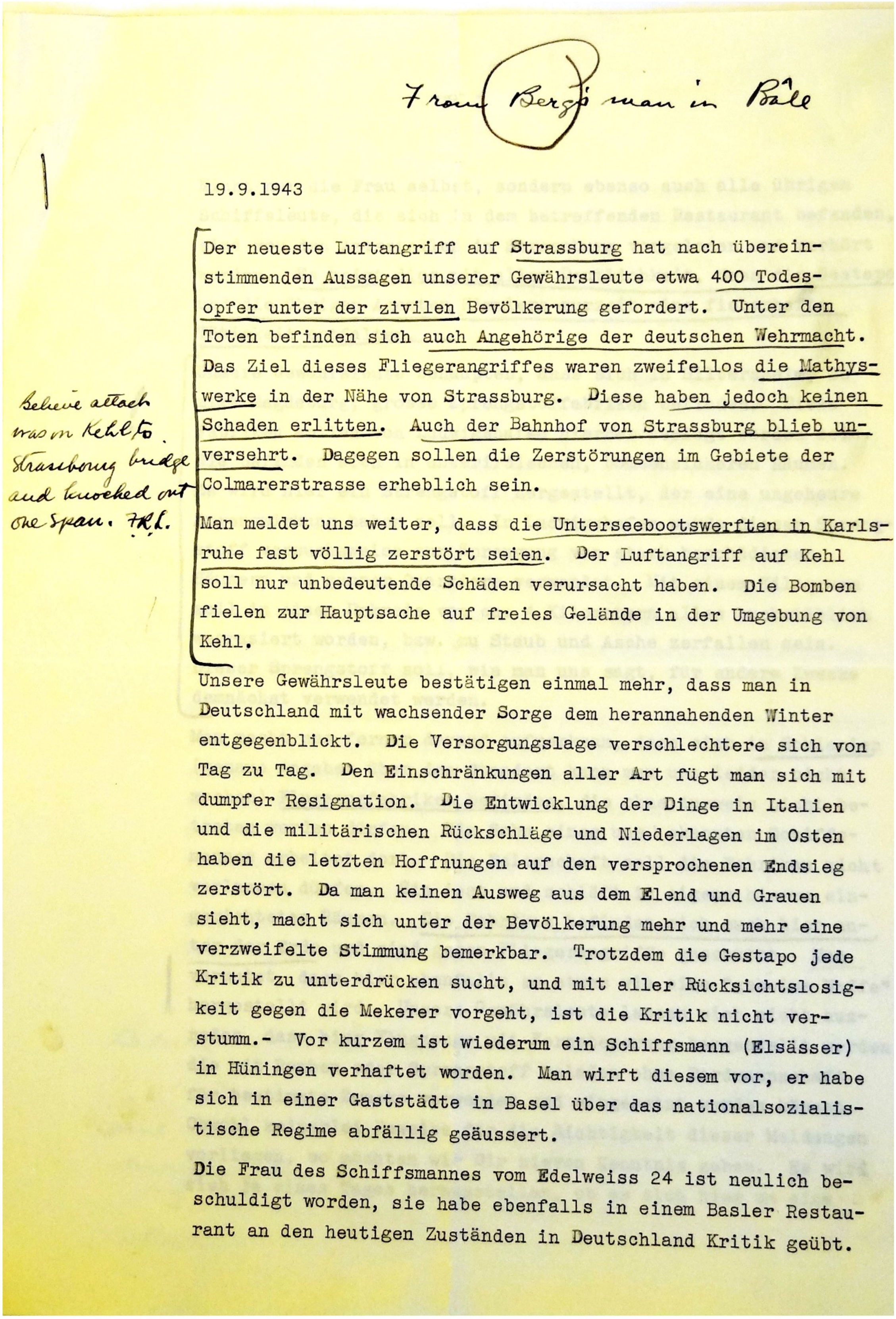
The concentration took place about 9 months ago.

Suggests we take a good look from the air.

493.

NARA RG 226, Entry 125, Box 6, Folder 78

Figure D.573: Several documents reported that there was a hidden underground nuclear facility somewhere in the Lüneburger Heide area south of Hamburg. Intelligence via Frederick Loofbourow (OSS agent 493) [NARA RG 226, Entry 125, Box 6, Folder 78].



Frau Bergs man in Bâle

19.9.1943

Der neueste Luftangriff auf Strassburg hat nach übereinstimmenden Aussagen unserer Gewährsleute etwa 400 Todesopfer unter der zivilen Bevölkerung gefordert. Unter den Toten befinden sich auch Angehörige der deutschen Wehrmacht. Das Ziel dieses Fliegerangriffes waren zweifellos die Mathyswerke in der Nähe von Strassburg. Diese haben jedoch keinen Schaden erlitten. Auch der Bahnhof von Strassburg blieb unversehrt. Dagegen sollen die Zerstörungen im Gebiete der Colmarerstrasse erheblich sein.

Believe attack was on Kehl to Strasbourg bridge and knocked out one span. FRL.

Man meldet uns weiter, dass die Unterseebootswerften in Karlsruhe fast völlig zerstört seien. Der Luftangriff auf Kehl soll nur unbedeutende Schäden verursacht haben. Die Bomben fielen zur Hauptsache auf freies Gelände in der Umgebung von Kehl.

Unsere Gewährsleute bestätigen einmal mehr, dass man in Deutschland mit wachsender Sorge dem herannahenden Winter entgegenblickt. Die Versorgungslage verschlechtere sich von Tag zu Tag. Den Einschränkungen aller Art fügt man sich mit dumpfer Resignation. Die Entwicklung der Dinge in Italien und die militärischen Rückschläge und Niederlagen im Osten haben die letzten Hoffnungen auf den versprochenen Endsieg zerstört. Da man keinen Ausweg aus dem Elend und Grauen sieht, macht sich unter der Bevölkerung mehr und mehr eine verzweifelte Stimmung bemerkbar. Trotzdem die Gestapo jede Kritik zu unterdrücken sucht, und mit aller Rücksichtslosigkeit gegen die Mekerer vorgeht, ist die Kritik nicht verstumm.- Vor kurzem ist wiederum ein Schiffsmann (Elsässer) in Hüningen verhaftet worden. Man wirft diesem vor, er habe sich in einer Gaststädte in Basel über das nationalsozialistische Regime abfällig geäussert.

Die Frau des Schiffsmannes vom Edelweiss 24 ist neulich beschuldigt worden, sie habe ebenfalls in einem Basler Restaurant an den heutigen Zuständen in Deutschland Kritik geübt.

NARA RG 226, Entry 125, Box 6, Folder 78

Figure D.574: Several documents reported that there was a hidden underground nuclear facility somewhere in the Lüneburger Heide area south of Hamburg. Intelligence via Frederick Loofbourow (OSS agent 493) [NARA RG 226, Entry 125, Box 6, Folder 78].

- 2 -

Nicht nur die Frau selbst, sondern ebenso auch alle übrigen Schiffsleute, die sich in dem betreffenden Restaurant befanden, sind von den Amtsstellen in Strassburg vorgeladen und verhört worden. Es zeigt dies mit aller Deutlichkeit, dass die Gestapo und die übrigen Agenten Himmlers zurzeit eine fieberhafte Tätigkeit entfalten.

Unsere Gewährsleute behaupten, dass sich in Hiltersheim, Bezirk Magdeburg, grosse Sprengstoffabriken befinden. Diese Fabriken sollen von Ludwigshafen hierher verlegt worden sein. Sie befinden sich in unterirdischen, bombensicheren Räumen. Es wird hier ein Strengstoff hergestellt, der eine ungeheure Sprengwirkung haben soll. In Ludwigshafen wurde dieser Sprengstoff versuchsweise zur Sprengung von stark beschädigten Häusern und ganzer Quartiere verwendet. Mit einem Kilogramm soll in einem Umkreis von ca. 4 Kilometern alles buchstäblich wegrasiert worden, bzw. zu Staub und Asche zerfallen sein. Dieser Sprengstoff soll, wie man uns sagt, für andere Zwecke demnächst verwendet werden.

Man macht uns ferner darauf aufmerksam, dass sich in Schlesien (genaue Angaben über den Standort kann man uns leider nicht machen) Flugzeugfabriken befinden, die ohne Ausweis nicht betreten werden dürfen. Ein Sohn eines uns bekannten Schiffsmannes arbeitet dort. Die Belegschaft soll die Fabriken nicht verlassen dürfen. Sie isst und schläft in eigens hierzu eingerichteten Räumen. Die Fabriken befinden sich auch hier unter der Erde und sind gegen Fliegerangriffe geschützt. Man vermutet, dass hier ebenfalls so etwas wie eine "geheime Waffe" hergestellt wird. Unsere Gewährsleute lassen sich nicht ausreden, dass hier Flugzeuge mit Fernsteuerung hergestellt werden, die mit Bomben oder Sprengstoff beladen ohne Bordmannschaft für bestimmte Zwecke verwendet und eingesetzt werden können. Obwohl keinerlei Beweise für die Richtigkeit dieser Meldungen vorliegen, so möchten wir Dir hievon Kenntnis geben. Es wird sich ja eines Tages herausstellen, ob es sich hier um eine

Figure D.575: Several documents reported that there was a hidden underground nuclear facility somewhere in the Lüneburger Heide area south of Hamburg. Intelligence via Frederick Loofbourow (OSS agent 493) [NARA RG 226, Entry 125, Box 6, Folder 78].

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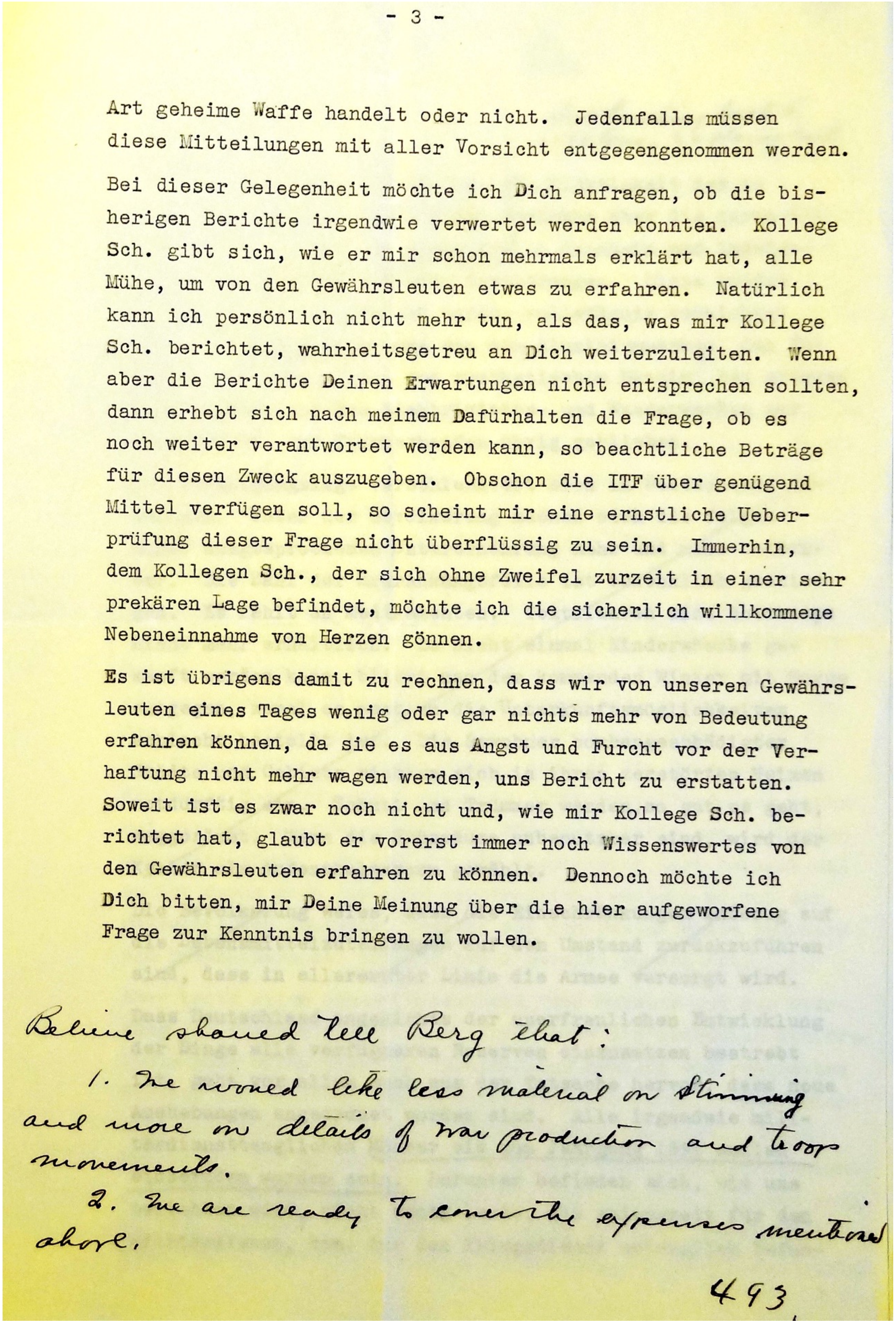
Authority NND 867125

NARA RG 226, Entry 125, Box 6, Folder 78



- 3 -

Art geheime Waffe handelt oder nicht. Jedenfalls müssen diese Mitteilungen mit aller Vorsicht entgegengenommen werden.

Bei dieser Gelegenheit möchte ich Dich anfragen, ob die bisherigen Berichte irgendwie verwertet werden konnten. Kollege Sch. gibt sich, wie er mir schon mehrmals erklärt hat, alle Mühe, um von den Gewährsleuten etwas zu erfahren. Natürlich kann ich persönlich nicht mehr tun, als das, was mir Kollege Sch. berichtet, wahrheitsgetreu an Dich weiterzuleiten. Wenn aber die Berichte Deinen Erwartungen nicht entsprechen sollten, dann erhebt sich nach meinem Dafürhalten die Frage, ob es noch weiter verantwortet werden kann, so beachtliche Beträge für diesen Zweck auszugeben. Obschon die ITF über genügend Mittel verfügen soll, so scheint mir eine ernstliche Ueberprüfung dieser Frage nicht überflüssig zu sein. Immerhin, dem Kollegen Sch., der sich ohne Zweifel zurzeit in einer sehr prekären Lage befindet, möchte ich die sicherlich willkommene Nebeneinnahme von Herzen gönnen.

Es ist übrigens damit zu rechnen, dass wir von unseren Gewährsleuten eines Tages wenig oder gar nichts mehr von Bedeutung erfahren können, da sie es aus Angst und Furcht vor der Verhaftung nicht mehr wagen werden, uns Bericht zu erstatten. Soweit ist es zwar noch nicht und, wie mir Kollege Sch. berichtet hat, glaubt er vorerst immer noch Wissenswertes von den Gewährsleuten erfahren zu können. Dennoch möchte ich Dich bitten, mir Deine Meinung über die hier aufgeworfene Frage zur Kenntnis bringen zu wollen.

Believe should tell Berg that:
1. We would like less material on Stimmung and more on details of war production and troop movements.
2. We are ready to cover the expenses mentioned above.

493

Figure D.576: Several documents reported that there was a hidden underground nuclear facility somewhere in the Lüneburger Heide area south of Hamburg. Intelligence via Frederick Loofbourow (OSS agent 493) [NARA RG 226, Entry 125, Box 6, Folder 78].

Background on Frederick Loofbourow [Powers 1993, p. 271]

Dulles never lacked for reports of new German explosives. One dated October 28, 1943, came from an OSS officer ostensibly serving as a senior economic analyst in the American consulate in Zurich who signed all his reports "493." This was Frederick Read Loofbourow, an executive of the Standard Oil Company of New Jersey, sent to Switzerland in 1942 by the Board of Economic Warfare to gather intelligence on German petroleum production. After the border was closed, Loofbourow was tapped by Dulles for OSS work and given a wide range of jobs through the end of the war.

Intelligence via Frederick Loofbourow [NARA RG 226, Entry 125, Box 6, Folder 78]

[See document photos on pp. 4210–4213.]

October 28, 1943.

NEW GERMAN EXPLOSIVE—SECRET WEAPON

Dr. Berg tells me that his friends know from countless sources that several factories and hundreds of workers have been transported from the Wiesental near Bâle to northern Germany. The workers' letters home are mailed from a great variety of towns—but all these towns are on the periphery of the Lüneburger Heide.

The story he hears is that they are all working in vast underground factories putting out a new explosive in aerial bombs. He has even heard that the container of the explosive is spherical.

A very large number of runways are being built in that region with calculated slowness and care to prevent detection from the air—and these are to accommodate the planes that will eventually come to load up with the new bombs for an attack on England.

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The concentration took place about 9 months ago.

Suggests we take a good look from the air.

493.

[Handwritten:] From Berg's man in Bâle [Basel, Switzerland]

19.9.1943

[...] Unsere Gewährsleute behaupten, dass sich in Hiltersheim, Bezirk Magdeburg, grosse Sprengstofffabriken befinden. Diese Fabriken sollen von Ludwigshafen hierher verlegt worden sein. Sie befinden sich in unterirdischen, bombensicheren Räumen. Es wird hier ein Strengstoff [Sprengstoff?] hergestellt, der eine ungeheuere Sprengwirkung haben soll. In Ludwigshafen wurde dieser Sprengstoff versuchsweise zur Sprengung von stark beschädigten Häusern und ganzer Quartiere verwendet. Mit einem Kilogramm soll in einem Umkreis von ca. 4 Kilometern alles buchstäblich wegrasiert worden, bzw. zu Staub und Asche zerfallen sein. Dieser Sprengstoff soll, wie man uns sagt, für andere Zwecke demnächst verwendet werden.

Man macht uns ferner darauf aufmerksam, dass sich in Schlesien (genaue Angaben über den Standort kann man uns leider nicht machen) Flugzeugfabriken befinden, die ohne Ausweis nicht betreten werden dürfen. Ein Sohn eines uns bekannten Schiffsmannes arbeitet dort. Die Belegschaft soll die Fabriken nicht verlassen dürfen. Sie isst und schläft in eigens hierzu eingerichteten Räumen. Die Fabriken befinden sich auch hier unter der Erde und sind gegen Fliegerangriffe geschützt. Man vermutet, dass hier ebenfalls so etwas wie eine "geheime Waffe" hergestellt wird. Unsere Gewährsleute lassen sich nicht ausreden, dass hier Flugzeuge mit Fernsteuerung hergestellt werden, die mit Bomben oder Sprengstoff beladen ohne Bordmannschaft für bestimmte Zwecke verwendet und eingesetzt werden können. Obwohl keinerlei Beweise für die Richtigkeit dieser Meldungen vorliegen, so möchten wir Dir hiervon Kenntnis geben. Es wird sich ja eines Tages herausstellen, ob es sich hier um eine Art geheime Waffe handelt oder nicht. Jedenfalls müssen diese Mitteilungen mit aller Vorsicht entgegengenommen werden. [...]

[...] Our sources claim that there are large explosives factories in Hiltersheim, Magdeburg district. These factories are said to have been moved here from Ludwigshafen. They are located in underground, bomb-proof facilities. A special [[explosive?] substance is produced here which is said to have an enormous explosive effect. In Ludwigshafen, this explosive was used on an experimental basis to blow up severely damaged houses and entire neighborhoods. With one kilogram, everything within a radius of approximately four kilometers should be literally razed away, or disintegrated to dust and ashes. We are told that this explosive will soon be used for other purposes.

We are also informed that there are aircraft factories in Silesia (unfortunately we are not given exact details of the location) which cannot be entered without a pass. A son of a shipman we know works there. The employees are not allowed to leave the factories. They eat and sleep in specially equipped rooms. The factories are also located underground and are protected against air raids. It is suspected that something like a "secret weapon" is also being produced here. Our sources will not be talked out of the fact that remote-controlled airplanes are produced here, which can be loaded with bombs or explosives and used for certain purposes without a crew on board. Although there is no proof that these reports are correct, we would like to inform you of them. One day it will become clear whether this is some kind of secret weapon or not. In any case, these reports must be taken with a grain of salt.

[Loofbourow seemed to have great confidence in his source “Dr. Berg” (not to be confused with Moe Berg, an OSS spy). Would it possible now to trace who that person actually was?

The new explosive reported by Dr. Berg was said to have “an enormous explosive effect” and clearly was not a conventional explosive. A fuel-air explosive (such as was being developed by Mario Zippermayr and others) could have an enormous explosive effect, but it would require on the order of a ton, not a kilogram, of fuel, and the fuel would be coal dust or other relatively well known substances. This report of a new explosive that was special substance that was so powerful that one kilogram of the new explosive could have a blast radius of several kilometers, seems to accurately describe the properties of weapons-grade uranium or plutonium. Dr. Berg reported that large factories with hundreds of people were producing the new explosive, which sounds like a large-scale production operation, not just small-scale lab experiments with minute quantities.

According to Dr. Berg, production began no later than early 1943. Based on current evidence about the technologies that were available in Germany at that time and that would have been suitable for producing fission bomb fuel, one of the most likely production methods would have been electromagnetic separation of uranium-235. That approach would have been highly similar to the U.S. calutrons at Oak Ridge, which also required hundreds of minimally trained workers to operate. Other possibilities would have been gas centrifuges or gaseous diffusion for enriching uranium-235, or a reactor or particle accelerators for breeding plutonium-239 or uranium-233.

For aerodynamic, stability, and targeting reasons, bombs are generally not spherical. The only reason to make a spherical bomb is if the bomb physics compels that choice—a spherical implosion bomb. Actually, this report gives many relevant details. It describes a bomb that:

1. Was spherical in overall shape, which strongly suggests an implosion design.
2. Contained on the order of a kilogram of an unusual material that was a new type of explosive.
3. Required large factories, hundreds of people, and over a year to produce enough of that unusual material.
4. Contained other components that are alluded to but not specified.
5. Had a blast radius of several kilometers.

Those details are highly consistent with others descriptions of a German fission implosion bomb.

The Lüneburger Heide or Heath is an area just south of Hamburg. Note the measures taken to avoid aerial surveillance (“to prevent detection from the air”) and aerial bombardment (“vast underground factories,” distribution “in a number of towns”) of this program. If those measures were successful, and if the equipment was evacuated, blown up, or buried before the end of the war, the whole program could have remained unnoticed by Allied countries, apart from a few intelligence reports such as those of Dr. Berg and the following documents, which do not appear to have been seriously pursued.

See also pp. 5033–5034 for a map and list of known underground facilities including Lüneburger Heide.]

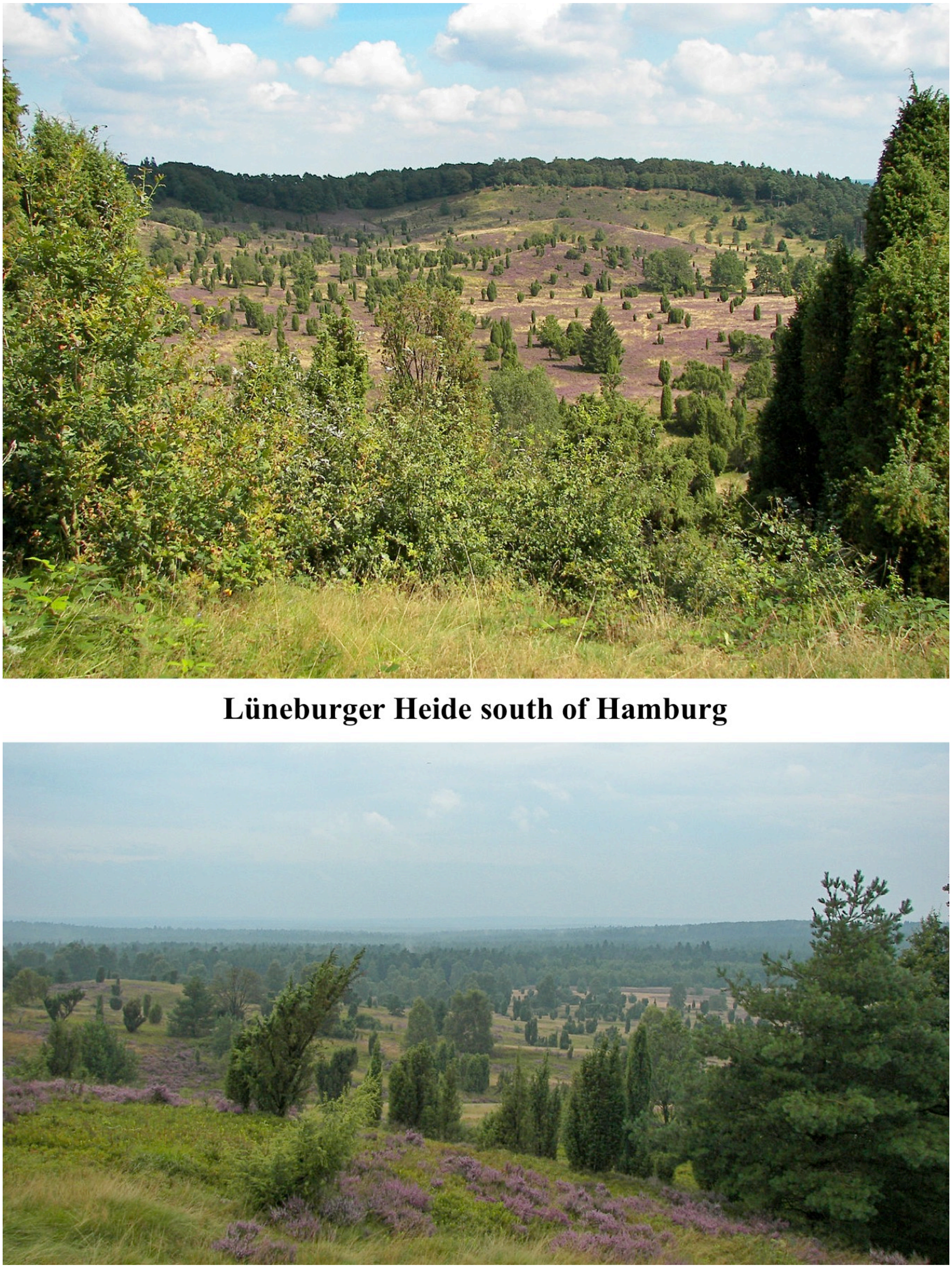

Figure D.577: Several documents reported that there was a hidden underground nuclear facility somewhere in the Lüneburger Heide area south of Hamburg. See also pp. 5033–5034.

From US Military Attaché Madrid Spain to War Department. 21 June 1944. Cable 12547. [NARA RG 165, Entry NM84-489, Box 175, Folder G-2 Book III a (Cables)]

To London and MILID, 12547.

Contact named Handtusch now returned to Germany eval FO states sea pointed last several days is aerial torpedo. Proof fired from Lueneburger Heide in direction Baltic Sea, impact area approximately 100 KM from Kiel. He stated storage depots these torpedos located in Lueneburger Heide near Lueneburg. Manufactured in new underground plants between Rostock and Stralsund.

Sharp.

BIOS 142. *Information Obtained from Targets of Opportunity in the Sonthofen Area.* 1945.

A. The S. S. Hauptamt (information from various sources)

Scientific research on new weapons and the production of armaments in Germany was controlled not only by the established ministries such as the R.L.M. but also by Speer's ministry and by the S. S. Hauptamt. [...]

Obergruppenführer Professor Kammler, one of the directors of the S.S. Hauptamt, was said to have great influence on Himmler and more influence on Hitler than Speer himself; and he was kept informed on all questions concerning armaments. The New Weapons section of the Waffenamt was apparently directed by a man called Bree. Standartenführer Klumm worked in this section and under him Lt. Kreutzfeld, who was interrogated.

One of the functions of the S.S. was to control the work of politically unreliable scientists who were kept in concentration camps. One of these camps was at Oranienburg, and research was done here on new weapons. [...] Another such camp was located at Nordhausen in the Harz, and came under the direct control of Kammler. Here the prisoners worked in an underground factory engaged on production. [...]

B. Information obtained from K. Kreutzfeld [...]

(g) Liquid air bomb

As the research on the atomic bomb under Graf von Ardenne and others was not proceeding as rapidly as had been hoped in 1944, it was decided to proceed with the development of a liquid air bomb. [...]

C. Interrogation of Josef Ernst [...]

(c) Scientific concentration camps

Ernst stated that he had been imprisoned at a concentration camp for politically unreliable scientists called "Camp Mecklenburg" in the Lüneburger Heide. This place was not known to Kreutzfeld, who was however acquainted with the Oranienburg camp. The possibility of bringing Ernst over to Oranienburg was also mentioned in Ernst's personal file, which had been given to him by Kreutzfeld for identification purposes. There was no mention of Camp Mecklenburg in this file. Ernst also stated that there was a similar camp at Maudhausen, near Vienna, but this was also unknown to Kreutzfeld. [...]

(f) Other work at Camp Mecklenburg

Ernst also stated that work was carried out at this camp on a new liquid air bomb, and liquid air gun (?), while trials on some kind of atomic bomb were made at or near the camp.

[The BIOS investigators interrogated Kurt Kreutzfeld, who had apparently been a member of the SS, and Josef Ernst, who had apparently been a "politically unreliable" scientist sentenced to work in concentration camps under the supervision of Kreutzfeld and other SS members. Ernst said he had worked at a concentration camp in the Lüneburger Heide where scientists were developing atomic bombs and other advanced weapons. Kreutzfeld denied that such a place existed and apparently implied to the BIOS investigators that Ernst was crazy. From the report, it seems that the BIOS investigators chose to believe the SS man's denials, and disbelieve the captive scientist's report about atomic bomb development.

The veracity of Ernst's statements is strongly supported by two points he includes that are corroborated by other sources but would have been very far from common knowledge:

- His description of Lüneburger Heide having a very large, very secret facility for the development of an atomic bomb is highly consistent with the statements of Otto Hahn and Frederick Loofbourow's informant, Dr. Berg.
- Ernst said there was another similar concentration camp where scientists were apparently forced to work on atomic bomb development at "Maudhausen, near Vienna." The Mauthausen concentration camp system west of Vienna included Gusen, a large underground complex where nuclear scientists worked on advanced weapons development (see pp. 3916, 4900, 5008ff.).

This report directly links Manfred von Ardenne and the atomic bomb development work, which strongly suggests that one of von Ardenne's specialties, electromagnetic isotope enrichment of uranium-235, was involved in the program. That aligns very well with Dr. Berg's report that many hundreds of workers in the Lüneburger Heide were operating factory equipment to produce small quantities of the special high-density material required by the new type of bomb, very much like the calutron operators at Oak Ridge. For another report linking Lüneburger Heide with atomic bomb development, see p. 4446.

See also: Lüneburger Heide: "Wir wissen nicht genau, was drin ist"—C-Waffen in der Heide aufgetaucht. [Lüneburger Heide: "We don't know exactly what is in there"—chemical weapons appear in the Heide.] *Focus*, 28 March 2017. https://www.focus.de/panorama/welt/lueneburger-heide-wir-wissen-nicht-genau-was-drin-ist-c-waffen-in-der-heide-aufgetaucht_id_6845571.html]

Memo to Lt. Col. P. M. Wilson. Atom-Bomb Specialist. 4 April 1946 [TNA FO 1031/112].

1. The following information has just come to hand and we should be glad if it could be passed on to the appropriate interested agencies.

2. Karl Heinz BOSECK, former Ustuf in the Waffen SS, alleges that he is an Atom-Bomb expert. He is now interned in No. 2 CIC, SANDBOSTEL and his P.O.W. No. is 204526.

[Karl-Heinz Boseck, born in 1915, was a mathematician who studied under Erich Schumann and became a member of the SS [Nagel 2011; Nagel 2012a, pp. 550, 560; Segal 2003, pp. 321–333].

"Atom-Bomb expert" implies much more than just early research. Boseck apparently worked in the SS's nuclear weapons development groups, which remain even more mysterious than other branches of the German nuclear program. Specifically, he helped run the "Mathematical Institute" at the Sachsenhausen concentration camp in Oranienburg [Nagel 2012a, p. 550; Segal 2003, pp. 321–333], an extremely interesting intersection of mathematical calculations, uranium from Auer Gesellschaft in Oranienburg, and slave labor from the concentration camp (perhaps for uranium enrichment?). That also supports Josef Ernst's assertion that the camp at Oranienburg did work related to the nuclear bomb development work at Lüneburger Heide (pp. 4218–4219).

Can other documents from Allied interrogations of Boseck be located, declassified, and released? What other information can be found about Boseck?]

Otto Hahn's autobiography [Otto Hahn 1968, p. 200].

Professor Staudinger schrieb mir, ein Offizier hätte ihm sein Ehrenwort gegeben, daß in der Lüneburger Heide kurz vor Kriegsende drei deutsche Atombomben einsatzbereit gelegen hätten.

Professor Staudinger wrote me that an officer had given him his word of honor that three German nuclear bombs had been ready for deployment in the Lüneburg Heath shortly before the end of the war.

[As Otto Hahn reported in his autobiography, after the war a German military officer in a position to know confirmed that this Lüneburger Heide program did indeed exist and had actually produced three completed fission bombs by the end of the war. With over two years to produce enough material, that could be quite possible. It is also possible that this Lüneburger Heide program produced one or more bombs that were used in the reported late 1944/early 1945 test explosions (Sections D.10–D.12). For a report that appears to link the Lüneburger Heide facility the Baltic atomic bomb test, see p. 4446.

Hermann Staudinger was a Nobel-Prize-winning German chemist just as Otto Hahn was, and of roughly the same age as Hahn. Hahn would have placed great faith in something that Staudinger told him. Since Hahn thought the statement was worthy of inclusion in his autobiography, and since he made no attempt to refute the statement (based on his own knowledge of wartime nuclear work), he seemed to imply that he accepted the statement as credible. Hahn's autobiography was only released after his death.]

Manfred von Ardenne. 1990. *Die Erinnerungen.* 10th ed. Munich: Herbig. p. 159

Bei Besuchen in Dahlem und Lichterfelde hatte ich 1941 Professor Otto Hahn die Frage gestellt, wieviel Gramm des reinen Isotops Uran-235 zur Entfesselung einer momentan ablaufenden Kernkettenreaktion benötigt würden. Er antwortete mir: "Wenige Kilogramm." In diesem absolut vertraulichen Gespräch vertrat ich die Auffassung, es sei technisch durchaus möglich, mit Hilfe hochgezüchteter magnetischer Massentrenner (die wir damals gedanklich und experimentell vorbereitet hatten), Uran-235-Mengen von einigen Kilogramm zu erhalten, wenn man dafür große Elektrokonzerne einsetzen würde.

During visits to Dahlem and Lichterfelde in 1941, I had asked Professor Otto Hahn how many grams of pure uranium-235 would be needed to unleash a nuclear chain reaction in an instant. He answered me: "A few kilograms." In this absolutely confidential conversation, I expressed the opinion that it was technically quite possible to obtain uranium-235 in quantities of a few kilograms with the help of highly sophisticated magnetic mass separators (which we had previously designed and experimentally developed), if large electrical corporations were used for this purpose.

Thomas Powers. 1993. *Heisenberg's War: The Secret History of the German Bomb.* New York: Alfred A. Knopf. p. 513, note 21.

In a letter to Rolf Hochhuth, June 27, 1988, Ardenne cites the conversation with Hahn on December 10, 1941, and quotes the answer of 1 to 2 kilograms. [...] Ardenne confirmed these conversations with me in an interview in Dresden, May 17, 1989, and showed me the signatures of Hahn and Heisenberg in his guest book.

Cable IN 5937 from Bern, Switzerland to Office of Strategic Services Director. 24 March 1944 [NARA RG 226, Entry A1-134, Box 219, Folder IN AZUSA Nov. '43 Sept. '45]

#2576-2581. AZUSA. [...]

The following is a report secured from Flute [Paul Scherrer] by 493: [...]

A super-Nazi, Lorens [Manfred von Ardenne] of Berlin-Lichterfelde-Ost is a financial and scientific swindler. He boasts of constructing an uranium bomb but he does not have adequate equipment. Lorens' associate is Breit [Fritz Houtermans] who was previously a Communist, was apprehended in Russia, but released in 1939 after which he turned into a fervent Nazi. Breit's work is in nuclear physics.

[Paul Scherrer's depiction of the personalities of Manfred von Ardenne and Fritz Houtermans is distorted by Scherrer's scientific jealousy, but Scherrer reported that von Ardenne stated very clearly during the war that he was producing uranium for a fission bomb.]

[According to conventional histories, Otto Hahn was not involved with the German nuclear weapons program. The above sources show that he actually had close ties to the program during the war. This strengthens the credibility of other information from Hahn (pp. 4220, 4504).

The above also shows that a priority of the program was to produce highly enriched uranium-235, especially using von Ardenne's calutron-like electromagnetic isotope separators (Section D.4.3).

The above also demonstrates that the program was focused on producing nuclear devices that would use "1 to 2 kilograms" or "a few kilograms" of uranium-235 to create a chain reaction "in an instant." A reactor would use a much larger quantity of unenriched or low-enriched uranium to produce a continuous, slow reaction, so the devices they were trying to build must have been bombs.

For a sphere of pure uranium-235, the critical mass is $\sim$46 kg without compression or a surrounding neutron reflector, but only $\sim$1.3 kg with compression and a neutron reflector (p. 5208). Thus the information from Hahn and von Ardenne appears to indicate that in 1941 there was an excellent understanding of these numbers and plans to use a bomb design with spherical implosion.

One electromagnetic isotope separator in von Ardenne's personal lab could not produce enough uranium-235 within a reasonable period of time (Section D.15.2), so in 1941 von Ardenne advocated to have many separators built by "large electrical corporations" and then operated in parallel at some other location.

Thus the information above is in excellent agreement with the reports of p. 4214: "vast underground factories" (at a location known to Otto Hahn, p. 4220) with "hundreds of workers" going into operation in 1942, using machines to produce a special material such that "with one kilogram, everything within a radius of approximately four kilometers should be literally razed away, or disintegrated to dust and ashes," when used in uniquely designed "aerial bombs" in which "the container of the explosive is spherical."]

Harry Vosser. Germans Are Still Striving to Perfect New V Weapons. *New York Times*. 22 October 1944, p. E5. [See more on p. 5383.]

V-3 is reported to be the atom bomb. [...] An electric shock from a small instrument set to operate at a given time detonates explosive and atom simultaneously. The expansion caused by a normal explosive substance, such as dynamite when it becomes a gas, is increased by the force of the disintegrating atoms.

V-3? *Time*, 27 November 1944, p. 88.

The terrible novelty of V-2 had by no means worn off yet, but London last week was already abuzz with speculation about V-3—supposedly an atomic bomb. [...]

The speculative London report suggested that the Nazis are using the same pressure principle to crush atoms. The crusher: A "Neuman" demolition charge, which explodes inward instead of outward. Used in a sphere, the Neuman charge might develop pressures of tens of thousands of tons per square inch at the center, perhaps enough to disintegrate an unstable atom such as uranium and release its explosive atomic energy.

[Egon Neumann developed sophisticated shaped charge explosives in 1910 [George Brown 1998, p. 166; Walters and Zukas 1989, pp. 12–13]. His name was presumably attached here to describe the general principle, not to imply that he was directly involved in the reported wartime atomic bomb development.

This article appears to describe the Schumann-Trinks implosion bombs or very similar work, and it supports the view that the work described in the postwar writings of Schumann and Trinks was indeed carried out during the war.]

Leslie R. Groves. 1962. *Now It Can Be Told: The Story of the Manhattan Project*. pp. 147–148.

Another incident that concerned us greatly was the appearance in a national magazine of an article hinting at the theory of implosion. While it did not violate any rules, it was most disturbing. A thorough investigation indicated that it resulted from the work of an alert and inquisitive reporter in another country.

[Clippings in a file at the Franklin Delano Roosevelt Library in Hyde Park, New York [Small Collections, Box 1, Folder 3, ATOMIC BOMB FILE] specifically link this comment from Leslie Groves to the 27 November 1944 article in *Time*. As Groves wrote, it would be quite concerning that any discussion of the implosion bomb design appeared in public at that time. What probably concerned him even more, although he did not mention that in his book, is that the *Time* article said the implosion bomb design details came from the German nuclear program, not the U.S. nuclear program. This evidence strongly supports the conclusion that Germany indeed had an advanced program developing nuclear weapons, and moreover that Leslie Groves knew the German nuclear program was much more advanced than he ever admitted in public.]

General Ivan Ilyichev. Intelligence reports to General Antonov and Joseph Stalin (15 November 1944 and 23 March 1945). Archive of the President of the Russian Federation, 93-81 (45) 37. **[For these very important documents on the design and testing of the German fission implosion bomb, see pp. 4525–4529.]**

Ordnance Technical Intelligence press release. August 1945. [NARA RG 498, Microfilm MP63-9_0137, Frames 623–624]

Ordnance OTI
For Immediate Release

For over two years, "detectives" of the Army Ordnance Department kept close tabs on German progress in the development of atomic weapons, it was revealed today by Lt. Col. John A. Keck, Chief Enemy Technical Intelligence Branch, Technical Division, Ordnance Service, TSFET.

"This shadowing of German science began in 1942," said Col. Keck, "when several Ordnance Officers, including myself, commenced work with British Intelligence in the United Kingdom. During the period before D-Day, allied agents on the continent were able to obtain from German proving grounds and research laboratories, information which gave definite evidence of steady progress in the atomic field. For some time, the race between German and American science was a close one, and had the Nazis been able to reach their goal, the outcome of the European war might have been entirely different."

Atoms had top priority on Col. Keck's list when he arrived in France with the 1st Army on D-Day. Information at his disposal gave several leads to the location of experimental stations in this line, but in the process of following them up, he hit several discouraging blind alleys. The first road took him to Cherbourg, where the absence of atomic proving grounds was somewhat compensated by the discovery of V-Bomb launching sites. Throughout the Normandy and Northern France campaigns, his searches gave little in the way of results. However, when the breakthrough in Germany got underway, the evidence began to pile up, culminating in the discovery of the great Nazi proving ground at Hillersleben. Here, it was learned that the Germans had gone far in the development of atomic bombs.

"However," said Col. Keck, "they weren't able to go far enough for several reasons, particularly the fact that they didn't have the facilities with which to conduct their experiments, and that our saturation bombing raids would throw their program far behind schedule. Nevertheless their progress was considerable and indicated that they were coming very close to the solution of the problem."

We were fully aware of their plans in this field, for sometimes whatever information we got from our agents went to the proper authorities in the States. This information was undoubtedly put at the disposal of our own scientists. However, it's interesting to note that our knowledge of enemy experiments in the atomic field far exceeded our knowledge of the closely-guarded experiments in the United States.

[The U.S. Army Ordnance Technical Intelligence office publicly stated that evidence proved "the Germans had gone far in the development of atomic bombs." What information were "allied agents on the continent... able to obtain from German proving grounds and research laboratories" during the war? What nuclear-related work was discovered at Hillersleben at the end of the war? Can the relevant U.S. reports be found at NARA or elsewhere?

Keck and the Ordnance Technical Intelligence office described an extended program to monitor German nuclear progress and gave accurate information about Hillersleben, Erich Schumann, and other aspects of German research in this and other press releases. As shown on the next pages, other U.S. government officials later forced them to deny all of that.]

Ordnance Technical Intelligence press release. August 1945. [NARA RG 498, Microfilm MP63-9_0137, Frames 625–626]

Ordnance OTI
For Immediate Release

"If the power of the Army's new atomic bomb is equal to that of 20,000 tons of TNT, its area of destruction would be a circle approximately one mile in diameter," said Colonel Leslie E. Simon, Director of the U.S. Army Ordnance Ballistics Research Center, Aberdeen Proving Ground, Md. Colonel Simon, who was interviewed shortly after release of information on the Army's latest secret weapon, has been in this theater on a special mission which included a 10,000 mile tour of German Ordnance installations and proving grounds. [...]

When asked of the extent to which the Germans had gone in the development of atom bombs, Colonel Simon said that several groups of German scientists had made some progress, but that they had not equalled our developments. He added, however, that they were definitely on the right track and it was a matter of time before they would be able to work something out.

One of the chief experts in this field, he said, was a Dr. Schumann, who was in charge of the research group of the Waffenamt (ordnance) in Berlin. With several other brilliant scientists, Dr. Schumann did much outstanding work, but, according to Colonel Simon, the Germans lagged behind us.

Colonel Simon said he did not believe that any German scientists had gone to Japan to continue their work, chiefly because they would be obliged to leave their laboratory facilities.

[Colonel Leslie Simon conducted extensive on-site visits and wrote detailed reports on German research facilities [Simon 1947a, 1947b, 1971]. He and the U.S. Army Ordnance Technical Intelligence office publicly stated that Erich Schumann (German, 1898–1985) was a "brilliant scientist" who "did much outstanding work," and that "the Germans had gone far in the development of atomic bombs." That view appears to be strongly supported by documentation about Schumann's wartime work (p. 4267). However, the Alsos Mission publicly declared that Schumann was only a "second-rate physicist" whose "main interest was the physics of piano strings" (p. 3315), and threatened the Ordnance Technical Intelligence office "against making further statements on this subject" (see below). This same microfilm MP63-9_0137 contains additional background information on the Hillersleben testing ground and U.S. colonels Keck and Simon—see for example frames 621–622, 638–646.]

Samuel Goudsmit to R. G. Ham. 10 August 1945 [NARA RG GOUDS, Entry UD-7420, Box 3, Folder "Historian's Office Inventory Control Job Goudsmit Box 4 Folder 6"].

The new outbursts of the 'omniscient' Colonel Keck... are deplorable and damaging. Please do something about this situation at once...

The German public opinion about the atomic bomb is as follows: They now believe that Hitler was not lying when he told them that he had a terrible weapon in store...

The following TA scientists have gone to work for the Russians...:

1) Dr. Riehl from Auer...

2) von Ardenne (cyclotron expert, etc.).

3) Gustav Hertz of Siemens, outstanding physicist, Nobel Prize winner, expert on isotope separation and cyclotron construction.

[See document photo on p. 4227.]

Monthly Intelligence Summary. July–August 1945. [NARA RG 77, Entry UD-22A, Box 168, Folder 202.3-1 LONDON OFFICE: Combined Intell Rpts.]

IX CENSORSHIP. [...]

e. The first wave of publicity after the use of the atom bomb brought forth a story from Lt. Col. John A. KECK, Chief of the Enemy Technical Intelligence Branch Ordnance Services, ETO, in which KECK purports to have conducted intelligence operations to determine the scope of enemy work on an atomic bomb. Col. KECK was interviewed by a representative of this office and admitted that he had not performed such a mission but denied having given the story to the Press. KECK stated that the story was released by the Public Relations Section of the Ordnance Services. Both KECK and the PRO were warned against making further statements on this subject.

NARA RG GOUDS, Entry UD-7420, Box 3, Folder "Historian's Office Inventory Control Job Goudsmit Box 4 Folder 6"

SECRET
ALSOS MISSION
BERLIN OFFICE
U. S. FORCES, EUROPEAN THEATRE

74

10 August 1945

DECLASSIFIED
E.O. 13526, Sec. 3.3
NW 60992 Tab 105
By JD/DP, NARA, Date 11/21/19

MEMORANDUM:

TO : Lt. Colonel R. G. Ham

The following TA information should be brought to the attention of Colonel Pash and Major Calvert:

1. PUBLICATIONS.

a. We cannot stop competent Germans who are available from giving information to reporters about the German development. The information that they are going to give may or may not be correct.

b. The new outbursts of the "omniscient" Colonel Keck (see "Stars and Stripes, 9 August 1945) are deplorable and damaging. Please do something about this situation at once.

c. The German public opinion about the atomic bomb is as follows:

They now believe that Hitler was not lying when he told them that he had a terrible weapon in store but that they had merely had bad luck by being slightly behind the development in the Allied countries. This has resulted in new confidence in the Hitler myth.

d. It is extremely unfortunate that, in the official publications, Lisa Meitner is mentioned as the originator of uranium splitting. She left Germany before that was discovered. Hahn and Strassmann are the real discoverers. As this is mentioned in every popular scientific book and article, it seems inadvisable to omit their names, as people may misconstrue this omission as having had some hidden purpose.

e. With regard to the above statements, it is urgently recommended that some authentic account of the absence of the atomic bomb development in Germany be published at once, especially in Germany.

2. AUER.

a. We have interrogated Dr. Ihwe who originally was our first target. His story merely confirmed what we already knew. We have confiscated some of the correspondence between

NO RESTRICTED DATA OR FORMERLY RESTRICTED DATA.
DOE HAS NO OBJECTION TO ITS DECLASSIFICATION.
COORDINATION REQUIRED WITH DOD, CIA
~~DOUGLAS A. HUGHES~~ G. Sullivan 3/24/86
REVIEWED BY HKSchmidt 3/28/86 DATE

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2.

Auer and Degussa and are studying it now. We have also interrogated a Miss Blobel, secretary to Dr. Riehl, who was in charge of the production of the metal. He himself has gone to work for the Russians. Miss Blobel is rather dumb, and not much information was gotten out of her.

3. RUSSIAN INTEREST.

a. The Russians have shown a definite interest in TA development. I don't know whether they had any real experts here except a general by the name of Klopin. It seems there are two brothers by this name, both either chemists or physicists. This may be the same Klopin who was mentioned as head of the uranium committee in the interrogation of the pseudo-scientist, Shishkov, as reported by B. T. Pash, Assimilated Ph.D.

b. The following TA scientists have gone to work for the Russians, probably somewhere near Moscow, and are presumably working on the TA problem:

1) Dr. Riehl from Auer (see above).

2) von Ardenne (cyclotron expert, etc.).

3) Gustav Hertz of Siemens, outstanding physicist, Nobel Prize winner, expert on isotope separation and cyclotron construction.

c. A small amount of material which was still in stock at Auer was also removed by the Russians. According to Miss Blobel, this amounted to just a little pile in a corner. That was the only estimate that I could obtain concerning the amount.

4. ROSBAUD.

a. We have found Rosbaud and are getting his complete story which serves as a magnificent confirmation of everything that we have found. He also has a very sound opinion about the personalities involved which coincides exactly with the results which we have obtained by painstakingly studying numerous documents. Rosbaud is giving his story exclusively to us and absolutely to no one else. However, he did have some connections with the Russians shortly after they occupied Berlin. Following are some points from his story:

1) Rosbaud realized the significance of the problem and was afraid that the two tons of heavy water in German hands might be lost to the scientific world. He, therefore,

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3.

informed the Russians about their existence and that they might probably have been evacuated to Hechingen. He also mentioned to them the names of the Germans who were connected with the problem. He gave them instructions to pass this information on to the British. He wrote a letter about this to Kapitza but never heard from him.

2) That the Germans were serious about the problem was clear from a statement which Gerlach made to him. Early in the year, when experiments indicated a sizeable neutron increase, Gerlach called Rosbaud and informed him about it. He was very excited and said that now they were sure to succeed. When Rosbaud pointed out that the time was long between laboratory experiments and a bomb. Gerlach agreed that that was true but said that, nevertheless, this new development would assure them of a softer peace. They apparently were convinced that they were far ahead of us.

b. It must be pointed out that the main story of Rosbaud was obtained and delivered to us a few days before the news broke regarding the atomic bomb and was not influenced by that event.

S. A. GOUDSMIT
Scientific Chief

SECRET

Figure D.578: Samuel Goudsmit to R. G. Ham. 10 August 1945 [NARA RG GOUDS, Entry UD-7420, Box 3, Folder "Historian's Office Inventory Control Job Goudsmit Box 4 Folder 6"]. "The new outbursts of the 'omniscient' Colonel Keck... are deplorable and damaging. Please do something about this situation at once... The German public opinion about the atomic bomb is as follows: They now believe that Hitler was not lying when he told them that he had a terrible weapon in store... The following TA scientists have gone to work for the Russians...: 1) Dr. Riehl from Auer... 2) von Ardenne (cyclotron expert, etc.). 3) Gustav Hertz of Siemens, outstanding physicist, Nobel Prize winner, expert on isotope separation and cyclotron construction."

J. C. Clark. 18 September 1945. Development and Use of Röntgenblitz Technique by the German Scientists during Period 1938–45. Alsos Intelligence Report KO-29365 [AFHRA Folder 170.2279E 18 SEP 1945; AFHRA B1763 frames 0252–0259. Also NARA RG 77, Entry UD-22A, Box 165, Folder ALSOS MATERIAL].

This report is based upon the interrogation of German scientists and scientific reports recovered during the period within a few months after the cessation of hostilities in the E.T.O. Unfortunately the men who apparently did most of the research and development work on the Röntgenblitz equipment, namely Dr. Steenbeck and possibly Dr. Mühlenpfordt working under Dr. Gustav Hertz at Siemens, Berlin, had already gone to Moscow to continue their work, and were not available in Germany for interrogation. However, Dr. Thomer, now working with Prof. H. Schardin at the French Laboratory at Leichtmetall Werke, St. Louis, Alsace, was available for questioning and was well acquainted with the equipment. [...]

Dr. Thomer got his degree at Leipzig in 1936 and worked at Siemens with Dr. Hertz from 1936 until 1938 when he left to go with Prof. Schardin at the Physikalisches Institut der Luftkriegs-Akademie, Berlin-Gatow. Here he used the Röntgenblitz technique for ballistic studies. [...]

By 1941 the Forschungslaboratory acquired high vacuum metal Röntgenblitz tubes from the research laboratory #2 of Siemenswerke for use in multiple flash x-ray studies. This tube and the auxillary circuit is the type which was used for the remainder of the work carried on by Prof. Schardin's workers as well as Dr. Rudi Schall, working under Dr. Erich Schumann at the WaF (research) Division of the Waffenamt, in Berlin. [...]

The uses to which the Germans put the Röntgenblitz equipment were learned by examining captured documents and by interrogation. These applications cover (a) target cavitation produced by projectiles passing through wooden blocks and water targets, (b) the smashing of a lead bullet upon impact with various targets, (c) cavity charge phenomena studies, (d) detonation phenomena studies and (e) an interesting study of the arming of a nose fuze a short distance in front of the muzzle of the gun. With the exception of the studies on detonation of an explosive charge done by Dr. Rudi Schall, all work with the Röntgenblitz equipment was done by Schardin's group, working principally with Dr. Thomer. Only a few German documents covering the above work were available for examination by the author during the investigation of this subject, but it is believed that a complete series of the reports of both Prof. H. Schardin's and Dr. Erich Schumann's groups have been recovered and forwarded through the proper military channels for filing and examination (see Col. L. E. Simon's U.S. Ord. Dept. report).

It was, however, definitively ascertained that the experimental techniques utilized to obtain flash radiographs of cavity charges and high explosive specimens were sensibly the same as those familiar to U.S. research workers. The German scientific groups recognized the value of this technique because it was learned that at least eight more Röntgenblitz units were under construction at the Siemenswerke, Berlin.

[Erich Schumann and Hubert Schardin led groups that conducted detailed research, development, and testing programs for implosion bombs. According to this document, the United States acquired "a complete series of the reports of both Prof. H. Schardin's and Dr. Erich Schumann's groups" and followed up with interrogations of personnel from those groups for several months after the war. Can all of that information be located and declassified now?]

Figure D.579: Historisch-Technisches Museum Versuchsstelle Kummersdorf: Apparent testing area for implosion designs; note numerous ports for mounting diagnostic equipment.

U.S. military intelligence card entry for Erich Schumann. Undated but apparently last updated summer 1945. [NARA RG 319, Entry A1-134B, Box ??, Folder XE170590 Schumann, Erich]

Ministerial Councilor and head of the research office in the Reich War ministry: Professor at the University of Berlin, director of the Second Institute of Physics and of the Second Institute of Theoretical Physics at the University of Berlin. Ph.D. in physics; October 1933, full professor in the faculty of Natural Sciences at the University of Berlin; Special fields are physics connected with armament, especially explosion waves and acoustics. Since the late twenties in the research office of the Reich War Ministry. Chairman of the Union of the Wehrmacht-Functionaries.

Informant considers Prof. SCHUMANN "a very dangerous man who always worked on highly secret missions for the German Army. Even during the Weimar Republic students were not allowed to enter his laboratory." Informant says that SCHUMANN is perhaps not a Nazi according to the party line, but he is a German nationalist, a pan-Germanist and entirely devoted to the German Army.

[This file is further evidence that U.S. investigators were very well aware of how important and how potentially dangerous Erich Schumann's wartime work was.

Yet the office of Leslie Groves tried to hide this information from the public (p. 4225), and Samuel Goudsmit knowingly gave false testimony to the U.S. Senate in which he claimed that Schumann was only a "second-rate physicist" whose "main interest was the physics of piano strings" (p. 3315).]

NARA RG 319, Entry A1-134B, Box ??, Folder XE170590 Schumann, Erich

Name SCHUMANN, Erich (Ger) | 0 | GERMANY (III) Berlin-Grunewald

Address Berlin-Grunewald, Königsweg 146

Description B. 5 Jan 1895

Misc.

Career Ministerial Councilor and head of the research office in the Reich War ministery: Professor at the University of Berlin, director of the Second Institute of Physics and of the Second Institute of Theoretical Physics at the University of Berlin. Ph.D. in physics; October 1933, full professor in the faculty of Natural Sciences at the University of Berlin; Special fields are physics connected with armament, especially explosian waves and accoustics. Since the late twenties in the research office of the Reich War Ministry. Chairman of the Union of the Wehrmacht-Functionaries.
Informant considers Prof. SCHUMANN "a very dangerous man who always worked on highly secret missions for the German Army. Even during the Weimar Republic students were not allowed to enter his laboratory." Informant sa, that SCHUMANN is perhaps not a Nazi according to the party line, but he i a German nationalist, a pan-Germanist and entirely devoted to the German Army.

365 | 6 | 9 | 14 | P | 0 X |

Figure D.580: U.S. military intelligence card entry for Erich Schumann. Undated but apparently last updated summer 1945. [NARA RG 319, Entry A1-134B, Box ??, Folder XE170590 Schumann, Erich]

Erwin Respondek. 6 November 1945. [NARA RG 226, Entry A1-210, Box 447, Folder WN 16162–16171]

Übersicht des Standes der wissenschaftlichen Arbeiten in Deutschland zur Atom-Bombe (bis Mai 1945)

[...] Prof. Schumann äusserte etwa 1944, dass das Problem der Uran-Bombe gelöst sei. Die Bombe solle an einem Fallschirm abgeworfen werden. Die Zündvorrichtung sei in technisch einfacher Form gelöst worden. Hierzu diene eine Neutronenquelle. Prof. Schumann sagte aber zugleich, dass es bisher nicht gelungen sei, das Uran zum explosiven Spontanzerfall zu bringen. [...]

Overview of the State of Scientific Work in Germany on the Atomic Bomb (until May 1945).

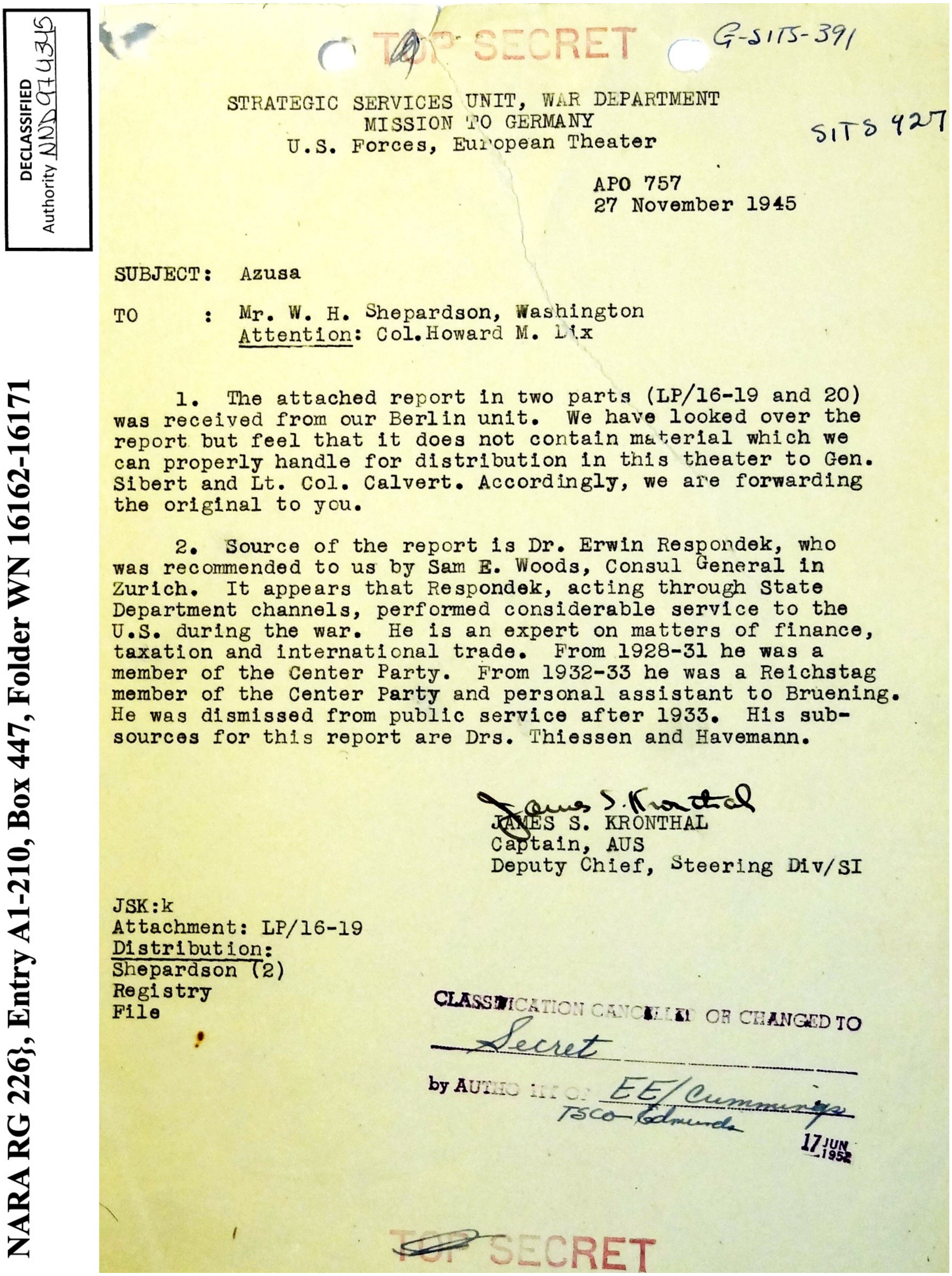
[...] Prof. Schumann stated around 1944 that the problem of the uranium bomb had been solved. The bomb should be dropped on a parachute. The ignition device was solved in a technically simple form. For this purpose, a neutron source is used. At the same time, however, Prof. Schumann said that so far it had not been possible to bring about the explosive spontaneous disintegration of uranium. [...]

[See document photos on pp. 4233–4236. Erwin Respondek (1894–1971) was a German economist who secretly passed information to the United States throughout the 1940s [Dippel 1992]. Despite the juicy title of Respondek's report, he appears to have been most familiar with the well-known basic nuclear research of the Kaiser Wilhelm Institute, to which he devoted most of the report.

However, he did include one intriguing paragraph about the development of an actual German atomic bomb. According to Respondek, the bomb:

- Involved Erich Schumann in its design, which strongly suggests that the bomb design employed shaped charges and implosion, Schumann's area of technical expertise.
- Used uranium as the fission fuel.
- Used a parachute. (This agrees with other accounts—see for example p. 4480.)
- Was intended to be dropped by an aircraft, at least up until 1944 (based on the parachute).
- Used a neutron source to initiate fission reactions at the right time. (That would be during implosion, and is consistent with the other accounts of the bomb design—see for example p. 4529.)
- Had been completed but not yet successfully tested, as of sometime in 1944. (That is consistent with the first successful test(s) being in late 1944/early 1945—see Sections D.10–D.12.)
- Was separate from and much more secret than the Kaiser Wilhelm Institute program (based on how much less Respondek knew about it).

There is also some evidence that information from Respondek led to the December 1943 Allied bombing of an important site associated with the German nuclear program [Dippel 1992, pp. 111–113]. Can more information on that incident be located in archives? Where was the site? What sort of work was actually being conducted at the site? What intelligence led to the bombing?]



TOP SECRET G-SITS-391

STRATEGIC SERVICES UNIT, WAR DEPARTMENT
MISSION TO GERMANY
U.S. Forces, European Theater

SITS 427

APO 757
27 November 1945

SUBJECT: Azusa

TO : Mr. W. H. Shepardson, Washington
Attention: Col. Howard M. Dix

1. The attached report in two parts (LP/16-19 and 20) was received from our Berlin unit. We have looked over the report but feel that it does not contain material which we can properly handle for distribution in this theater to Gen. Sibert and Lt. Col. Calvert. Accordingly, we are forwarding the original to you.

2. Source of the report is Dr. Erwin Respondek, who was recommended to us by Sam E. Woods, Consul General in Zurich. It appears that Respondek, acting through State Department channels, performed considerable service to the U.S. during the war. He is an expert on matters of finance, taxation and international trade. From 1928-31 he was a member of the Center Party. From 1932-33 he was a Reichstag member of the Center Party and personal assistant to Bruening. He was dismissed from public service after 1933. His sub-sources for this report are Drs. Thiessen and Havemann.

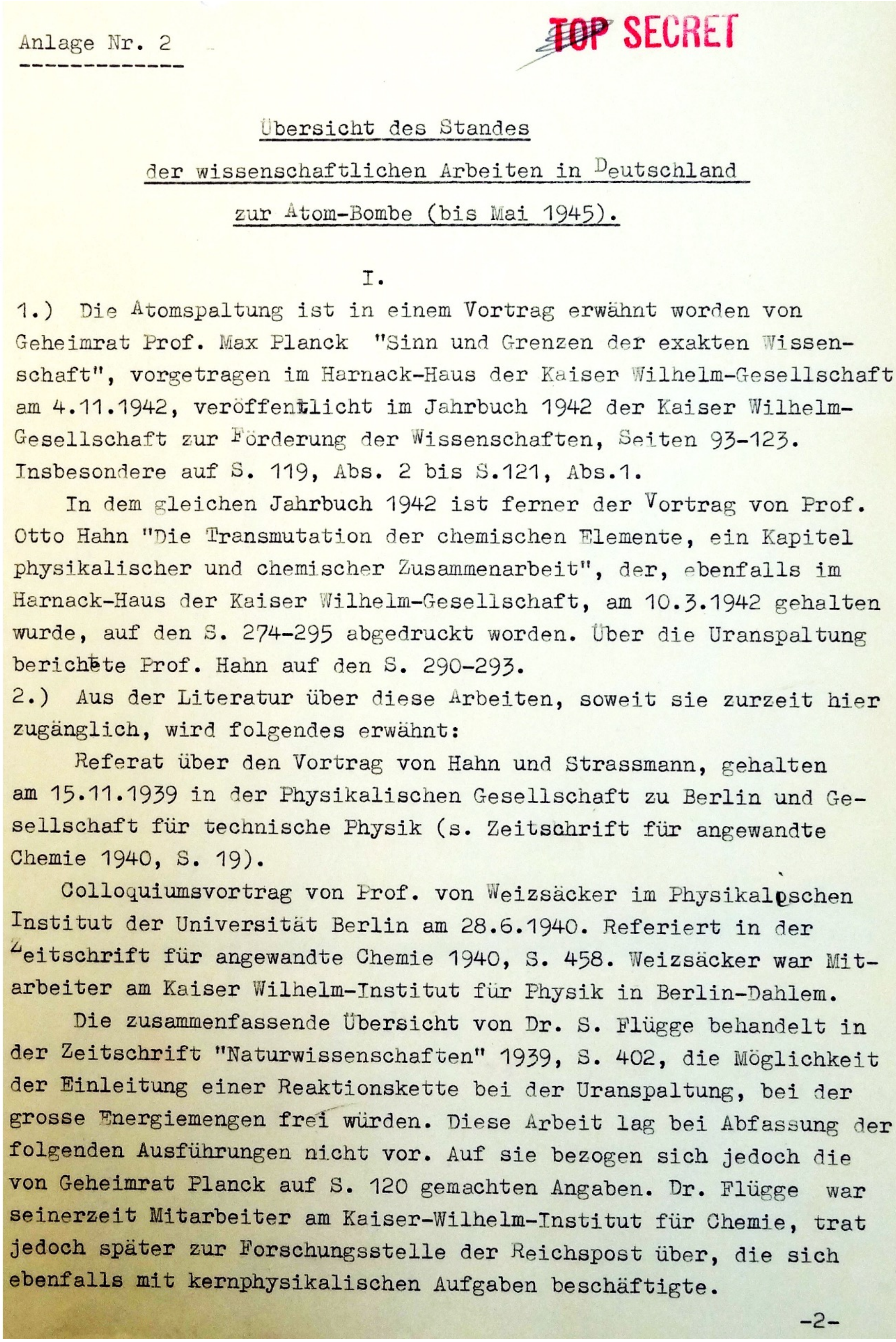
James S. Kronthal
JAMES S. KRONTHAL
Captain, AUS
Deputy Chief, Steering Div/SI

JSK:k
Attachment: LP/16-19
Distribution:
Shepardson (2)
Registry
File

CLASSIFICATION CANCELLED OR CHANGED TO
Secret
by AUTHORITY OF EE/Cummings
TSCO–Edmunds
17 JUN 1952

TOP SECRET

Figure D.581: James S. Kronthal to W. H. Shepardson and Howard M. Dix. 27 November 1945 [NARA RG 226, Entry A1-210, Box 447, Folder WN 16162–16171].



Anlage Nr. 2

TOP SECRET

Übersicht des Standes
der wissenschaftlichen Arbeiten in Deutschland
zur Atom-Bombe (bis Mai 1945).

I.

1.) Die Atomspaltung ist in einem Vortrag erwähnt worden von Geheimrat Prof. Max Planck "Sinn und Grenzen der exakten Wissenschaft", vorgetragen im Harnack-Haus der Kaiser Wilhelm-Gesellschaft am 4.11.1942, veröffentlicht im Jahrbuch 1942 der Kaiser Wilhelm-Gesellschaft zur Förderung der Wissenschaften, Seiten 93-123. Insbesondere auf S. 119, Abs. 2 bis S.121, Abs.1.

In dem gleichen Jahrbuch 1942 ist ferner der Vortrag von Prof. Otto Hahn "Die Transmutation der chemischen Elemente, ein Kapitel physikalischer und chemischer Zusammenarbeit", der, ebenfalls im Harnack-Haus der Kaiser Wilhelm-Gesellschaft, am 10.3.1942 gehalten wurde, auf den S. 274-295 abgedruckt worden. Über die Uranspaltung berichtete Prof. Hahn auf den S. 290-293.

2.) Aus der Literatur über diese Arbeiten, soweit sie zurzeit hier zugänglich, wird folgendes erwähnt:

Referat über den Vortrag von Hahn und Strassmann, gehalten am 15.11.1939 in der Physikalischen Gesellschaft zu Berlin und Gesellschaft für technische Physik (s. Zeitschrift für angewandte Chemie 1940, S. 19).

Colloquiumsvortrag von Prof. von Weizsäcker im Physikalischen Institut der Universität Berlin am 28.6.1940. Referiert in der Zeitschrift für angewandte Chemie 1940, S. 458. Weizsäcker war Mitarbeiter am Kaiser Wilhelm-Institut für Physik in Berlin-Dahlem.

Die zusammenfassende Übersicht von Dr. S. Flügge behandelt in der Zeitschrift "Naturwissenschaften" 1939, S. 402, die Möglichkeit der Einleitung einer Reaktionskette bei der Uranspaltung, bei der grosse Energiemengen frei würden. Diese Arbeit lag bei Abfassung der folgenden Ausführungen nicht vor. Auf sie bezogen sich jedoch die von Geheimrat Planck auf S. 120 gemachten Angaben. Dr. Flügge war seinerzeit Mitarbeiter am Kaiser-Wilhelm-Institut für Chemie, trat jedoch später zur Forschungsstelle der Reichspost über, die sich ebenfalls mit kernphysikalischen Aufgaben beschäftigte.

-2-

NARA RG 226, Entry A1-210, Box 447, Folder WN 16162-16171

Figure D.582: Erwin Respondek. 6 November 1945 [NARA RG 226, Entry A1-210, Box 447, Folder WN 16162–16171].

NARA RG 226}, Entry A1-210, Box 447, Folder WN 16162-16171

-4- ~~TOP~~ SECRET

Heisenberg, seit 1942 Direktor am Kaiser-Wilhelm-Institut für Physik, und Prof. Bothe, Direktor des Instituts für Physik am Kaiser-Wilhelm-Institut für Medizinische Forschung, Heidelberg. Unabhängig von diesem wissenschaftlichen Kreis arbeitete das HWA weiterhin unmittelbar am Uran-Problem, insbesondere unter Mitwirkung von Prof. Schumann.

Die Ziele des wissenschaftlichen Kreises konzentrierten sich von Anfang an auf die Schaffung eines "Uran-Brenners", der z.B. zur Kesselheizung von Schiffen dienen könnte. Die Versuche wurden mit dem handelsüblichen Uran-Metall vorgenommen und nicht mit dem reinen Uran-Isotop 235. Es wurde bei jedem Versuch mit grossen Mengen des gewöhnlichen Uran-Metalls gearbeitet, und zwar sollten grundsätzlich einzelne Vorgänge der Reaktion erforscht werden. Ferner wurde mit besonderer Umsicht das Problem des Strahlenschutzes behandelt, insbesondere für die bei der Uran-Spaltung auftretenden gefährlichen Neutronen-Strahlen. In medizinischer Hinsicht lagen schon frühere Untersuchungen vor von Prof. Rajewsky, Direktor des Kaiser-Wilhelm-Institutes für Biophysik, Frankfurt a.Main. Ohne einen genügenden Strahlenschutz ist die Verwendung des Uran-Brenners zur Kesselfeuerung und dergl. nicht denkbar.

Die Versuche wurden nicht sehr intensiv betrieben, insbesondere wurden sie durch die Herstellung und Formgebung des Uran-Metalls (Auergesellschaft) und die Herstellung von Schwerem Wasser in Deutschland (Prof. Harteck, Hamburg) stark verzögert.

Mit einer Anreicherung des Uran-Isotops 235 wurde erst Ende 1944 begonnen. Versuche an einer grösseren Menge von reinem Uran 235 wurden, soweit bekannt, bis Kriegsende nicht durchgeführt. Für Frühjahr 1945 war ein Großversuch geplant, der nicht mehr zur Ausführung kam. Der Stillstand war durch die gesteigerten Luftangriffe auf Deutschland herbeigeführt worden.

IV.

An Einzelheiten sei noch folgendes bemerkt:

1) Prof. Schumann äusserte etwa 1944, dass das Problem der Uran-Bombe gelöst sei. Die Bombe solle an einem Fallschirm abgeworfen werden. Die Zündvorrichtung sei in technisch einfacher Form gelöst worden. Hierzu diene eine Neutronenquelle. Prof. Schumann sagte aber zugleich, dass es bisher nicht gelungen sei, das Uran zum explosiven Spontanzerfall zu bringen.

2.) Ende Februar 1945 wurde infolge der schweren Luftangriffe auf Berlin das wertvolle Schwere Wasser nach Stadtilm/Thür. verfrachtet. Dr. Diebner übersiedelte etwa im März dorthin. Bei der Bedrohung des Gebietes von Stadtilm durch die amerikanischen Armee wurde Dr. Diebner dem Verlauten nach als Geheimnisträger auf Anordnung von Saukel durch den SD nach Weimar in Schutzhaft genommen. Von da soll er dann mit dem Ziel Innsbruck später weitergereist sein. Prof. Gerlach war ab Februar bereits vorwiegend in München und kam nur zu gelegentlichen Besprechungen nach Berlin.

Figure D.583: Erwin Respondek. 6 November 1945 [NARA RG 226, Entry A1-210, Box 447, Folder WN 16162–16171].

Attachment II

THE STAGE REACHED BY SCIENTIFIC RESEARCH ON THE ATOM BOMB IN GERMANY, AS OF MAY 1945.

1. The atomic timor was mentioned by Geheimrat Prof. Max Planck in a lecture entitled "Sinn Und Grenzen der exakten Wissenchaften" (Meaning and Limits of Exact Science). The lecture was delivered on 4 November, 1942, at the Harnack-Haus of the Kaiser Wilhelm Gesellschaft and was published in the society's 1942 yearbook (Jahrbuch 1942 der Kaiser Wilhelm Gesellschaft zur Forderung der Wissenschaften), pages 92 - 123. Particular mention of the subject is made on page 119, para 2 to page 121, para 1.

The same 1942 yearbook of the Kaiser Wilhelm Gesellschaft contains a lecture by Prof. Otto Hahn "Die Transmutation der chemischen Elemente, ein Kapitel physikalischer und chemischer Zusammenarbeit" (The Transmutation of Chemical Elements, a Chapter in the Collaboration of Physics and Chemistry). This lecture was delivered at the Harnack Haus of the Kaiser Wilhelm Gesellschaft on 10 March, 1942, and appears in the yearbook on pages 274 -295. On Pages 290 - 293 Professor Hahn discusses the splitting of uranium.

2. The following refers to literature still currently available which is based on this research:

Review of the lecture by Hahn and Strassmann, delivered on 15 November 1939, in the Physikalische Gesellschaft fur technische Physik (see Zeitschrift fur angewandte Chemie 1940, page 19).

Seminar lecture by Prof. Weizsäcker at the Institute for Physics of the University of Berlin on 28 June, 1940. Reviewed in "the Zeitschrift für angewandte Chemie", 1940, page 458. Weizsacker was collaborator in the Kaiser Wilhelm Institute for Physics in Berlin-Dahlem.

A compendium by Dr. S. Flügge in the journal "Naturwissenschaften" of 1939, page 402, discusses the possibility of chain reaction in the splitting of uranium and the consequent generation of great masses of energy. This research work, however, had not yet been carried out when the following expositions were presented. However, it was to this that Prof. Planck refers on page 120. Dr. Flügge has been a collaborator in the Kaiser Wilhelm Institute for Chemistry, but had later accepted an appointment with the Reichspost which also carried on work in nuclear physics.

Expositions similar to the ones presented before the Physikalische Gesellschaft Berlin were presented by Prof. Hahn some time in the Winter of 1939/40 before the Deutsche Chemische Gesellschaft. He made mention of the work done in collaboration with Prof. LiseMeitner and Dr. Strassmann

IV.

Additional Particulars:

1. About 1944, Professor Schummann declared that the problem of the uranium bomb had been solved and that the problem of the fuze had been solved in a technically simple form. The fuzing, he declared, was connected with a neutron source, but he added that, so far, it had not been possible to explode the uranium by spontaneous disintegration.

2. Because of the concentrated air attacks on Berlin, the valuable heavy water was shipped to Stadtilm/Thuringia late in February, 1945. Dr. Diebner moved to that city somewhat later, probably in March. When the Stadtilm district was threatened by the advance of American forces, Dr. Diebner was taken to Weimar by the SD (Sicherheitsdienst) and placed in protective custody, reportedly on orders of Sauckel and because he possessed vital secret information. He is said to have left Weimar later with the intention of going to Innsbruck. Prof. Gerlach had already spent most of his time in Munich since February and only occasionally came to Berlin for conferences.

Figure D.584: Erwin Respondek. 6 November 1945 [NARA RG 226, Entry A1-210, Box 447, Folder WN 16162–16171].

Erich Schumann. 2 October 1940. Unclassified draft article on explosives research for popular publication [Bundesarchiv Militärarchiv Freiburg N822/17].

[Erich Schumann (German, 1898–1985) was a high-ranking physicist in the wartime German Army Ordnance Office. He was an expert on conventional explosives and on using shaped explosive charges in a wide variety of geometries for different purposes. At the end of the war, almost all of his wartime papers were destroyed by the Germans or captured and classified by the Allies. However, there is strong evidence from multiple postwar sources that Schumann designed and demonstrated large, highly sophisticated, spherical implosion bombs during the war. If furnished with fission fuel in the center, such spherical implosion designs would have been quite suitable for nuclear weapons.

One of the few surviving and relevant wartime documents is this 2 October 1940 draft article on explosives research that Schumann was preparing for publication. Because the article was intended for unclassified publication, it omitted or downplayed many important aspects. Yet it did make clear that no later than September 1940, Schumann and his coworkers:

- Knew that nuclear explosives could potentially be a million times more powerful than chemical explosives (explosive energies up to megatons of TNT equivalent).
- Wanted to use the shock waves produced by chemical explosives to produce the highest possible pressures and temperatures (which immediately suggests a spherical implosion, from basic physical principles).
- Were keenly interested in using (implosive) shock waves from chemical explosives to trigger nuclear reactions.
- Were trying to make the production of suitable shock waves highly precise and "mathematically controlled."
- Could not discuss the details in an unclassified article "because of the significance of special arrangements in terms of weapons technology."

See pp. 4242–4244 for photographs of some pages from this document.]

[...] Der Zustand der Detonation ist dadurch gekennzeichnet, dass die Aktivierungsenergie dem Sprengstoff durch eine Stosswelle zugeführt wird, wobei die beim Zerfall des Stoffes freiwerdende Energie das Fortschreiten der Stosswelle unterstützt. Es ist leicht einzusehen, dass bei der gegenseitigen Kopplung von Wellenausbreitung und Sprengstoffzerfall sich in einem genügend ausgedehnten Sprengkörper ein stationärer Zustand herausbildet, der für die gesamten detonativen Erscheinungen charakteristisch ist.

Die Fortpflanzungsgeschwindigkeit dieser stationären Zersetzung heisst Detonationsgeschwindigkeit. Da diese verhältnismässig einfach messbar ist, liegt für sie ein umfangreiches Messmaterial vor, das zum wertvollsten Besitz der experimentellen Sprengstoffphysik gehört, stellt doch die Detonationsgeschwindigkeit die einzige wirklich physikalische Messgrösse dar, mit der heute ein Sprengstoff charakterisiert werden kann.

[...] The state of detonation is characterized by the fact that the activation energy is supplied to the explosive by a shock wave, whereby the energy released during the decay of the substance supports the progression of the shock wave. It is easy to see that in a sufficiently large explosive device, when the wave propagation and explosive decay are coupled together, a steady state is formed which is characteristic of all detonative phenomena.

The propagation velocity of this stationary decomposition is called the detonation velocity. Since it is relatively easy to measure, there is extensive measured information available for it, which is one of the most valuable possessions of experimental explosives physics, since the detonation velocity is the only really physical major measurement which can be used today to characterize an explosive.

Die geschilderten energetischen Verhältnisse im molekularen Verband der Sprengstoffe sind grundsätzlich die gleichen, wie wir sie vom korpuskularen Verband des Atomkerns kennen. Obgleich beim Kernzerfall eine sehr grosse Energie frei wird, besitzt der Atomkern doch eine grosse Stabilität, weil zur Einleitung des Zerfalls eine erhebliche Aktivierungsarbeit geleistet werden muss. Die heute möglichen Kernzertrümmerungen entsprechen bei diesem Vergleich, der sich nur auf die qualitativen energetischen Verhältnisse erstreckt, vollständig dem stillen Zerfall von Sprengstoffmolekülen. Da die Kernenergien den chemischen Bindungsenergien, aus denen die Sprengstoffe ihre Leistungsfähigkeit schöpfen, um mindestens 6 Grössenordnungen überlegen sind, würde durch die Kernreaktionen die Möglichkeit von Sprengstoffen unvorstellbar grosser Brisanz gegeben sein, wenn es gelingen würde, die Kernreaktion detonativ, d.h. durch Stosswellen, auszulösen. Ganz abgesehen von der geschichtlich einschneidenden Bedeutung einer solchen Möglichkeit, einen Stoff von wirklich gigantischer Zerstörungskraft in menschliche Hände zu geben, würden wir damit die Materie unter thermodynamischen Bedingungen vorzuliegen haben, wie sie sonst nur an ganz wenigen Stellen des Universums vorkommen. Fraglos wäre der kernreaktionäre Sprengstoff physikalische Realität, wenn es gelänge, eine Stosswelle genügender Intensität zu erzeugen, die einen Kernzerfall einleiten könnte. Da jedoch selbst bei den schwereren, am wenigsten stabilen Atomen die Aktivierungsenergie noch nach Millionenvolt gemessen wird, besitzen wir keine Möglichkeit, eine solch intensiv Stosswelle zu erzeugen. Es fehlt bei den Kernreaktionen eben die Abstufung der Aktivierungsarbeiten, wie sie bei den Sprengstoffen von den Initial- bis zu den Sicherheitssprengstoffen gegeben ist; durch diese ist es möglich, durch fast beliebig kleine Impulse über die Initialstoffe äusserst stabile chemische Verbindungen zum detonativen Zerfall zu bringen. [...]

The described energetic conditions in the molecular bond of explosives are basically the same as we know them from the nuclear bond of the atomic nucleus. Although a very large amount of energy is released during nuclear disintegration, the atomic nucleus has great stability, because a considerable amount of activation work must be done to initiate disintegration. In this comparison, which only covers the qualitative energetic conditions, the nuclear disintegration possible today corresponds completely to the simple disintegration of explosive molecules. Since nuclear energies are at least 6 orders of magnitude greater than the chemical binding energies from which explosives derive their power, nuclear reactions would be unimaginably explosive if it were possible to trigger the nuclear reaction via detonations, i.e. by shock waves. Quite apart from the historically far-reaching significance of such a possibility of putting a substance of truly gigantic destructive power into human hands, we would then be able to produce matter under thermodynamic conditions that otherwise occur only in very few places in the universe. There is no doubt that the nuclear-reactive explosive would be a physical reality if it were possible to generate a shock wave of sufficient intensity to initiate nuclear disintegration. However, since the activation energy of even the heaviest, least stable atoms is still measured in millions of volts, we have no way of generating such an intense shock wave. The nuclear reactions lack the gradation of activation energy that is present in explosives, from early explosives to safety explosives; this makes it possible to cause extremely stable chemical compounds to undergo detonative decay by means of almost arbitrarily small impulses via the initial substances. [...]

Für die Sprengwirkung sind nun nicht allein die thermodynamischen Zustandsgrössen an der Unstetigkeitsstelle, die die Detonationsfront kennzeichnet, massgebend, sondern in entscheidendem Masse ihr weiterer räumlicher Verlauf. Für die Berechnung von räumlichen Feldern der in den Schwaden herrschenden Zustandsgrössen liegen jedoch keine genügenden theoretischen Grundlagen vor. Glücklicherweise liefert nun die Röntgenblitztechnik auf experimentellem Wege den Feldverlauf einer der wichtigsten Zustandsgrössen, nämlich der Gasdichte der Schwaden. Dadurch, dass der Dichtesprung an der Detonationsfront durch die Röntgenblitzmethode der Messung zugänglich ist, erhält man nicht nur einen Einblick in der Zerfallsprozess, sondern durch den weiteren räumlichen Dichteverlauf auch in die für die Wirkung entscheidenden Schwadenströmungserscheinungen. Das Arbeitsvermögen der Schwaden ist nämlich nicht allein durch den Drucksprung in der Detonationsfront bestimmt, sondern wesentlich durch den zeitlichen Druckverlauf an der Sprengstoffoberfläche. Dieser ist jedoch durch die Strömungsvorgänge der Schwaden gegeben, die sich auf Grund von Röntgenblitzaufnahmen verfolgen lassen. Fraglos werden sich die thermodynamischen Kenntnisse, die zu einer Berechnung der Strömungsvorgänge bei den in den Schwaden vorliegenden Drucken von über 100 000 atm und Gasdichten in der Grössenordnung derjenigen fester Körper bisher fehlten, aus den nach der Röntgenblitzmethode gewonnenen experimentellen Ergebnissen gewinnen lassen. Damit dürfte die Einführung der Röntgenblitzmethode in die Sprengstoffphysik, die ebenfalls meinem Institute entstammt[1)], über den engeren Rahmen der Sprengstoffforschung hinaus für die gesamte Physik der Materie bei extremen Bedingungen von fruchttragender Bedeutung sein.

[1)] Eine sprengstoffphysikalische Röntgenblitzarbeit wird erstmalig in dem vorliegenden Heft veröffentlicht (Arbeit Schall)

For the blast effect, not only the thermodynamic state variables at the discontinuity point, which characterizes the detonation front, are decisive, but also to a decisive extent its further spatial course. However, there is no sufficient theoretical basis for the calculation of spatial fields of the state variables prevailing in the windrows. Fortunately, the X-ray flash technique now provides the field progression of one of the most important state variables, namely the gas density of the plume, by experimental means. Since the density jump at the detonation front is accessible by the X-ray flash method of measurement, one does not only get an insight in the disintegration process, but also, through the further spatial density course, into the vapor flow phenomena which are decisive for the effect. The working capacity of the vapors is not only determined by the pressure jump in the detonation front, but essentially by the pressure curve over time at the surface of the explosive. However, this is given by the flow processes of the vapors, which can be followed on the basis of X-ray flash photographs. There is no doubt that the experimental results obtained using the X-ray flash method will provide the thermodynamic knowledge needed to calculate the flow processes at pressures of over 100,000 atm and gas densities of the order of magnitude of those of solid bodies in the vapors. Thus, the introduction of the X-ray flash method into explosives physics, which also originates from my institute[1)], should be of fruitful importance beyond the narrower framework of explosives research for the entire physics of matter under extreme conditions.

[1)] An X-ray flash study on the physics of explosives is published for the first time in this issue (work of Schall)

[...] Die soeben bei der Erläuterung des Brisanzbegriffes geäusserten Gedanken deuten bereits eine Theorie der gesamten Sprengstoffwirkung an. Eine solche allgemeine Theorie hat jedoch nicht nur die Vorgänge an der Sprengstoffoberfläche selbst, sondern auch Einwirkungen auf weiter entfernt liegende Punkte zu erfassen. Als Ursache solcher mittelbarer Sprengstoffwirkungen kommen neben der direkten Schwadeneinwirkung die Stosswelle im an den Sprengstoff angrenzenden Medium oder an der Sprengstoffoberfläche beschleunigte und dann ballistisch wirkende Materialteile in Betracht. Die bei den je nach der beabsichtigten Wirkung verschiedenen Anordnungen der Sprengobjekte auftretenden Fragen hier näher zu erörtern, verbietet sich bei der waffentechnischen Bedeutung spezieller Anordnungen von selbst. Auch bei mittelbaren Wirkungen werden die Vorgänge an der Sprengstoffoberfläche als in jedem Falle entscheidende Kraftquelle Ausgangspunkt weiterer Untersuchungen sein müssen.

Das Ergebnis der vorstehenden Überlegungen kann dahin zusammengefasst werden, dass Wege aufgezeigt und Untersuchungsmethoden angegeben werden, die detonativen Erscheinungen in den allgemeinen Rahmen der Physik einzuordnen. Eine solche Behandlung von Sprengstofffragen nach rein physikalischen Gesichtspunkten hat die Schaffung physikalischer Messmethoden für die die Wirkung und Handhabung bestimmenden Grössen zur notwendigen primären Folge. Die weitere Verfolgung dieser Methoden muss zu einer allgemeinen Theorie der Sprengwirkungen führen, die Ablauf und Auswirkung jeder Sprenganordnung rechnerisch zu beherrschen erlaubt und damit der Sprengtechnik wertvollste Unterlagen schafft. Rückwirkend auf die allgemeine Physik werden die sprengstoffphysikalischen Ergebnisse wieder dieser neue Erkenntnisse bringen, liegt doch im Detonationsvorgang die Materie unter Bedingungen vor, wie sie bei anderen physikalischen Erscheinungen experimentell nicht zu verwirklichen sind.

[...] The thoughts just expressed in the explanation of the explosive concept already suggest a theory of the entire effect of explosives. However, such a general theory must not only cover the processes on the surface of the explosive itself, but also effects at points further away. In addition to the direct effect of vapor, the cause of such indirect explosive effects can be the shock wave in the medium adjacent to the explosive or on the explosive surface, which accelerates and then causes ballistically acting matter components. The questions arising from the different arrangements of the explosives depending on the intended effect cannot be discussed here in detail because of the significance of special arrangements in terms of weapons technology. Even in the case of indirect effects, the processes on the surface of the explosives, as the decisive source of power in any case, will have to be the starting point for further investigations.

The result of the above considerations can be summarized as showing ways and indicating investigation methods to classify the detonative phenomena within the general framework of physics. Such a treatment of explosives issues from a purely physical point of view has the necessary primary consequence of creating physical measuring methods for the variables determining the effect and handling. The further pursuit of these methods must lead to a general theory of blasting effects which allows the sequence and effects of each blasting arrangement to be controlled mathematically and thus provides the blasting technique with valuable documentation. Retrospectively on the general physics, the results of blasting physics will again bring new insights, since in the detonation process, matter is present under conditions that cannot be experimentally realized in other physical phenomena.

Bundesarchiv Militärarchiv Freiburg N822/17. Erich Schumann. 2 October 1940.
Unclassified draft article on explosives research for popular publication.

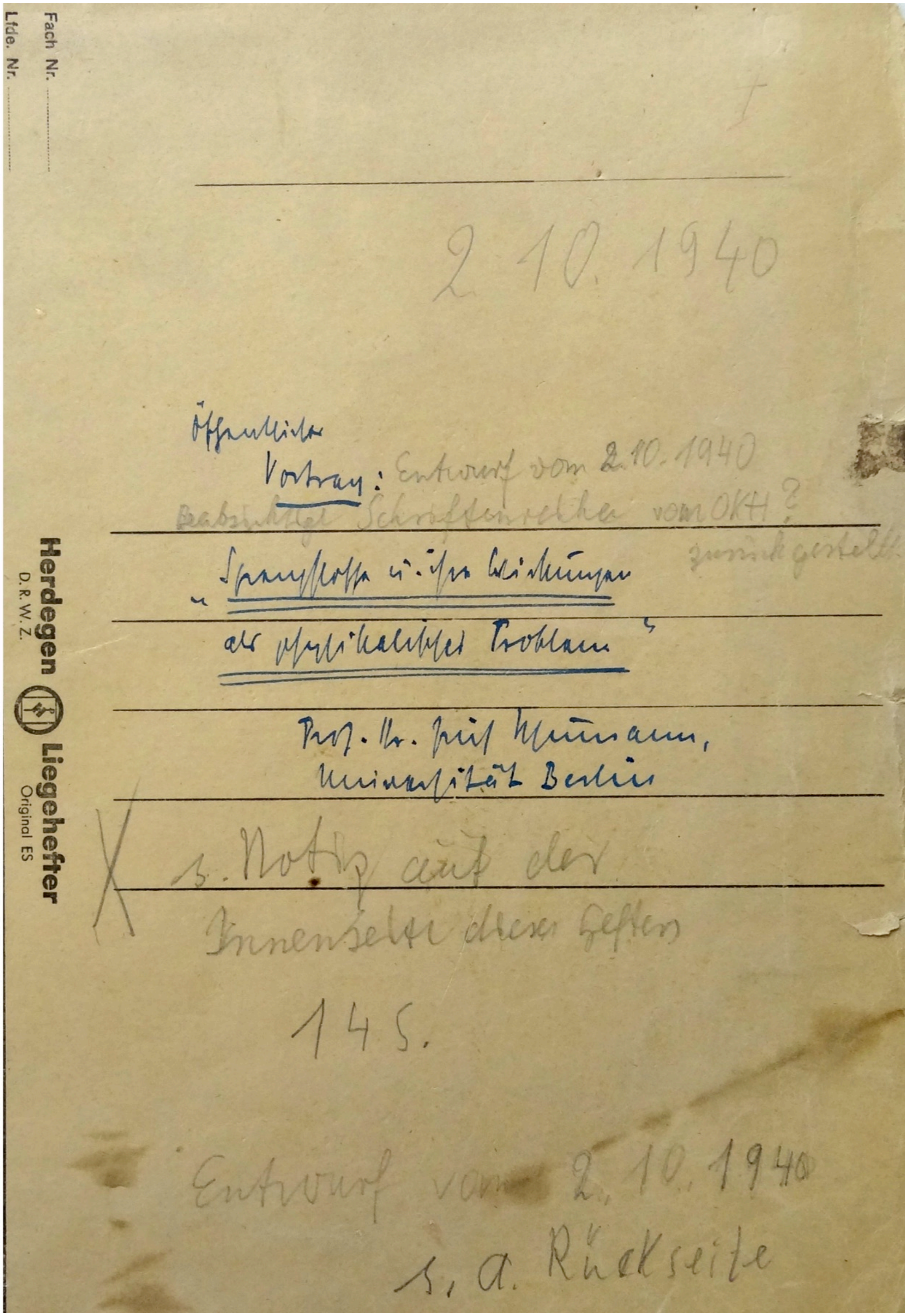
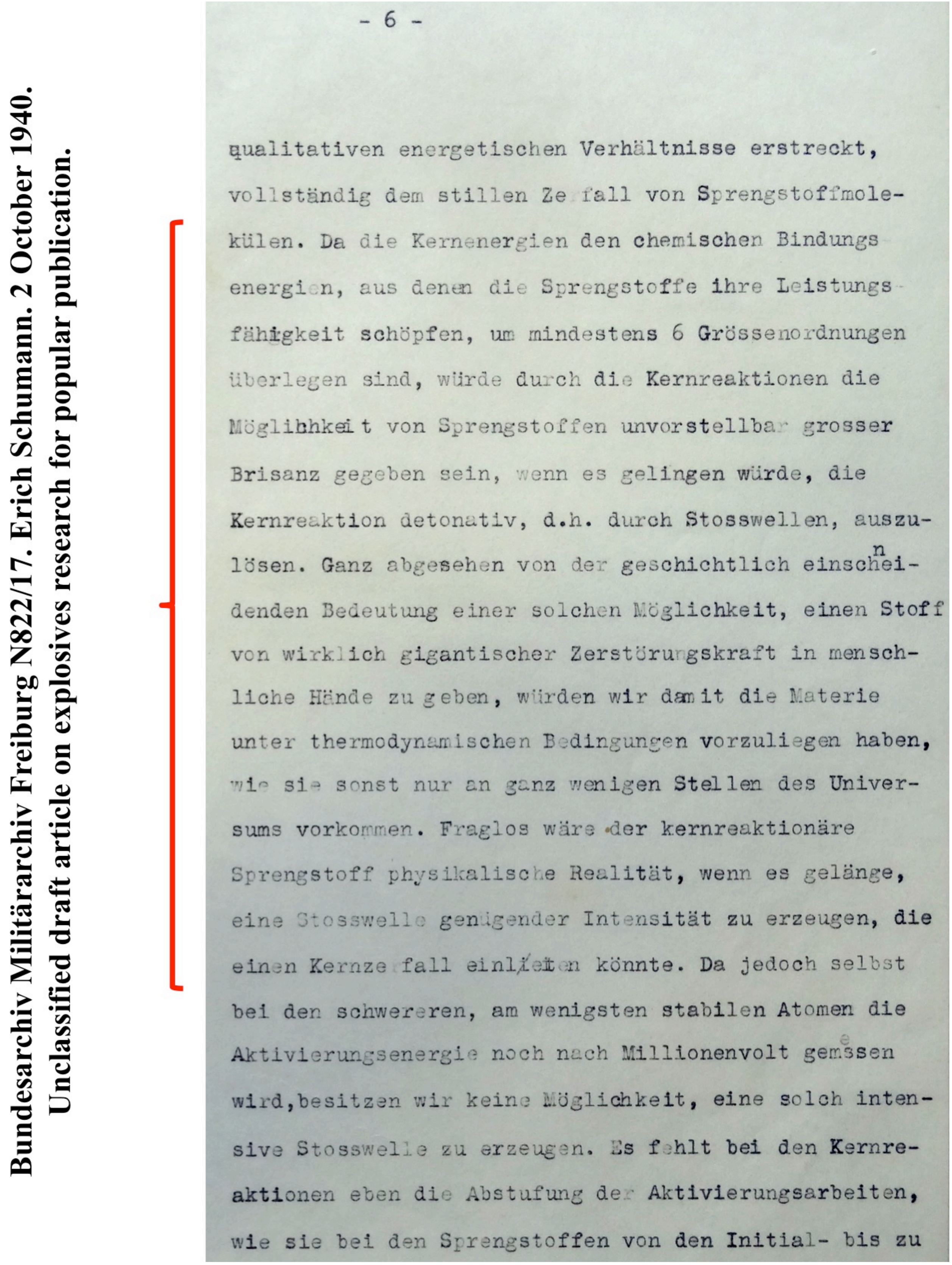


Figure D.585: Pages from Erich Schumann's 2 October 1940 unclassified draft article on explosives research, intended for popular publication but never published, mentioning an ongoing German military program on nuclear bombs using implosion [Bundesarchiv Militärarchiv Freiburg N822/17].



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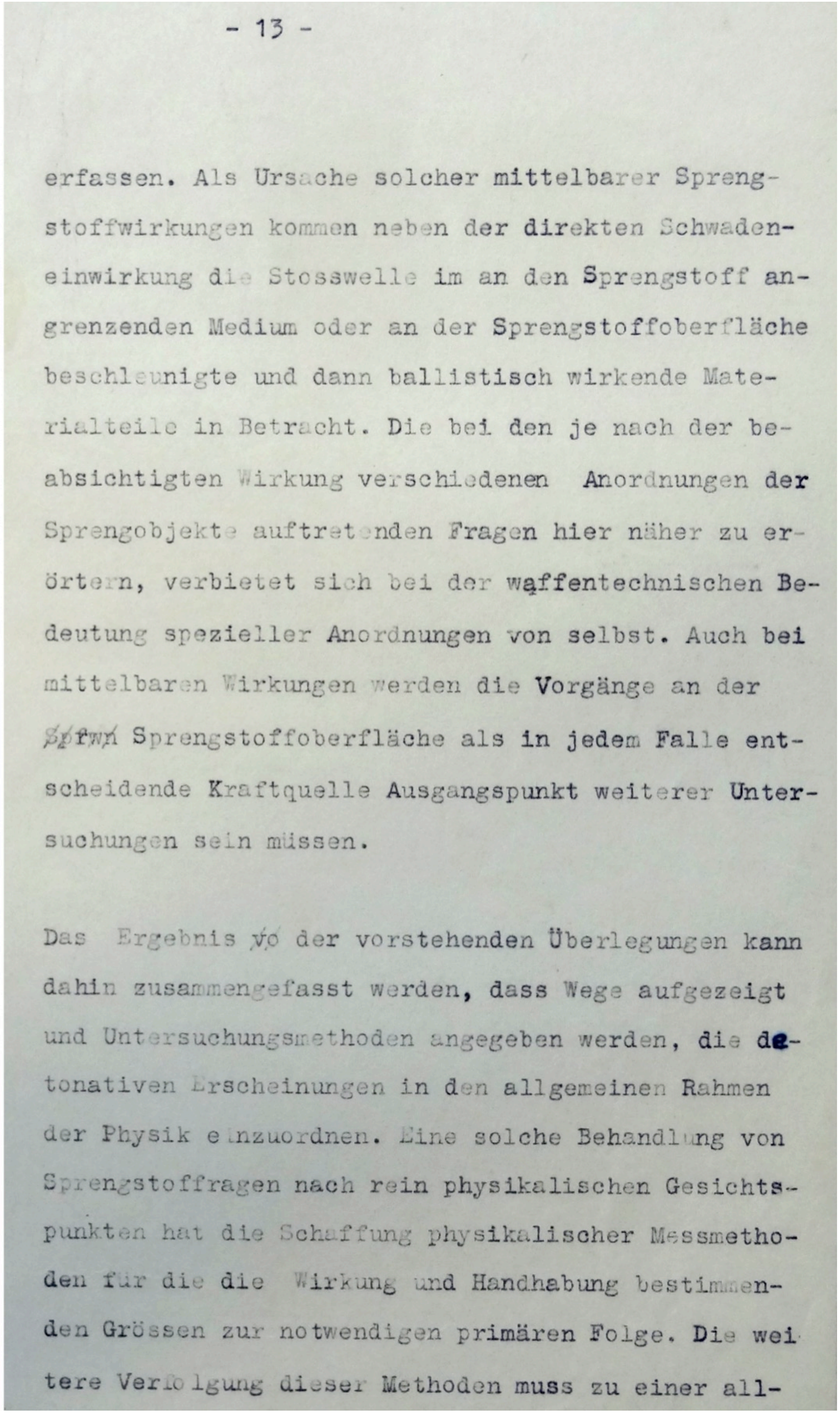
qualitativen energetischen Verhältnisse erstreckt,
vollständig dem stillen Zerfall von Sprengstoffmole-
külen. Da die Kernenergien den chemischen Bindungs
energien, aus denen die Sprengstoffe ihre Leistungs-
fähigkeit schöpfen, um mindestens 6 Grössenordnungen
überlegen sind, würde durch die Kernreaktionen die
Möglibhkeit von Sprengstoffen unvorstellbar grosser
Brisanz gegeben sein, wenn es gelingen würde, die
Kernreaktion detonativ, d.h. durch Stosswellen, auszu-
lösen. Ganz abgesehen von der geschichtlich einschnei-
denden Bedeutung einer solchen Möglichkeit, einen Stoff
von wirklich gigantischer Zerstörungskraft in mensch-
liche Hände zu geben, würden wir damit die Materie
unter thermodynamischen Bedingungen vorzuliegen haben,
wie sie sonst nur an ganz wenigen Stellen des Univer-
sums vorkommen. Fraglos wäre der kernreaktionäre
Sprengstoff physikalische Realität, wenn es gelänge,
eine Stosswelle genügender Intensität zu erzeugen, die
einen Kernzerfall einleiten könnte. Da jedoch selbst
bei den schwereren, am wenigsten stabilen Atomen die
Aktivierungsenergie noch nach Millionenvolt gemessen
wird, besitzen wir keine Möglichkeit, eine solch inten-
sive Stosswelle zu erzeugen. Es fehlt bei den Kernre-
aktionen eben die Abstufung der Aktivierungsarbeiten,
wie sie bei den Sprengstoffen von den Initial- bis zu

Figure D.586: Pages from Erich Schumann's 2 October 1940 unclassified draft article on explosives research, intended for popular publication but never published, mentioning an ongoing German military program on nuclear bombs using implosion [Bundesarchiv Militärarchiv Freiburg N822/17].

Bundesarchiv Militärarchiv Freiburg N822/17. Erich Schumann. 2 October 1940.
Unclassified draft article on explosives research for popular publication.



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erfassen. Als Ursache solcher mittelbarer Sprengstoffwirkungen kommen neben der direkten Schwadeneinwirkung die Stosswelle im an den Sprengstoff angrenzenden Medium oder an der Sprengstoffoberfläche beschleunigte und dann ballistisch wirkende Materialteile in Betracht. Die bei den je nach der beabsichtigten Wirkung verschiedenen Anordnungen der Sprengobjekte auftretenden Fragen hier näher zu erörtern, verbietet sich bei der waffentechnischen Bedeutung spezieller Anordnungen von selbst. Auch bei mittelbaren Wirkungen werden die Vorgänge an der ~~Spfwn~~ Sprengstoffoberfläche als in jedem Falle entscheidende Kraftquelle Ausgangspunkt weiterer Untersuchungen sein müssen.

Das Ergebnis ~~vo~~ der vorstehenden Überlegungen kann dahin zusammengefasst werden, dass Wege aufgezeigt und Untersuchungsmethoden angegeben werden, die detonativen Erscheinungen in den allgemeinen Rahmen der Physik einzuordnen. Eine solche Behandlung von Sprengstoffragen nach rein physikalischen Gesichtspunkten hat die Schaffung physikalischer Messmethoden für die die Wirkung und Handhabung bestimmenden Grössen zur notwendigen primären Folge. Die weitere Verfolgung dieser Methoden muss zu einer all-

Figure D.587: Pages from Erich Schumann's 2 October 1940 unclassified draft article on explosives research, intended for popular publication but never published, mentioning an ongoing German military program on nuclear bombs using implosion [Bundesarchiv Militärarchiv Freiburg N822/17].

Erich Schumann, Kurt Diebner, et al. February 1942 [1941 data]. *Energiegewinnung aus Uran: Ergebnisse der vom Heereswaffenamt veranlassten Forschungsarbeiten zur Nutzbarmachung von Atomkernenergien.* Archiv der Max-Planck-Gesellschaft, I. Abteilung, Rep. 34, Nr. 105. See photos of a few pages on pp. 4246–4248.

b. Sprengstoff. Die störende Wirkung von U_{238} nimmt mit wachsender Temperatur zu. Ein Sprengstoff würde daher höchstens sehr kleine Mengen von U_{238} erhalten dürfen. Außer der vollständigen Isotopentrennung, die grundsätzlich sicher durchführbar, aber technisch sehr schwierig ist, kommen wir heute theoretisch einen zweiten Web zur Herstellung eines Sprengstoffs, der aber erst erprobt werden kann, wenn eine Uranmaschine läuft. Aus U_{238} bildet sich nämlich durch die Absorption von Neutronen ein Stoff ("Element 94"), der noch leichter spaltbar sein muss als U_{235}. Da dieser Stoff chemisch von Uran verschieden ist, muss man ihn aus dem Uran einer stillgelegten Maschine leicht abtrennen können. Doch kennen wir heute weder die Menge, in der er entsteht, noch seine Eigenschaften genau genug für eine ganz sichere Voraussage.

Da sich in jeder Substanz einige freie Neutronen befinden, würde es zur Entzündung des Sprengstoffs genügen, eine hinreichende Menge (vermutlich etwa 10–100 kg) räumlich zu vereinigen.

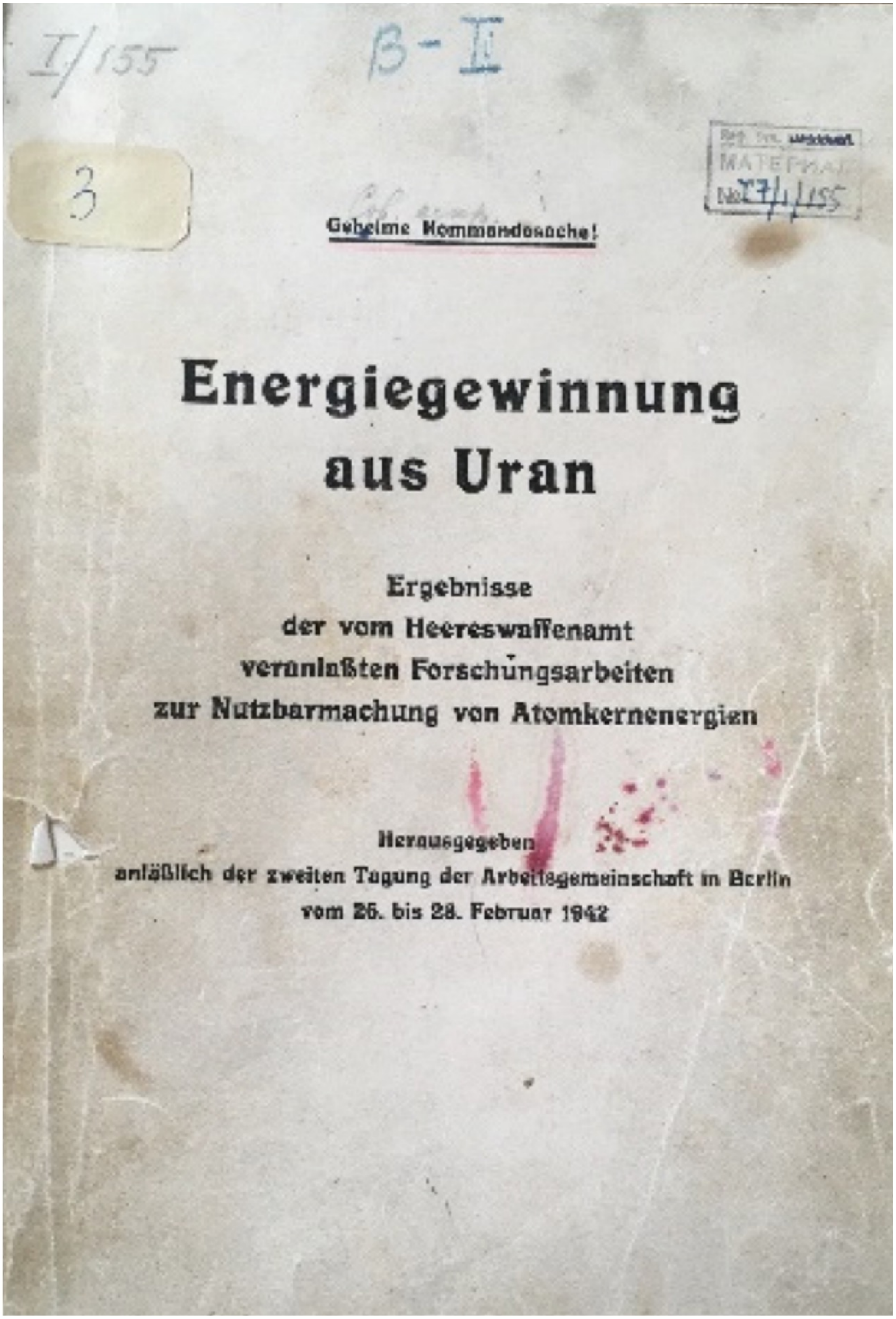
b. Explosive. The disruptive effect of U_{238} increases with increasing temperature. An explosive would therefore only be allowed to contain very small quantities of U_{238} at most. Apart from the complete separation of isotopes, which can be carried out safely in principle but is technically very difficult, we now have a second theoretical way of producing an explosive, but this can only be tested when a uranium machine is running. From U_{238} a substance ("element 94") is formed by the absorption of neutrons, which must be even easier to fission than U_{235}. Since this substance is chemically different from uranium, it must be possible to separate it easily from the uranium of a previously operating machine [used reactor fuel]. But today we know neither the amount in which it is produced nor its properties precisely enough for a completely safe prediction.

Since there are some free neutrons in each substance, it would be enough to spatially combine a sufficient amount (probably about 10–100 kg) to ignite the explosive.

[Erich Schumann and his colleagues at the Heereswaffenamt (including Kurt Diebner) created this secret compendium and presented it to the German government in February 1942. Thus the major results in it are from 1941 or earlier. This document demonstrates that as of 1941, German scientists:

- Were actively working to develop a fission bomb, not just a reactor.
- Knew that ^{235}U could be separated from ^{238}U and that highly enriched ^{235}U would be quite suitable for use in a fission bomb.
- Knew that plutonium-239 (element 94) could be bred from ^{238}U in a fission reactor, could be chemically separated from the remaining uranium afterward, and would be highly suitable for use in a fission bomb.
- Knew that 10–100 kg of sufficiently pure fission fuel should be enough for a fission bomb. This is a very early and excellent conservative estimate of the required mass (compare the values in the table on p. 5208 for the case of no compression, no reflector, and no fusion boosting). It clearly disproves postwar historical myths claiming that Germans did not know the required mass or mistakenly believed it to be several tons.
- Knew that a bomb would need to "spatially combine" that fission fuel on a sufficiently rapid timescale before the explosion. That seems to be a clear connection to the work on implosion designs that Schumann and his colleagues had already been developing for quite some time.]

Archiv der Max-Planck-Gesellschaft, I. Abteilung, Rep. 34, Nr. 105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B-II

3

Geheime Kommandosache!

Energiegewinnung
aus Uran

Ergebnisse
der vom Heereswaffenamt
veranlaßten Forschungsarbeiten
zur Nutzbarmachung von Atomkernenergien

Herausgegeben
anläßlich der zweiten Tagung der Arbeitsgemeinschaft in Berlin
vom 26. bis 28. Februar 1942

Figure D.588: Pages from Erich Schumann's February 1942 compendium, *Energiegewinnung aus Uran: Ergebnisse der vom Heereswaffenamt veranlassten Forschungsarbeiten zur Nutzbarmachung von Atomkernenergien*, informing the German government that an atomic bomb can be made with 10–100 kg of fissile material [Archiv der Max-Planck-Gesellschaft, I. Abteilung, Rep. 34, Nr. 105].

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(im allgemeinen Wasserstoff) enthält. Beim Zusammenstoß mit diesen Atomen geben die Neutronen ihre Energie ab und werden so abgebremst. Es ist günstig, die Bremssubstanz nicht mit dem Uran zu mischen, sondern die Maschine aus abwechselnden Schichten von Uran und Bremssubstanz aufzubauen; denn dann kommt ein Neutron, das einmal in die Bremssubstanz eingetreten ist, im allgemeinen nicht wieder mit einem Uranatom in Berührung, ehe es seine ursprüngliche Energie abgegeben hat und dadurch für die Spaltung von U_{235} hochwirksam geworden ist.

Die Bremssubstanz selbst absorbiert freilich ebenfalls Neutronen. Man muß deshalb möglichst schwach absorbierende Bremssubstanzen wählen. Für eine Maschine mit natürlichem Uran kommt als Bremssubstanz nach unserer heutigen Kenntnis nur schwerer Wasserstoff (Deuterium) in Betracht, der leider nur als sehr geringe Beimengung des gewöhnlichen Wasserstoffs vorkommt und in mühsamen Verfahren abgetrennt werden muß.

Eine völlige Trennung der beiden Uranisotopen voneinander liegt technisch noch in weiter Ferne. Aussichtsreich ist aber eine Anreicherung von U_{235} etwa auf das Doppelte der ursprünglichen Menge. Dadurch würde der störende Einfluß des U_{238} vermindert; man würde kleinere Maschinen bauen und vermutlich gewöhnlichen Wasserstoff als Bremssubstanz verwenden können.

b. Sprengstoff. Die störende Wirkung von U_{238} nimmt mit wachsender Temperatur zu. Ein Sprengstoff würde daher höchstens sehr kleine Mengen von U_{238} enthalten dürfen. Außer der vollständigen Isotopentrennung, die grundsätzlich sicher durchführbar, aber technisch sehr schwierig ist, kennen wir heute theoretisch einen zweiten Weg zur Herstellung eines Sprengstoffs, der aber erst erprobt werden kann, wenn eine Wärmemaschine läuft. Aus U_{238} bildet sich nämlich durch die Absorption von Neutronen ein Stoff ("Element 94"), der noch leichter spaltbar sein muß als U_{235}. Da dieser Stoff chemisch vom Uran verschieden ist, muß man ihn aus dem Uran einer stillgelegten Maschine leicht abtrennen können. Doch kennen wir heute weder die Menge, in der er entsteht, noch seine Eigen-

Figure D.589: Pages from Erich Schumann's February 1942 compendium, *Energiegewinnung aus Uran: Ergebnisse der vom Heereswaffenamt veranlassten Forschungsarbeiten zur Nutzbarmachung von Atomkernenergien*, informing the German government that an atomic bomb can be made with 10–100 kg of fissile material [Archiv der Max-Planck-Gesellschaft, I. Abteilung, Rep. 34, Nr. 105].

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schaften genau genug für eine ganz sichere Voraussage.

Da sich in jeder Substanz einige freie Neutronen befinden, würde es zur Entzündung des Sprengstoffs genügen, eine hinreichende Menge (vermutlich etwa 10 - 100 kg) räumlich zu vereinigen.

3. Experimentelle Untersuchung der Materialien.

Die Arbeitsgruppe hat zahlreiche Experimente durchgeführt, die im wesentlichen drei verschiedene Ziel verfolgten:

1. Genaue Kenntnis des Spaltungsvorgangs (Bericht III 1)
2. Feststellung der zum Bau der Maschine geeigneten Materialien.
3. Feststellung der richtigen Menge, räumlichen Anordnung und Dimensionierung der verwendeten Materialien.

Das erste Ziel ist rein wissenschaftlich und soll lediglich der technischen Anwendung eine möglichst breite Erkenntnisgrundlage liefern. Das zweite und dritte Ziel sind technischer Natur. Um diese beiden letzten Ziele zu erreichen, wurden zwei Sorten von Experimenten ausgeführt:

1. Untersuchung einzelner Materialien (Bericht III 2)
2. Modellversuche (Bericht III 3)

Es hat sich als notwendig erwiesen, die kernphysikalischen Eigenschaften der Materialien sehr viel genauer zu bestimmen, als es früher üblich war. Die Modellversuche prüfen eine der geplanten Maschine ähnliche, aber kleinere Anordnung; sie werden entsprechend den Fortschritten der Materialbeschaffung mit immer größeren Anordnungen wiederholt und sollen so schließlich zum Bau der ersten Maschine überleiten.

Das wichtigste Ergebnis der Experimente ist, daß aus etwa 5 to Uranmetall und 5 to schwerem Wasser eine selbsttätige Maschine gebaut werden könnte. Doch sind die genannten

Archiv der Max-Planck-Gesellschaft, I. Abteilung, Rep. 34, Nr. 105

Figure D.590: Pages from Erich Schumann's February 1942 compendium, *Energiegewinnung aus Uran: Ergebnisse der vom Heereswaffenamt veranlassten Forschungsarbeiten zur Nutzbarmachung von Atomkernenergien*, informing the German government that an atomic bomb can be made with 10–100 kg of fissile material [Archiv der Max-Planck-Gesellschaft, I. Abteilung, Rep. 34, Nr. 105].

Erich Schumann and Gerd Hinrichs. March 1943. HEC 2590. *On the Increase of the Effect of Hollow Explosive Slabs Caused by Control of Ignition (Lenses).* English translation. U.K. Imperial War Museum, Duxford Archive. For photos of some pages, see pp. 4250–4255.

By suitable control of the detonation waves in the explosive by means of a lens an increase of efficiency of more than 25% has been achieved with (H 15) explosive slabs for engineers. The application to short projectiles and mines is full of possibilities.

Extensive experiments on explosions have shown in the course of the last year that the effect of the hollow explosive slab can be substantially increased, especially in the case of a hemispherical hollow space, by suitable control of the detonation wave. This shaping of the detonation wave, also called ignition control, makes it possible to influence within certain limits the shaping of the covering material. the most successful means of assisting this is the "lens".

Erich Schumann. 1943. HEC 5919. *The Scientific Basis of the Hollow Charge Effect.* English translation. U.K. Imperial War Museum, Duxford Archive. For photos of some pages, see pp. 4256–4257.

In the g. Kdos. 229/41 Wa F (most secret document) such ignition guides, made of explosives of suitable detonation velocity and interlaid as lens shaped bodies between the ignition point and the hollow space were suggested by myself. [...]

I predicted the possibility of such an effect at the conference of the Academy of Aeronautical Research on 25.10.40[....]

HEC 2590 (English translation). Erich Schumann and Gerd Hinrichs. March 1943.
Report on tests of explosive lenses. Imperial War Museum, Duxford Archive.

H.Kl.
H. E. C. 2 5 9 0 .

(From the Physical Institute No. 2 of the University of Berlin.)

INFORMATION PRELIMINARY TO REPORT 43 / 2

ON THE INCREASE OF THE EFFECT OF HOLLOW EXPLOSIVE SLABS

CAUSED BY CONTROL OF IGNITION (LENSES).

BY PROFESSOR DR. ERICH SCHUMANN AND DR. GERD HEINRICHS.

RESULT :

By suitable control of the detonation waves in the explosive by means of a lens an increase of efficiency of more than 25 % has been achieved with (H 15) explosive slabs for engineers. The application to short projectiles and mines is full of possibilities.

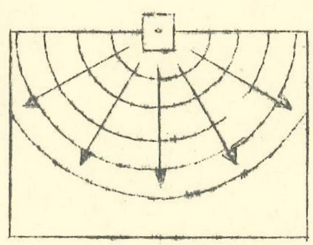
Figure D.591: Excerpts from a March 1943 report by Erich Schumann and Gerd Hinrichs showing the design and successful experimental demonstration of explosive lenses [HEC 2590, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 2590 (English translation). Erich Schumann and Gerd Hinrichs. March 1943.
Report on tests of explosive lenses. Imperial War Museum, Duxford Archive.

H. E. C. 2 5 9 0 / 2 .

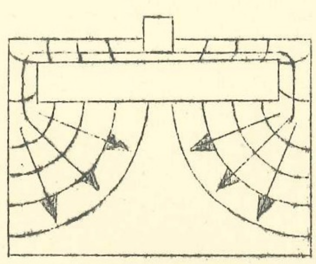
Extensive experiments on explosions have shown in the course of the last year that the effect of the hollow explosive slab can be substantially increased, especially in the case of a hemi-spherical hollow space, by suitable control of the detonation wave. This shaping of the detonation wave, also called ignition control, makes it possible to influence within certain limits the shaping of the covering material. The most successful means of assisting this is the "lens". Below the two most important methods of ignition are to be compared and illustrated.

1) The old point shaped ignition :



The detonation wave advances in the explosive in the form of a spherical wave.

2) The new annular type ignition:

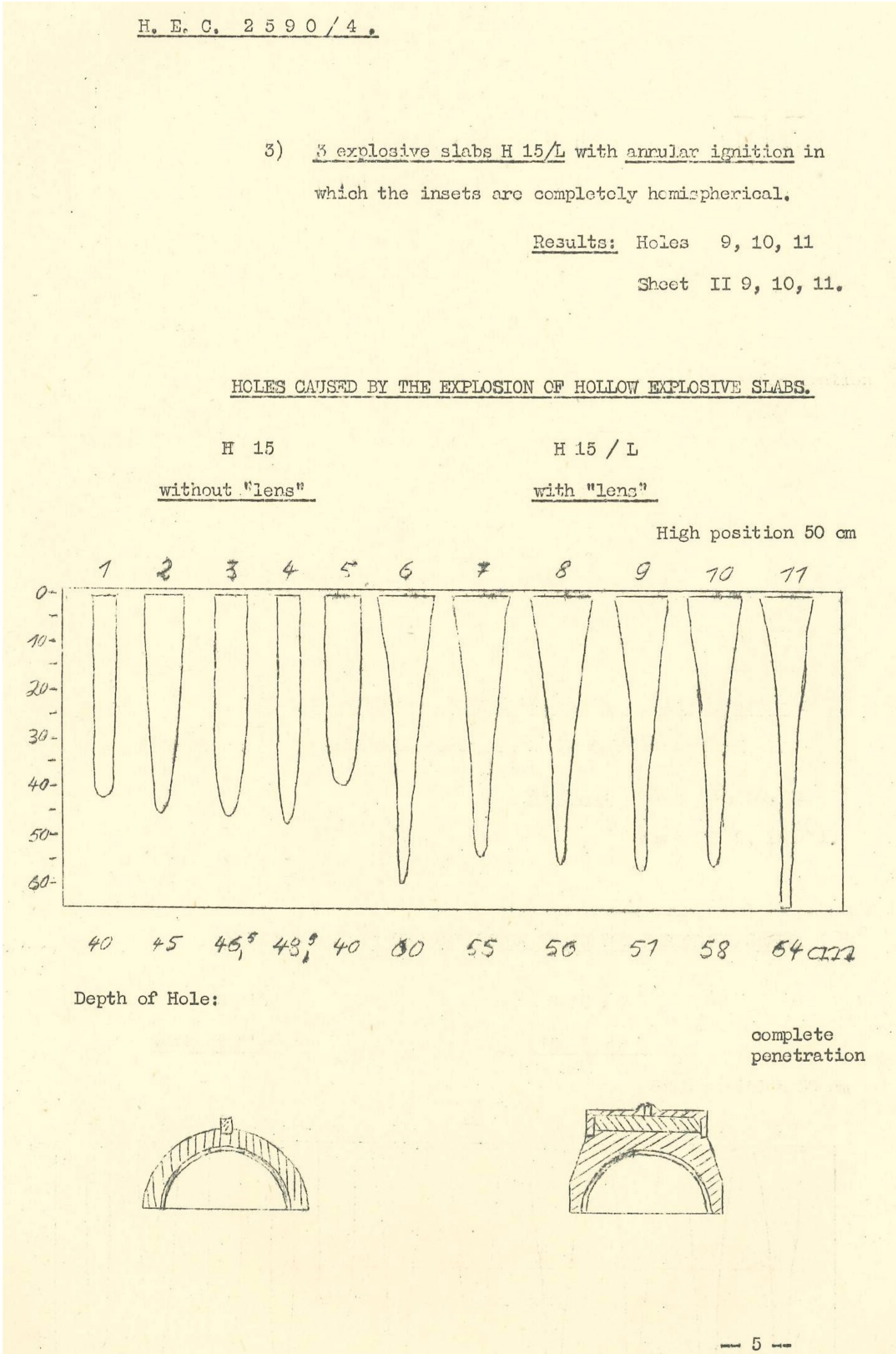


With the assistance of a "lens" made of inexplosive material the detonation wave is forced to ignite the explosive in a circle and to advance in the explosive from this circle in "trumpet form." In this way the detonation wave is better suited to the hollow space forms.

-- 3 --

Figure D.592: Excerpts from a March 1943 report by Erich Schumann and Gerd Hinrichs showing the design and successful experimental demonstration of explosive lenses [HEC 2590, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 2590 (English translation). Erich Schumann and Gerd Hinrichs. March 1943.
Report on tests of explosive lenses. Imperial War Museum, Duxford Archive.



H. E. C. 2590/4.

3) 3 explosive slabs H 15/L with annular ignition in which the insets are completely hemispherical.

Results: Holes 9, 10, 11

Sheet II 9, 10, 11.

HOLES CAUSED BY THE EXPLOSION OF HOLLOW EXPLOSIVE SLABS.

H 15 without "lens"

H 15 / L with "lens"

High position 50 cm

Depth of Hole:

complete penetration

— 5 —

Figure D.593: Excerpts from a March 1943 report by Erich Schumann and Gerd Hinrichs showing the design and successful experimental demonstration of explosive lenses [HEC 2590, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 2590 (English translation). Erich Schumann and Gerd Hinrichs. March 1943. Report on tests of explosive lenses. Imperial War Museum, Duxford Archive.

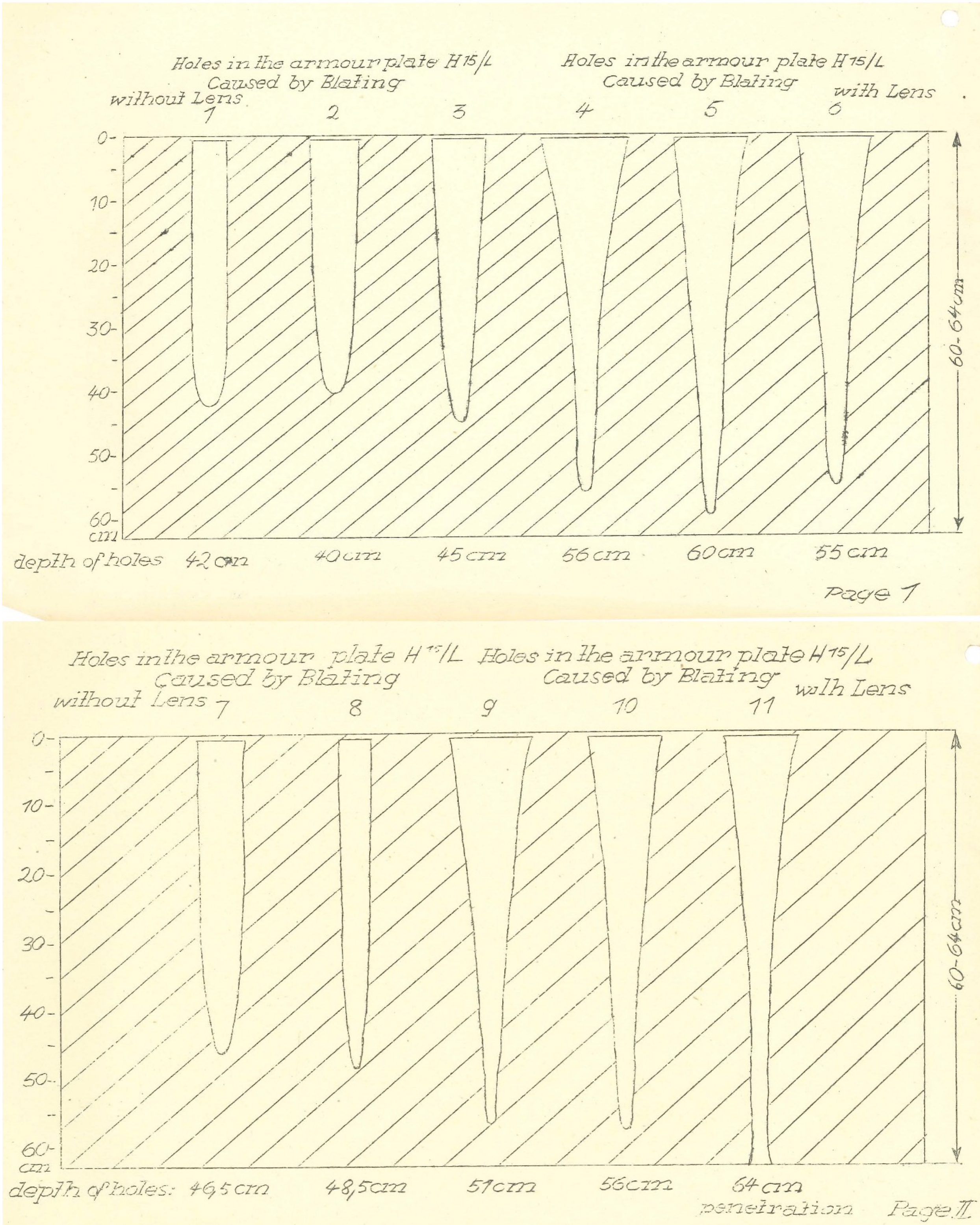


Figure D.594: Excerpts from a March 1943 report by Erich Schumann and Gerd Hinrichs showing the design and successful experimental demonstration of explosive lenses [HEC 2590, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 2590 (English translation). Erich Schumann and Gerd Hinrichs. March 1943. Report on tests of explosive lenses. Imperial War Museum, Duxford Archive.

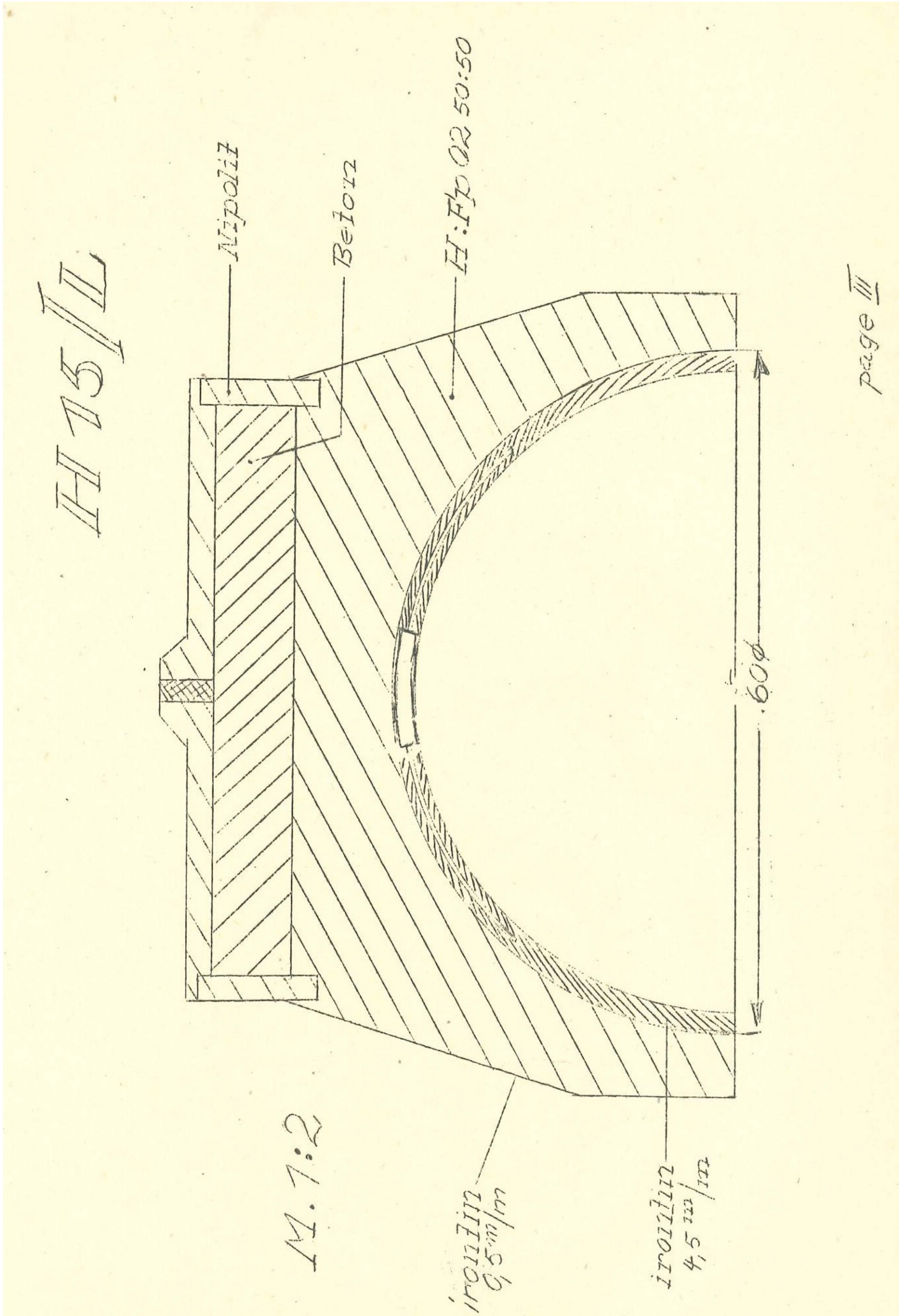


Figure D.595: Excerpts from a March 1943 report by Erich Schumann and Gerd Hinrichs showing the design and successful experimental demonstration of explosive lenses [HEC 2590, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 2590 (English translation). Erich Schumann and Gerd Hinrichs. March 1943.
Report on tests of explosive lenses. Imperial War Museum, Duxford Archive.

Abb. S 1: Versuchsaufbau des Körpers H 15/I.

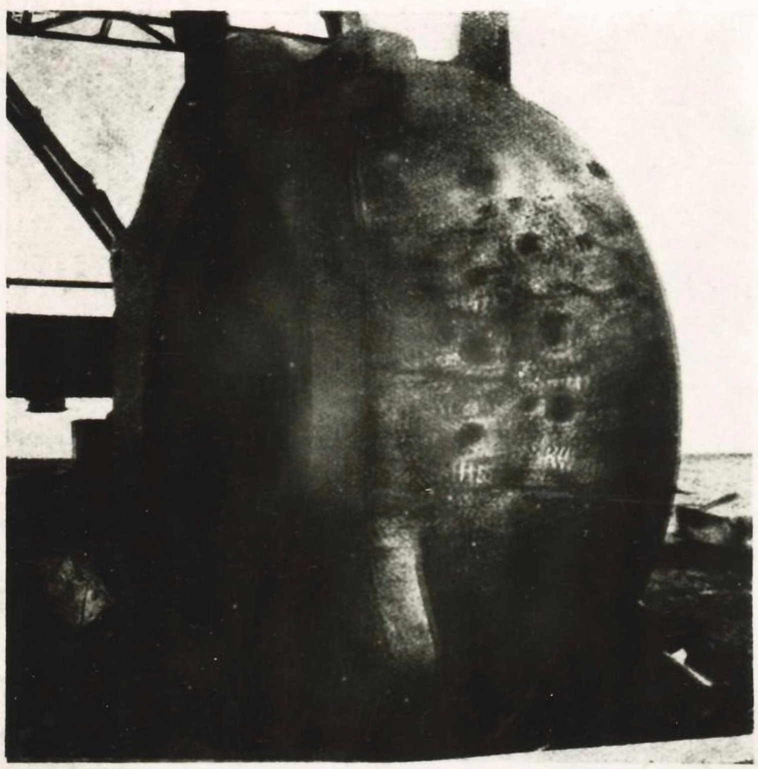


Abb. S 2: Kuppel mit Sprenglöchern der Sprengkörper H 15 u. H 15/I.

Figure D.596: Excerpts from a March 1943 report by Erich Schumann and Gerd Hinrichs showing the design and successful experimental demonstration of explosive lenses [HEC 2590, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 5919 (English translation). Erich Schumann. 1943.
Cites other reports on explosive lenses. Imperial War Museum, Duxford Archive.

H. E. C. 5919/27.

The effective velocity zone of the shell is consequently considerably expanded with coupled charges of this type with various ignition moments (echelon ignition).

Reports will be given shortly regarding the results of tests when firing with hollow charges of this type. Furthermore this arrangement can also be used for firing by means of the second charge smoke, gas or incendiaries through the hole, penetrated by the first charge.

C. Hollow charges with guided ignition.

The focussing process of the active vapours is decisive for the explosive efficiency of a hollow charge. This in itself is not solely dependent on the shape and cavity liner but also on the sequence, in which the individual liner elements are influenced by the detonation front, e.g. being influenced by guiding the detonation wave. In the g. Kdos. 229/41 Wa F (most secret document) such ignition guides, made of explosives of suitable detonation velocity and interlaid as lens shaped badies between the ignition point and the hollow space were suggested by myself. Still more effective and simple in practice is the guiding of the detonation wave by interlaying with inert materials (inert lenses) which do not convey the detonation. The fact that solely by means of guiding the detonating wave in this way a hollow charge effect without employing a cavity (see ill.8), can be achieved is of no little theoretical interest.

-- 28 --

Figure D.597: Excerpts from a 1943 report by Erich Schumann, citing his other reports on explosive lenses going back to 1940 [HEC 5919, English translation, U.K. Imperial War Museum, Duxford Archive].

HEC 5919 (English translation). Erich Schumann. 1943.
Cites other reports on explosive lenses. Imperial War Museum, Duxford Archive.

H. E. C. 5 9 1 9 / 28 .

I predicted the possibility of such an effect at the conference of the Academy of Aeronautical Research on 25.10.40; it was then generally considered to be quite incredible. Practical applications, of course, have not been made with the effect as yet.

However, the application of guided ignition with hollow charges proved to be of considerable importance. Even with the simplest possible construction by means of a disc arranged between the point of ignition and the hollow space (e.g. made of concrete) increases of performance up to 100 % were achieved with some hollow charges-hemispherical hollow space with low lying ignition point.

Even with a highly developed hollow charge as is represented by the Engineers charge H 15 in its latest design, the application of the lens increased the performance by over 25 % (HE physics report 43/2 preliminary report) (E.Schumann and G. Hinrichs : "Increase of effect with hollow charges by means of ignition guiding (lenses)".). A comparison of the penetration performances may be seen in ill. 9. It should be emphasized at this point that the greater depth effect of the lens charge is not connected with a decrease in the diameter of the hole.

For the application of the hemispherical shape with lens it is of importance when using hollow charge shells that with the maximum economy of HE weight the depth effect of distended pointed pointed hollow space shaped is achieved by means of a ballistically more favourable distribution of the mass. Tests regarding the application in shells and mortar shells are in progress.

-- 29 --

Figure D.598: Excerpts from a 1943 report by Erich Schumann, citing his other reports on explosive lenses going back to 1940 [HEC 5919, English translation, U.K. Imperial War Museum, Duxford Archive].

G-303. Walter Herrmann, Georg Hartwig, Heinz Rackwitz, Walter Trinks, and H. Schaub. 1944. ***Versuche über die Einleitung von Kernreaktionen durch die Wirkung explodierender Stoffe.*** **[*Experiments on Initiation of Nuclear Reactions by Explosives.*] Deutsches Museum number FA 002/0721. https://digital.deutsches-museum.de/item/FA-002-721/**

[See document photos on pp. 4260–4262. This report describes one of the long series of Schumann-Trinks implosion experiments. This particular experiment was a simple test using fusion fuel but no fission fuel. The report showed both from experimental measurements and from theoretical calculations that implosion by chemical explosives had far too little energy to produce significant pure fusion reactions. Thus in other documents when members of the Schumann-Trinks group discussed "atomic bombs" that used implosion, they clearly knew that fission fuel was an essential component of such bombs: either fission fuel only, or a combination of fission and fusion fuel. Where are all the other reports on all the other experiments by the Schumann-Trinks group throughout the entire war?]

1) Es wurde des öfteren vorgeschlagen, zur Einleitung von Kern- und Kettenreaktionen die Schwadengeschwindigkeit bei der Explosion von Sprengstoffen zu benutzen. Es sollten dabei die entstehenden Kernprozesse die Wirkung von Explosionsstoffen erhöhen. Obwohl dieser Weg nach einfachen Ueberlegungen ungangbar scheint, wurden, um endlich eine experimentell begründete Aussage darüber geben zu können, auf Anregung von Herrn Prof. Gerlach in der Heeresforschungsstelle Kdf. einige orientierende Versuche durchgeführt.	1) It has often been proposed to use the gas velocity during the explosion of explosives to initiate nuclear and chain reactions. The resulting nuclear processes should increase the effect of explosives. Although this approach seems unfeasible on the basis of simple considerations, in order to finally be able to make an experimentally substantiated statement about it, a number of preliminary tests were carried out at the Army Research Center Kummersdorf at the suggestion of Prof. Gerlach.
2) Durchführung der Versuche: In zylindrische Sprengkörper aus Trinitrotoluol (12 cm Ø, 10 cm Höhe); (5,0 cm Ø, 8 cm Höhe) wurden in der Mitte der Grundfläche kleine Kegel (1,5 cm Ø, 3,0 cm Höhe) aus Deutero-Paraffin eingesetzt. Die im Sprengstoff laufenden Druckwellen sollten die D-Atome des Deutero-Paraffins beschleunigen und durch zusammenstossende D-Atome Neutronen erzeugen. Zum Nachweis dieser D-D-Reaktion wurde unter dem Paraffinkegel ein Silber-Indikator vorgesehen, dessen Aktivität, durch die Neutronen der D-D-Reaktion angeregt, gemessen werden sollte. Die Aktivitätsmessungen wurden mit β-Zählrohr, Verstärker und Zählwerk ausgeführt.	2) Performance of the experiments: Small cones (1.5 cm Ø, 3.0 cm high) of deutero-paraffin were placed in the center of the base of cylindrical explosives made of trinitrotoluene (12 cm Ø, 10 cm high); (5.0 cm Ø, 8 cm high). The pressure waves in the explosive were intended to accelerate the D atoms of the deutero-paraffin and generate neutrons by colliding D atoms. To detect this D-D reaction, a silver indicator was placed under the paraffin cone, the radioactivity of which was to be measured after stimulation by the neutrons of the D-D reaction. The radioactivity measurements were carried out using a β detection tube, amplifier, and counter.

3) Ergebnisse:
Bei zwei Sprengungen mit entsprechend vorbereiteten Spreng-Zylindern (12,0 x 10,0 cm) wurde die Stahlunterlage zerechlagen und von den untergelegten Ag-Folien keine nennenswerten Reste gefunden. Teile der Stahlunterlage zeigten am Zählrohr keine Erhöhung des Null-Effektes (16 Stösse je Minute). Nach einigen Vorversuchen mit Sprengkörpern von 5,0 x 8,0 cm wurden damit zwei Sprengungen durchgeführt und der Silber-Indikator schliesslich zwischen zwei Stahlscheiben von je 3mm Dicke gelegt. Auch die in diesem Falle erhalten gebliebenen mehrere cm^2 grossen Teile des Ag-Bleches (0,3 mm dick) zeigten keine messbare Aktivität.

Rechnet man mit einer häufigsten Schwadengeschwindigkeit von etwa 10^6 cm/sec, dann entspricht diese einer Teilchenenergie von rund 1 e-Volt, d.H. unter Voraussetzung einer Gaussverteilung (Schiefe etwa ___) wird die Hauptmenge aller Teilchen eine Energie von rund 1 eV haben und die Zahl deren, die eine D-D-Reaktion auslösen könnten ($\sim 10^5$ eV), dürften ausserordentlich gering sein (___% von $N_{1\ \mathrm{Volt}}$). Demgemäss kann man also kaum Kernreaktionen in messbarer Grösse erwarten. Hinzu kommt ferner, die Schwierigkeit des Nachweises selbst. Wählt man als Neutronen-Indikator Ag mit der Elektronen-Halbwertszeit von 24 sec, dann ergibt eine einfache Ueberlegung, dass dieser bei der kurzen Reaktionszeit des Sprengstoffes ($\sim 10^{-5}$ sec) nur etwa den 10^{-7} Teil der Aktivität annimmt, den er bei Bestrahlung bis zur Sättigung (~ 8) erreichen würde. Um eine Aktivität von 1 Teilchen/min zu erreichen, müsste also bei Sättigungsbestrahlung der Indikator 10^7 Stösse/1 Min. erzeugen; dies würde etwa einer Neutronenstrahlung entsprechen, die eine 100 Curie Ra-Be-Neutronenquelle emittiert. Eine solche Neutronenstrahlung steht aber im Widerspruch zu der Energie der Explosionsschwaden von etwa 1 eV.

3) Results:
In two blasts with appropriately prepared blasting cylinders (12.0 x 10.0 cm), the steel base was crushed and no significant remains of the Ag foils placed underneath were found. Parts of the steel base showed no increase over the background level (16 counts per minute) on the detection tube. After some preliminary tests with detonators measuring 5.0 x 8.0 cm, two detonations were carried out and the silver indicator was finally placed between two steel disks, each 3 mm thick. Even the parts of the Ag sheet (0.3 mm thick) measuring several cm^2 that remained in this case showed no measurable activity.

If one assumes a most probable gas velocity of about 10^6 cm/sec, then this corresponds to a particle energy of about 1 electron-volt, i.e. assuming a Gaussian distribution (deviation about ___); the bulk of all particles will have an energy of about 1 eV and the number of those that could trigger a D-D reaction ($\sim 10^5$ eV) is likely to be extremely small (___% von $N_{1\ \mathrm{Volt}}$). Accordingly, one can hardly expect nuclear reactions of a measurable amount. In addition, there is the difficulty of the detection itself. If silver with a beta half-life of 24 seconds is chosen as the neutron indicator, then a simple consideration shows that with the short reaction time of the explosive ($\sim 10^{-5}$ seconds) it only attains about 10^{-7} parts of the activity that it would achieve if irradiated to saturation (~ 8). In order to achieve an activity of 1 particle/min, the indicator would therefore have to generate 10^7 counts/1 min at saturation irradiation; this would correspond approximately to neutron radiation emitted by a 100 Curie Ra-Be neutron source. However, such neutron radiation is in contradiction to the energy of the explosion gases of about 1 eV.

Versuche über die Einleitung von Kernreaktionen durch die Wirkung explodierender Stoffe.

Von W. Herrmann, G. Hartwig, H. Rackwitz, Gottow und W. Trinks und H. Schaub, HWA.

1) Es wurde des öfteren vorgeschlagen, zur Einleitung von Kern- und Kettenreaktionen die Schwadengeschwindigkeit bei der Explosion von Sprengstoffen zu benutzen. Es sollten dabei die entstehenden Kernprozesse die Wirkung von Explosionsstoffen erhöhen ~~stören~~. Obwohl dieser Weg nach einfachen Ueberlegungen ungangbar scheint, wurden, um endlich eine experimentell begründete Aussage darüber geben zu können, auf Anregung von Herrn Prof. Gerlach in der Heeresforschungsstelle Kdf. einige orientierende Versuche durchgeführt.

2) Durchführung der Versuche:
In zylindrische Sprengkörper aus Trinitrotoluol (12 cm Ø, 10 cm Höhe; 5,0 cm Ø, 8,0 cm Höhe) wurden in der Mitte der Grundfläche kleine Kegel (1,5 cm Ø, 3,0 cm Höhe) aus Deutero-Paraffin eingesetzt. Die im Sprengstoff laufenden Druckwellen sollten die D-Atome des Deutero-Paraffins beschleunigen und durch zusammenstossende D-Atome Neutronen erzeugen. Zum Nachweis dieser D-D-Reaktion wurde unter dem Paraffinkegel ein Silber-Indikator vorgesehen, dessen Aktivität, durch die Neutronen der D-D-Reaktion angeregt, gemessen werden sollte. Die Aktivitätsmessungen wurden mit β-Zählrohr, Verstärker und Zählwerk ausgeführt.

3) Ergebnisse:
Bei zwei Sprengungen mit entsprechend vorbereiteten Sprengzylindern (12,0 x 10,0 cm) wurde die Stahlunterlage zerschlagen und von den untergelegten Ag-Folien keine nennenswerten Reste gefunden. Teile der Stahlunterlage zeigten am Zählrohr keine Erhöhung des Null-Effektes (16 Stösse je Minute). Nach einigen Vorversuchen mit Sprengkörpern von 5.0 x 8,0 cm wurden damit zwei Sprengungen durchgeführt und der Silber-Indikator schliesslich zwischen zwei Stahlscheiben von je 3mm Dicke gelegt ~~getan~~. Auch die in diesem Falle erhalten gebliebenen mehrere cm^2 grossen Teile des Ag-Bleches (0,3 mm dick) zeigten keine messbare Aktivität.

Rechnet man mit einer häufigsten Schwadengeschwindigkeit von etwa 10^6 cm/sec, dann entspricht diese einer Teilchenenergie von rund 1 eVolt, d.h. unter Voraussetzung einer Gaussverteilung (Schiefe etwa) wird die Hauptmenge aller Teilchen eine Energie von rund 1 eV haben und die Zahl derer, die eine D-D-Reaktion auslösen könnten ($\sim 10^5$ eV), dürften ausserordentlich gering sein (% von $N_{1\ Volt}$). Demgemäss kann man also kaum Kernreaktionen in messbarer Grösse erwarten. Hinzu kommt ferner, die Schwierigkeit des Nachweises selbst. Wählt man als Neutronen-Indikator Ag mit der Elektronen-Halbwertszeit von 24 sec, dann ergibt eine einfache Ueberlegung, dass dieser bei der kurzen Reaktionszeit des Sprengstoffes (10^{-5} sec) nur etwa den 10^{-7} Teil der Aktivität annimmt, den er bei Bestrahlung bis zur Sättigung ($\sim 8^{-}$) erreichen würde. Um eine Aktivität von 1 Teilchen / min zu erreichen, müsste also bei Sättigungsbestrahlung der Indikator 10^7 Stösse/ 1 Min. erzeugen; dies würde etwa einer Neutronenstrahlung entsprechen, die eine 100 Curie Ra-Be-Neutronenquelle emittiert. Eine solche Neutronenstrahlung steht aber im Widerspruch zu der Energie der Explosionsschwaden von etwa 1 eV.

Figure D.599: G-303. Walter Herrmann, Georg Hartwig, Heinz Rackwitz, Walter Trinks, and H. Schaub. 1944. *Versuche über die Einleitung von Kernreaktionen durch die Wirkung explodierender Stoffe.* Deutsches Museum number FA 002/0721. https://digital.deutsches-museum.de/item/FA-002-721/

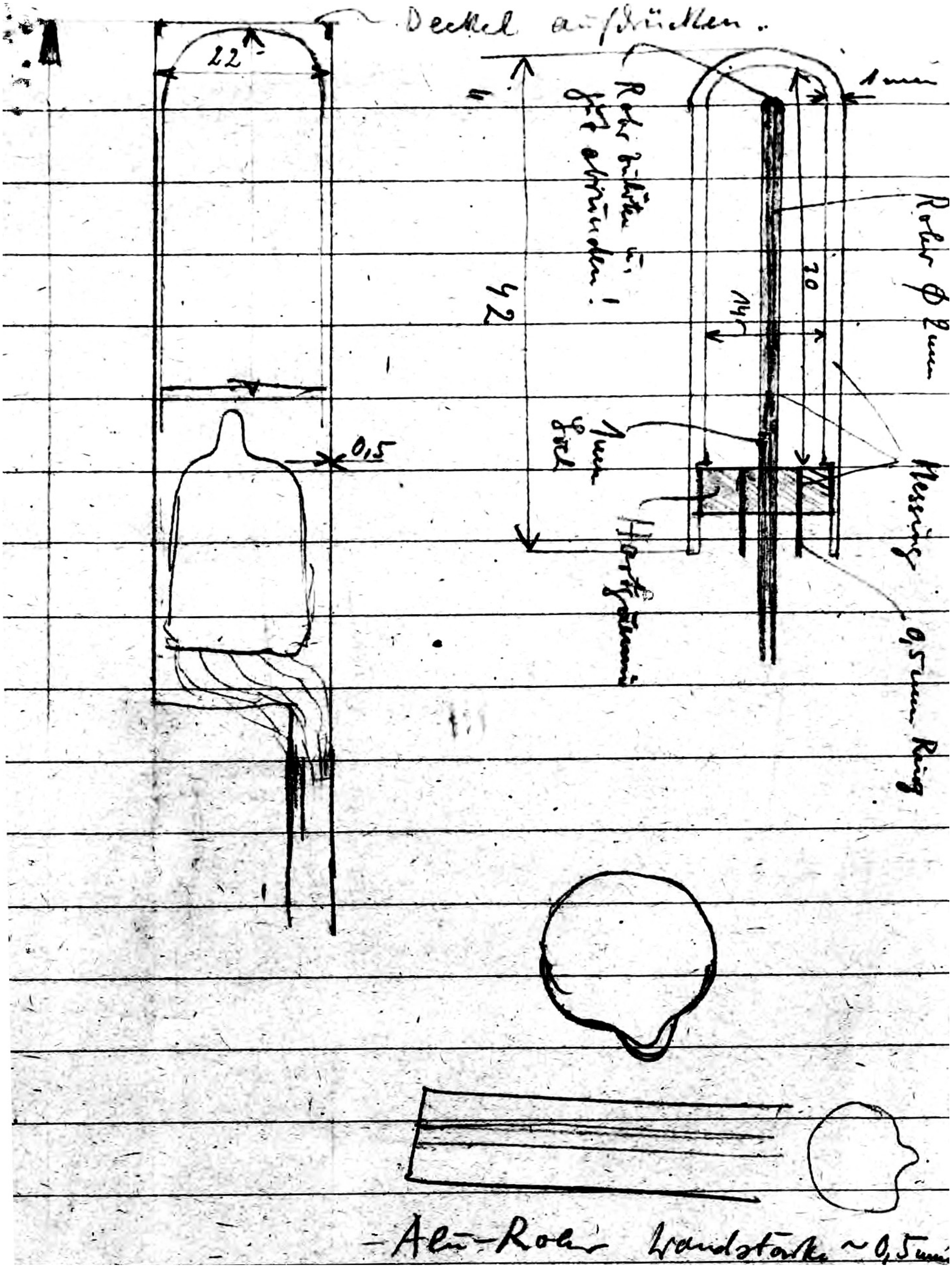


Figure D.600: G-303. Walter Herrmann, Georg Hartwig, Heinz Rackwitz, Walter Trinks, and H. Schaub. 1944. *Versuche über die Einleitung von Kernreaktionen durch die Wirkung explodierender Stoffe.* Deutsches Museum number FA 002/0721. https://digital.deutsches-museum.de/item/FA-002-721/

Rechnung zu der Arbeit Herrmann – Trinks.

N_t = Anzahl der aktiven Atome nach der Bestrahlungszeit t

N_∞ = " " " " " t_∞ (Sättigung)

$N_t = N_\infty(1-e^{-\lambda t}) = N_\infty(1-e^{-\frac{0,693}{T}\cdot t})$

$= N_\infty(1-e^{-\frac{0,693}{25}\cdot 10^{-5}})$

$\boxed{\begin{array}{l} HWZ\ T = 25\ sec \\ t = 10^{-5}\ sec \end{array}}$

$N_t = N_\infty(1-e^{-2,8\cdot10^{-7}})$

$\ln(e^{-2,8\cdot10^{-7}}) = -2,8\cdot10^{-7}$

$\frac{-2,8\cdot10^{-7}}{Mod(2,30)} = \log(e^{-2,8\cdot10^{-7}}) \sim -10^{-7} = \log f$

$0 - 10^{-7} = \log f$

$\underbrace{(1-10^{-7})-1}_{\text{Stellenzahl}} = \log f$

Näherungsweise ist für $\log a \to 1 : a \to 1$

Also $e^{-\lambda t} = 1-10^{-7}$

$1-e^{-\lambda t} = \cancel{1-1}+10^{-7} \cong 10^{-7}$

also ist: $\boxed{N_t = 10^{-7}\times N_\infty}$

Ausdehnstahl Rohr Ø 14 mm

Messingrohr 2 mm Ø $l \geqq 10$ cm

oder Vollmessing 2 mm Ø, $l \geqq 10$ cm

Bohrer 0,5 mm, Arbeitslänge 6 cm

Orka- Wotha Export.

0,5 g Ra-Be geben ~ $10^5 / 1''$ (Herrmann)

Figure D.601: G-303. Walter Herrmann, Georg Hartwig, Heinz Rackwitz, Walter Trinks, and H. Schaub. 1944. *Versuche über die Einleitung von Kernreaktionen durch die Wirkung explodierender Stoffe.* Deutsches Museum number FA 002/0721. https://digital.deutsches-museum.de/item/FA-002-721/

Erich Schumann. 1949. *Die Wahrheit über die deutschen Arbeiten und Vorschläge zum Atomenergie-Problem (1939–45).* Unpublished manuscript from Schumann estate [courtesy of Rainer Karlsch].

[This manuscript is an unfinished, unpublished attempt by Schumann to describe the parts of the German nuclear program with which he was involved. In its current form, the manuscript is missing many pages, and those that do exist are often simply abbreviated notes for what Schumann intended to write.]

[S. 38] Wenn über die in Deutschland gegen Kriegsende geplanten und vorbereiteten Versuche bisher nichts berichtet worden ist, so hat das seinen Grund darin, das nur wenige Wissenschaftler darüber unterrichtet waren und die Akten im April 1945 vernichtet werden mußten.

[p. 38] If nothing has been reported about the experiments planned and prepared in Germany towards the end of the war, this is due to the fact that only a few scientists were informed and the files had to be destroyed in April 1945.

[S. 39] Diese Vorschläge, die ich im Herbst 1944 dem Chef des Heereswaffenamts, General d. Art. Leeb, vorlegte, basieren auf gemeinsam mit Trinks angestellten Überlegungen im Anschluss an unsere Arbeiten[2)] auf dem Gebiet der Sprengstoffphysik.

2) niedergelegt in den Berichten des Reichsforschungsrats (Sprengstoffphysikberichte, herausgegeben vom Bevollmächtigten für Sprengstoffphysik), ferner in den Berichten der Forschungsabteilung des Heereswaffenamts und in etwa 40 Geheimpatentschriften.

[p. 39] These proposals, which I submitted to the Chief of the Army Ordnance Office in the fall of 1944, General d. Art. Leeb, presented, are based on considerations shared with Trinks following our work in the field of explosives physics[2)].

2) set forth in the reports of the Reich Research Council (Explosives Physics Reports, issued by the Explosives Physics Commissioner), in the reports of the Army Ordnance Research Department and in about 40 secret patents.

[S. 121] Immer wieder, insbesondere in der Presse und von nicht kompetenten Stellen wird behauptet, Hitler habe an die A-Bomb geglaubt, diese sei die unausgesprochene Wunderwaffe in seinen Bluffreden gewesen.

Alle mit der Atomangelegenheit sachlich befassten amtlichen Stellen wissen, dass das nicht der Fall war. Erst Ende 1941 ist Hitler durch den Postminister Dr. Ohnesorge über das Atomenergieproblem unterrichtet worden. [...] Hitler war skeptisch und lehnte ab, noch schärfer als bei seiner Unterrichtung über die Rakete.

[p. 121] Again and again, especially in the press and from incompetent sources, it is alleged that Hitler had believed in the A-bomb, which had been the unspoken miracle weapon in his bluffing stories.

All the official bodies concerned with the nuclear issue know that this was not the case. At the end of 1941, Hitler was briefed by the postmaster Ohnesorge about the nuclear energy problem. [...] Hitler was skeptical and rejected it, even more sharply than his briefing on the rocket.

[S. 127] Im übrigen machte sich schon der Einfluss der Waffen-SS geltend, der dahin ging, ein eigenes Waffenamt aufzubauen und es selbstverständlich ablehnte, dass das OKW in irgendeiner Weise hinein zureden vermochte.

[p. 127] Moreover, the influence of the Waffen-SS, which set out to set up its own weapons office and, of course, refused to allow the Army to speak in any way, became apparent.

[S. 131] Deutschland hat nie reines ^{235}U in nennenswerten Mengen hergestellt; nur Harteck 1943 bis 44 mittels Zentrifuge (Anreicherung). Clusius-Verfahren ging nicht, weil Thermodiffusionskoeffizient negativ war.

[p. 131] Germany never made pure ^{235}U in appreciable quantities; only Harteck 1943 to 44 by means of centrifuge (enrichment). Clusius method did not work because thermal diffusion coefficient was negative.

[Erich Schumann's implosion systems would have been highly suitable for compressing fission fuel, thus making a complete fission bomb. In this manuscript, Schumann did not describe that; with the highly compartmentalized security of German secret weapons programs, he may not have known much about it. In any event, with postwar Allied interrogations, trials, prison sentences, and executions of Germans who had performed various tasks during the war, Schumann certainly would not have wanted to admit anything that he had known or been involved with.

Schumann stated that he filed "about 40 secret patents" during the war, which presumably covered the material for which he was granted patents in the postwar period. The view that Schumann's postwar papers reflect wartime work is strongly supported by the fact that in August 1945, the U.S. Army Ordnance Technical Intelligence office publicly stated that based on evidence they had collected, Erich Schumann was a "brilliant scientist" who "did much outstanding work" "in the development of atomic bombs"; other U.S. officials then threatened the Ordnance Technical Intelligence office "against making further statements on this subject" (p. 4225). The importance of Schumann's work is supported by Erwin Respondek's 1945 testimony too (p. 4232). The notion that Schumann's postwar papers accurately reflect wartime work is also supported by an April 1947 Russian report that is highly similar to Schumann's work and likely based on some of his wartime papers that were captured by the Russians [Kozyrev 2005].

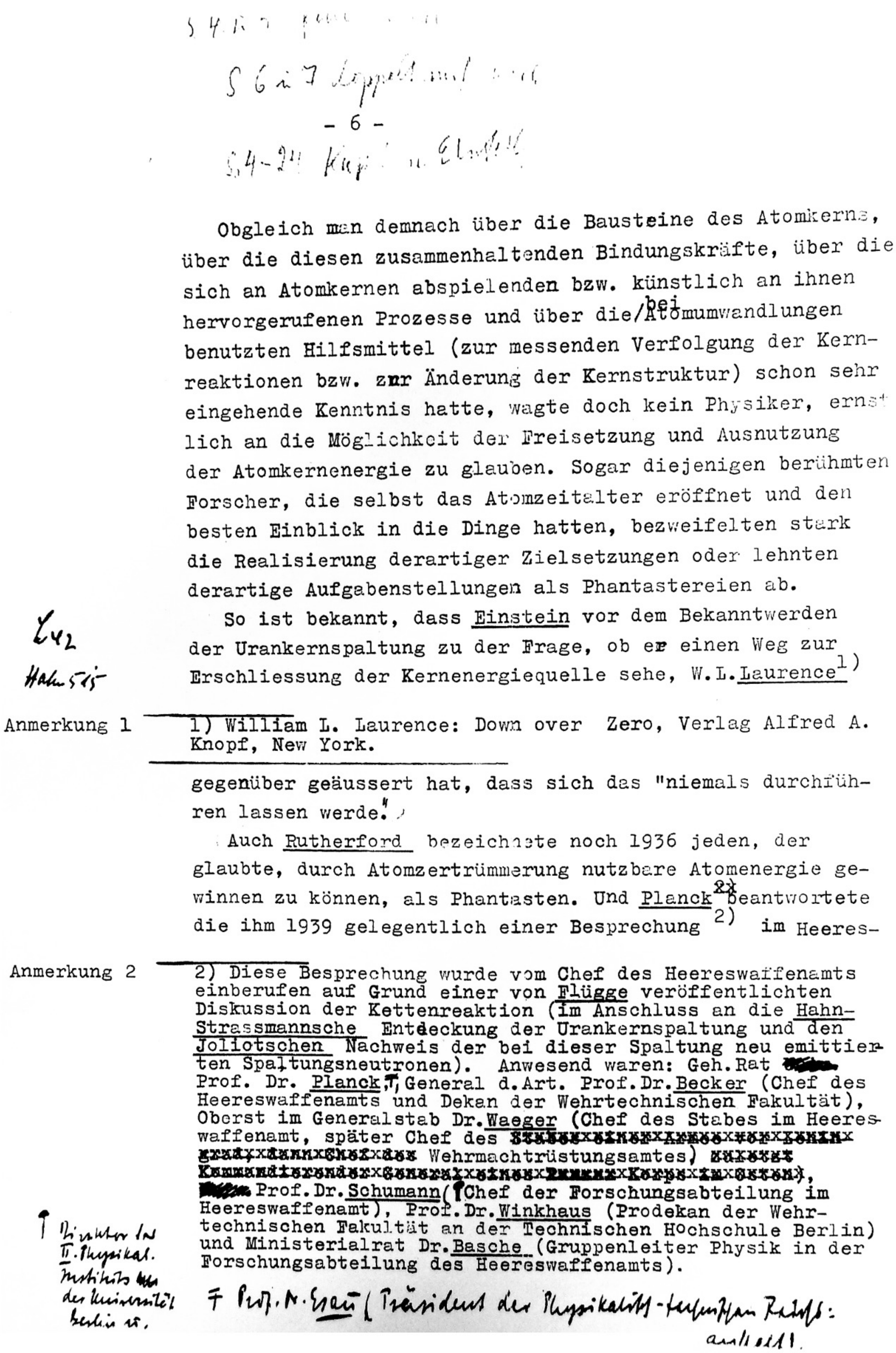
Schumann confirmed (1) the fact that the SS eclipsed the Army Ordnance in the German nuclear program, (2) the extreme secrecy of the nuclear program during the war, and (3) the destruction of evidence at the end of the war, all consistent with the testimony of Werner Grothmann.

Schumann wrote that he was unaware of enriched uranium sources other than Paul Harteck's centrifuges. Yet Werner Holtz and Werner Schwietzke in his own Army Ordnance Office spent several years developing uranium centrifuges (pp. 3560–3562); the fact that Schumann completely omitted any mention of that fact demonstrates that he withheld important information in this and other writings.]

1

Bucheinteilung

Figure D.602: The table of contents of an unpublished 1949 manuscript by Erich Schumann, describing some (but only some) of the wartime German nuclear work.



S 6 u 7 doppelt

- 6 -

S 4-24 Kopie u. Einschl.

Obgleich man demnach über die Bausteine des Atomkerns, über die diesen zusammenhaltenden Bindungskräfte, über die sich an Atomkernen abspielenden bzw. künstlich an ihnen hervorgerufenen Prozesse und über die/bei Atomumwandlungen benutzten Hilfsmittel (zur messenden Verfolgung der Kernreaktionen bzw. zur Änderung der Kernstruktur) schon sehr eingehende Kenntnis hatte, wagte doch kein Physiker, ernstlich an die Möglichkeit der Freisetzung und Ausnutzung der Atomkernenergie zu glauben. Sogar diejenigen berühmten Forscher, die selbst das Atomzeitalter eröffnet und den besten Einblick in die Dinge hatten, bezweifelten stark die Realisierung derartiger Zielsetzungen oder lehnten derartige Aufgabenstellungen als Phantastereien ab.

L 42

Hahn 515

So ist bekannt, dass Einstein vor dem Bekanntwerden der Urankernspaltung zu der Frage, ob er einen Weg zur Erschliessung der Kernenergiequelle sehe, W.L.Laurence[1)]

Anmerkung 1 — 1) William L. Laurence: Down over Zero, Verlag Alfred A. Knopf, New York.

gegenüber geäussert hat, dass sich das "niemals durchführen lassen werde."

Auch Rutherford bezeichnete noch 1936 jeden, der glaubte, durch Atomzertrümmerung nutzbare Atomenergie gewinnen zu können, als Phantasten. Und Planck beantwortete die ihm 1939 gelegentlich einer Besprechung[2)] im Heeres-

Anmerkung 2 — 2) Diese Besprechung wurde vom Chef des Heereswaffenamts einberufen auf Grund einer von Flügge veröffentlichten Diskussion der Kettenreaktion (im Anschluss an die Hahn-Strassmannsche Entdeckung der Urankernspaltung und den Joliotschen Nachweis der bei dieser Spaltung neu emittierten Spaltungsneutronen). Anwesend waren: Geh.Rat [redacted] Prof. Dr. Planck, General d.Art. Prof.Dr.Becker (Chef des Heereswaffenamts und Dekan der Wehrtechnischen Fakultät), Oberst im Generalstab Dr.Waeger (Chef des Stabes im Heereswaffenamt, später Chef des ~~Stabes einer Armee vor Leningrad, dann Chef des~~ Wehrmachtrüstungsamtes) ~~zuletzt Kommandierender General eines Panzer Korps im Osten~~), [redacted] Prof.Dr.Schumann (†Chef der Forschungsabteilung im Heereswaffenamt), Prof.Dr.Winkhaus (Prodekan der Wehrtechnischen Fakultät an der Technischen Hochschule Berlin) und Ministerialrat Dr.Basche (Gruppenleiter Physik in der Forschungsabteilung des Heereswaffenamts).

† Direktor des II. Physikal. Instituts der Universität Berlin u.

‡ Prof. Dr. Esau (Präsident der Physikalisch-Technischen Reichsanstalt)

Figure D.603: A page from an unpublished 1949 manuscript by Erich Schumann, describing some (but only some) of the wartime German nuclear work.

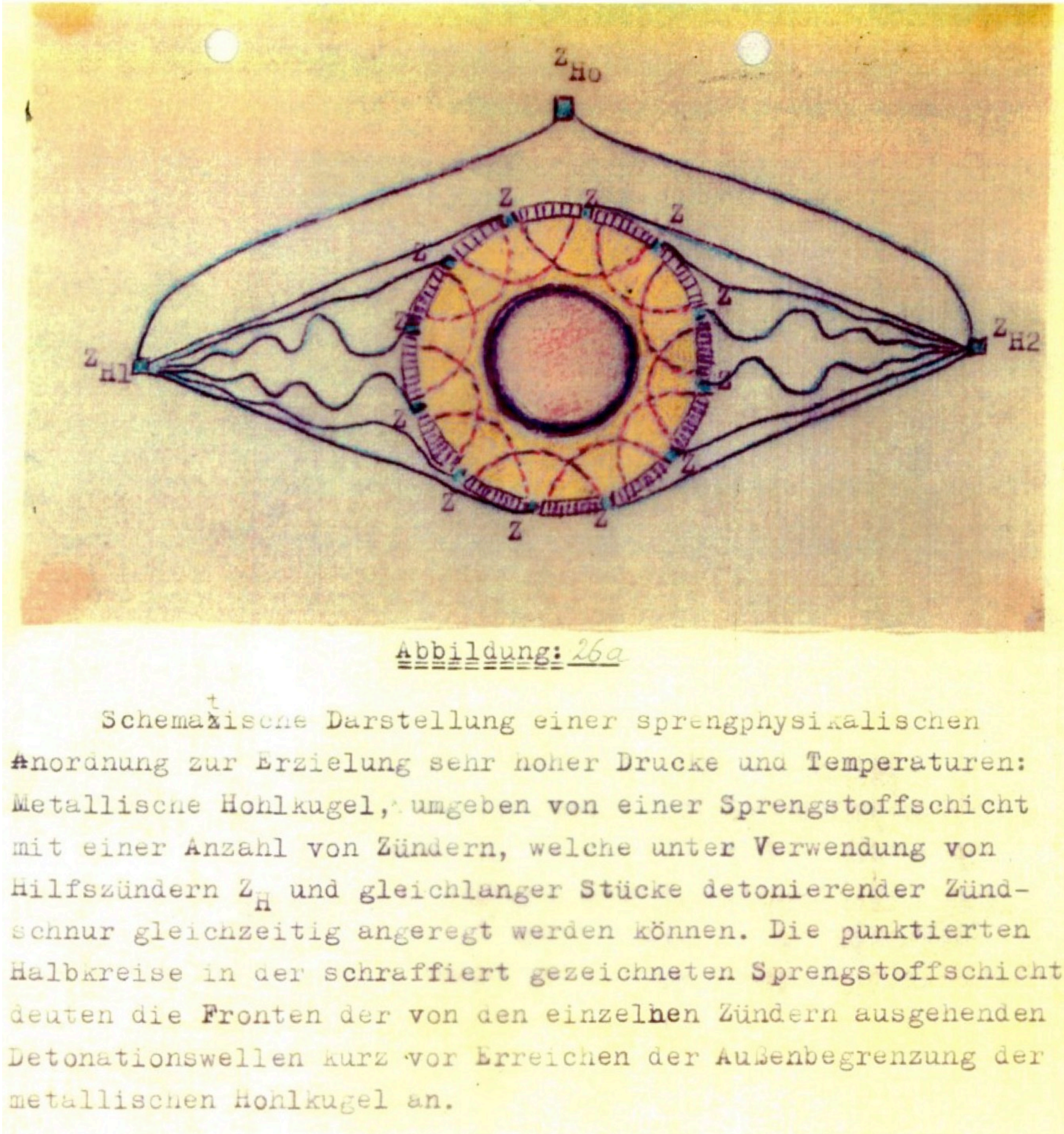


Abbildung: 26a

Schematische Darstellung einer sprengphysikalischen Anordnung zur Erzielung sehr hoher Drucke und Temperaturen: Metallische Hohlkugel, umgeben von einer Sprengstoffschicht mit einer Anzahl von Zündern, welche unter Verwendung von Hilfszündern Z_H und gleichlanger Stücke detonierender Zündschnur gleichzeitig angeregt werden können. Die punktierten Halbkreise in der schraffiert gezeichneten Sprengstoffschicht deuten die Fronten der von den einzelnen Zündern ausgehenden Detonationswellen kurz vor Erreichen der Außenbegrenzung der metallischen Hohlkugel an.

Figure D.604: A page from an unpublished 1949 manuscript by Erich Schumann, describing a spherical implosion bomb design with multiple concentric layers. (See also p. 4278.) Schumann's caption says: "Schematic representation of an explosive physical arrangement for achieving very high pressures and temperatures: Hollow metallic sphere surrounded by a layer of explosives with a number of detonators which can be triggered simultaneously using auxiliary detonators Z_H and pieces of detonating fuse of equal length. The dotted semicircles in the hatched explosive layer indicate the fronts of the detonation waves emanating from the individual detonators shortly before reaching the outer boundary of the hollow metallic sphere." Other pages from Schumann described additional details of the design, including explosive lenses of TNT and RDX within the outer layer, the arrangement of both fission and fusion fuel near the center, and methods of testing the device by mounting it on a tower and using sophisticated high-speed diagnostic instruments to record the explosion.

Letter from Erich Schumann to Ernst Telschow. 2 April 1948 [AMPG, Abt. III, Rep. 83, Nr. 286].

Prof. Dr. Erich Schumann
Göttingen, den 2. April 48
Vertraulich
An Herrn Gen. Dir. Dr. E. Telschow
Max-Planck-Gesellschaft zur
Förderung der Wissenschaften in Göttingen

Im Verlauf von sprengstoff-physikalischen Forschungsarbeiten, insbesondere der die Zündführung bei Hohlsprengkörpern betreffenden Untersuchungen, führten Überlegungen, die ich im Oktober 1943 gemeinsam mit Dr. Walter Trinks anstellte, zu dem Schluss, dass es zufolge der in unseren Berichten [Forschungsabteilung H Wa F, Reichsforschungsrat (Bevollmächtigter für Sprengstoffphysik) und etwa 40 Patentschriften] niedergelegten Erkenntnissen möglich sein müsse, Umwandlungen z. B. von Kohle in Diamant vorzunehmen und ferner Atomenergie auch durch Reaktionen zwischen leichten Elementen freizumachen.

Prinzip: Die außerordentliche Verdichtung der Materie und damit einhergehende ungeheuere Temperatursteigerung, wie sie sich im Entwicklungsgang der Sterne infolge der Gravitation vollzieht, soll im Experiment dadurch erzwungen werden, dass man die hohe Sprengstoff-physikalisch gewonnene kinetische Energie einer großen Masse auf eine wesentlich kleinere Masse überträgt. Siehe nachstehende schematische Darstellung. (Die zu verdichtende Substanz wird im gasförmigen Zustand in einer metallischen Hohlkugel untergebracht, welche außen mit einer Schicht eines brisanten Sprengstoffs belegt ist. Bei geeigneter, gleichmäßig über die ganze Oberfläche der Sprengstoffschicht eingeleiteter Zündung wird für eine gewisse kurze Zeit ein hoher Druck auf die metallische Kugel ausgeübt, unter dessen Einwirkung das Metall in den plastischen Zustand gerät und zum Mittelpunkt hin beschleunigt wird. Dadurch wird die eingeschlossene Gasmasse außerordentlich rasch verdichtet und dabei sehr hoch erhitzt):

Prof. Dr. Erich Schumann
Göttingen, 2 April 48
Confidential
To General Director Dr. E. Telschow
Max Planck Society for the
Advancement of Sciences in Göttingen

In the course of research work in the physics of explosives, in particular the investigations into the detonation of hollow explosives, considerations which I carried out in October 1943 with Dr. Walter Trinks, led to the conclusion that according to the findings laid down in our reports [Research Department H Wa F, Reich Research Council (Commissioner for Explosives Physics) and about 40 patent specifications], it must be possible to carry out transformations, e.g. of coal into diamond, and moreover to release nuclear energy also through reactions between light elements.

Principle: The extraordinary compression of matter and the associated enormous increase in temperature, as it occurs in the evolution of stars as a result of gravity, can be forcibly created in the experiment by transferring the high kinetic energy of a large mass, obtained by explosive physics, to a much smaller mass. See the schematic diagram below. (The substance to be compressed is placed in the gaseous state in a metallic hollow sphere, which is covered on the outside with a layer of explosive material. When a suitable ignition is applied uniformly over the entire surface of the explosive layer, a high pressure is applied to the metal sphere for a short time, which causes the metal to plasticize and accelerate towards the center. This causes the enclosed mass of gas to be compressed extremely rapidly and thereby to heat up very rapidly):

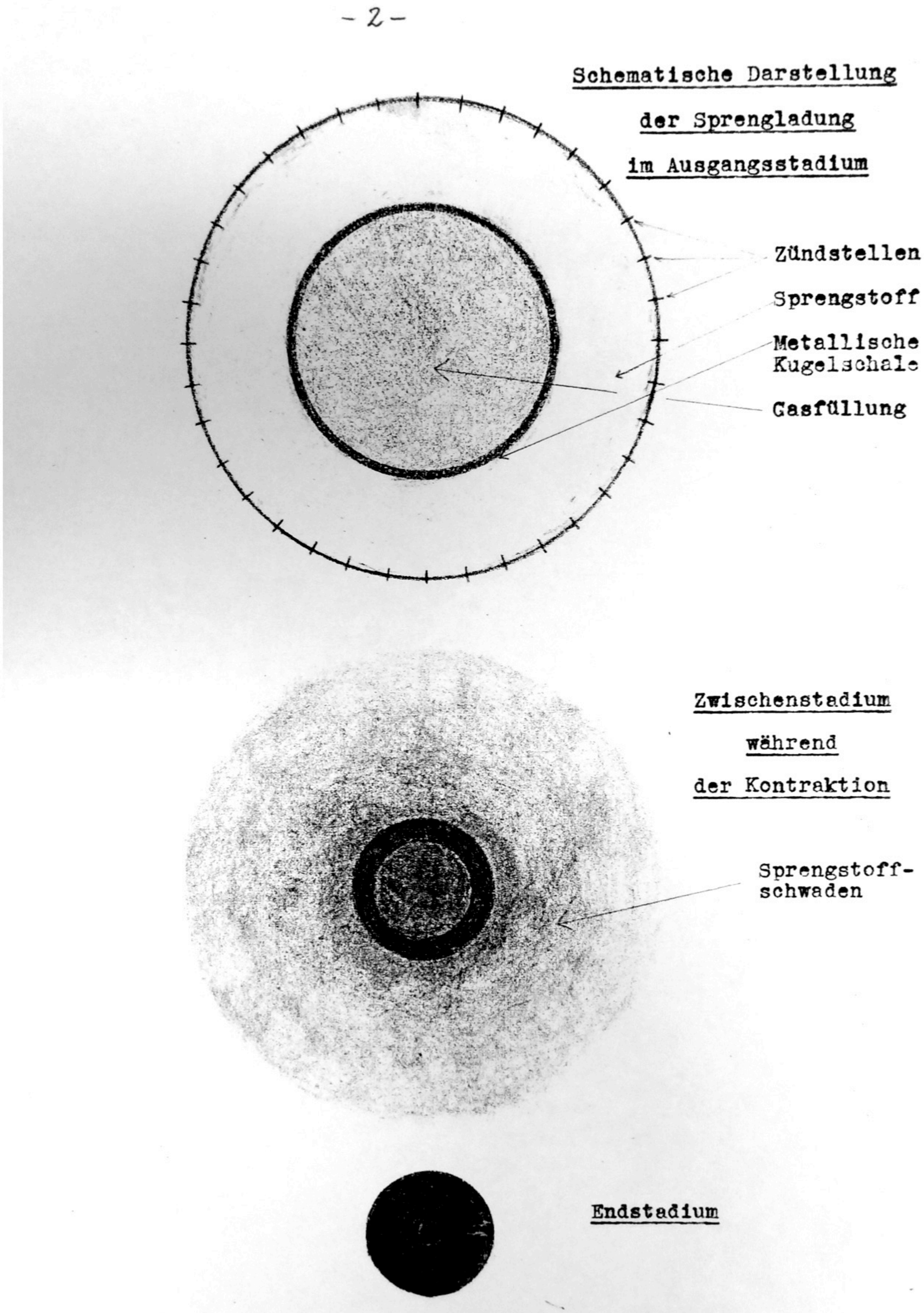


Figure D.605: A 1948 drawing by Erich Schumann, showing a spherical implosion bomb design with multiple concentric layers used to trigger nuclear reactions [AMPG, Abt. III, Rep. 83, Nr. 286].

Es war 1944/45 nicht mehr möglich, die bereits vorbereiteten Versuche durchzuführen, denn vom damaligen Ministerium für Bewaffnung und Munition wurden derartige Versuche nicht unterstützt, ja sogar verboten. Die experimentellen Möglichkeiten und theoretischen Überlegungen wurden aber damals von Dr. Trinks in einer Arbeit, die er als Habilitationsschrift zu benutzen gedachte, niedergelegt. Diese Arbeit wurde weisungsgemäß 1945 mit den übrigen Geheimakten vernichtet und 1947 nach Rücksprache mit Ihnen für die dortige Behörde von Dr. Trinks rekonstruiert.

In 1944/45 it was no longer possible to carry out the experiments already prepared, because the then Ministry of Armaments and Ammunition did not support such experiments and even prohibited them. The experimental possibilities and theoretical considerations were, however, laid down by Dr. Trinks at that time in a paper which he intended to use as his habilitation thesis. This work was destroyed together with the other secret files in 1945, as ordered, and in 1947, after consultation with you, it was reconstructed by Dr. Trinks for the local authorities.

Besteht beispielsweise die erwähnte Kugelschale aus Eisen, die Füllung aus Wasserstoffgas vom Anfangsdruck 1 Atm., beträgt die Wandstärke der Kugelschale etwa 1/50 ihres Durchmessers und rechnet man weiter mit einer Anfangsgeschwindigkeit der Schalenelemente von etwa 3200 m/sec, welche noch bequem erreichbar erscheint, so ergibt sich—nach Trinks—im Endzustand ein Energiegehalt des verdichteten Wasserstoffgases von etwa 10^{15} erg/g, d.h. mehr als 10 000 mal soviel, wie die brisantesten Sprengstoffe besitzen. Geht man von einem herabgesetzten Anfangsdruck des eingeschlossenen Gases aus, so ist mit noch höheren Energiedichten zu rechnen, also z.B. bei 0,1 Atm. etwa mit 10^{16} erg/g, das ist das 100 000-fache des Wertes für die brisantesten Sprengstoffe.

If, for example, the spherical shell mentioned above consists of iron, the filling of hydrogen gas of the initial pressure of 1 Atm., the wall thickness of the spherical shell is about 1/50 of its diameter and if one continues to calculate with an initial speed of the shell elements of about 3200 m/sec, which still seems to be comfortably attainable, this results—after Trinks—in the final state an energy content of the compressed hydrogen gas of about 10^{15} erg/g, i.e. more than 10,000 times as much as the most explosive explosives possess. If one assumes a reduced initial pressure of the enclosed gas, even higher energy densities can be expected, e.g. at 0.1 atm. about 10^{16} erg/g, i.e. 100,000 times the value for the most explosive explosives.

Durch extrem anwachsende Strahlungsverluste beim Überschreiten der Temperaturgrenze des nichtentarteten Elektronengases, sowie durch sprunghaft erhöhte Kompressibilität bei Überschreiten der Druckgrenze des nichtentarteten Elektronengases werden die theore- tisch möglichen Zündwerte (Temperaturen von 10–100 Millionen Grad und Drucke von 100 Milliarden bis 100 Billionen Atm) allerdings nur annährend erreicht werden können. Diese Schwierigkeiten beginnen jedoch erst von etwa 4 Millionen Grad bei einem Druck von 250 Millionen Atm. An merklich zu werden, während unter ihrer Inrechnungsetzung ein weiterer Anstieg auf etwa 10 Millionen Grad bei einem Druck von etwa 10 Milliarden Atm., das ist nahezu der Zustand im Sonnenmittelpunkt, erwartet werden kann.

However, due to extremely increasing radiation losses when the temperature limit of the non-degenerate electron gas is exceeded, as well as due to a sudden increase in compressibility when the pressure limit of the non-degenerate electron gas is exceeded, the theoretically possible ignition values (temperatures of 10–100 million degrees and pressures of 100 billion to 100 trillion Atm) can only be approximately reached. However, these difficulties only start from about 4 million degrees at a pressure of 250 million Atm. It is possible to notice them, whereas if they are taken into account, a further increase to about 10 million degrees at a pressure of about 10 billion Atm., which is almost the state in the center of the sun, can be expected.

Dann sind aber zumindest die beiden Deuteronen-Reaktionen

But then at least the two deuteron reactions

$$^{2}\mathrm{D} + {}^{2}\mathrm{D} = {}^{3}\mathrm{He} + {}^{1}\mathrm{n}$$

$$^{2}\mathrm{D} + {}^{2}\mathrm{D} = {}^{3}\mathrm{Tr} + {}^{1}\mathrm{H}\,,$$

deren Einsetzen im Entwicklungsgang der Sterne bereits bei 200 000^{o} beginnt[x)], genügend wahrscheinlich[xx)], so dass sie auch während der etwas kurzen Zeiten, die bei dem geplanten Hohlkugelverfahren zur Verfügung stehen (etwa 0,001 sec), in so ausreichendem Umfang stattfinden, dass erhebliche Energiebeträge gewonnen werden können.

whose onset in the evolutionary process of stars already starts at 200,000^{o} [x)], sufficiently probable[xx)], so that even during the somewhat short times available in the planned hollow-sphere process (about 0.001 sec), they take place in such a sufficient amount that considerable amounts of energy can be gained.

Wird z.B. 1/2 Kubikmeter (ca 9 g) schweren Wasserstoffgases vom Druck 0,1 Atm. vollständig nach dem obigen Reaktionsgleichungen umgesetzt, so wird ein Energiebetrag von rund 10^{19} erg entsprechend etwa 275 to Trinitrotoluol, frei. Noch erheblich höhere Beträge können unter Heranziehung anderer leichter Elemente, z. B. Lithium oder Bor, gewonnen werden.

If e.g. 1/2 cubic meters (approx. 9 g) of heavy hydrogen gas of pressure 0.1 Atm. are completely converted according to the above reaction equations, an energy amount of about 10^{19} erg corresponding to about 275 tons of TNT is released. Even considerably higher amounts can be obtained by using other light elements, e.g. lithium or boron.

Erich Schumann

Erich Schumann

[x)] Vgl. Bethe u. Marshak, Rep. on Progr. in Phys. 6, 1–15, 1939.

[xx)] Nachgewiesen in dem Hauptbericht Abschn. V, S. 36 unter Benutzung der von Gamow und Teller (Phys. Rev. (2) 53, 608, 1938) verbesserten theoretischen Beziehungen von Atkinson und Houtermans, der Rechnungen von Bethe (Phys. Rev. (2) 55, 434, 1939), sowie der experimentellen Werte des Wirkungsquerschnittes der Deuteronenreaktionen von Ladenburg u. Kanner (Phys. Rev. (2) 52, 911, 1937) und der Messungen von Burhop (Proc. Phil. Soc. 32, 643, 1936).

[x)] See Bethe and Marshak, Rep. on Progr. in Phys. 6, 1–15, 1939.

[xx)] Proven in the main report, section V, p. 36, using the theoretical relations of Atkinson and Houtermans improved by Gamow and Teller (Phys. Rev. (2) 53, 608, 1938), the calculations of Bethe (Phys. Rev. (2) 55, 434, 1939), as well as the experimental values of the cross section of the deuteron reactions of Ladenburg and Kanner (Phys. Rev. (2) 52, 911, 1937) and the measurements of Burhop (Proc. Phil. Soc. 32, 643, 1936).

[This 1948 letter briefly described a spherical implosion bomb design with multiple concentric layers used to trigger nuclear reactions. While the letter did not delve into still-classified details such as uranium and explosive lenses, clearly it was closely tied both to Schumann's wartime work and to his postwar patents (which are presented on the following pages).]

Erich Schumann and Walter Trinks. Patent DE977825. Vorrichtung, um ein Material zur Einleitung von mechanischen, thermischen oder nuklearen Prozessen auf extrem hohe Drücke und Temperaturen zu bringen. [Device for the introduction of a material for the introduction of mechanical, thermal or nuclear processes to extremely high pressures and temperatures.] Filed 13 August 1952.

[...] In solchen Fällen kann man sich eines Verfahrens bedienen, das darauf beruht, die kinetische Energie einer größeren Masse nahezu vollständig auf eine möglichst kleine Masse in einem sehr kleinen Raumgebiet zu übertragen. Man erreicht durch den Übergang von großen zu kleinen Massen größte Energiedichten, ganz analog wie man einen hohen Druck beim Übergang von großen zu kleinen Flächen erhält oder große Lasten mit einer kleinen Kraft durch Anwendung langer Wege hebt.

Dieses Prinzip der Übertragung der kinetischen Energie großer Massen auf kleinere findet z.B. Anwendung beim sogenannten Wasserhammer oder hydraulischen Widder; eine größere in Strömung befindliche Wassermenge wird plötzlich gebremst; der dabei auftretende Staudruck hebt einen Bruchteil der gestauten Wassermenge auf eine bestimmte Höhe empor und verleiht demselben so einen höheren Betrag an potentieller Energie pro Volumeneinheit, als das ursprünglich fließende Wasser an kinetischer Energie besaß.

Gemäß der Erfindung wird für die Erzeugung extrem hoher Drücke und Temperaturen eine Vorrichtung vorgeschlagen, die eine geschlossene Kammer für das auf die Drücke und Temperaturen zu bringende Material besitzt, bei der eine jenem Material gegenüberliegende, selbst nicht aus Sprengstoff bestehende Wand der Kammer mit einem Sprengstoff belegt ist, wobei diese Wand und ihre Sprengstoffbelegung so ausgebildet sind, daß die Wand durch den bei der Detonation des Sprengstoffes auftretenden Druck auf das genannte Material hin bewegt und in eine zu dem genannten Material hin konkave Form plastisch verformt wird.

[...] In such cases, a method can be used which is based on transferring the kinetic energy of a larger mass almost completely to a mass as small as possible in a very small spatial region. From the transition from large to small masses one attains the greatest energy density, just as a high pressure is obtained in the transition from large to small surfaces, or large loads are lifted with a small force by the application of long paths.

This principle of transferring the kinetic energy of large masses to smaller ones is, for example, applied in the so-called water hammer or hydraulic ram; a larger stream of water is suddenly braked; the pressure occurring in the process lifts a fraction of the accumulated water to a certain height and thus gives it a higher amount of potential energy per unit volume than the kinetic energy of the initially flowing water.

According to the invention, an apparatus is proposed for the production of extremely high pressures and temperatures, which has a closed chamber for the material to be subjected to pressures and temperatures, in which a wall of the chamber, which does not consist of explosives itself, is lined with an explosive, this wall and its explosive covering being designed in such a way that the wall is moved towards the said material by the pressure occurring during the detonation of the explosive and is plastically deformed into a concave shape towards the said material.

Diese Vorrichtung beruht zum Teil auf dem Prinzip der sogenannten Hohlsprengladung. Der maßgebende Teil solcher Hohlsprengladungen besteht aus einem metallischen Hohlkörper von vorzugsweise kegel-, glocken- oder flaschenförmiger Gestalt, welcher außen mit einem Sicherheitssprengstoff, z.B. Hexogen oder Trinitrotoluol, umgeben ist. Bei der Detonation des letzteren gehen die einzelnen Wandelemente des genannten Hohlkörpers unter dem Einfluß des Druckes von etwa 100 000 Atm in den plastischen Zustand über und erhalten eine nach innen gerichtete Geschwindigkeit von mehreren Kilometern pro sec. Beim Zusammentreffen der beschleunigten Wandelemente auf der Hohlraumachse wird ihre Bewegung gebremst, wobei auf einen geschmolzenen Anteil ihrer Masse ein hoher Druck ausgeübt wird. Durch diesen Druck werden die flüssig gewordenen Teilchen in Form eines feinen Strahles mit großer Geschwindigkeit aus dem sich zusammenziehenden Hohlraum herausgepreßt. Bei geeigneter Hohlraumform erreicht man in solchen Hohlsprengladungen Strahlgeschwindigkeiten bis zur doppelten Detonationsgeschwindigkeit, also beispielsweise bei Hexogen 2×8 km/sec = 16 km/sec. Dieser Geschwindigkeit entspricht ein Druck im Quellgebiet des Strahles von etwa 10^7 kg/cm^2. [...]

An dem folgenden speziellen Beispiel soll dies näher erläutert werden. Die zu verdichtende Substanz sei in gasförmigem Zustand in einer metallischen Hohlkugel untergebracht, welche außen mit einer Schicht eines brisanten Sprengstoffes belegt ist. Bei geeigneter, gleichmäßig über die ganze Oberfläche eingeleiteter Zündung der Sprengstoffschicht wird für kurze Zeit ein sehr hoher Druck auf die Kugelschale ausgeübt, unter dessen Einwirkung das Metall wie bei den Hohlsprengkörpem in den plastischen Zustand gerät und zum Kugelmittelpunkt hin beschleunigt wird. Dadurch wird die eingeschlossene Gasmasse außerordentlich rasch verdichtet und dabei sehr hoch erhitzt.

This device is based, in part, on the principle of the so-called shaped-charge blasting. The decisive part of such hollow-spring bladders consists of a metallic hollow body of preferably conical, bell-shaped or bottle-shaped shape which is externally provided with a safety explosive, for example hexogen or trinitrotoluene. During the detonation of the latter, the individual wall elements of said hollow body are converted into the plastic state under the influence of the pressure of about 100,000 atmospheres, and receive an inward velocity of several kilometers per second. When the accelerated wall elements meet on the cavity axis, their movement is braked, a high pressure being exerted on a molten portion of their mass. By this pressure the particles, which have become fluid, are pressed out of the constricting cavity in the form of a fine jet at high speed. With a suitable cavity shape, jet velocities of up to twice the detonation velocity are achieved in such hollow-jet blowers, for example, in the case of hexogen 2×8 km/sec = 16 km/sec. This pressure corresponds to a pressure in the source region of the jet of about 10^7 kg/cm^2. [...]

This will be explained in more detail in the following specific example. The substance to be compacted is placed in a gaseous state in a metallic hollow sphere, which is externally coated with a layer of a high explosive. In the case of a suitable ignition of the explosive layer uniformly introduced over the entire surface, a very high pressure is exerted on the ball shell for a short time, under the effect of which the metal becomes, as in the case of the hollow bubble bodies, into the plastic state and is accelerated towards the ball center point. As a result, the enclosed gas mass is extremely rapidly compressed and thereby heated very high.

Die dabei auftretenden Beschleunigungen sind ungeheuer groß. Während der Kontraktion der Hohlkugel nimmt ihre Wandstärke dauernd zu. Nähert sich dabei die Innenfläche dem Kugelmittelpunkt, so erhalten die an der Innenfläche gelegenen Materialteilchen sehr hohe Geschwindigkeiten. Man erkennt dies sofort, wenn man sich vergegenwärtigt, welchen Raum das von der Außenfläche—auch bei einem nur kleinen zurückgelegten Weg derselben—überstrichene Volumen einnimmt, wenn es als Kugel um den Mittelpunkt angeordnet wird.

The accelerations occurring in this case are enormous. During the contraction of the hollow spheres their wall thickness increases continuously. As the inner surface approaches the center of the sphere, the material particles located on the inner surface are given very high velocities. This is immediately apparent when we consider the space being spanned—even for a small distance travelled—when it is arranged as a sphere around the center.

Geht man beispielsweise von einer Hohlkugel vom Innendurchmesser $2R = 100$ cm und der Wandstärke 2 cm aus, so füllt das Schalenmaterial eine Kugel vom Durchmesser

If, for example, a hollow sphere with an internal diameter of $2R = 100$ cm and wall thickness 2 cm is compacted, the shell material fills a sphere of diameter

$$2R_0 = 2\sqrt[3]{52^3 - 50^3} = 2\sqrt[3]{15608} \approx 50 \text{ cm}, \tag{D.1}$$

wenn die Hohlkugel völlig zusammengeschrumpft ist, und legt während des letzten Teiles der Kontraktion die Außenfläche einen Weg von nur ⅒ mm zurück, so beträgt in der gleichen Zeit der entsprechende Weg der Innenfläche 2,66 cm, das ist 266mal soviel.

when the hollow sphere is completely shrunk, and during the last part of the contraction the outer surface is a path of only ⅒ mm, the corresponding distance of the inner surface is 2.66 cm, which is 266 times as much.

In Fig. 1a bis 1d ist die Kontraktion einer Hohlkugel im Schnitt schematisch dargestellt. Die starke Schrumpfung des Innenraumes, besonders gegen Ende des Vorganges im Vergleich mit der verhältnismäßig geringen Abnahme des Außendurchmessers, macht das Auftreten enormer Beschleunigungen verständlich. [...]

In Figs. 1a to 1d, the contraction of a hollow sphere is shown schematically in section. The severe shrinkage of the interior, especially towards the end of the process compared with the relatively small decrease in the outside diameter, makes the occurrence of enormous accelerations understandable. [...]

Bei der Beschleunigung mittels detonierender Sprengstoffe sind Anfangsgeschwindigkeiten von $\bar{v}$ = 3000 bis 4000 m/sec. noch bequem erreichbar. [...]

During acceleration by means of detonating explosives, initial velocities from $\bar{v} =$ 3000 to 4000 m/sec are yet easily accessible. [...]

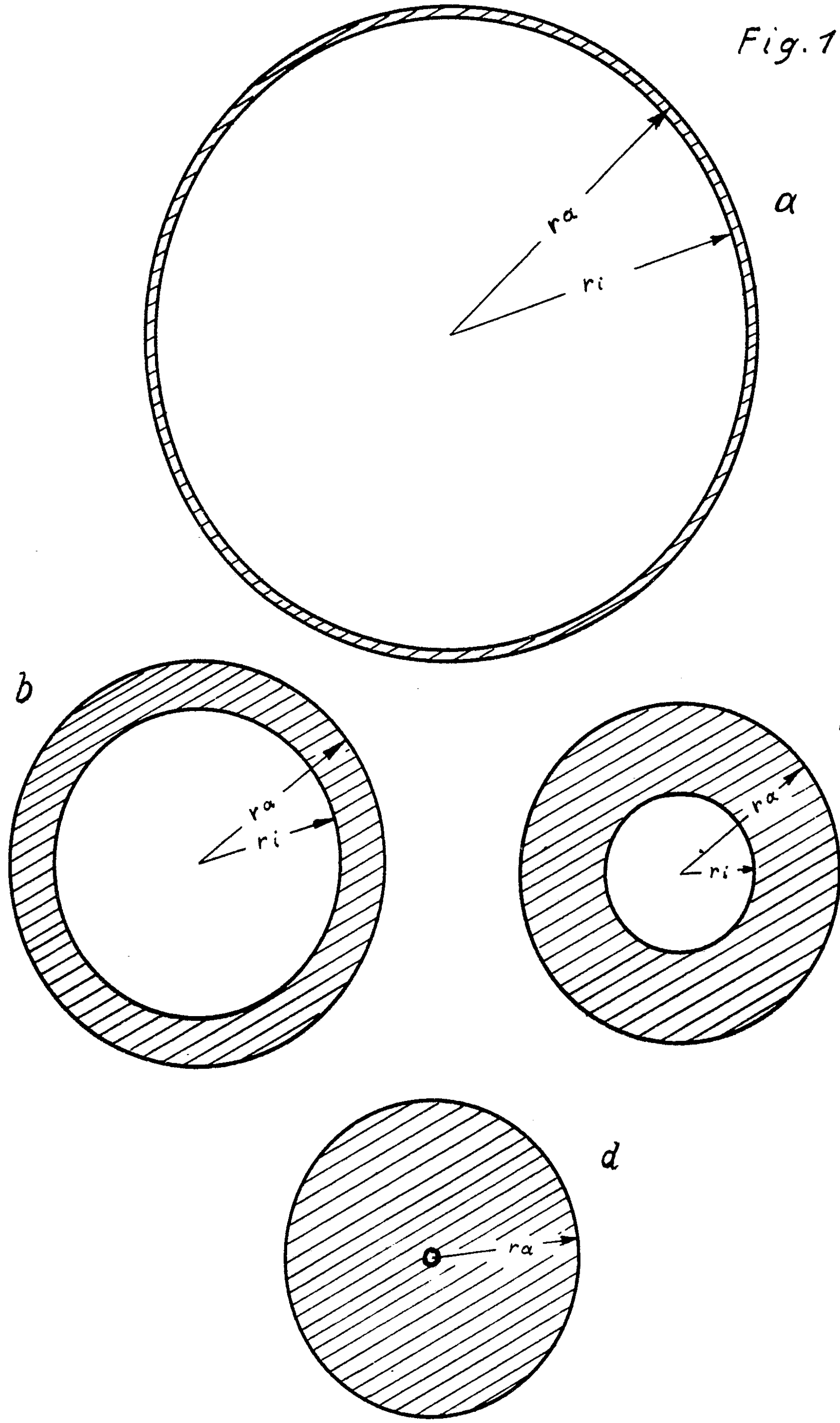


Figure D.606: Figure from Schumann-Trinks patent application showing the implosion of a spherical shell to form a solid sphere of matter.

Zur technischen Durchführung des vorgeschlagenen Verfahrens ist folgendes zu bemerken:

For the technical implementation of the proposed method, the following should be noted:

Bei der visuellen Beobachtung eines Sprengvorganges, beispielsweise der Detonation einer Bombe, gewinnt man leicht den Eindruck, als ob dieser Vorgang sich recht ungeordnet vollzöge und daß man sich bei den ungeheuren Belastungen des Materials immer mit gewissen nicht steuerbaren Zufälligkeiten abfinden müsse.

When visually observing a blasting process, for example the detonation of a bomb, one easily gains the impression that this process is quite disordered, and that with respect to the enormous loads, one must always accept certain uncontrollable, random incidents.

Die modernen Untersuchungsmethoden mit mechanischen Hochleistungszeitdehnern, Funken-, Kerrzellen- und Röntgenblitzkinematographen haben jedoch ergeben, daß Detonationsvorgänge mit derselben Exaktheit ablaufen wie andere physikalische Vorgänge und daß ihr Ablauf und der eintretende Endzustand genau reproduzierbar sind, wenn nur stets von den gleichen Anfangszuständen ausgegangen wird.

However, the modern methods of investigation with high-performance mechanical time-lengtheners, spark-, Kerr-cells, and X-ray flash kinematographs have shown that detonation processes proceed with the same exactness as other physical processes and that their sequence and the final state are exactly reproducible when only the same initial states are always assumed.

Man darf daher bei der Vorbereitung einer Sprengung nicht glauben, es komme nicht so genau darauf an, sondern es ist sehr wichtig, aber auch zugleich lohnend, äußerste Sorgfalt dabei aufzuwenden. Es ist häufig vorgekommen, daß erwartete Effekte erst verspätet nachgewiesen werden konnten, weil man sie nach einem nicht genügend sorgfältig vorbereiteten und deshalb mißglückten Vorversuch voreilig abgetan hat.

It is therefore not permissible, when preparing a blasting, to believe that it is not so important, but it is very important, but at the same time worthwhile, to devote extreme care to it. It has often happened that the expected effects could not be demonstrated until later, because they were prematurely dismissed after a preliminary experiment which had not been carefully prepared and therefore failed.

Für die Vorbereitung von Anordnungen zur Durchführung des beschriebenen Verfahrens gilt das eben Gesagte ganz besonders, und es ist nicht zuletzt aus diesem Grunde in den angeführten Beispielen von einer Hohlkugel mit dem verhältnismäßig großen Durchmesser von 1 m gesprochen worden, weil dann Ungenauigkeiten leichter zu vermeiden sind.

For the preparation of arrangements for carrying out the described method, the above is particularly true, and for this reason, in the examples given, a hollow sphere with the comparatively large diameter of 1 meter has been discussed, since inaccuracies are then easier to avoid.

Besonders ist es die möglichst strenge Einhaltung der Gleichzeitigkeit der Zündung, die in allen vorliegenden Fällen von besonderer Bedeutung ist und die sich bei größeren Körpern leichter erzielen läßt als bei kleineren. Es ist verhältnismäßig schwierig, einen Sprengkörper an allen Punkten einer beliebig geformten Oberfläche gleichzeitig zu zünden. Statt einer flächenhaften Zündung empfiehlt es sich deshalb, eine solche in möglichst vielen Einzelpunkten vorzunehmen.

It is particularly important to observe as closely as possible the simultaneity of the ignition, which is of particular importance in all cases, and which is easier to obtain in larger bodies than in smaller ones. It is relatively difficult to simultaneously ignite an explosive at all points of any arbitrarily shaped surface. Instead of a large-area ignition, it is therefore recommended to carry out such an operation in as many individual points as possible.

Einen verhältnismäßig hohen Grad der Gleichzeitigkeit erreicht man dabei mit Hilfe der sogenannten detonierenden Zündschnur (kabelähnlich umsponnene Nitropentaerythrit-oder Fulminat-Seele), indem man Hilfszündpunkte Z_H anwendet, von denen man zu den eigentlichen Zündpunkten Z_1, Z_2, Z_3,... gleich lange Stücke dieser Zündschnur mit konstanter Detonationsgeschwindigkeit (etwa 7500 m/sec) führt.

To reach a relatively high degree of simultaneity place with the help of so-called detonating fuse (braided nitropentaerythrite or fulminate-soul) by introducing secondary ignition points Z_H, from which one of the actual ignition points Z_1, Z_2, Z_3,... pieces of equal length this detonating cord leads (about 7500 m/sec) at a constant velocity of detonation.

In Fig. 7 ist eine spreng-physikalische Anordnung zur Erzielung sehr hoher Drücke und Temperaturen dargestellt. Die metallische Hohlkugel B ist von einer Sprengstoffschicht Sp umgeben mit einer Anzahl von Zündern Z, die unter Verwendung von Hilfszündern Z_H und gleich langer Stücke detonierender Zündschnüre gleichzeitig gezündet werden können. Die punktierten Halbkreise in der schraffiert gezeichneten Sprengstoffschicht deuten die Fronten der von den einzelnen Zündern ausgehenden Detonationswellen kurz vor Erreichen der Außenbegrenzung der metallischen Hohlkugel B an.

Fig. 7 shows an explosive physical arrangement for achieving very high pressures and temperatures. The metallic hollow sphere B is surrounded by an explosive layer Sp with a number of detonators Z which can be ignited simultaneously using auxiliary detonators Z_H and equally long pieces of detonating lines. The punctured semicircles in the shaded explosive layer indicate the fronts of the detonation waves emanating from the individual detonators shortly before the outer limit of the metallic hollow sphere B is reached.

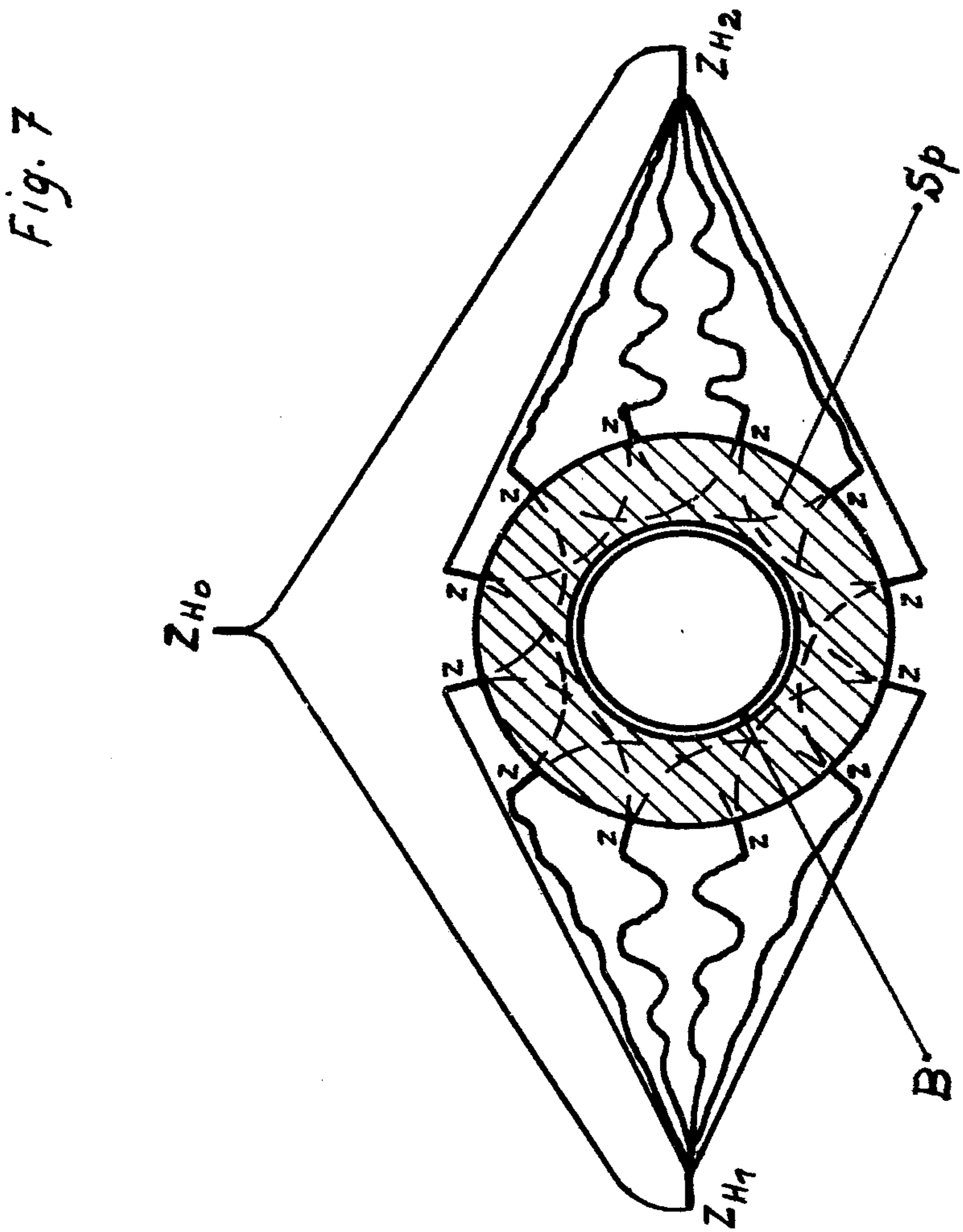


Figure D.607: Figure from Schumann-Trinks patent application showing a spherical implosion bomb design with multiple concentric layers used to trigger nuclear reactions. (See also p. 4267.)

Bei Verwendung elektrischer Zünder ist darauf zu achten, daß diese eine sehr geringe und konstante Verzugszeit aufweisen. Einer Zeitdifferenz von einer millionstel Sekunde entspricht bereits ein Weg der Detonationsfront von rund 1 cm, jedoch ebenfalls ein solches Stück der detonierenden Zündschnur, so daß bei deren Verwendung gute Genauigkeiten zustande kommen. Fehler durch etwa vorhandene Fehlstellen oder Unregelmäßigkeiten in der Schnur können dadurch vermieden werden, daß für jede Übertragungsstrecke mehrfache Schnüre verwendet werden.

When using electric igniters, care must be taken that these have a very low and constant delay time. A time difference of one millionth of a second corresponds already to a distance of about 1 cm of the detonation front, but also to such a portion of the detonating fuse, so that good accuracies are obtained when they are used. Flaws caused by any imperfections or irregularities in the line can be avoided by using multiple lines for each transfer path.

Eine Glättung der gewünschten kugelförmigen, zum Mittelpunkt hinlaufenden Detonationsfront ist in Anlehnung an die Optik durch die Verwendung von "Sprengstofflinsen" möglich. Ähnlich wie dort die Lichtstrahlen kann man hier ein divergentes Bündel von Detonationsstrahlen in ein konvergentes umwandeln, indem man in dem Sprengkörper mit der Detonationsgeschwindigkeit D entweder konvexe oder konkave Linsen aus einem Sprengstoff mit größerer Detonationsgeschwindigkeit als D zwischen den Zünder und die zu beschleunigende Hohlkugeloberflache einschiebt. So kann man beispielsweise konvexe Linsen aus Trinitrotoluol bei einem Hauptsprengkörper aus Hexogen oder konkave Linsen aus Hexogen oder Nitropentaerythrit bei einem Hauptsprengkörper aus Trinitrotoluol verwenden.

A smoothing of the desired spherical detonation front leading to the center is possible according to principles similar to those in optics through the use of "explosive lenses." Similar to light beams, a divergent bundle of detonation beams can be transformed into a convergent one by inserting either the convex or concave lenses of an explosive with a greater detonation velocity than D between the detonators and the hollow spherical surface to be accelerated. For example, convex lenses made of trinitrotoluene can be used within a main body made of hexogen, or concave lenses made of hexogen or nitropentaerythrite within a main body made of trinitrotoluene.

Sprengstoffe mit noch kleineren Detonationsgeschwindigkeiten, beispielsweise Bergwerkssprengstoffe, sind für derartige Anwendungen nicht geeignet.

Explosives with even lower detonation velocities, for example mining explosives, are not suitable for such applications.

Obgleich sie einen größeren "Brechungsindex" ergeben würden, wird man doch wegen ihrer zu geringen Homogenität von ihrem Gebrauch für den vorliegenden Zweck absehen.

Although they would give a larger "index of refraction," their inadequate homogeneity will be considered to be of no use for the present purpose.

Die Form der Trennflächen zwischen den Sprengstoffen mit den verschiedenen Detonationsgeschwindigkeiten (D_1 und D_2) ergibt sich sehr einfach aus der folgenden Bedingung für die Wege s der Detonationsstrahlen

The shape of the interfaces between the explosives with the different detonation velocities (D_1 and D_2) is obtained very simply from the following condition for the paths s of the detonation rays

$$\frac{s_1}{D_1} + \frac{s_2}{D_2} = \text{const} = \frac{s_{10}}{D_1} + \frac{s_{20}}{D_2} \tag{D.2}$$

für eine einfache Trennfläche

for a simple separation surface

oder

or

$$\frac{s_1}{D_1} + \frac{s_2}{D_2} + \frac{s_1'}{D_1} = \text{const} = \frac{s_{10}}{D_1} + \frac{s_{20}}{D_2} + \frac{s_{10}'}{D_1} \tag{D.3}$$

für eine doppelte Trennfläche bei "Linsen", wobei sich die Indizes 1 und 2 auf die beiden Sprengstoffe und der Index 0 auf den kürzesten Detonationsweg beziehen.

for a double separation surface for "lenses," the indices 1 and 2 refer to the two explosives and the index 0 to the shortest detonation path.

In der Fig. 8 ist eine solche Umkehr der Krümmung der Detonationsflächen bei der Verwendung von Trinitrotoluol mit $D_1 = 6500$ m/sec und eines Zwischenkörpers aus Nitropentaerythrit mit $D_2 = 7800$ m/sec dargestellt. Die Figur zeigt, wie durch Einschaltung derartiger Sprengstoff-Linsen die gestrichelt dargestellten Detonationsflächen im Lauf ihres Fortschreitens der Krümmung der zu beschleunigenden Masse M angepaßt werden.

Fig. 8 shows such a reversal of the curvature of the detonation surfaces during the use of trinitrotoluene with $D_1 = 6500$ m/sec and an intermediate body of nitropentaerythritol with $D_2 = 7800$ m/sec. The figure shows how, by the activation of such explosive lenses, the detonation surfaces represented by dashed lines are adapted in the course of their progress to the curvature of the mass M to be accelerated.

Zur Erzielung einer möglichst großen Energiedichte ist es vorteilhaft, einen Sprengstoff mit möglichst hoher Detonationsgeschwindigkeit, z.B. Hexogen, für die Beschleunigung der Hohlkugelwand zu verwenden. Zweckmäßig preßt man dann die Sprengstoffumhüllung des Druckgefäßes als einzelne Teilstücke. Auf diese Weise läßt sich eine bessere Homogenität der Sprengstoffhülle und damit ein gleichmäßigerer Ablauf der Detonation erzielen als mit gegossenen Mischungen, welche häufig Lunker und andere Inhomogenitäten enthalten.

In order to achieve the greatest possible energy density, it is advantageous to use an explosive with the highest possible detonation speed, for example, hexogen [RDX], for the acceleration of the hollow ball wall. Expediently, the explosive lining of the pressure vessel is then pressed as individual parts. In this way, a better homogeneity of the explosive shell and thus a more uniform discharge of the detonation can be achieved than with cast mixtures, which often contain voids and other inhomogeneities.

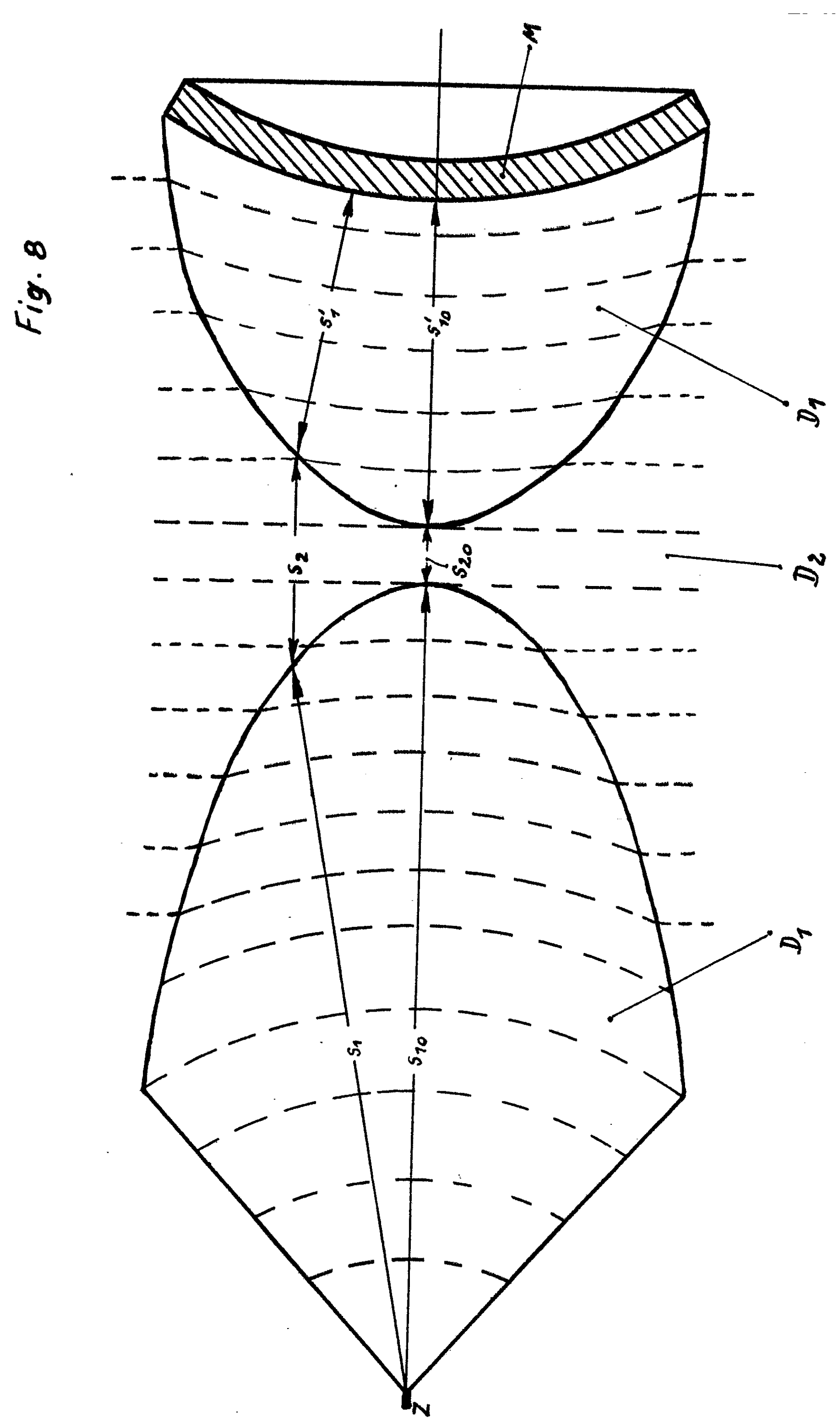


Figure D.608: Figure from Schumann-Trinks patent application showing an explosive lens containing shaped segments of two different explosive materials with different explosion velocities.

Im Hinblick auf einen möglichst gleichmäßigen Ablauf der Detonation, insbesondere auch auf ein möglichst regelmäßiges Anlaufen derselben in der Umgebung der Zündstellen sowie auf eine gute Aus- nutzung des Sprengstoffes ist es ferner vorteilhaft, die Sprengstoffschicht außen mit einer Verdämmung zu versehen und den ganzen Körper beispielsweise in Beton oder Erdbereich einzubetten. Beispielsweise ist es zweckmäßig, die nach außen frei werdende Sprengstoffenergie zugleich anderweitig auszunutzen, indem man derartige Versuche in Bergwerken oder Steinbrüchen durchführt.

Zur besseren Beobachtung der Vorgänge während und kurz nach der Detonation sowie zur leichteren Auffindung der verbleibenden Rückstände, welche die wertvollen Endprodukte enthalten, wird es sich jedoch auch häufig empfehlen, den Sprengkörper unverdämmt einige Meter über einer möglichst ebenen und glatten Fläche des Erdbodens frei aufzuhängen.

Im übrigen ist eine Zerlegung der Hohlkugel in viele Einzelteile nicht zu erwarten, da sie zusammenschrumpft und ihre Wandstärke dann 20- bis 30-mal so groß wie der Innenraum weit ist. Nachteilig ist bei den erwähnten Ausführungsbeispielen, daß sich bei den größeren der geplanten Körper recht erhebliche Gewichte ergeben, so daß auch aus diesem Grunde gegossene Sprengkörper kaum in Frage kommen, weil diese zu unhandlich werden würden. Eine eiserne Hohlkugel vom Durchmesser 1 m und der Wandstärke von nur 1 cm wiegt z.B. etwa 250 kg. Dazu kommt bei 20 cm starker Belegung ein Sprengstoffgewicht von etwa 1500 kg. Zusammen mit der Außenverdämmung ergibt sich so ein Gesamtgewicht von rund 2 t. [...]

With a view to the as uniform as possible of the detonation, in particular also to a regular start-up of the same in the vicinity of the ignition points, as well as to a good utilization of the explosive, it is also advantageous to provide the explosive layer with an external tamper and to place the whole arrangement in concrete or in earth, too. For example, it is practical to simultaneously exploit the outwards-released explosive energy by performing such experiments in mines or quarries.

For the better observation of the processes during and shortly after the detonation as well as for the easier detection of the remaining residues, which contain the valuable end products, it is also frequently recommended to freely hang the explosive device a few meters above a flat and smooth surface of the ground.

Moreover, it is not to be expected that the hollow spheres will be decomposed into many parts, since they shrink together and their wall thickness is then 20 to 30 times as large as the interior space. It is disadvantageous in the case of the mentioned exemplary embodiments that the larger of the planned bodies produce quite considerable weights so that explosive bodies cast for this reason are scarcely to be considered because they would become too bulky. An iron hollow sphere of diameter 1 m and wall thickness of only 1 cm weighs for example about 250 kg. In addition, an explosive weight of about 1500 kg is obtained when the coating is 20 cm thick. Together with the outer insulation, this results in a total weight of around 2 tons. [...]

[Compare Erich Schumann's designs for a two-ton spherical implosion bomb with other descriptions of the German fission bomb design (p. 4195), especially Ivan Ilyichev's 23 March 1945 report (p. 4529).]

Neben der eben beschriebenen Abänderung der prinzipiell sehr einfachen, jedoch in der praktischen Durchführung etwas komplizierten rein kugelförmigen dynamischen Druckzelle gibt es noch eine ganze Reihe anderer Möglichkeiten, die Grundidee der Übertragung der kinetischen Energie größerer, sprengphysikalisch beschleunigter Massen auf wesentlich kleinere Massen und der Erzeugung hoher Drücke und Temperaturen auf diesem Wege zu verwirklichen.

Hierzu werden noch einige Ausführungsbeispiele angegeben. Zunächst soll auf eine Anordnung mit zylindrischer Druckkammer eingegangen werden. Diese hat eine Reihe von Vorzügen, insbesondere auch deshalb, weil sich dabei besonders einfache Wege zur Einleitung der Zündung ergeben. Als Beispiel hierfür ist in der Fig. 11 schematisch eine solche Anordnung im Aufriß dargestellt. Die Druckkammer B besteht aus einem Zylinder, auf dessen Grundflächen Halbkugeln aufgesetzt sind. Der Sprengstoff Sp umgibt die Zylinderwand in Form eines Doppelkegels, längs dessen Grundlinie die Zündung gleichzeitig erfolgt. Dazu ist der Sprengstoff Sp umhüllt mit einem Mantel aus inertem Material J, beispielsweise Zement, welcher selbst wiederum außen mit einer dünnen Sprengstoffschicht Sp verkleidet ist. Wird dann letztere gleichzeitig in den beiden Spitzen des entstandenen Doppelkegels gezündet, so läuft die Detonation zugleich in zwei Ästen die beiden Kegelmäntel entlang, ohne dabei zunächst den inneren Sprengkörper zu beeinflussen, weil jener durch die inerten Zwischenschichten geschützt ist.

In addition to the modification of the purely spherical dynamic pressure cell which has been described above, but which is somewhat complicated in practice, there are also a whole series of other possibilities for the transfer of the kinetic energy of larger, physically accelerated masses to substantially smaller masses and the generation of high pressures and temperatures in this way.

For this purpose, a few exemplary embodiments are given. First, an arrangement with a cylindrical pressure chamber will be described. This has a number of advantages, in particular also because there are particularly simple ways of initiating the ignition. An example of such an arrangement is shown schematically in Fig. 11. The pressure chamber B consists of a cylinder, on the bases of which are placed hemispheres. The explosive Sp surrounds the cylinder wall in the form of a double cone, along which the ignition takes place at the same time. For this purpose, the explosive Sp is covered with a jacket of inert material J, for example cement, which itself is once again covered with a thin explosive layer Sp. If the latter is then ignited simultaneously in the two peaks of the resulting double cone, the detonation runs simultaneously into two branches along the two conical coats, without first affecting the inner explosive, because the latter is protected by the inert intermediate layers.

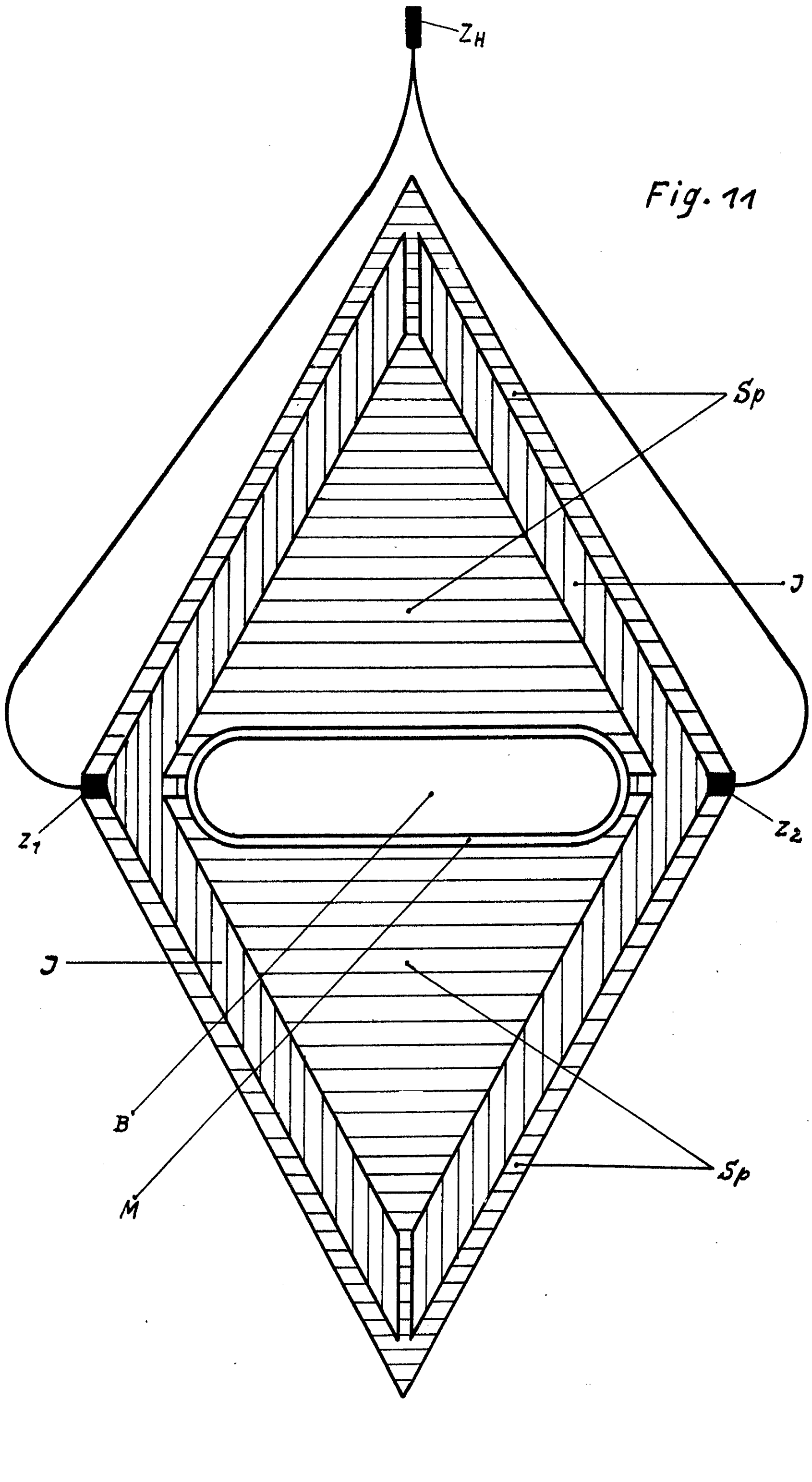


Figure D.609: Figure from Schumann-Trinks patent application showing a biconic implosion bomb.

Bei dem Zusammentreffen der beiden Zündäste wird dann erst der innere Sprengstoffdoppelkegel längs seiner Grundlinie, an welcher die inerte Umhüllung unterbrochen ist, intensiv gezündet. Durch die Wahl der symmetrischen Zündungsäste von den beiden Spitzen des Doppelkegels aus wird eine größere Gleichmäßigkeit mit einer besonders kräftigen Einleitung der Zündung des Hauptkörpers verbunden. Bei dieser Zündung werden nun die Elemente der mittleren Zone des metallischen Hohlzylinders gleichzeitig von der Detonation erfaßt und zur Achse hin beschleunigt. Dort werden nun entweder durch die rasche Kompression einer Gas-oder Dampffüllung oder aber, bei evakuiertem Hohlraum, beim Zusammentreffen der Wandelemente auf der Hohlraumachse hohe Drücke und Temperaturen erzeugt.

When the two ignition branches meet, the inner explosive double cone is then intensively ignited along its basic line, at which the inert enclosure is interrupted. By selecting the symmetrical ignition branches from the two tips of the double cone, greater uniformity is combined with a particularly powerful introduction of the ignition of the main body. At this time, the elements of the central zone of the metallic hollow cylinder are simultaneously caught by the detonation and accelerated towards the axis. In this case, high pressures and temperatures are generated either by the rapid compression of a gas or steam filling or, in the case of an evacuated cavity, when the wall elements meet on the cavity axis.

Eine im Prinzip ähnliche Anordnung mit zylindrischer Druckkammer B ist in der Fig. 12 dargestellt. Der Unterschied gegenüber der im vorhergehenden beschriebenen besteht erstens darin, daß hier die Druckkammer B an ihren Grundflächen durch starke verdämmende Metallplatten Me abgeschlossen ist, und zweitens die Wellenfront bei der Detonation durch linsenähnliche Sprengstoffanordnungen, beispielsweise aus Trinitrotoluol und Hexogen, weitgehend einer Zylinderfläche angeglichen wird. Die Zündführung Z_f verläuft innerhalb einer Packung aus inertem Material J.

A basically similar arrangement with a cylindrical pressure chamber B is shown in Fig. 12. The difference compared to the one described above consists, first, in that the pressure chamber B is terminated at its base surfaces by strong, damming metal plates Me, and second the wavefront is largely matched to a cylinder surface by detonation by means of lens-like explosive arrangements, for example from trinitrotoluene and hexogen. The ignition guide Z_f runs within a pack of inert material J.

Fig. 12

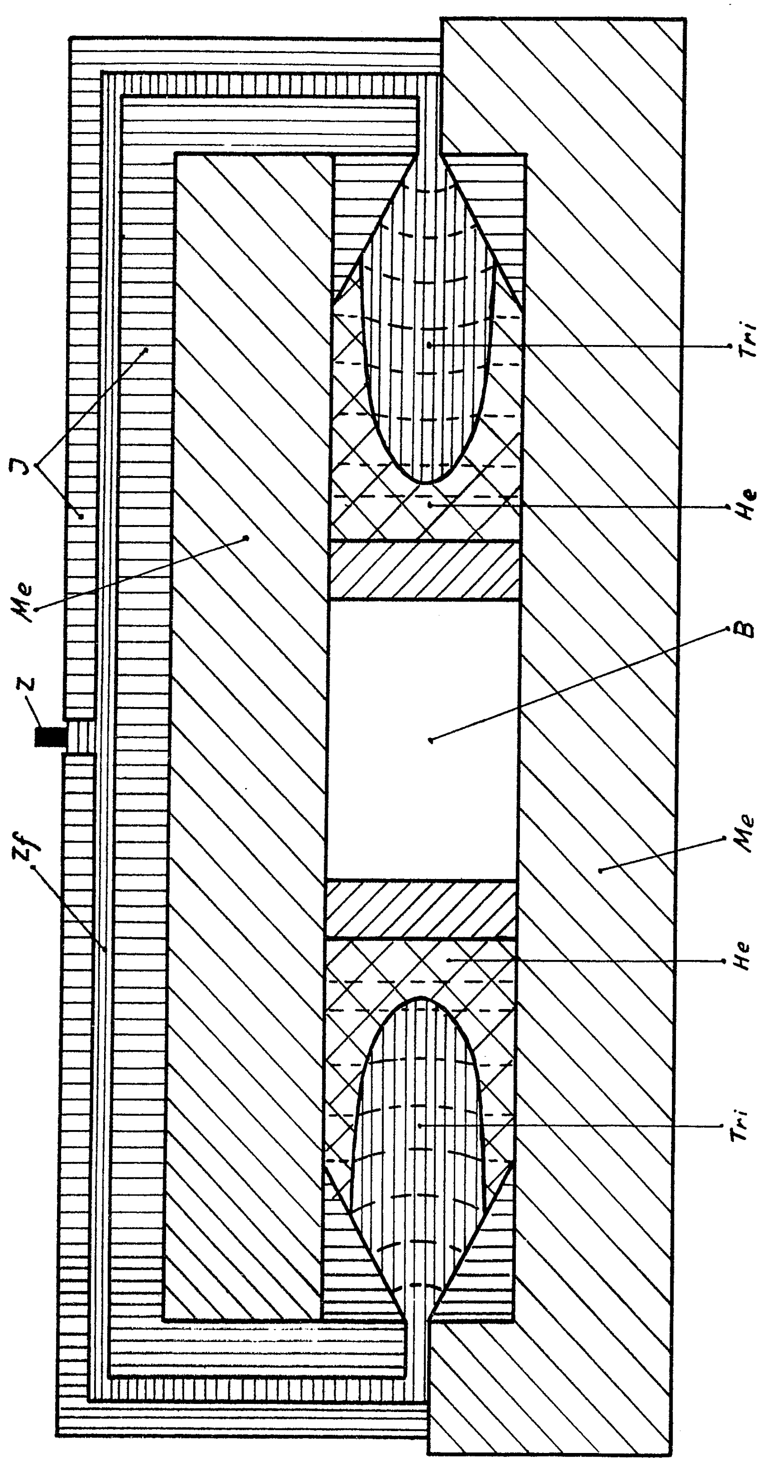


Figure D.610: Figure from Schumann-Trinks patent application showing a cylindrical implosion bomb.

Walter Trinks. German patent DE977862. Vorrichtung nach Patent 977825 zur Behandlung von Material mit hohen Drücken und Temperaturen. Filed 13 August 1952.

Die Verformung und Beschleunigung der Hilfsmasse erfordert eine beträchtliche Energiemenge, die für die Druckerzeugung innerhalb der Kammer verlorengeht. Es besteht daher das Bedürfnis, diese Hilfsmasse aus einem relativ leichten und plastischen Material herzustellen, und es bewährte sich besonders Aluminium.

Auch die Kammerwände kann man ganz oder teilweise aus Aluminium herstellen. [...]

PATENTANSPRUCH:

Vorrichtung nach Patent 977 825 zur Behandlung von Material mit hohen Drücken und Temperaturen, dadurch gekennzeichnet, daß die durch die Detonation zu beschleunigende Masse (und gegebenenfalls die Kammerwand) aus Aluminium besteht.

The deformation and acceleration of the auxiliary mass requires a considerable amount of energy which is lost for the generation of the printer within the chamber. There is therefore a need to manufacture these auxiliary materials from a relatively light and plastic material, and aluminum has proved particularly suitable.

The chamber walls can also be made entirely or partly from aluminum. [...]

PATENT CLAIM:

Apparatus according to patent 977,825 for the treatment of material with high pressures and temperatures, characterized in that the mass to be accelerated by the detonation (and, if appropriate, the chamber wall) consists of aluminum.

Walter Trinks. German patent DE977839. Vorrichtung nach Patent 977825 zur Erzielung hoher Drücke und Temperaturen zwecks Einleitung mechanischer, thermischer oder nuklearer Prozesse mittels einer gleichmaessig mit Sprengstoff belegten, die Reaktionskammer umschliessenden Hohlkugel. Filed 13 August 1952.

PATENTANSPRUCH:

Vorrichtung nach Patent 977 825 zur Behandlung von Material mit hohen Drücken und Temperaturen, dadurch gekennzeichnet, daß mehrere Kugeln mit von innen nach außen zunehmender Wandstärke und Sprengstoffbelegung ineinander angeordnet sind.

PATENT CLAIM:

A device according to patent 977,825 for the treatment of material with high pressures and temperatures, characterized in that a set of spherical shells are arranged concentrically with wall thickness and explosive material increasing from the inside outwards.

Erich Schumann and Walter Trinks. Patent DE977863. Vorrichtung zur Behandlung von Material mit hohen Drücken und Temperaturen. Filed 13 August 1952.

Das Hauptpatent betrifft eine Vorrichtung, um Material zur Einleitung von mechanischen, thermischen oder nuklearen Prozessen auf extrem hohe Drücke und Temperaturen zu bringen. Dabei sieht man eine geschlossene Kammer für das auf die Drücke und Temperaturen zu bringende Material vor und belegt eine jenem Material gegenüberliegende, selbst nicht aus Sprengstoff bestehende Wand der Kammer mit einem Sprengstoff. Die Wand und ihre Sprengstoffbelegung werden so ausgebildet, daß die Wand durch den bei einer Detonation des Sprengstoffes auftretenden Druck auf das genannte Material hin bewegt und in eine zu dem genannten Material hin konkave Form plastisch verformt wird.

Für die Freimachung von Atomenergie auf der Uranbasis ist es von großem Nachteil, daß, abgesehen von dem verhältnismäßig seltenen Vorkommen der Uranerze, ein ganz ungeheurer Aufwand erforderlich ist, um das spaltbare, nur mit ganz geringem Prozentsatz im Uran enthaltene Isotop abzutrennen oder um das ihm gleichwertige Plutonium zu gewinnen.

Bei diesem Sachverhalt ist es von großer Bedeutung, daß außer den Spaltungen der wenig stabilen schweren Kerne, z.B. des Uran 235 oder des Plutoniums, noch andere Kernprozesse existieren, bei denen ebenfalls große Energiebeträge frei werden, wobei jedoch die Ausgangsprodukte dieser Prozesse viel häufiger vorkommen und mit verhältnismäßig geringem Aufwand, z.B. aus Wasser, rein dargestellt werden können.

Es handelt sich hier im Gegensatz zu den Spaltprozessen der schweren Kerne, welche am Ende des periodischen Systems der Elemente stehen, um Reaktionen zwischen den Kernen der leichtesten Elemente, z.B. leichter und schwerer Wasserstoff, Lithium, Beryllium und Bor. [...]

The main patent relates to a device for bringing material to extremely high pressures and temperatures to initiate mechanical, thermal or nuclear processes. In this case, a closed chamber is provided for the material to be subjected to the pressures and temperatures, and a wall of the chamber, which is opposite to the material, is exposed to an explosive. The wall and its explosive coating are formed in such a way that the wall is moved towards the said material by the pressure occurring upon detonation of the explosive and is plastically deformed into a concave shape towards the said material.

For the liberation of atomic energy on the basis of uranium, it is a great disadvantage that, apart from the relatively rare occurrence of the uranium ores, a tremendous effort is required to produce the fissionable, separable small percentage of the isotope contained in the uranium or to obtain the equivalent plutonium.

In this state of affairs it is of great importance that, besides the fission of the less stable heavy nuclei, for example uranium 235 or plutonium, other nuclear processes also exist in which large amounts of energy are also released, but the starting products of these processes are much more common and are produced with relatively little effort, for example from water.

Here, in contrast to the fission processes of the heavy nuclei, which are at the end of the periodic table of the elements, in order to establish reactions between the nuclei of the lightest elements, for example light and heavy hydrogen, lithium, beryllium and boron. [...]

Temperaturen und Drucke der erforderlichen Höhe lassen sich experimentell und kurzzeitig mit sprengphysikalischen Mitteln erreichen und zur Einleitung und Durchführung von Atomkernreaktionen verwenden, wenn man die in dem Patent 977 825 beschriebenen Vorrichtungen zur Erzeugung höchster Drücke und Temperaturen nutzbar macht.

Temperatures and pressures of the required magnitude can be obtained experimentally and for short times by explosive-physical means and can be used to initiate and carry out atomic nuclear reactions if the devices described in patent 977,825 are used to generate the highest pressures and temperatures.

[...] Eine andere Form der Druckkammer besteht gemäß Fig. 4 in einer mit der zu behandelnden Substanz angefüllten, in brisanten Sprengstoff *Sp* eingebetteten Hohlkegel *B*, beispielsweise aus Eisen, Kupfer, Zink, Aluminium, Blei, Wolfram, Graphit od. dgl., deren Wandung gleichzeitig als zu beschleunigende Hilfsmasse dient. Die Schrumpfung des Innenraumes bei gleichzeitiger Zündung der auf der Oberfläche der Sprengstoffumhüllung angeordneten Zünder *Z* macht das Auftreten enormer Beschleunigungen verständlich.

[...] According to Fig. 4, another form of the pressure chamber consists of a hollow cone *B*, which is filled with the substance to be treated and is embedded in explosive explosive *Sp*, for example of iron, copper, zinc, aluminum, lead, tungsten, graphite or the like, at the same time serves as an auxiliary mass to be accelerated. The shrinkage of the interior while simultaneously igniting the detonator *Z* located on the surface of the explosive envelope makes it possible to achieve enormous accelerations.

Zur Glättung der Detonationsfront und zur Anpassung derselben an die Außenoberfläche der Kugel in der Umgebung der einzelnen Zündstellen können auch hier Linsen aus Sprengstoffen mit verschiedenen Detonationsgeschwindigkeiten angeordnet sein.

For smoothing the detonation front and adapting it to the outer surface of the ball in the vicinity of the individual ignition points, here, too, lenses of explosives with different detonation velocities can be arranged.

Zur Verlängerung der Einwirkungszeit können zwei oder mehrere der Hohlkugeln ineinandergeschachtelt sein, wobei Wandstärke und Sprengstoffbelegung der jeweils folgenden äußeren Hohlkugel stärker dimensioniert sind als diejenigen der jeweils vorhergehenden inneren Hohlkugel. [...]

To prolong the exposure time, two or more of the hollow spheres can be nested within each other. Both the wall thickness and the thickness of the explosive liner of the next outer hollow sphere must be shaped larger than those of the preceding inner hollow spheres. [...]

Wird z.B. ½ Kubikmeter schweren Wasserstoffgases vom Anfangsdruck 0,1 at, das sind rund 9 g, nach den Reaktionsgleichungen

For example, ½ cubic meter of deuterium gas with the initial pressure 0.1 atmosphere, which is about 9 g, according to the reaction equations becomes

$$ {}^{2}_{1}\mathrm{D} + {}^{2}_{1}\mathrm{D} = {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n} + 3.3\,\mathrm{MeV} \tag{D.4} $$

und

and

$$ {}^{2}_{1}\mathrm{D} + {}^{2}_{1}\mathrm{D} = {}^{3}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} + 4.0\,\mathrm{MeV} \tag{D.5} $$

[...] Ferner ist zu beachten, daß bei den dann erreichten hohen Temperaturen auch andere Kernprozesse genügend wahrscheinlich werden, so daß sie mit zur Energieerzeugung herangezogen werden können.

[...] It should also be noted that, in the case of the then high temperatures, other nuclear processes become sufficiently probable so that they can be used for the generation of energy.

Bei Anwesenheit von Protonen wird z.B. auch die sehr energiereiche Reaktion

In the presence of protons, for example, also the very energetic reaction

$$ {}^{3}_{1}\mathrm{Tr} + {}^{1}_{1}\mathrm{H} = {}^{4}_{1}\mathrm{He} + 20\ \mathrm{MeV} \tag{D.6}$$

stattfinden, welche nach den Deuteronenprozessen die wahrscheinlichste Kernreaktion ist, oder bei Anwesenheit von Lithium die Reaktionen

takes place, which is the most probable nuclear reaction after the deuteron processes, or the reactions in the presence of lithium

$$ {}^{7}_{3}\mathrm{Li} + {}^{1}_{1}\mathrm{H} = 2\,{}^{4}_{2}\mathrm{He} + 17\ \mathrm{MeV} \tag{D.7}$$

und

and

$$ {}^{6}_{3}\mathrm{Li} + {}^{2}_{1}\mathrm{D} = 2\,{}^{4}_{2}\mathrm{He} + 22.5\ \mathrm{MeV} \tag{D.8}$$

sowie

just as

$$ {}^{7}_{3}\mathrm{Li} + {}^{2}_{1}\mathrm{D} = 2\,{}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n} + 15\ \mathrm{MeV} \tag{D.9}$$

welch letztere wiederum Neutronen befreit.

which in turn liberates neutrons.

Die Deuteronenprozesse spielen dann vergleichsweise die Rolle des leicht entzündlichen Zündholzes, das die schwerer entzündlichen Brennstoffe anzündet.

The deuteron processes then play comparatively the role of the highly flammable match that ignites the heavy flammable fuel.

Diesem Umstand kann man gemäß der Erfindung dadurch nutzbringend Rechnung tragen, daß man zugleich mit der Füllung der anzuwendenden Druckzellen mit Wasserstoff, insbesondere schwerem Wasserstoff, andere leichte Elemente, z.B. Lithium, Beryllium, Bor oder auch leichten Wasserstoff als Elemente oder in Form von chemischen Verbindungen an der Innenwand der Druckzellen oder auch in der Wand der Druckzellen, durch dünne Schichten vom Innenraum getrennt, zur Anwendung bringt. So empfiehlt sich beispielsweise die Verwendung von schwerem Lithiumhydrid (LiD).

According to the invention, this circumstance can be taken advantage of by virtue of the fact that, at the same time as the filling of the pressure cells to be applied with hydrogen, in particular heavy hydrogen, other light elements, for example, lithium, beryllium, boron or also light hydrogen as elements or in the form of chemical compounds on the inner wall of the pressure cells or also in the wall of the pressure cells, separated from the inner space by thin layers. For example, the use of heavy lithium hydride (LiD) is recommended.

Insgesamt wird so die Befreiung eines Energiebetrages möglich, der die zur Einleitung dieser Kernreaktionen aufzuwendende chemische Energie des Sprengstoffes (ungefähr 10^{16} erg) sehr beträchtlieh überschreitet.

In general, the liberation of an energy supply is possible, which greatly exceeds the chemical energy of the explosive (about 10^{16} erg) to be expended for the initiation of these nuclear reactions.

Auch die bei der einen der D-Kernreaktionen frei werdenden Neutronen können zur weiteren Befreiung von Energie herangezogen werden. Die Reaktion

The neutrons released in one of the D nuclear reactions can also be used to further release energy. The reaction

$$ {}^{6}_{3}\mathrm{Li} + {}^{1}_{0}\mathrm{n} = {}^{3}_{1}\mathrm{Tr} + {}^{4}_{2}\mathrm{He} \tag{D.10}$$

würde z.B. auf Grund der Massenbilanz die Energie von 4,7 MeV befreien, oder die entsprechende Reaktion mit Bor

would, for example, free the energy of 4.7 MeV on account of the mass balance, or the corresponding reaction with boron

$$ {}^{10}_{5}\mathrm{B} + {}^{1}_{0}\mathrm{n} = {}^{7}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He} \tag{D.11}$$

würde ungefähr 3 MeV freisetzen.

would release about 3 MeV.

Ferner kann man die bei der Deuteronenreaktion frei werdenden Neutronen dazu benutzen, die Spaltung des U^{235} in dem natürlichen Uran, also dem gewöhnlichen Isotopengemisch, vorzunehmen.

Furthermore, the neutrons liberated in the deuteron reaction can be used to carry out the fission of U^{235} in natural uranium, that is, the ordinary isotope mixture.

Wenn die Innenwand der das Deuterium enthaltenden Druckzelle mit einer genügend starken Graphitschicht ausgekleidet wird, auf die eine Schicht Uran folgt, werden die frei werdenden Neutronen mit sehr hohem Energiegehalt auf thermische Neutronen abgebremst, ehe sie die Uranschicht erreichen. Dort werden sie dann nicht vom U^{238} eingefangen, sondern können an dem U^{235} die Spaltung hervorrufen. Man müßte dann nur, wie in allen Fällen, in denen die frei werdenden Neutronen herangezogen werden sollen, durch eine geeignete Außenhülle der anzuwendenden Druckzellen ein Entweichen nach außen verhindern, ähnlich wie dies bei den Atombomben durch den sogenannten “Tamper” geschieht.

When the inner wall of the pressure cell containing the deuterium is lined with a sufficiently strong graphite layer followed by a layer of uranium, the liberating neutrons with a very high energy content are decelerated to thermal neutrons before they reach the uranium layer. There they are not caught by the U^{238}, but can cause the fission of the U^{235}. As in all cases in which the neutrons which are liberated are released, it is only necessary to prevent the escape from the outside by means of a suitable outer shell of the pressure cells to be applied, similar to that of the atom bombs by the so-called “tamper.”

Man kann auch die frei werdenden Neutronen aus den D-Kernreaktionen zunächst zu einer unmittelbaren Temperatursteigerung im Zentrum der Druckzelle benutzen, indem man dort eine winzige Menge Cadmium anbringt, welches die Neutronen unter Erhitzung absorbiert.

Wesentlich wichtiger als die Befreiung von Atomenergie zu militärischen Zwecken ist die Herstellung und Verwendung von Neutronen für friedliche Aufgaben.

Auf die Bedeutung und die große Intensität der bei der Umsetzung von Deuterium entstehenden Neutronenstrahlung wurde bereits weiter vorn hingewiesen. Hier sei nur noch hinzugefügt, daß selbst, wenn mit Hilfe des beschriebenen Verfahrens nur eine Temperatur von 2 Millionen Grad erreichbar wäre, aus nur 2 g schwerem Wasserstoff während 1 zehntausendstel sec nach den Resultaten von Bethe sowie Gamow und Teller ungefähr $3 \cdot 10^{21}$ Neutronen frei gemacht werden, was etwa 10^{18} Curie bzw. einer Radium-Berylliumquelle von rund 1 Milliarde kg entspricht. Eine starke Hochspannungsanlage würde 350 Jahre benötigen, um diese Neutronenmenge zu erzeugen.

Derartige Neutronenintensitäten sind bisher nur in den "Uran-piles" beobachtet worden. Ihre Erzeugung erfordert dort jedoch einen unvergleichlich größeren Aufwand, als er bei dem vorgeschlagenen Verfahren erforderlich ist.

PATENTANSPRÜCHE:

1. Vorrichtung nach Patent 977 825 zur Behandlung von Material mit hohen Drücken und Temperaturen, dadurch gekennzeichnet, daß die Wandung der Wasserstoff, insbesondere schweren Wasserstoff, enthaltenden Druckzelle leichte Elemente, wie Lithium, Beryllium, Bor oder leichten Wasserstoff als Element oder in gebundener Form aufweist.

It is also possible to use the free neutrons from the deuterium nuclear reactions for a direct increase in temperature at the center of the pressure cell by applying a minute quantity of cadmium which absorbs the neutrons while heating.

Essentially more important than the liberation of nuclear energy for military purposes is the production and use of neutrons for peaceful tasks.

The importance and the great intensity of the neutron radiation generated during the reaction of deuterium has already been pointed out before. In this case, it should be added that even if, by means of the method described, only a temperature of 2 million degrees is attainable, from only 2 g of heavy hydrogen is formed during one ten-thousandth of a second, according to the results of Bethe, and Gamow and Teller, approximately $3 \cdot 10^{21}$ neutrons, which is about 10^{18} Curie, or corresponding to a radium-beryllium source of around one billion kg. A strong high-voltage system would take 350 years to produce this neutron quantity.

Such neutron intensities have hitherto been observed only in "uranium piles." However, their production requires an incomparably greater effort there than is required in the proposed method.

PATENT CLAIMS:

1. Apparatus according to patent 977,825 for the treatment of material with high pressures and temperatures, characterized in that the wall of the pressure cell containing hydrogen, in particular heavy hydrogen, has light elements, such as lithium, beryllium, boron or light hydrogen as element or in bound form.

2. Vorrichtung nach Anspruch 1, dadurchgekennzeichnet, daß die leichten Elemente die Innenwand der Zelle bedecken.

2. Device according to Claim 1, characterized in that the light elements cover the inner wall of the cell.

3. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die leichten Elemente durch eine dünne Schicht abgedeckt sind.

3. Device according to Claim 2, characterized in that the light elements are covered by a thin layer.

4. Vorrichtung nach Anspruch 1 oder folgenden, dadurch gekennzeichnet, daß die Wand wenigstens teilweise aus Uran, insbesondere natürlichem Uran, besteht.

4. Device according to Claim 1 or the following, characterized in that the wall is at least partly of uranium, in particular of natural uranium.

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß das Uran durch Graphit abgedeckt ist.

5. Device according to Claim 4, characterized in that the uranium is covered by graphite.

Top Secret Cable from Warsaw to Secretary of State. 7 March 1946 [NARA RG 77, Entry UD-22A, Box 160, Folder 205.2 Cables Incoming, Top Secret]

From: Warsaw

To: Secretary of State

Nr: 300 7 March 1946

Nr 300. Signed Lane.

Information has been given this Embassy by a capable young engineer working in the zinc industry, that one of the best if not the only material for atomic bomb containers is cadmium. According to the informant the cadmium output of Poland in 1945 amounted to 49.15 tons, and in January of 1946 to 10.9 tons. In 1945 there was exported to Russia the total Polish cadmium output.

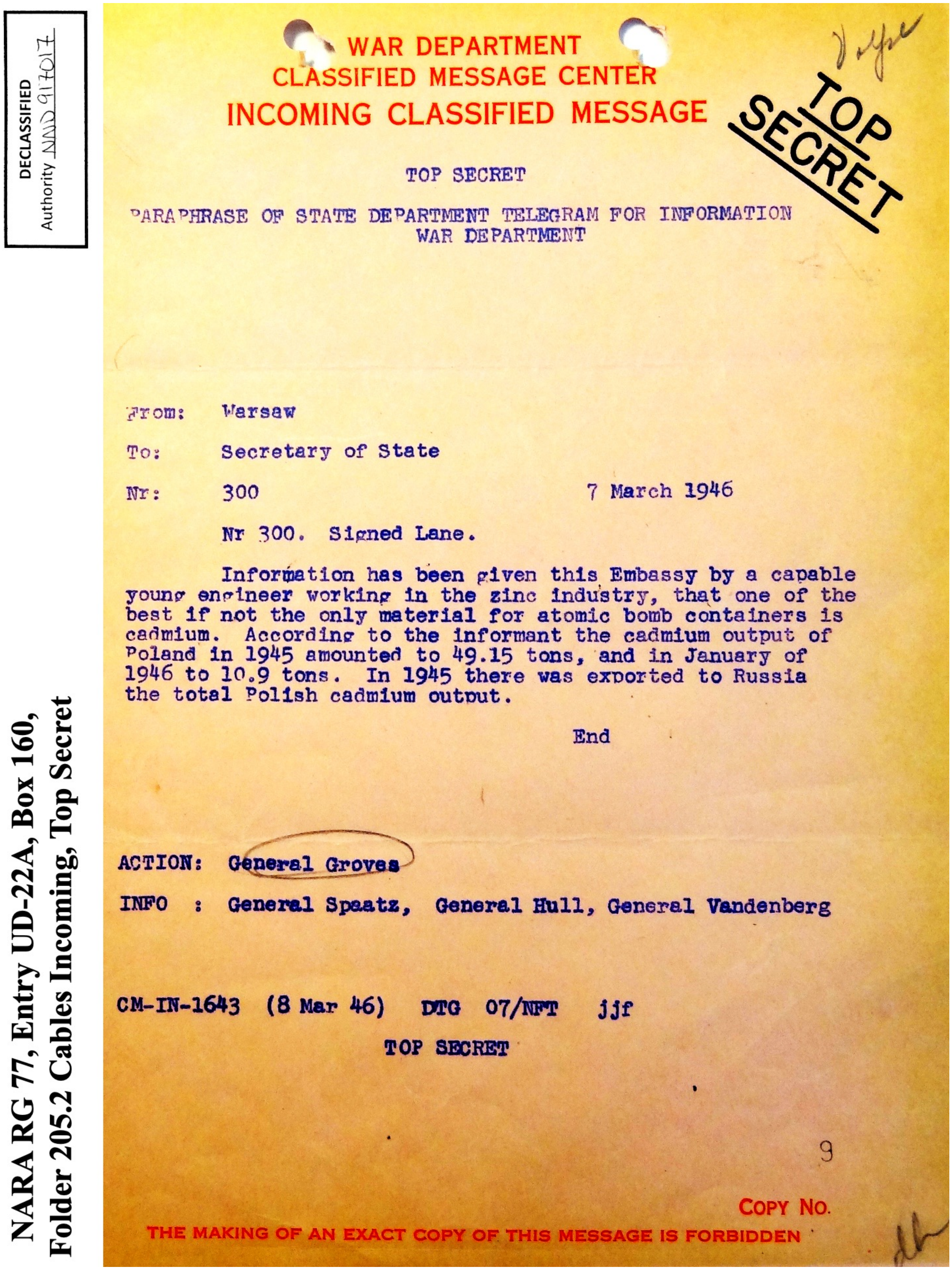
End

ACTION: General Groves

INFO: General Spaatz, General Hull, General Vandenberg

[See document photo on p. 4294.

A "capable young engineer" in Poland stated that atomic bomb case designs use a layer of cadmium, apparently based on his personal experience in the wartime German program. That detail is highly consistent with the bomb descriptions given by Schumann and Trinks (above) and also by Ilyichev (p. 4529).]



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TOP SECRET

PARAPHRASE OF STATE DEPARTMENT TELEGRAM FOR INFORMATION
WAR DEPARTMENT

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CM-IN-1643 (8 Mar 46) DTG 07/NFT jjf

TOP SECRET

9

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THE MAKING OF AN EXACT COPY OF THIS MESSAGE IS FORBIDDEN

NARA RG 77, Entry UD-22A, Box 160, Folder 205.2 Cables Incoming, Top Secret

Figure D.611: Top Secret Cable from Warsaw to Secretary of State. 7 March 1946 [NARA RG 77, Entry UD-22A, Box 160, Folder 205.2 Cables Incoming, Top Secret].

Walter Trinks. Undated but probably summer 1945. [NARA RG 319, Entry A1-134B, Box ??, Folder XE098301 Trinks, Walter]

Dr. Walter Trinks
Int. No. 8-3448-M-AA
7th Coy.

TO THE AMERICAN COMMAND OF THE INTERNMENT CAMP? CIC-STAFF.

When I was imprisoned at Bad Aibling an American officer in an address asked German scientists and specialists to present themselves. Having presented myself I was told to give further written information on my altuition [education] and my career. Having been transferred to this camp I could not do so. I am a Physicist and have been employed with the OKH [Oberkommando des Heeres] until the end of the war in the research dept. of the office for arms [Heereswaffenamt] as referee for the physics of explosions and blasting. The tasks of that dept. included:

1st Research of physical phenomena at the explosion

2nd Augmentation of and defense against the effect of blasting materials through physical methods

3rd Research of difficulties and troubles.

4th The replacement of valuable raw materials.

During the war the principal labor was dedicated to the principle of hollow charges and its use in armour breaking amunition as F-I-7,5 cm grenade, HL(ABC), 10 cm G.Hl, rifle grenade, Panzerfaust and Panzerschreck, Panzerhandgrenade, Redcap, Magnetic H 3 and H 15.

At the end of the war I was occupied with experiments for producing extreme high pressures and temperatures, extreme velocities (up to 15 km/sec) and heavy swingings of the air [shock waves]. The practical use of these researches comprises:

1st for the war: the defense against V-weapons super- and atomic bombs by destroying them before they reach their target and the initiation of atomic bombs.

2nd for peacetime: the producing of artificial diamonds and the enriching of minerals and materials.

3rd for purely scientific research of special molecules and atoms under extreme pressures and temperatures.

I esteem these researches to be important and promising and therefore ask to be allowed to prosecute them at the service of the U.S.A.

[See document photos on pp. 4296–4297. Due to the number of English spelling and capitalization mistakes, this document appears to have been written in English by Trinks himself, not translated by a native English speaker. For ease of understanding, I have corrected most of the document's English mistakes in the above transcription.

Trinks was imprisoned by the U.S. Army from June 1945 to June 1946, and he informed them that "At the end of the war I was occupied with experiments for... the initiation of atomic bombs." Where are the detailed reports on his interrogations and everything he told U.S. officials about his wartime work? What exactly did he work on after the war, and for whom?]

NARA RG 319,
Entry A1-134B, Box ??,
Folder XE098301
Trinks, Walter

NW 87073 DocId:33614254 Page 3

Declassified Case: NW# 87073 Date: 06-06-2024

Screened Date: 06-06-2024 DOCID: 33614254

Best available image

8-3446

D 98301

RELEASE FROM CIVILIAN INTERNMENT CAMP NO.

ENTLASSUNGSSCHEIN FÜR ZIVILPERSONEN AUS DEM INTERNIERUNGSLAGER NR. 8

HEADQUARTERS NINTH INFANTRY DIVISION
Third US Army
Dritte Amerikanische Armee.

This is to certify that Dr. T R I N K S, Walter
Hiermit wird bestätigt, daß (name and address)
(Name und Adresse)

OBERNDORF bei Salzburg, Watzmannstrasse 185

whose signature appears below and who has been interned at Civilian Internment Camp as indicated above for the following reasons:
die/der Unterzeichnete, die/der aus folgenden Gründen im Internierungslager für Zivilpersonen, wie oben angeführt, interniert war: SA-Member, [illegible]

from 24, June 1945 to 6, June 1946

has been released, ~~provisionally released, paroled~~ (Strike out words not applying) from internment upon order of the duly appointed Military Government Review Board for Bavaria No. 2
ist auf Grund einer Entscheidung des kurzlich eingesetzten Prüfungsausschusses für Bayern No. 2 von der Internierung entlassen, vorläufig entlassen, ehrenwörtlich entlassen worden. (Nichtzutreffendes durchstreichen).

The bearer will not be rearrested for any of the reasons stated in the first paragraph of this letter, except by express order of the Director of Military Government for Bavaria.
Der Inhaber dieses Entlassungsscheines darf nicht wieder verhaftet werden aus einem in Paragraph 1 dieses Briefes angeführten Grund, außer auf Grund eines ausdrücklichen Befehles des Direktors der Militärregierung für Bayern.
If provisionally released or paroled: Under terms of the provisional release or parole bearer will (State provisions).
Bei nur vorläufiger oder ehrenwörtlicher Entlassung: Unter den Bedingungen der vorläufigen oder ehrenwörtlichen Entlassung hat Entlassene r (Angabe der Bedingungen):

X X X X X X X X X X

Bearer will upon his arrival home report to the Landrat of the Kreis nearest to his place of abode and register his name, date of registery and the Military Government Review Board which has ordered his release.
Der Inhaber dieses Entlassungsscheines hat sich bei seiner Ankunft in seinem Wohnort sofort beim Landrat des seinem Wohnort nächsten Kreises zu melden und zu registrieren, unter Angabe des Prüfungsausschusses, der seine Entlassung veranlaßt hat.

Bearer has been instructed that his continued freedom is dependent upon his future conduct and compliance with the laws and regulations of Allied Military Government.
Der Inhaber dieses Entlassungsscheines ist darüber aufgeklärt worden, daß seine Freiheit von seinem jeweiligen Verhalten sowie seiner Einfügung in die Gesetze und Verordnungen der Allierten Militärregierung abhängig ist.

Figure D.612: Walter Trinks was imprisoned by the U.S. Army from June 1945 to June 1946. Where are the detailed reports on his interrogations and everything he told U.S. officials about his wartime work? [NARA RG 319, Entry A1-134B, Box ??, Folder XE098301 Trinks, Walter]

NARA RG 319,
Entry A1-134B, Box ??,
Folder XE098301
Trinks, Walter

Dr.Walter Trinks
Int.NO.8-3448-M-AA
7th Coy.

TO THE
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2nd for peacetime: the producing of artificial diamonds and the enriching of minerals and materials.
3rd for purely cientific research of special molecules and atom under extrem pressures and temperatures.

I esteem these researches tobe important and promising and therefor ask to be allowed to prosecute them at the service of the U.S.A.

(Signed Dr.Walter Trinks

Figure D.613: During his imprisonment by the U.S. Army, Walter Trinks informed U.S. officials that "At the end of the war I was occupied with experiments for... the initiation of atomic bombs." Where are the detailed reports on his interrogations and everything he revealed about his wartime work? What exactly did he work on after the war, and for whom? [NARA RG 319, Entry A1-134B, Box ??, Folder XE098301 Trinks, Walter].

Kurt Diebner. UK Patent 841,387. Thermonuclear Reactions. Filed 30 November 1956.

I, Kurt Diebner, of Eppendorfer Stieg 8, Hamburg 39, Germany, of German nationality do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to a method for the ignition of the thermonuclear fuels deuterium and tritium.

Amongst known attempts for the generation of very high temperatures, two in particular promise to be successful, of which each one currently permits when using a suitable arrangement, the attainment of temperatures of the order of 10^5 °K to 10^6 °K and over. One of these methods is the generation of converging shock waves through suitable ignition of an explosive in the form of a hollow body at its outer shell. The other method consists in generating highly ionised gases by concentrated discharges and making use of the pinch- effect in a restricted space. One possible method of execution recorded in the literature is given by an electric arc burning between two carbon electrodes, between which a condenser battery of high capacity and with a high voltage charge is briefly short-circuited.

The present invention consists in a method for the ignition of the thermonuclear fuels deuterium and tritium, to initiate thermonuclear reactions, wherein converging compression shock waves are produced in a hollow body by solid or liquid explosives, the generation of high temperatures in the centre of convergence of the shock waves being combined with an increase of temperature generated by concentrated electrical discharges in the fusionable nuclear fuels so that the temperature raising effects are superimposed and temperatures necessary for fusion processes are produced at the centre of the converging shock wave.

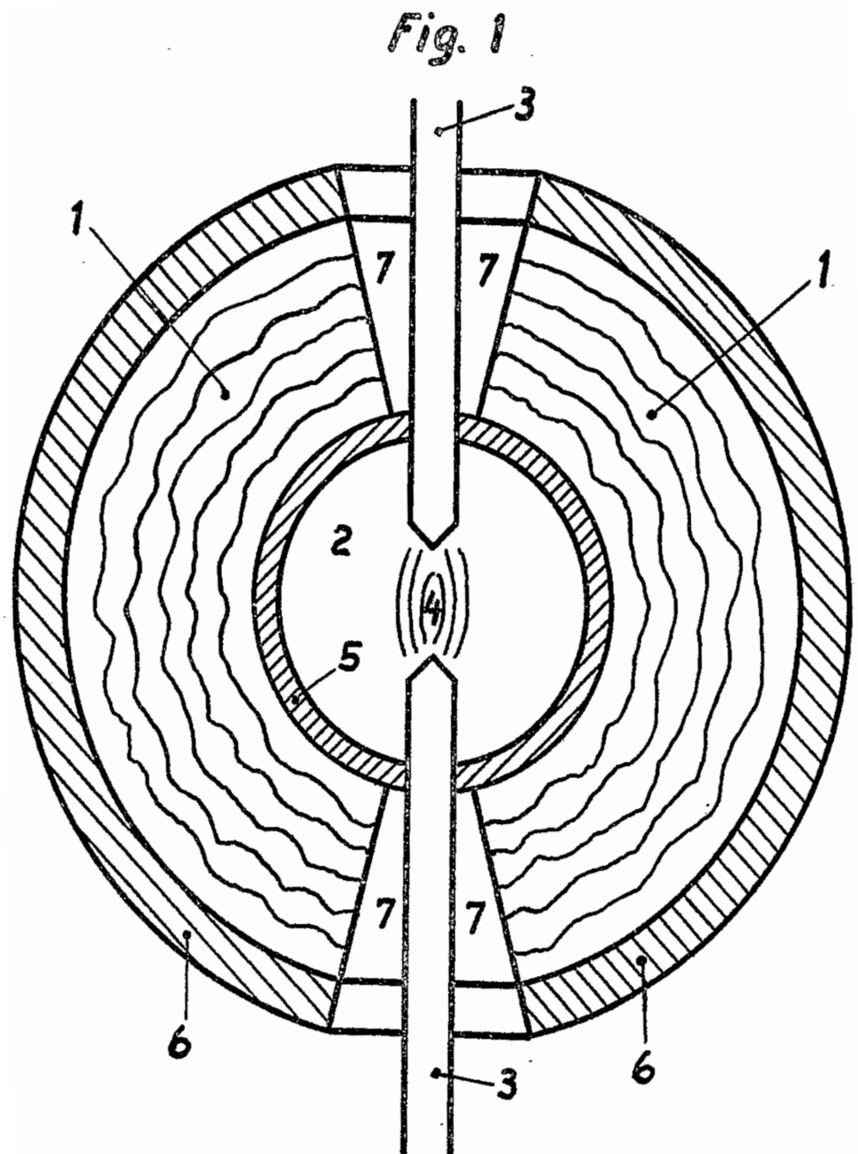
The invention further consists in a method for the ignition of thermonuclear fuels to promote thermonuclear reactions therein, which consists in detonating an explosive charge in the form of a hollow body surrounding the thermonuclear fuel, thereby generating a converging shock wave in the interior thereof, and creating a concentrated electrical discharge in the thermonuclear fuel at the centre of convergence of the shock wave in order to attain a temperature sufficient for the ignition of the thermonuclear fuel.

In the accompanying drawings:–

Figure 1 is a diagrammatic view of apparatus for carrying out the method according to the present invention, and

Figure 2 shows a wiring diagram for the apparatus of figure 1.

In carrying the invention into effect according to one convenient mode by way of example, reference 1 (figure 1) denotes an explosive body of spherical shell shape provided with two openings in the shape of a truncated cone, in which a spherically shaped high pressure container 5 is embedded for the uptake of the deuterium 2, perhaps in gaseous form under very high pressure. The spherically shaped high pressure container can however also be dispensed with, and the deuterium can be incorporated directly under pressure into the explosive material. The explosive body 1 can be surrounded by a further spherical shell 6, which tamps the explosive body towards the outside. Two insulated electrodes, for example lithium (lithium 6), between which an electric arc 4 can burn, are introduced into the high pressure container 5. For this purpose the electrode material should have a low nuclear charge number and be as thin as possible in order to maintain at a low level the larger proton reflection with its related higher nuclear charge number. Lithium 6 is furthermore particularly suitable because with it tritium is formed in the thermonuclear combustion process.



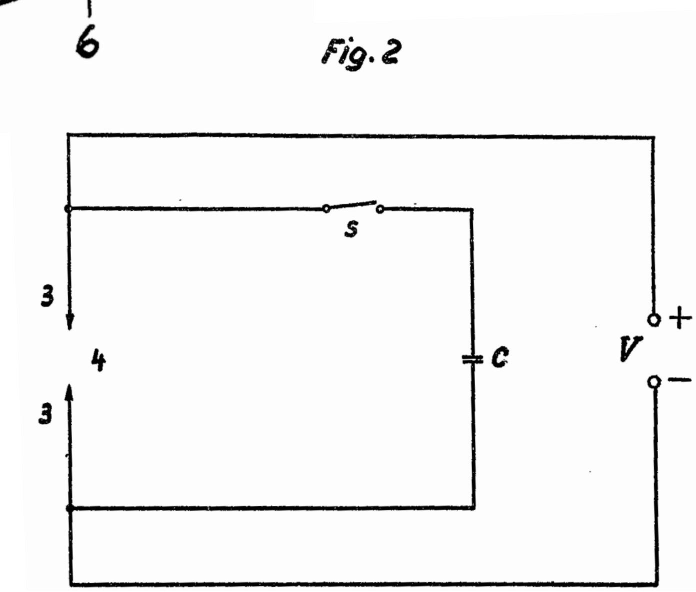


Figure D.614: Figures from Kurt Diebner's U.K. Patent 841,387.

An example is shown in Figure 2 of an electric connection for the electric arc and the connected condenser, in which C represents a condenser. S is a suitable switch which can connect the condenser to the electric arc. V is the source of tension for the electric arc 4. The release of the thermonuclear reaction in the deuterium gas 2 is now to proceed as follows:

The explosive material is so ignited at the boundary surface between 6 and 1, that a converging shock wave results, which after exceeding the boundary surface 5, runs towards the centre of the electric arc 4, and there contributes to an increase of the temperature of the already burning electric arc. The electric arc burns thereby in a gas of high pressure, so that under these circumstances it can already operate on its own at temperatures of the order of 10,000 degrees and more.

The height of the temperature to be reached in the moment when the shock wave reaches the centre of convergence 4, depends amongst other things on the geometry of the arrangement, and on the explosive material used (trinitrotoluol or hexogen or others). It also depends on whether a high pressure container 5 is used, and the material from which it is composed, as well as finally on the temperature, power and shape of the electric arc.

When the shock wave has reached the centre of convergence, further suitable measures are provided according to Figure 1, which permit further considerable heating of the gas (plasma) which is under the highest pressure and which has thereby become highly conductive. Because of this in the example provided, a further additional heating of the deuterium by the electric spark follows, directly before the compression shock reaches in its last phase the centre of convergence. Through this combination of the various methods in an appropriate sequence it is possible to attain the highest temperatures during the arrival of the shock wave in the centre of convergence. A further condition is that the electrodes are still active at the moment of the setting in of the discharge. Since it is an electrical process which is being dealt with, when the condenser C which has been charged with high voltage is suddenly discharged, and since on the other hand the deuterium gas in the electric arc 4 is already extensively pre-ionised, it is possible to add at least partially, to the convergence centre, the energy accumulated in the condenser. Furthermore, at the moment of connecting the condenser, because of the magnetic effects in the discharge path, an adiabatic contraction of the highly ionised plasma in the sense of the pinch-effect takes place, which has the effect of raising the temperature. In the given circumstances it is merely a question of the amount of energy accumulated in the condenser and which is available for the continuation of the working process, and the temperature in the convergence centre 4 can be increased additionally to such an extent, that the added energy is great enough to allow the thermonuclear ignition of the deuterium gas to take place.

Besides the given example, temperature effects can be superposed or supplemented, additional consideration being taken of an adiabatic compression and suitable temporal sequence with combination of gas discharges, spark discharges, a mechanically or chemically generated adiabatic compression, detonation wave or some of them, which are suitable for producing the temperatures necessary for the ignition of the gaseous, liquid, and if need be solid thermonuclear fuels. It is also possible for example, to fill the space 7 with liquid deuterium, tritium or D_2O, in the manner that the deuterium 2 serves as initiator for further larger quantities of thermonuclear fuel. Installations with half spherical-hollow bodies can also be constructed, which can also cause the ignition of the thermonuclear fuel, in the convergence centre,—such a fuel corresponding to the deuterium 2—and/or to use the latter for the initial ignition of further quantities of the same or of other thermonuclear fuels. Any other form of hollow body which permits the production of a suitable converging compression shock under suitable ignition is also admissible according to the purposes for which the ignited thermonuclear fuel is to be used, whereby it is particularly to be noted, that these installations can also be used to produce thermonuclear reactions which do not lead or need not lead to ignition.

It is also conceivable, for example, for deuterium enclosed in a volume, to be preheated by adiabatic compression, electrical discharges or any other means, and then to be ignited by a linear and/or if necessary converging compression shock, or else to achieve this with adiabatically pre-heated thermonuclear fuel, using concentrated electrical discharges. Such installations as mentioned in the last example are suitable when their intermittent activity is controlled for the production of mechanical energy. The process explained in Figure 1 can also be carried out in a large pressure container and thus be suitable for maintaining in this large boiler, pressures and/or temperatures required for energy withdrawal or energy generation for certain purposes. This can take place during the intermittent or continuous running of several such processes, respectively repeated any number of times, whereby temperatures and/or pressures can be added to any desired purpose, such as heat engines, the drive of turbines, and others.

What I claim is:–

l. A method for the ignition of the thermonuclear fuels deuterium and tritium, to initiate thermonuclear reactions, wherein converging compression shock waves are produced in a hollow body by solid or liquid explosives, the generation of high temperatures in the centre of convergence of the shock waves being combined with an increase of temperature generated by concentrated electrical discharges in the fusionable nuclear fuels so that the temperature-raising effects are superimposed and temperatures necessary for fusion processes are produced at the centre of the converging shock waves.

2. A method for the ignition of thermonuclear fuels to promote thermonuclear reactions therein, which consists in detonating an explosive charge in the form of a hollow body surrounding the thermonuclear fuel, thereby generating a converging shock wave in the interior thereof, and creating a concentrated electrical discharge in the thermonuclear fuel at the centre of convergence of the shock wave in order to attain a temperature sufficient for the ignition of the thermonuclear fuel.

3. A method as claimed in claim 1 or 2, wherein the processes of the converging percussion wave and of the concentrated electrical discharges are temporarily connected in sequence in such a manner that, the electrical discharge is first effected at the instant when the percussion wave just reaches the convergence centre.

4. A method as claimed in claim 1, 2, or 3, wherein in order to increase the effect of the converging percussion wave a tamping of the explosive is used on its outer side.

5. A method as claimed in any of claims 1 to 4, distinguished in that, the thermonuclear nuclear fuels to be ignited, whether gaseous or liquid, are under high pressure.

6. A method as claimed in any of claims 1 to 5, distinguished in that, the electrical discharges take place in a space which is considerably pre-heated by adiabatic compression which is generated chemically.

7. A method as claimed in any of claims 1 to 6, wherein the nuclear fuel to be ignited is surrounded by a pressure container, the components of which will further increase the action of the converging shock wave.

8. A method as claimed in any of claims 1 to 7, wherein by initiating thermonuclear reactions in

a small volume, the initial condition is created for initiating fusion reactions in a larger volume of thermonuclear fuel.

9. A method as claimed in any of claims 1 to 8, wherein the thermonuclear reactions take place in a suitable container for the maintenance of required pressures and/or required temperatures, and that thus the fusion energy can be utilized.

10. A method as claimed in claim 9, wherein the process is repeated periodically or not periodically, and it serves for driving turbines, heat engines and/or other power combinations.

11. A method for the ignition of thermonuclear fuels substantially as described with reference to the accompanying drawings.

Kurt Diebner. 1962. Fusionsprozesse mit Hilfe konvergenter Stosswellen—einige ältere und neuere Versuche und überlegungen. *Kerntechnik* 4:3:89–93.

[See pp. 4303–4305.]

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Fusionsprozesse mit Hilfe konvergenter Stoßwellen – einige ältere und neuere Versuche und Überlegungen

Von K. Diebner

Forschungs- und Erprobungsstelle für Schiffsbetriebstechnik an der Staatlichen Schiffsingenieurschule, Flensburg

Zusammenfassung

In einem zusammenfassenden Bericht wird die Diskussion über die Anwendung konvergenter Stoßwellen für die Plasmaphysik rückblickend dargestellt. Ausgehend von den theoretischen und experimentellen Untersuchungen an Kugel- und Zylinderstoßwellen wird chronologisch über die wesentlichsten bis heute bekannten Vorschläge berichtet. Die notwendigen Abmessungen der Kugel und die Sprengstoffmenge der einfachsten Hohlkugelanordnungen sowie die Kombination mechanischer Stoßwellen mit adiabatischer magnetischer Kompression, Vorheizung durch eine Gasentladung und Knallfunkenstrecken zur Stoßwellenerzeugung werden diskutiert. Die Aussichten periodisch arbeitender Fusionsreaktormodelle, die auf der Basis konvergenter Stoßwellen beruhen, werden diskutiert.

Die Möglichkeiten der Aufheizung von Deuterium und Deuterium-Tritium-Gemischen auf Fusionstemperaturen mit Hilfe von mechanischen Stoßwellen werden heute bereits in den einführenden Lehrbüchern erwähnt und diskutiert. Eine Reihe von magnetischen Hochtemperatur-Plasmaerzeugern nutzen Stoßwellen für die Aufheizung der fusionsfähigen Gase praktisch aus. Allein diese Tatsachen rechtfertigen einen Rückblick auf die Anfänge dieser Entwicklung und einen zusammenfassenden Bericht über die bisher vorliegenden Vorschläge und Erfahrungen.

Das Verfahren, mit Stoßwellen hohe Temperaturen und Drucke zu erzeugen, wurde bereits während des Krieges bei der Formgebung von Sprengkörpern verwandt (Durchschlagskraft der Panzerfaust). Eine feste Sprengkörperhohlladung wird etwa in eine Form nach Abb. 1 gebracht und an der Stelle Z gezündet. Die sich an der kugelförmigen Innenoberfläche O bildenden Schwaden werden senkrecht abgestrahlt und vereinigen sich im Brennpunkt F des Hohlkörpers H. Obgleich die Wege der Detonationswelle im Sprengkörper verschieden lang sind, kann man durch geeignete Formgebung erreichen, daß die Schwaden gleichzeitig im Brennpunkt eintreffen und hohe Temperaturen erzeugen.

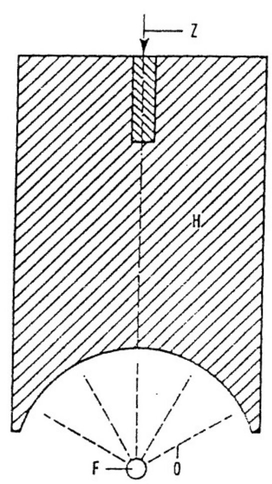


Abb. 1: Hohlkörper. Einfachste Form einer Sprengstoffanordnung zur Zündung und Erzeugung einer halbkugelförmigen konvergenten Stoßwelle

Figure D.615: Kurt Diebner's paper describing (among other designs) a spherical implosion fission bomb with a deuterium-tritium fusion boost in the center [Diebner 1962].

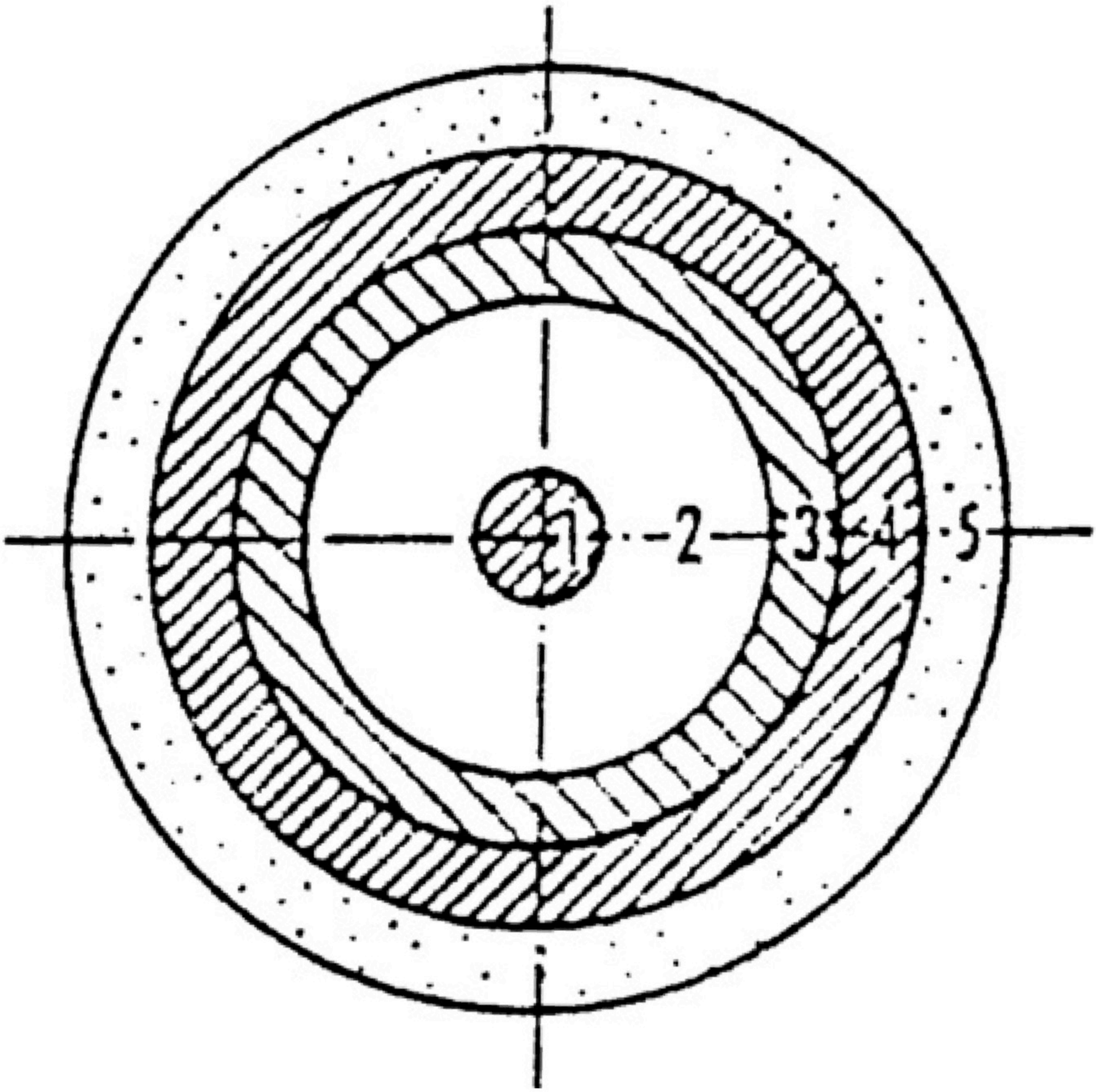
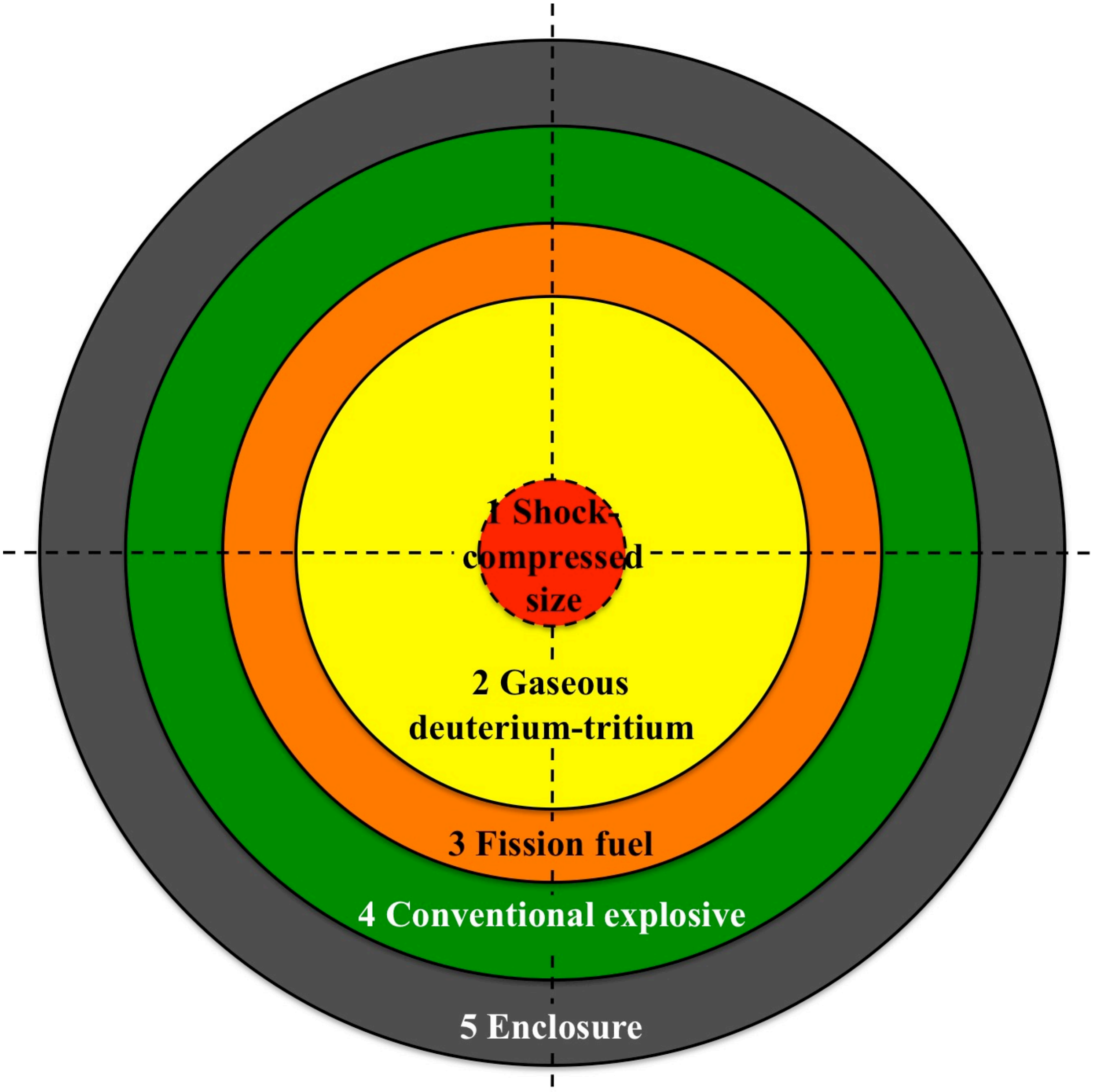


Abb. 5: Kugelschalenanordnung von Kernspaltstoff (3) und gewöhnlichem Sprengstoff (4), die in einer Verdämmung (5) eingeschlossen sind. Im Hohlraum (2) der Schichtfolge befindet sich gasförmiges Deuterium bzw. ein Deuterium-Tritium-Gemisch. Das Reaktionsvolumen der Stoßwelle ist wieder (1). Die Schale (3) ist so dimensioniert, daß der Kernspaltstoff erst dann eine kritische Anordnung darstellt, wenn durch Detonation der Schale (4) eine Stoßwelle die Hohlkugel in der Nähe des Konvergenzzentrums zu einem kompakten Gebilde zusammenschiebt

Figure D.616: Kurt Diebner's schematic illustration of a spherical implosion fission bomb design with a deuterium-tritium fusion boost in the center [Diebner 1962].



Kugelschalenanordung von Kernspaltstoff (3) und gewöhnlichem Sprengstoff (4), die in einer Verdämmung (5) eingeschlossen sind. Im Hohlraum (2) der Schichtfolge befindet sich gasförmiges Deuterium bzw. ein Deuterium-Tritium-Gemisch. Das Reaktionsvolumen der Stoßwelle ist wieder (1). Die Schale (3) ist so dimensioniert, daß der Kernspaltstoff erst dann eine kritische Anordnung darstellt, wenn durch Detonation der Schale (4) eine Stoßwelle die Hohlkugel in der Nähe des Konvergenzzentrums zu einem kompakten Gebilde zusammenschiebt.

A spherical shell arrangement of fission fuel (3) and conventional explosive (4) which is enclosed in a casing (5). In the central cavity (2) of the sequence of layers, there is gaseous deuterium or a deuterium-tritium mixture. The reaction volume of the shock wave is (1). The shell (3) is dimensioned in such a way that the fission fuel is only a critical assembly when, by detonation of the layer (4), a shock wave compresses the hollow sphere into a compact structure around the convergence center.

Figure D.617: Redrawn and translated version of Kurt Diebner's schematic illustration of a spherical implosion fission bomb design with a deuterium-tritium fusion boost in the center.

Vincent Nouzille and Olivier Huwart. 1999. Comment la France a recruté des savants de Hitler. *L'Express* no. 2498 (20 May), p. 122. https://www.lexpress.fr/informations/comment-la-france-a-recrute-des-savants-de-hitler_633743.html

La France recrute d'autres savants au passé controversé. En mars 1945, le Pr Hubert Schardin, l'un des patrons du centre de recherches de la Luftwaffe à Berlin-Gatow, formait des stagiaires en vue de créer une ultime "arme miracle" pour Hitler! Replié à Biberach, dans le Wurtemberg, il est fait prisonnier par le commandant Lutz, de la 1re division blindée de l'armée française. Le 7 mai 1945, Lutz indique à Schardin qu'il aura "toute liberté d'action". Le lendemain, jour de la capitulation allemande, le savant note dans son agenda: "Le travail a repris"... Avec une trentaine d'autres ingénieurs, il s'installe près de la frontière franco-allemande et devient codirecteur du Laboratoire de recherches balistiques et aérodynamiques de Saint-Louis (Haut-Rhin), créé spécialement par le ministère de l'Armement.

Parmi la centaine de recrues allemandes qui rejoignent progressivement ce laboratoire militaire se trouve le Dr Rudi Schall, un physicien berlinois de renom, venu d'un autre centre de recherches militaires. Agé aujourd'hui de 85 ans, retiré près du lac de Constance, il confie à L'Express: "C'est vrai que j'étais membre du parti nazi, comme beaucoup de mes collègues qui y étaient plus ou moins obligés, sans être forcément actifs. En 1945, les Américains nous ont embarqués, mais ils nous traitaient comme des moins-que-rien. Les Britanniques, eux, m'ont proposé de m'embaucher, mais sans que ma femme puisse me rejoindre. Alors que les Français ont été très chaleureux. La dénazification des postes était en cours en Allemagne. Mais on nous a dit que cela ne nous concernait pas. Je suis arrivé début 1946 à Saint-Louis." Rudi Schall succédera à Schardin comme codirecteur de ce laboratoire, devenu en 1959 le symbole de la nouvelle coopération militaire franco-allemande!

France is recruiting other scientists with a controversial past. In March 1945, Professor Hubert Schardin, one of the bosses of the Luftwaffe Research Centre in Berlin-Gatow, prepared assistants to create a final "miracle weapon" for Hitler! Folded back to Biberach, Württemberg, he was taken prisoner by Commander Lutz, of the 1st Armoured Division of the French Army. On May 7, 1945, Lutz told Schardin that he would have "complete freedom of action." The next day, the day of the German surrender, the scientist noted in his diary: "Work has resumed"... With about thirty other engineers, he settled near the Franco-German border and became co-director of the Laboratoire de recherches balistiques et aérodynamiques de Saint-Louis (Haut-Rhin), created especially by the Ministry of Armament.

Among the hundred German recruits who are gradually joining this military laboratory is Dr. Rudi Schall, a renowned Berlin physicist from another military research centre. Now 85 years old, retired near Lake Constance, he told L'Express: "It is true that I was a member of the Nazi party, like many of my colleagues who were more or less obliged to do so, without necessarily being active. In 1945, the Americans took us in, but they treated us like less than nothing. The British offered to hire me, but my wife could not join me. While the French were very warm and friendly. The denazification of posts was under way in Germany. But we were told that this did not concern us. I arrived in early 1946 in Saint-Louis." Rudi Schall succeeded Schardin as co-director of this laboratory, which became the symbol of the new Franco-German military cooperation in 1959!

Certaines embauches sont encore plus troublantes. Selon l'historien allemand Ulrich Albrecht, le comte Helmut Zborowski, ingénieur chez BMW, est emprisonné en 1945 à cause de son appartenance aux Waffen SS. Ce lourd passé n'empêche pas la France, en 1947, de convier Zborowski à rejoindre la Société européenne de propulsion par réaction (SEPR). Ce scientifique controversé créera, en 1950 à Paris, le Bureau technique Zborowski. Subventionné sur fonds publics par la Snecma, l'ex-SS concevra un drôle d'engin à décollage vertical, le Coléoptère, véritable gadget technique, dont les essais en vol se révéleront dangereux...

Le gouvernement tient également à conserver quelques chimistes allemands. Arrêtés par les Américains, Walter Reppe—qualifié de "nazi bon teint"—et Karl Wurster—présumé "criminel de guerre"—seront blanchis et rejoindront leurs postes à l'usine de Ludwigshafen, avec la bienveillance des Français. Tous les Alliés pratiquent le même cynisme. Le cas d'Otto Ambros, un des directeurs d'IG Farben, est exemplaire. Ambros a participé à la décision d'utiliser le zyklon B dans les chambres à gaz. Il a également supervisé une usine de caoutchouc synthétique à Auschwitz-Buna-Monowitz, dans laquelle de nombreux déportés ont été maltraités. Interrogé par des militaires français en août 1945, il rédige un rapport ultrasensible sur la production allemande de nouveaux gaz de combat (tabun, sarin, soman). De quoi intéresser les promoteurs d'armes chimiques françaises! Puis, selon l'historienne Marie-France Ludmann-Obier, ce scientifique, considéré comme "criminel de guerre", est invité par le ministère de la Guerre à Paris pour faire des conférences! Après des mois de pressions américaines, les Français finissent par livrer Ambros à des GI. Un tribunal de Nuremberg le condamne en 1948 à huit ans de prison pour esclavage. Libéré en 1951, il fera carrière comme conseiller d'un grand groupe chimique aux Etats-Unis...

Some hires are even more troubling. According to the German historian Ulrich Albrecht, Count Helmut Zborowski, an engineer at BMW, was imprisoned in 1945 because of his membership of the Waffen SS. This heavy history did not prevent France, in 1947, from inviting Zborowski to join the European Society for Jet Propulsion (SEPR). This controversial scientist created the Zborowski Technical Office in Paris in 1950. Subsidized on public funds by Snecma, the ex-SS will design a strange vertical take-off device, the Beetle, a real technical gadget, whose flight tests will prove dangerous...

The government also wants to keep some German chemists. Arrested by the Americans, Walter Reppe—described as a "well-rounded Nazi"—and Karl Wurster—allegedly a "war criminal"—were cleared and returned to their posts at the Ludwigshafen factory, with the goodwill of the French. All Allies practice the same cynicism. The case of Otto Ambros, one of the directors of IG Farben, is exemplary. Ambros was involved in the decision to use zyklon B in the gas chambers. He also supervised a synthetic rubber factory in Auschwitz-Buna-Monowitz, where many deportees were mistreated. When questioned by French soldiers in August 1945, he wrote a highly sensitive report on the German production of new poison gases (tabun, sarin, soman). This is of interest to French chemical weapons promoters! Then, according to historian Marie-France Ludmann-Obier, this scientist, considered a "war criminal," was invited by the Ministry of War in Paris to give lectures! After months of American pressure, the French finally delivered Ambros to GIs. A Nuremberg tribunal sentenced him in 1948 to eight years in prison for slavery. Released in 1951, he made a career as an advisor to a large chemical group in the United States...

[Ambros, Schardin, Schall, and Zborowski appear to have played important roles in the German nuclear weapons program, and likely used that knowledge to help the postwar French nuclear weapons program. Almost certainly there are extensive French files on their wartime and postwar work, but those files remain unavailable.]

Ingeborg Brandt, who worked in the Hans Lindemayer group in Anklam and then Friedland. Letter to Karl Spietz. 20 October 1995. Heimatmuseum Friedland, Akte Nr. 157. [Karlsch 2005, pp. 169, 230]

Vor unserer Halle war so eine Art Terrasse. Man nannte dies Prüfstand. Dort stand so eine Kugel [...] Ich selbst schätze sie auf einen Durchmesser von 1,80 Meter.

There was a kind of terrace in front of our hall. This was called the test stand. There was such a ball [...] I estimate it to be 1.80 meters in diameter.

Irene König, who worked in Anklam and then Friedland. 16 July 2004 interview by Heiko Petermann. [Karlsch 2005, pp. 169–170]

Da wurden zwei Aluminiumkugeln ineinander gesetzt, eine große und eine kleine, und die dampften. Zuerst dachte ich, die kochen darin Wasser. Aber ich habe mich natürlich nicht getraut zu fragen, das war ja alles so geheim. Wir wurden dann nach dem Bombenangriff nach Friedland verlagert. Lindemayer ging nach Nordhausen, und Johann Grüner übernahm die Leitung der Gruppe. In Friedland wurden die Kugeln in einem großen Kessel mit hoher Geschwindigkeit gedreht. Manchmal war ein gewaltiges Getöse und Donnern zu hören. Die Ingenieure erzählten uns dann, dass sie Versuche mit Druckminderern durchführen.

There were two aluminum spheres, one placed inside the other, one large and one small, and they steamed. At first I thought they were boiling water in them. But of course I did not dare to ask, it was all so secret. We were then transferred to Friedland after the bomb attack. Lindemayer went to Nordhausen, and Johann Grüner took over the management of the group. In Friedland the spheres were turned in a large cauldron at high speed. Sometimes there was a tremendous roar and thunder. The engineers then told us that they were doing experiments with pressure reducers.

[Ilyichev's March 1945 description of the German implosion bomb design (see p. 4529) includes two hollow aluminum spheres, a large outer aluminum explosive case and a smaller aluminum pusher inside that.

"In addition to the Lindemayer group, a second research team headed by Dr. Ing. Wolfgang Steurer came to Friedland in 1944. He was considered to be one of the best experts in the field of material testing and was particularly well-known in aluminum alloys. His group consisted of 24 scientists, technicians and assistants. [...] Employees had been seen in protective suits during materials transport and at work. Details were not disclosed." [Karlsch 2005, p. 170]

See also:

Christoph Regel, Die Erprobungsstelle Rechlin, in: *Flugerprobungsstellen bis 1945.* Bonn 1998, pp. 60ff.

Heimatmuseum Friedland, Nr. 157: Karl Spietz to Gerhard Remdt 26.4.1966, 24.2.1967; Karl Spietz to *Neue Friedländische Zeitung* 15 September 1995.

Wer waren die Gummimänner von Friedland? *Neue Friedländer Zeitung* 7 June 1995.]

Heinrich Himmler's chief adjutant Werner Grothmann on nuclear weapon designs [Krotzky 2002]. See pp. 3414–3415 regarding the background and reliability of this source.

[S. 9] Was ich weiß ist die tatsächliche Vorbereitung für die Prototypenproduktion der zwei durchkonstruierten Atombombentypen für Uran und Plutonium. [...] Ich durfte davon nichts wissen, deshalb kann ich nur sagen, dass es um zwei Standardtypen für den Einsatz gegen Städte ging und noch zwei weitere unterschiedlich grosse, die sollten frontverwendungsfähig sein und kleinere Ladungen enthalten. Ich erfuhr erst nach dem Krieg davon, dass die eine von den beiden kleineren ein Ladungsäquivalent, also eine vergleichbare Sprengmaterialmenge, von ich glaube 130 Tonnen gehabt hätte. Die sollte gegen Bahntunnels, Hafenanlagen und Militäreinrichtungen eingesetzt werden. Der Punkt war, dass die kleinen Waffen nur ganz wenig Material benötigten, denn daran bestand ja erstmal der Mangel. Von der grösseren hörte ich nur eine Angabe, die ich nicht bestätigen kann, da ging es um drei Kilotonnen, das muss offen bleiben.

[S. 18] Was da im einzelnen alles gelaufen ist, erfuhr ich nie. Es war aber so, dass es zwei ganz verschiedene Konstruktionen gab, von einer dritten, zu der ich sonst nichts weiß, hörte ich erst recht nicht viel. Die muß wie eine aufgequollene Bombe ausgesehen haben. Zu den beiden anderen weiß ich, dass die kleinere ungefähr die Größe der SC 250 gehabt hatte, aber das Gewicht war höher. Die größere Waffe hätte eine Kugelform besessen mit einem Durchmesser von über einem Meter. Die war sehr schwer, obwohl der Bombenkörper selbst aus Aluminium gewesen sein soll. Es hieß, wenn man das Gewicht reduziert, geht die Ladung nicht hoch. Dann war eine Variante geplant, bei der der Bombenkörper selbst Bestandteil des Sprengsytems gewesen sein soll. Ich kann das jetzt nicht besser sagen, es ging jedenfalls darum, das Gewicht zu reduzieren und trotzdem eine richtig große Sprengkraft zu erhalten.

[p. 9] What I know is the actual preparation for the prototype production of the two fully constructed atomic bomb types for uranium and plutonium. [...] I was not allowed to know anything about it, so I can only say that there were two standard types for use against cities and two more of a different size, which were supposed to be front-usable [for tactical battlefield use] and contain smaller charges. I learned only after the war that one of the two smaller ones would have had a charge equivalent, that is a comparable explosive material quantity, of I believe 130 tons. This was supposed to be used against railway tunnels, port facilities and military installations. The point was that the small weapons required only very little material, which overcame first of all the shortage [of fission fuel]. Of the larger one I heard only a statement, which I cannot confirm, that it was about three kilotons, that must remain [an] open [question].

[p. 18] I never heard what all was going on in detail. It was true, however, that there were two entirely different constructions; of a third, about which I do not know anything else, I did not hear much. It must have looked like a swollen bomb. About the other two, I know that the smaller was about the size of the SC 250, but the weight was higher. The larger weapon would have possessed a spherical shape with a diameter of over one meter. It was very heavy, even though the bomb body itself was supposed to be out of aluminum. It was said, if one reduces the weight, the yield is not as high. For this purpose, a variant was planned, in which the bomb body itself was supposed to have been a component of the explosive system. I cannot say better now, it was anyway to reduce the weight and still get a really big explosive energy.

[S. 44] Ja, jetzt kommt noch das dritte Problem. Wir haben ja schon mal darüber gesprochen, dass die Wissenschaftler eine Zündung in der Luft in einer bestimmten Höhe haben wollten. Es sollte eine Höhe von ungefähr 400 Metern sein. Es gab aber erst mal keinen einzigen Zündmechanismus, der das zuverlässig schaffte, obwohl viele daran gearbeitet hatten. Es ist sogar überlegt worden, das mit Zeitzünder zu machen, ich weiß aber nicht, ob das durchgeführt worden ist. Das Problem war ja, wenn man einen Aufschlagzünder nimmt, verpufft der größte Teil der Wirkung. Dann wäre die Waffe die ganze Mühe nicht wert gewesen. Bei dem Versuch, der im Spätherbst 44 mit dem Fallschirmabwurf durchgeführt worden war, hatten sie etwas ausprobiert. Ich weiß aber nicht, ob das wirklich ein Annäherungszünder gewesen ist.

[p. 44] Yes, now comes the third problem. We have already talked about the fact that the scientists wanted to have an ignition in the air at a certain altitude. It should be an altitude of approximately 400 meters. But there was not even a single ignition mechanism that made it reliable, even though many had worked on it. It was even thought of doing this with a time fuse, but I do not know if this was done. The problem was, if one uses an impact fuse, most of the effect fizzles. Then the weapon would not have been worth the effort. In the test, which was carried out in late autumn 44 with the parachute drop, they had tried out something. But I do not know if this was really a proximity fuse.

[S. 42] Übrigens, was die Physiker Himmler im Privatvortrag zur Wasserstoffbombe sagten, das hatte ihn wirklich elektisiert, weil er hörte, dass die Sprengwirkung hundertmal größer sein würde als bei der Uranbombe.

[p. 42] By the way, what the physicists told Himmler in their private lecture on the hydrogen bomb had really electrified him, because he heard that the explosive effect would be a hundred times greater than that of the uranium bomb.

[Can other relevant documents from or about the following people be located in archives?

- Alfred Baubin
- Adolf Busemann
- Rolf Engel
- Siegfried Flügge
- Erich Purucker
- Rudi Schall
- Hubert Schardin
- Karel Staller
- Gustav Thomer
- Walter Trinks
- Others?]

[Grothmann appeared to describe work on at least five different types of nuclear weapons:

1. A tactical bomb using U-235 (produced in any of several uranium enrichment facilities that Grothmann alluded to) with an explosive yield of less than a kiloton (Grothmann thought he remembered 130 tons). He compared it to the size of an SC 250 bomb, a common cylindrical German bomb with a 37-cm diameter and 120-cm body length (Fig. D.618), but said it was heavier than an SC 250 (heavier than 250 kg). In principle, a bomb of that size might have been an implosion bomb design employing cylindrical compression as considered by Gottfried Guderley as well as Erich Schumann and Walter Trinks; see p. 4286. Alternatively it might have been a biconic implosion bomb design employing focused compression from each end, as considered by Schumann and Trinks; see p. 4284. R. P. Linstead and T. J. Betts, the U.K. and U.S. chairs of CIOS, wrote in their final report about German V-rockets armed with atomic bombs that were much smaller than the standard V-2 payload of 1000 kg (p. 5076). The bomb described by Grothmann and the CIOS chairs does not match the characteristics of a gun-type fission bomb. For example, the U.S. Little Boy had a mass of 4400 kg, diameter of 71 cm, and length of 300 cm, and because of its inherent physics used a very large amount of uranium, had a very low efficiency, and produced a large explosive yield, in contrast to the weapon that Grothmann described.

2. A tactical bomb using Pu-239 (produced in any of several plutonium breeding facilities that Grothmann alluded to). Other than the difference in fuel, presumably this bomb had the same design as the tactical uranium bomb, as well as a roughly comparable yield.

3. A strategic bomb using U-235 with an explosive yield of several kilotons. (Grothmann thought he remembered 3 kilotons, but he seemed uncertain; that value may have been the yield of one of the small tests, not the yield that a fully fueled and deployed version of the bomb would have.) The bomb was a sphere with a diameter of somewhat over 1 meter, an aluminum shell, and a large mass. It apparently used a sophisticated implosion system. All of these details are highly consistent with the bomb design reported by Ilyichev (pp. 4525 and 4529).

4. A strategic bomb using Pu-239. Presumably this bomb had the same design as the strategic uranium bomb, as well as a roughly comparable yield.

5. A hydrogen bomb or H-bomb using fusion reactions but initiated by reactions in fission fuel. According to Grothmann, its explosive yield would be a hundred times larger than a fission bomb, or on the order of a megaton. Grothmann knew much less about this bomb design, but he described it as “a swollen bomb.” That might be taken to mean an oversized spherical implosion bomb, which could match the description of a “sloika” or layer-cake H-bomb design. Alternatively, Grothmann’s wording might be construed to mean an ellipsoidal shape, which could match the description of a Prandtl-Meyer two- or three-stage H-bomb design (p. 4411). This bomb was expected to be operational by late 1945 (p. 4405) or early 1946 (p. 3419), which suggests that it was at a fairly advanced stage of development, not merely a paper design. For more information on German development of fusion fuels and fusion bombs, see Sections D.9 and D.15.6.]

Figure D.618: SC 250 bomb, which Grothmann said was comparable in size to the smallest German nuclear weapon. See pp. 4284 and 4286 for what the internal structure may have looked like.

PW Intelligence Bulletin 1/47, 13 March 1945 [NARA RG 165, Entry NM84-79, Box 1915]. See document photo with diagram on p. 4314.

16. Microbe Bombs

PW saw appr one hundred 250 kg bombs stored in a hall at Flughorst Ost, MAGDEBURG. PW was told that these were microbe bombs.

As described to PW, the bomb has two detonating chambers (one in front and one in back) with 2 side fuses. In the center of the shell is an empty lead lined chamber with threaded opening on the side into which a tube is screwed. The opening has 8 threads and when the tube is screwed into the last thread it is opened and the microbes which have been stored in the tube escape into the chamber. The opening is smeared with a gelatinous substance to prevent the escape of germs.

PW thinks the germs are of cholera type.

(Source: Gefr August KIEFFER, KG MATERN captured 1 Mar vic AMMERN)

Military Intelligence Service, 26 March 1945 [NARA RG 165, Entry NM84-187, Box 137, Folder BW 55]. See document photo with diagram on p. 4315.

G-2 COMMENT:

This (250 kg) seems quite large for a single BW bomb. Further interrogation is contemplated, and information will be forwarded.

[The German PW said he had seen special bombs stored at a Luftwaffe base and gave a relatively detailed description of their design. The PW had heard and the Allied interrogators just assumed that the bombs were biological. Since the design was "only" biological, the report was ultimately declassified by the U.S. government.

The design as given by the PW makes absolutely no scientific sense if the small, dangerous, final component that must be inserted in the middle is biological. There is too much explosive, too little "biological agent," and a mysterious tamper in between made of lead or some other extremely dense metal. Any biological agent in the middle would be destroyed by the intense heat and intense pressure created by the explosives at both ends. The design also does not make any sense for chemical weapons or fuel-air explosives.

But what if that small, dangerous, final component in the PW's design is nuclear? Compare the PW's design with the descriptions from Werner Grothmann and Erich Schumann.

Notice how many of these special bombs the PW said he saw.]

DECLASSIFIED
Authority NND945074

NARA RG 165, Entry NM84-79, Box 1915,
PW Intelligence Bulletin 1/47, 13 March 1945

SECRET

PW Intelligence Bulletin No 1/47

15. Pressluft (Continued)

Employment

PW saw the shells only at HEESEN trng grounds. Pressluft Granaten were thought to be especially effective against tk concentrations. Instructing Officer stated that they would be used only as a last resort for fear of Allied gas retaliation.

The supply at that time (Nov 44) was too small for effective use.

(Source: Uffz Rene HERTENS (Belgian) 1 Coy 1501 Heeres Kost Arty Abt captured 5 March BAERL)

Shipments of Pressluft Granaten

PW reports that he saw ammo being evacuated from an ammo dump nr KÖLN in the STADTWALD-KÖLN Forest. PW was prevented from entering the dump, and was told that Pressluft ammo was stored here. The ammo was packed in gray painted boxes appr 45-50 x 35-40 cm. PW thinks the boxes had no markings (?).

(Source: Gren Felix ZYTINSKI (Pole) 2 Tp 3 Arty Regt captured 5 March)

July 44 PW helped load 16 freight cars with 45 Pressluft Granaten each. Shells were appr 17 cm diameter and shaped like an hour-glass. Loading took place in BERLIN W of the S edge of the small KIENHORST (GSGS 4480/BERLIN/ I/A 1b). Shells were shipped to XANTEN for use on the W front.

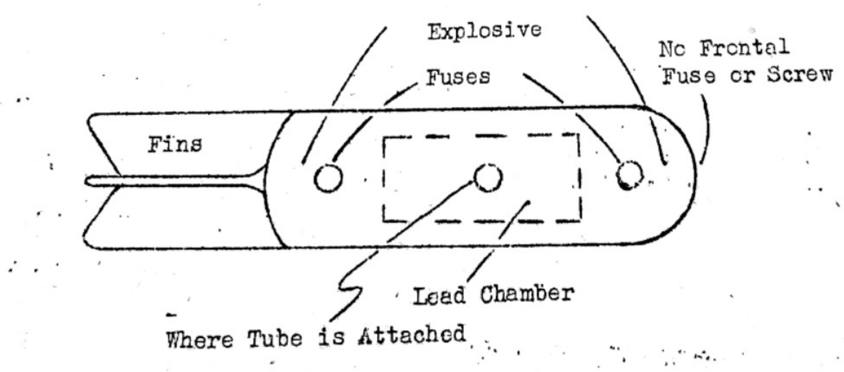
(Source: O/Gefr Johannes CARSTENS 8 Coy 1225 Inf Regt captured 2 Mar vic BROCKHUYSEN)

16. Microbe Bombs

PW saw appr one hundred 250 kg bombs stored in a hall at Flughorst Ost, MAGDEBURG. PW was told that these were microbe bombs.

As described to PW, the bomb has two detonating chambers (one in front and one in back) with 2 side fuzes. In the center of the shell is an empty lead lined chamber with threaded opening on the side into which a tube is screwed. The opening has 8 threads and when the tube is screwed into the last thread it is opened and the microbes which have been stored in the tube escape into the chamber. The opening is smeared with a gelatinous substance to prevent the escape of germs.

PW thinks the germs are of cholera type.



(Source: Gefr August KIEFFER, KG MATERN captured 1 Mar vic AMMERN)

SECRET
- 29 -

Figure D.619: PW Intelligence Bulletin 1/47, 13 March 1945 [NARA RG 165, Entry NM84-79, Box 1915].

DECLASSIFIED
Authority NWD 750122

NARA RG 165, Entry NM84-187, Box 137, Folder BW 55

Distribution: 27 Mar 45
Mr Merck
Lt Col Cole (2)
SGO
NDD
OSS
OSRD

ETOUSA
Col Paget
Dr. Maas
Scien.Br.
Col Pash

SECRET

WAR DEPARTMENT
Military Intelligence Service
Washington

26 March 1945

BW INFORMATION

SOURCE: MFIU No 1, 13 March 45, PW Intelligence Bulletin No 1/47
(From CPM) Desperation Warfare

E X T R A C T

* * * * * * * * *

16. Microbe Bombs

PW (captured 1 Mar vic AMMERN) saw appr one hundred 250 kg bombs stored in a hall at Flughorst Ost, MAGDELBURG. PW was told that these were microbe bombs.

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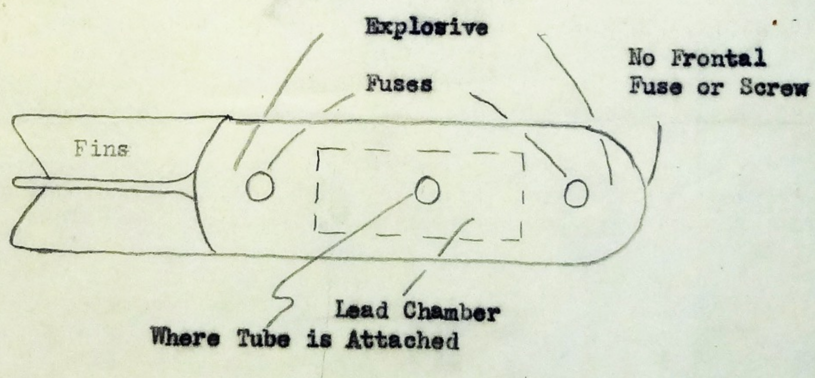

* * * * * * * * *

G-2 COMMENT:

This (250kg) seems quite large for a single BW bomb. Further interrogation is contemplated, and information will be forwarded.

Figure D.620: Military Intelligence Service, 26 March 1945 [NARA RG 165, Entry NM84-187, Box 137, Folder BW 55].

D.9 Fusion Fuel and Bomb Design

[Wolfgang Ferrant (German?, ??–??), Ulrich Jetter (German, 1914–??), Alfred Klemm (German, 1913–2013), Karl Lintner (Austrian, 1917–2015), Josef Mattauch (Austrian, 1895–1976), Erich Schumann, Georg Stetter (Austrian, 1895–1988), Walter Trinks (German, 1910–1995), and many others worked in teams that researched and produced significant amounts of fusion fuels and potential methods to use them:

- German patents, articles, and other documents from 1933 through 1945 discussed how to produce fusion reactions in high-voltage tubes (pp. 3992–4004 and 4319–4365). That technology would have been very useful as a fusion neutron initiator in a fission bomb, as described by Kurt Diebner (p. 4299) and Ivan Ilyichev (p. 4529).

- In postwar papers apparently based on wartime work, Erich Schumann and Walter Trinks (pp. 4288–4293) and Kurt Diebner (pp. 4298–4305) independently described spherical implosion bomb designs with a center of fusion fuel inside a spherical shell of fission fuel. That "fusion boosting" approach could have greatly increased the yield of a fission bomb by supplying far more neutrons to induce fission reactions.

- A number of documents show that there was wartime work using lithium and deuterium together as fusion fuel (pp. 4343–4379). Because lithium deuteride is solid and not a gas or cryogenic liquid, it makes an ideal fuel for hydrogen bombs.

- During the war, Alfred Klemm (under the direction of Josef Mattauch) perfected a method to separate the lithium-6 isotope from the predominant lithium-7 in natural lithium (pp. 4382–4385). That would only be useful for nuclear applications. Klemm also stated that there was wartime work to produce tritium, another very potent fusion fuel (p. 4384).

- In 1950 Ulrich Jetter (German, 1914–??) published a detailed proposal that fusion bombs could use lithium-6 deuteride as readily storable solid fuel, rather than the much more troublesome cryogenic deuterium and tritium (p. 4386). Based on the other documents available, Jetter's description appears to be based on wartime German work. Officially, lithium-6 deuteride was first considered in the United States by Edward Teller in 1947 and in the Soviet Union by Vitaly Ginzberg in 1949, was first tested by the United States in 1954, and is commonly used in modern H bombs [Goncharov 1996a, 1996b; Chuck Hansen 1988, 2007; Rhodes 1995; Sublette 2019; Wellerstein and Geist 2017].

- In 1946, several scientists and engineers reported that during the war, Germany had been working on a 6-ton radioactive bomb, as well as methods to deliver it by rockets or aircraft (pp. 4376, 4388–4401, and 5411). Such a massive bomb would have been very challenging to deliver, and could presumably only have been justified if it were a hydrogen bomb. Conventional explosives, a dirty bomb of conventional explosives with radioactive material, chemical weapons, biological weapons, and even fission bombs could have been packaged into much smaller and much more easily deliverable sizes (and if necessary, several of them could have been delivered separately to the same target).

- A 1946 U.S. intelligence document mentioned wartime German research on H-bomb development as well as nuclear-armed ballistic missiles (p. 4406).

- In 1944–1945, several independent sources reported that Germany was developing a bomb with a six-mile blast radius, which is characteristic of the several-megaton energy of an H bomb, in stark contrast to the much smaller several-kiloton energy of a plain fission bomb (pp. 4403–4405).

- Friedwardt Winterberg, who worked very closely with Kurt Diebner after the war, published a highly distinctive ellipsoidal H-bomb design that looks rather different than standard U.S. H-bomb designs, but that is deeply steeped in earlier German hydrodynamics and physics research (p. 4411). A surviving 1944 sketch from Walther Gerlach shows an ellipsoid in conjunction with nuclear reactions involving deuterium, which seems to support the wartime origin of Winterberg's ellipsoidal H-bomb design (p. 4415).

- Werner Grothmann stated that the German nuclear program was developing several different bomb types, including a hydrogen bomb. He said that the hydrogen bomb looked like a "swollen bomb" (ellipsoidal?), would have been a hundred times more powerful than a fission bomb (megatons vs. tens of kilotons), and was expected to be ready in 1946 (which suggests that it had already progressed far in its development by 1945); see pp. 3419 and 4310. Other sources expected the German hydrogen bomb to be ready even sooner, sometime in 1945, if the war had continued (pp. 4405, 4372, 4397).

- In 1947, when Edward Teller was trying unsuccessfully to invent a workable design for the U.S. hydrogen bomb, he sent a highly unusual, specific, and urgent request for Siegfried Flügge to help him with a "physics... program... of interest and importance to the national security," stating that Flügge would "be of marked assistance in carrying out the aforementioned program" (p. 5042). In fact, the late-wartime and postwar influx of scientists and engineers who were from or at least had knowledge of the German nuclear program included Karl-Friedrich Bonhoeffer, Wernher von Braun, Rudolf Brill, Adolf Busemann, Walter Dornberger, Rudolf Edse, Krafft Ehricke, Wilhelm Eitel, Gerhard Falck, Karl Fiebinger, Wolfgang Finkelnburg, Rudolf Fleischmann, Siegfried Flügge, Walter Glaser, Wilhelm Groth, Gottfried Guderley, Paul Harteck, Otto Haxel, Richard Herzog, Johannes Hans Jensen, Willibald Jentschke, Ulrich Jetter, Georg Joos, Hartmut Kallmann, Hans Kammler, Gerald Klein, Stanley Kronenberg, Heinz Maier-Leibnitz, Werner Maurer, Hugo Neuert, Walter Nielsch (?), Edgar Petersen, Heinz Schlicke, Erich Schumann, Otto Schwede, Edmund Sorg, Kurt Starke, Wolfgang Steurer, Ernst Stuhlinger, Hans Suess, Herbert Wagner, Wilhelm Westphal, Friedwardt Winterberg, Karl Wirtz, Gernot Zippe, etc. (p. 5038). Many of those scientists appear to have been closely tied to the wartime German work on H-bombs, and may have especially aided the U.S. H-bomb development program between 1945 and 1954.

Table D.3 summarizes some of the major sources and details regarding the megaton-level H-bomb that was under development during the war.]

Primary sources for hydrogen bomb design

	Sänger 1944	***Daily Mail* 44**	***Evening Std.* 45**	**Kober 1945**	**Ferrant 1945**	**Schumann 1945-52**	**Kästner 1946**	**Sorg 1946**	**Thirring 1946**	**von Braun 1946**	**Zumpe 1946**	**U.S. Intel 1946-51**	**Klemm '47, '04**	**Granziani 1948**	**Jetter 1950**	**Grothmann 2000-2002**
Bomb mass	6 tons					Tons	6 tons	6 tons	6 tons	6 tons	6 tons				Tons	"Swollen bomb" (apparently very large)
Explosive energy		6-mile blast radius (~1.6 mega-tons)	6-mile blast radius (~1.6 mega-tons)	10^6 greater than nitro-glycerin (mega-tons)	Mega-tons poten-tially	Megatons potentially						"Even more deadly weapon than the atomic bomb" (>>20 kilotons)		6-mile blast radius (~1.6 mega-tons)	Mega-tons	"100x greater than that of the uranium bomb" (megatons)
Method of action	H-bomb implied by bomb mass and priority	H-bomb implied by blast radius	"Atomic" reactions; H-bomb implied by blast radius	H-bomb with lithium hydride (LiD?)	Explosive with lithium deuteride (LiD) and fission fuel	H-bomb with lithium deuteride (LiD) and fission fuel	Radio-active; H-bomb implied by bomb mass and parachute	H-bomb implied by bomb mass and priority	Lithium hydride (LiD?) H-bomb with fission bomb trigger	H-bomb implied by bomb mass and priority	H-bomb implied by bomb mass and priority	H-bomb with lithium hydride, deuterium and/or tritium	Highly secret military project using lithium -6 and tritium	H-bomb implied by blast radius	H-bomb with lithium deuteride (LiD) & fission bomb trigger	Hydrogen bomb; fission bomb as trigger
Vehicle	Rocket	Rocket					Parachute from plane	Plane		Rocket	Rocket	Rocket		Rocket		
Ready			Oct. 1945	"Test site" by 1945				Later 1945						Soon		1946
People involved	Aus-trian scien-tists		Groth	Stetter, other Austrian scientists, Gerlach, Toma-schek, AEG scientists	Ferrant, AEG scientists, Austrian scientists (implied)	Schumann, Trinks	Kästner, Petersen, Sorg, Austrian nuclear scientists, Schulz-Kampf-henkel	Peter-sen, Sorg	Jentschke and other Austrian nuclear scientists	von Braun, SS and Kammler (implied)	(Likely Puru-cker and his car full of bomb plans)	Stetter, Jentschke, Lintner, Mattauch, Ortner, Czulius, Schintl-meister	Klemm, Mattauch, Austrian nuclear scientists (implied), production elsewhere		Jetter	Himmler, SS, Kammler (implied), Austrian nuclear scientists
Places	Austria	French launch site	Celle	Austria, Berlin, Munich	Berlin, Austria	Berlin area	Austria	Austria and Baltic coast	Austria	Baltic coast		Austria	Tail-fingen, Berlin, Austria			Austria, Berlin

Table D.3: Details about hydrogen bomb design from primary sources.

Rausch von Traubenberg. 1933. Die bei der Lithiumzertrümmerung auftretende durchdringende Strahlung. *Die Naturwissenschaften* 21:694.

Wie wir kürzlich zeigen konnten, treten bei der künstlichen Umwandlung des Lithiumkernes durch Protonen auch γ-Strahlen auf, deren Nachweis uns mit Hilfe des Geiger-Müllerschen Zählrohres gelang. Wir haben inzwischen die Versuche mit verbesserten Hilfsmitteln wiederholt und eine Abschätzung der Härte der γ-Strahlen vorgenommen. Die Messungen wurden wieder so gestaltet, daß Lithium und ein bei unseren geringen Protonengeschwindigkeiten nicht zertrümmerbares Element, in diesem Falle Eisen, abwechselnd in den Gang der Wasserstoffkanalstrahlen gestellt wurden. Durch solche Differenzmessungen machten wir uns ebenso wie bei den früheren Untersuchungen von der Röntgenstrahlen sowie von der NZ (= Höhenstrahlen + radioaktiven Strahlen) frei und maßen die Lithiumstrahlung allein. Es wurde durch Zwischenschalten verschieden dicker Bleischichten als Hauptanteil eine weiche Komponente nachgewiesen, deren Intensität durch etwas 0,3 mm Blei auf die Hälfte geschwächt wurde. Bei einer maximalen Röhrenspannung von 58 kV und einem Röhrenstrom von 1 mA erhielten wir bei 1 mm Blei und einem Abstand von 48 mm des Zählrohrendes vom Lithium etwa 3 Quanten pro Minute.

As we have recently shown, the artificial transformation of the lithium nucleus by protons also involves γ rays, which we were able to detect with the aid of the Geiger-Müller tube. In the meantime we have repeated the experiments with improved aids and made an estimate of the intensity of the γ rays. The measurements were again designed in such a way that lithium and an element which can not be broken down at our low proton velocities, in this case iron, were alternately placed in the path of the hydrogen beams. As a result of these differences, we were able to distinguish between the effects of the X-ray beams and the NZ (= cosmic radiation + radioactive rays) and the lithium. A soft component, the intensity of which was weakened by half by 0.3 millimeter of lead, was detected as a major component by interposing different thicknesses of lead. At a maximum tube voltage of 58 kV and a tube current of 1 mA, we obtained about 3 quanta per minute with 1 mm lead and a distance of 48 mm from the tube end of the lithium.

[H. Rausch von Traubenberg did important very early work on fusion reactions and tritium production. See also:

> H. Rausch von Traubenberg, A. Eckardt, and R. Gebauer. 1933. Über den Nachweis von γ-Strahlen bei der Zertrümmerung von Lithium. *Zeitschrift für Physik* 80:557–558.

Von Traubenberg and other German scientists began using neutron reflectors around their nuclear reaction experiments no later than 1936. See pp. 4196–4197. Neutron reflectors are important for both fission reactors and fission bombs.]

Arno Brasch and Fritz Lange, AEG, German Patent DE 662036. Verfahren zur Anregung und Durchführung von Kernprozessen [Process for the Excitation and Execution of Nuclear Processes]. Filed 21 December 1934. Issued 9 June 1938.

[See document photos on pp. 4324–4325.]

Die vorliegende Erfindung bezieht sich auf ein Verfahren, um Eingriffe in den Atomkern in erheblich größerem Umfange und vor allen Dingen mit größerem Nutzeffekt vorzunehmen, als dies bisher möglich war.

Erfindungsgemäß können nicht nur radioaktive Substanzen in wesentlicher Menge wirtschaftlich erzeugt werden, sondern es bietet sich auch die Möglichkeit, zur Energiegewinnung aus dem Atomkern zu gelangen. [...]

Die wesentlichen Methoden zur Erzeugung von Neutronen sind bisher:

1. Heliumteile werden auf Beryllium geworfen und lösen dort Neutronen aus.

2. Röntgen- oder Gammastrahlen von mehr als 1,5 Milionen Volt fallen auf Beryllium und rufen dort den gleichen Vorgang hervor.

3. Der kürzlich entdeckte sog. schwere Wasserstoff (Diplogen) wird auf Diplogen geschossen.

Das letzte Verfahren ist das weitaus ergiebigste und im Rahmen der vorliegenden Erfindung deshalb von Bedeutung, weil es damit möglich war, die Auslösung von Neutronen und anderen Kernreaktionen bei sehr niedrigen Spannungsbereichen bis hinunter zu einigen 1000 Volt zu erzielen.

The present invention relates to a method for carrying out reactions of the atomic nucleus to a considerably greater extent and, above all, with greater efficiency than was previously possible.

According to the invention, not only can radioactive substances be produced economically in a substantial amount, but there is also the possibility of getting energy from the atomic nucleus. [...]

So far the essential methods for the generation of neutrons are:

1. Helium particles impact on beryllium and release neutrons.

2. X-rays or gamma-rays of more than 1.5 million volts fall on beryllium and there cause the same process.

3. The recently discovered so-called heavy hydrogen (deuterium) is fired at deuterium.

The last method is by far the most productive and important in the present invention, since it has thus been possible to achieve the triggering of neutrons and other nuclear reactions at very low voltage ranges up to a few thousand volts.

Die kinetische Energie von Atomen oder Elektronen, die mit etwa 0.13 Volt beschleunigt sind, ist etwa gerade so groß wie die von Atomen oder Elektronen, deren Temperatur 1000^o C beträgt. Wenn man sich die Aufgabe stellt, Kernprozesse dadurch anzuregen und durchzuführen, daß man Stoffe niedriger Ordnungszahl hohen Temperaturen unterwirft, so gelingt dies nur, wenn man die Temperatur so hoch steigert, daß die kinetische Energie der Atome oder Elektronen etwa gerade so groß ist, wie zur Einleitung von Kernprozessen mit Hilfe von durch elektrische Felder beschleunigten Atomen oder Elektronen erforderlich wäre. Es ist somit zur Einleitung derartiger Prozesse eine Steigerung der Temperatur auf ungefähr 10 Millionen Grad Celsius erforderlich. [...]

Zur Herstellung des gleichzeitigen Auftretens beider Vorgänge wird man den Vorgang der Erzeugung des Vordrucks verhältnismäßig langzeitig im Vergleich zu dem eigentlichen Entladungsprozeß wählen. Wenn z.B. die Dauer des Funkenentladungsvorganges etwa 10^{-6} Sek. beträgt, wird man die Dauer des Vordrucks etwa zu 10^{-4} Sek. wählen.

Die Erzeugung des Vordrucks kann entweder mit dem Verfahren nach Ramsauer, wo Zeiten von ungefähr 10^{-4} Sek. gerade erreicht werden können, vorgenommen werden oder ebenfalls durch eine zweite länger dauernde Entladung, die räumlich von der eigentlichen Funkenentladung getrennt ist.

Zu ihrer Herstellung kann man sich mit Vorteil einer schnellaufenden Dynamomaschine bedienen, die durch Entnahme elektrischer Energie in sehr kurzer Zeit abgebremst wird und in Zeiten bis zu ¹⁄₁₀ Sek. Leistungen von der Größenordnung 1 Million kW zu entnehmen erlaubt.

The kinetic energy of atoms or electrons accelerated at about 0.13 volts is about the same as that of atoms or electrons whose temperature is 1000^o C. If the task is to stimulate and carry out nuclear processes by subjecting substances of low atomic number to high temperatures, this is only achieved by raising the temperature so high that the kinetic energy of the atoms or electrons is about the same as that for the initiation of nuclear processes by means of electrons accelerated by electric fields. Thus, an increase of the temperature to about 10 million degrees Celsius is required to initiate such processes. [...]

In order to produce the simultaneous occurrence of both processes, the process of producing the preliminary pressure will be selected relatively long in comparison with the actual discharge process. If, for example, the duration of the spark discharge process is approximately 10^{-6} seconds, the duration of the pre-pressurization will be chosen to be about 10^{-4} seconds.

The pre-pressurization can be produced either by means of the method of Ramsauer, where times of approximately 10^{-4} seconds can be achieved, or by a second longer-lasting discharge which is spatially separated from the actual spark discharge.

To establish the pre-pressurization, one can advantageously use a high-speed dynamo machine, which is decelerated by withdrawal of electrical energy in a very short time and in periods of up to ¹⁄₁₀ seconds, of the order of magnitude of a million kilowatts.

Die mit diesen Verfahren erzeugbaren Temperaturen und Drucke sollen nun erfindungsgemäß angewendet werden zur Einleitung von Kernreaktionen. Hierfür kommen insbesondere Elemente niederer Ordnungszahl in Betracht, also Wasserstoff, schwerer Wasserstoff, Lithium und Bor.

The temperatures and pressures which can be produced with these processes are now to be used according to the invention for initiating nuclear reactions. Particularly suitable for this purpose are elements of low atomic number, such as hydrogen, heavy hydrogen, lithium and boron.

Die Reaktion, die mit den geringsten Hilfsmitteln einzuleiten ist, ist die Reaktion eines schweren Wasserstoffkernes mit einem anderen schweren Wasserstoffkern. In diesem Falle würde also entweder bei der Ramsauer Methode der Gewehrlauf, in den hineingeschossen wird, mit Diplogengas gefüllt sein bzw. bei dem Funkenverfahren würde die Entladung in schwerem Wasser oder vielleicht einem Kohlenwasserstoff, dessen Wasserstoffatome aus schwerem Wasserstoff bestehen, stattfinden. Hierbei bilden sich dann Neutronen, die natürlich in üblicher Weise zur Erzeugung radioaktiver Elemente verwendet werden können. Es ist auch denkbar, daß Reaktionen von dem Gas bzw. der Flüssigkeit mit Stoffen der Kammerwand bzw. in der Flüssigkeit suspendierter Teilchen eingeleitet werden. Es sind aber bekanntlich zu allen Prozessen mit Elementen höherer Ordnungszahl entsprechend höhere Temperaturen notwendig.

The reaction to be initiated with the slightest aid is the reaction of a heavy hydrogen nucleus with another heavy hydrogen nucleus. In this case, therefore, either the Ramsauer method's gun barrel, into which one would shoot, would be filled with deuterium gas, or the spark would be discharged in heavy water, or perhaps a hydrocarbon, the hydrogen atoms of which are composed of heavy hydrogen. In this case, neutrons are formed, which can, of course, be used in a conventional manner to generate radioactive elements. It is also conceivable that reactions from the gas or the liquid are introduced with substances of the chamber wall or in the liquid of suspended particles. However, as is known, correspondingly higher temperatures are necessary for all processes with elements of higher order number.

Als weitere Reaktionen kommen in Frage die Reaktion von Wasserstoff mit Lithium und Bor. Wenn es gelingt, überhaupt einmal so hohe Temperaturen zu erreichen, daß Kernreaktionen in Gang kommen, so ist die Möglichkeit gegeben, die aus diesen Reaktionen frei werdenden Energien wieder zu benutzen, um neue Stoffmengen auf die nötige Reaktionstemperatur zu bringen.

Further reactions are the reaction of hydrogen with lithium and boron. If it is possible at all to reach such high temperatures as to cause nuclear reactions to take place, the possibility exists of reusing the energies released from these reactions in order to bring new quantities of matter to the necessary reaction temperature.

Im Falle des Arbeitens mit Gasen wird es erforderlich sein, beträchtliche Drucke anzuwenden.

In the case of working with gases, it will be necessary to apply considerable pressures.

Bei Reaktionen oder Radioaktivitäten, die mit der Emission schneller geladener Korpuskeln verbunden sind, besteht die Möglichkeit, die Energie dieser Teilchen auszunutzen, indem man sie in einem Vakuumentladungsgefäß für sehr hohe Spannungen, insbesondere einem Ring oder Lamellenrohr, gegen ein elektrisches Feld entsprechender Höhe anlaufen läßt. Als besondere Anwendungsgebiete der Strahlungen, die bei Kernreaktionen bzw. künstlicher Radioaktivität auftreten, muß die Möglichkeit der Wetterbeeinflussung durch Schaffung von Kondensationskernen in Luft, insbesondere vom Flugzeug aus, erwähnt werden. Dabei wird es zweckmäßig sein, die Strahler in möglichst großem Abstand vom Flugzeug zu halten (durch Nachschleppen).

In the case of reactions or radioactivities which are associated with the emission of fast charged particles, it is possible to utilize the energy of these particles by starting them in a vacuum charging vessel for very high voltages, in particular a ring or lamellar tube, against an electric field of corresponding magnitude. The possibility of influencing the weather by the formation of condensation nuclei in air, in particular from aircraft, must be mentioned as special fields of application of the radiation which occur during nuclear reactions or artificial radioactivity. In this case, it will be expedient to keep the radiators as far as possible from the aircraft (by towing them).

Außerdem kommen die Strahlungen von den erwähnten und anderen Kernreaktionen für medizinische Zwecke in Frage. Dabei wird besonders eine schnelle Elektronenstrahlung von Wert sein.

In addition, the radiations from the mentioned and other nuclear reactions for medical purposes come into question. A high-speed electron beam will be of particular value.

Da bekanntlich das Geschwindigkeitsspektrum aller β-Strahlungen kontinuierlich ist und bis zu sehr geringen Geschwindigkeiten herabreicht, ist es erforderlich, für den erwähnten Zweck eine solche Strahlenquelle immer in Verbindung mit einer magnetischen Monochromatisierungseinrichtung zu verwenden.

Since, as is known, the velocity spectrum of all beta-rays is continuous and runs down to very low velocities, it is necessary for such a purpose to always use such a radiation source in conjunction with a magnetic monochromatization device.

Als wesentlichster Punkt kommt ganz allgemein die Gewinnung von Energie aus dem Atomkern in Frage, indem man z.B. die Wärmeentwicklung der auftretenden Strahlen benutzt, um damit eine Wärmekraftmaschine zu betreiben.

In general, the most important point is to obtain energy from the atomic nucleus, for example by using the heat produced by the emitted rays in order to operate a heat engine.

Hierbei ergibt sich die Möglichkeit, unter Verzicht auf großen Nutzeffekt Maschinen mit sehr großer Leistung pro Gewichtseinheit zu bauen.

This makes it possible to build machines with both high efficiency and very high power per unit of weight.

DEUTSCHES REICH

AUSGEGEBEN AM
2. JULI 1938

REICHSPATENTAMT

PATENTSCHRIFT

№ 662036
KLASSE 40c GRUPPE 17
B 168181 VI/40c
Tag der Bekanntmachung über die Erteilung des Patents: 9. Juni 1938

Allgemeine Elektricitäts-Gesellschaft in Berlin*)

Verfahren zur Anregung und Durchführung von Kernprozessen

Patentiert im Deutschen Reiche vom 21. Dezember 1934 ab

Die vorliegende Erfindung bezieht sich auf ein Verfahren, um Eingriffe in den Atomkern in erheblich größerem Umfange und vor allen Dingen mit größerem Nutzeffekt vorzunehmen, als dies bisher möglich war.

Erfindungsgemäß können nicht nur radioaktive Substanzen in wesentlicher Menge wirtschaftlich erzeugt werden, sondern es bietet sich auch die Möglichkeit, zur Energiegewinnung aus dem Atomkern zu gelangen.

Aus dem natürlichen Zerfall der radioaktiven Elemente ist zu ersehen, wie viel Energie grundsätzlich in 1 g Materie aufgehäuft sein kann und bis zum völligen Zerfall in mehr oder weniger langer Zeit entsprechend den jeweiligen Zerfallskonstanten frei wird.

Es sind dies Energiemengen, die etwa millionenfache Beträge dessen ausmachen, was beispielsweise bei der bisher üblichen Verbrennung unserer Treibmittel, Kohle, Öl usw., zur Wirkung gelangt.

Seit einigen Jahren beschäftigt sich die Physik damit, wenn auch bisher aus rein wissenschaftlichen Gründen, Atomumwandlungen unabhängig vom Spontanzerfall der relativ sehr seltenen radioaktiven Elemente auf künstlichem Wege zu erreichen. Diese Bestrebungen führten auch zum Erfolg, und zwar bisher dadurch, daß man auf elektrischem Wege Strahlen erzeugte, die den vom Radium ausgesendeten Strahlen gleich oder ähnlich waren und damit andere Stoffe bombardierte. Wenn auch die durch solche Versuche gewonnenen Erkenntnisse über die durch das Radium gezogenen Grenzen hinausgingen, so war doch grundsätzlich bisher an eine Energiegewinnung auf diesem Wege nicht zu denken, weil nur ein winziger Bruchteil der ausgesendeten Strahlen zum Kernprozeß führten.

Unter anderem eröffnete hier die kürzliche Entdeckung der Neutronen besondere Möglichkeiten, weil diese Teilchen Kernreaktionen mit 100%igem Nutzeffekt erlauben.

So ist es jetzt möglich, damit künstliche Radioaktivitäten, die etwa denen 1 mg Radium gleich sind, zu erzeugen.

Wenn auch, wie bereits ausgeführt, die Neutronen Kerneffekte mit großer Ausbeute hervorrufen, so ist doch die Herstellung der Neutronen selbst vorläufig nur mit relativ sehr geringem Nutzeffekt möglich.

Die wesentlichen Methoden zur Erzeugung von Neutronen sind bisher:

1. Heliumteile werden auf Beryllium geworfen und lösen dort Neutronen aus.

2. Röntgen- oder Gammastrahlen von mehr als 1,5 Milionen Volt fallen auf Beryllium und rufen dort den gleichen Vorgang hervor.

3. Der kürzlich entdeckte sog. schwere Wasserstoff (Diplogen) wird auf Diplogen geschossen.

**) Von dem Patentsucher sind als die Erfinder angegeben worden:*

Arno Brasch in New York, V. St. A.,

und Dr. Fritz Lange in Charkow, Union der Sozialistischen Sowjet-Republiken.

2 662 036

Das letzte Verfahren ist das weitaus ergiebigste und im Rahmen der vorliegenden Erfindung deshalb von Bedeutung, weil es damit möglich war, die Auslösung von Neutronen und anderen Kernreaktionen bei sehr niedrigen Spannungsbereichen bis hinunter zu einigen 1000 Volt zu erzielen.

Die kinetische Energie von Atomen oder Elektronen, die mit etwa 0,13 Volt beschleunigt sind, ist etwa gerade so groß wie die von Atomen oder Elektronen, deren Temperatur 1000° C beträgt. Wenn man sich die Aufgabe stellt, Kernprozesse dadurch anzuregen und durchzuführen, daß man Stoffe niedriger Ordnungszahl hohen Temperaturen unterwirft, so gelingt dies nur, wenn man die Temperatur so hoch steigert, daß die kinetische Energie der Atome oder Elektronen etwa gerade so groß ist, wie zur Einleitung von Kernprozessen mit Hilfe von durch elektrische Felder beschleunigten Atomen oder Elektronen erforderlich wäre. Es ist somit zur Einleitung derartiger Prozesse eine Steigerung der Temperatur auf ungefähr 10 Millionen Grad Celsius erforderlich.

In neuerer Zeit ist es beispielsweise durch die von C. Ramsauer entwickelte Methode möglich geworden, Temperaturen von außerordentlicher Höhe zu erzeugen.

Es wird hierbei folgendes Verfahren benutzt:

Ein Geschoß wird mit Geschwindigkeiten bis zu 1000 m/Sek. abgeschossen und in einen Gewehrlauf hineingeschossen. Hierbei entstehen gewaltige Drucke bis zu 10 Millionen Atm. und damit sehr hohen Temperaturen, die schon bei verhältnismäßig einfachen Hilfsmitteln bis zu 200 000° C betragen.

Es ist nun der Erfindungsgedanke, unter Verwendung solcher extremer Temperaturen und bei Benutzung geeigneter Substanzen Kernreaktionen sehr hoher Ausbeute herzustellen.

Hierfür gibt es eine Anzahl von Ausführungsbeispielen. Einmal der schon angedeutete Fall, daß in einen Gewehrlauf, in dem die zu behandelnde Substanz sich als Gas befindet, ein Projektil hineingeschossen wird.

Besonders ist es vorteilhaft, gemäß der Erfindung den Anfangsdruck nach Möglichkeit klein zu halten bis hinunter zu 1 mm Hg, da nicht die Erzeugung möglichst hoher Dichten, sondern vor allem hoher Temperaturen erstrebt wird. Die Höhe des erreichbaren Druckes ist, wie Ramsauer gezeigt hat, um so höher, je größer die Länge des Geschosses ist.

Außerdem wurden Versuche zur Erzeugung sehr hoher Drucke und Temperaturen unternommen, indem eine Kondensatorbatterie sehr großer Kapazität über einen Funken in einer schwer kompressiblen Flüssigkeit, Öl, Wasser usw., entladen wird. Hierbei entstehen tatsächlich außerordentlich hohe Drucke und Temperaturen. Dieses Verfahren ist besonders wirksam, wenn man dafür sorgt, daß die Spannung an dem Funken bzw. dem dadurch eingeleiteten Lichtbogen nicht sofort zusammenbricht.

Dies ist erreichbar einerseits durch Verwendung und Beimengung von Substanzen hoher Elektronenaffinität, besonders aber durch Anwendung sehr hoher Drucke. Solche hohen Drucke können bis zu einem gewissen Grade durch die Druckwelle in der inkompressiblen Flüssigkeit, die vom Funken selbst ausgelöst wird, erzeugt werden. Es wird sich aber empfehlen, noch unter Hinzunahme anderer Mittel den Druck über die hierdurch gegebenen Möglichkeiten zu steigern. Vor allen Dingen erscheint es als wesentlich, daß der Hochdruck sich nicht erst während des Ablaufs der Entladung allmählich aufbaut und auch hierzu wertvolle Energie verbraucht wird, sondern nach Möglichkeit auf anderem Wege und vor Beginn der eigentlichen Entladung hergestellt wird.

Dabei wird man zunächst an mechanische Hilfsmittel denken und ein Gefäß aus möglichst widerstandsfähigem Material (Stahl) mit einer gänzlich gasfreien nicht zusammendrückbaren Flüssigkeit füllen sowie es unter einen Druck setzen, wie er mit mechanischen Hilfsmitteln noch erreichbar ist (bis zu einigen 1000 Atm.).

Wesentlich weiter wird man kommen, wenn man diesen Vordruck nur stoßartig erzeugt sowie unter Ausnutzung der Trägheit von Flüssigkeit und Wand und der mechanischen Überbeanspruchbarkeit fester Körper in kurzen Zeiten.

Zur Herstellung des gleichzeitigen Auftretens beider Vorgänge wird man den Vorgang der Erzeugung des Vordrucks verhältnismäßig langzeitig im Vergleich zu dem eigentlichen Entladungsprozeß wählen. Wenn z. B. die Dauer des Funkenentladungsvorganges etwa 10^{-6} Sek. beträgt, wird man die Dauer des Vordrucks etwa zu 10^{-4} Sek. wählen.

Die Erzeugung des Vordrucks kann entweder mit dem Verfahren nach Ramsauer, wo Zeiten von ungefähr 10^{-4} Sek. gerade erreicht werden können, vorgenommen werden oder ebenfalls durch eine zweite länger dauernde Entladung, die räumlich von der eigentlichen Funkenentladung getrennt ist.

Zu ihrer Herstellung kann man sich mit Vorteil einer schnellaufenden Dynamomaschine bedienen, die durch Entnahme elektrischer Energie in sehr kurzer Zeit abgebremst wird und in Zeiten bis zu $^{1}/_{10}$ Sek. Leistungen von der Größenordnung 1 Million kW zu entnehmen erlaubt.

Figure D.621: Arno Brasch and Fritz Lange, AEG. German Patent DE 662036. Verfahren zur Anregung und Durchführung von Kernprozessen [Process for the Excitation and Execution of Nuclear Processes]. Filed 21 December 1934. Issued 9 June 1938.

Die mit diesen Verfahren erzeugbaren Temperaturen und Drucke sollen nun erfindungsgemäß angewendet werden zur Einleitung von Kernreaktionen. Hierfür kommen insbesondere Elemente niederer Ordnungszahl in Betracht, also Wasserstoff, schwerer Wasserstoff, Lithium und Bor.

Die Reaktion, die mit den geringsten Hilfsmitteln einzuleiten ist, ist die Reaktion eines schweren Wasserstoffkernes mit einem anderen schweren Wasserstoffkern. In diesem Falle würde also entweder bei der Ramsauer Methode der Gewehrlauf, in den hineingeschossen wird, mit Diplogengas gefüllt sein bzw. bei dem Funkenverfahren würde die Entladung in schwerem Wasser oder vielleicht einem Kohlenwasserstoff, dessen Wasserstoffatome aus schwerem Wasserstoff bestehen, stattfinden. Hierbei bilden sich dann Neutronen, die natürlich in üblicher Weise zur Erzeugung radioaktiver Elemente verwendet werden können. Es ist auch denkbar, daß Reaktionen von dem Gas bzw. der Flüssigkeit mit Stoffen der Kammerwand bzw. in der Flüssigkeit suspendierter Teilchen eingeleitet werden. Es sind aber bekanntlich zu allen Prozessen mit Elementen höherer Ordnungszahl entsprechend höhere Temperaturen notwendig.

Als weitere Reaktionen kommen in Frage die Reaktion von Wasserstoff mit Lithium und Bor. Wenn es gelingt, überhaupt einmal so hohe Temperaturen zu erreichen, daß Kernreaktionen in Gang kommen, so ist die Möglichkeit gegeben, die aus diesen Reaktionen frei werdenden Energien wieder zu benutzen, um neue Stoffmengen auf die nötige Reaktionstemperatur zu bringen.

Im Falle des Arbeitens mit Gasen wird es erforderlich sein, beträchtliche Drucke anzuwenden.

Bei Reaktionen oder Radioaktivitäten, die mit der Emission schneller geladener Korpuskeln verbunden sind, besteht die Möglichkeit, die Energie dieser Teilchen auszunutzen, indem man sie in einem Vakuumentladungsgefäß für sehr hohe Spannungen, insbesondere einem Ring oder Lamellenrohr, gegen ein elektrisches Feld entsprechender Höhe anlaufen läßt. Als besondere Anwendungsgebiete der Strahlungen, die bei Kernreaktionen bzw. künstlicher Radioaktivität auftreten, muß die Möglichkeit der Wetterbeeinflussung durch Schaffung von Kondensationskernen in Luft, insbesondere vom Flugzeug aus, erwähnt werden. Dabei wird es zweckmäßig sein, die Strahler in möglichst großem Abstand vom Flugzeug zu halten (durch Nachschleppen).

Außerdem kommen die Strahlungen von den erwähnten und anderen Kernreaktionen für medizinische Zwecke in Frage. Dabei wird besonders eine schnelle Elektronenstrahlung von Wert sein.

Da bekanntlich das Geschwindigkeitsspektrum aller β-Strahlungen kontinuierlich ist und bis zu sehr geringen Geschwindigkeiten herabreicht, ist es erforderlich, für den erwähnten Zweck eine solche Strahlenquelle immer in Verbindung mit einer magnetischen Monochromatisierungseinrichtung zu verwenden.

Als wesentlichster Punkt kommt ganz allgemein die Gewinnung von Energie aus dem Atomkern in Frage, indem man z. B. die Wärmeentwicklung der auftretenden Strahlen benutzt, um damit eine Wärmekraftmaschine zu betreiben.

Hierbei ergibt sich die Möglichkeit, unter Verzicht auf großen Nutzeffekt Maschinen mit sehr großer Leistung pro Gewichtseinheit zu bauen.

Patentansprüche:

1. Verfahren zur Anregung und Durchführung von Kernprozessen, dadurch gekennzeichnet, daß Stoffe niedriger Ordnungszahl Temperaturen unterworfen werden, bei denen die kinetische Energie der Atome oder Elektronen etwa gerade so groß ist, wie zur Einleitung von Kernprozessen mit Hilfe von durch elektrische Felder beschleunigten Atomen und Elektronen erforderlich wäre.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die hierzu nötigen Temperaturen hergestellt werden durch eine Anordnung, bei der ein hochbeschleunigtes Projektil in einen zweiten äußerst druckwiderstandsfähigen Gewehrlauf bzw. Kanonenrohr geschossen wird, und daß dieser zweite Lauf mit Substanzen gefüllt ist, die in Verbindung mit der hohen entstehenden Temperatur zu Kernreaktionen führen.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß der Anfangsdruck klein gehalten wird.

4. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die erforderlichen hohen Drucke durch einen möglichst kurzzeitigen elektrischen Funken sehr hoher Leistung in einer nicht zusammendrückbaren Flüssigkeit hergestellt werden.

5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß auf mechanischem Wege ein möglichst großer Vordruck angewendet wird, um das Zusammenbrechen des Funkens zu verhindern.

6. Verfahren nach Anspruch 4 und 5, dadurch gekennzeichnet, daß der gewünschte hohe Vordruck durch den von

einer Schwungmaschine höchster Leistung gespeisten Funken oder Lichtbogen, der von dem eigentlichen Kompressionsfunken sehr kurzer Dauer räumlich getrennt ist, hervorgerufen wird.

7. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Druckkammer oder der Gewehrlauf, in dem das hochbeschleunigte Projektil hineingeschossen wird, mit Diplogengas gefüllt ist.

8. Verfahren nach Anspruch 1, 4, 5 und 6, dadurch gekennzeichnet, daß die nicht zusammendrückbare Flüssigkeit aus schwerem Wasser bzw., falls eine Isolationsflüssigkeit gewählt werden muß, aus Kohlenwasserstoff besteht, wobei dessen Wasserstoffatome aus schwerem Wasserstoff gebildet werden.

9. Verfahren nach Anspruch 1, 3, 4, 5, 6, 7 und 8, dadurch gekennzeichnet, daß normaler Wasserstoff bzw. Wasser in Verbindung mit Lithium und Bor bzw. Beryllium zu Kernreaktionen benutzt werden.

10. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die aus diesen Reaktionen frei werdenden Energien wieder benutzt werden, um neue Stoffmengen auf die nötige Reaktionstemperatur zu bringen.

11. Verfahren nach Anspruch 1, 2, 4, 5 und 6, dadurch gekennzeichnet, daß die dabei entstehenden schnellen geladenen Korpuskeln in einem Vakuumentladungsgefäß, insbesondere einem Ring oder Lamellenrohr, gegen ein elektrisches Feld entsprechender Höhe anlaufen, um die Energie dieser Teilchen auszunutzen.

12. Die Anwendung des Verfahrens nach den Ansprüchen 1 bis 11 zur Erzeugung medizinisch wirksamer Strahlen.

13. Die Anwendung des Verfahrens nach den Ansprüchen 1 bis 11 zum Betrieb von Wärmekraftmaschinen.

BERLIN. GEDRUCKT IN DER REICHSDRUCKEREI

Figure D.622: Arno Brasch and Fritz Lange, AEG. German Patent DE 662036. Verfahren zur Anregung und Durchführung von Kernprozessen [Process for the Excitation and Execution of Nuclear Processes]. Filed 21 December 1934. Issued 9 June 1938.

R. S. Malton, a.k.a. Richard S. Morse. 2 June 1945 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)].

In connection with investigational work now underway relative to the development of Manhattan District projects by the Germans, a certain amount of information probably can be obtained from Mr. A. Brasch of the Electronized Chemical Corporation at 122 East 42nd Street, New York City.

Mr. Brasch is a former German citizen, and I am sure he has been thoroughly investigated. As an atomic physicist in 1938 he was approached by members of the general German staff to initiate research along lines of interest to the Manhattan District. Because of his connections with Siemens Halske and A.E.G. and the University of Berlin some information might be forthcoming if required at this late date.

James E. Nolan to Francis J. Smith. 14 June 1945 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)].

1. Inclosed is copy of the letter submitted by Confidential Informant No. 16 of the Boston Branch Office.

2. Siemens Halske and A.E.G. referred to are the German branches [sic, actually counterparts] of Westinghouse and General Electric respectively.

3. According to informant Brasch was asked personally by Marshall Werner von Blomberg, German Chief of Staff in 1938, to remain in Germany to do atomic research. Brasch is Jewish and believed it wiser to leave the country.

4. Confidential Informant No. 16 is identified as Richard S. Morse of the National Research Corporation.

5. For your information and any action which you may deem necessary.

[See document photos on p. 4327.

Werner von Blomberg was the Reichsminister of War from May 1935 to January 1938. Thus no later than January 1938, the German government, and in particular the German military, was actively pursuing nuclear weapons. They attempted to recruit Arno Brasch to work on that program despite the fact that he was Jewish. Similarly, Gustav Hertz appears to have held an important position in the German nuclear weapons program throughout the war despite his Jewish ancestry (Section D.4.4).]

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SECRET

ARMY SERVICE FORCES
MANHATTAN ENGINEER DISTRICT
INTELLIGENCE AND SECURITY DIVISION
BOSTON BRANCH OFFICE
P. O. BOX 2277
BOSTON, MASSACHUSETTS

Germ Res.

IN REPLY REFER TO EIDM MI-16
DSM bl-3635i

14 June 1945

Subject: Positive Intelligence

To: Major Francis J. Smith, Washington Liaison Office, Washington, D. C.

1. Inclosed is copy of the letter submitted by Confidential Informant No. 16 of the Boston Branch Office.

2. Siemens Halske and A. E. G. referred to are the German branches of Westinghouse and General Electric respectively.

3. According to informant Brasch was asked personally by Marshall Werner Von Blomberg, German Chief of Staff in 1938, to remain in Germany to do atomic research. Brasch is Jewish and believed it wiser to leave the country.

4. Confidential Informant No. 16 is identified as Richard S. Morse of the National Research Corporation.

5. For your information and any action which you may deem necessary.

James E. Nolan
JAMES E. NOLAN,
2nd Lt., Corps of Engineers,
Intelligence Officer.

Incl.:
Ltr (cy)

Cc: DIO, w/incl

Allgemeine Elektrische Gesellschaft

OPY

SECRET

This do
No.

June 2, 1945

Old Line Book Company
P. O. Box 1172
Boston 3, Massachusetts

Dear Mike:

In connection with investigational work now underway relative to the development of Manhattan District projects by the Germans, a certain amount of information probably can be obtained from Mr. A. Brasch of the Electronized Chemical Corporation at 122 East 42nd Street, New York City.

Mr. Brasch is a former German citizen, and I am sure he has been thoroughly investigated. As an atomist physicist in 1938 he was approached by members of the general German staff to initiate research along lines of interest to the Manhattan District. Because of his connections with Siemens Halske and A. E. G. and the University of Berlin some information might be forthcoming if required at this late date.

Sincerely yours,

/s/ R. S. Malton

Tom Malton

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44-June 45)

Figure D.623: R. S. Malton, a.k.a. Richard S. Morse, 2 June 1945. James E. Nolan to Francis J. Smith, 14 June 1945. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]

Auergesellschaft. U.K. Patent GB 508,233. Method for Carrying Out Nuclear Reactions. Filed 7 February 1937. Issued 28 June 1939.

We, DEGEA AKTIENGESELLSCHAFT (AUERGESELLSCHAFT), of 16–19, Rotherstrasse, Berlin, 0.17, Germany, a German Company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:-

Artificial nuclear reactions are initiated by the bombardment of nuclei with light elementary particles. With the use of charged particles (protons, α particles) energies of 10^3 to 10^7 volts are necessary for overcoming the coulombic repulsion powers, in order to ensure a sufficient yield for the penetration of the particles into the bombarded nucleus.

Such a repulsion does not exist for neutrons, so that neutrons of small speed can penetrate into nuclei and produce reactions, as experiments actually show.

Unfortunately, there are no direct sources producing neutrons; they arise, if nuclei, for example, Be, are irradiated with α-particles of high energies (about 10^6 volts) or γ-rays very rich in energy (about $2{\cdot}10^6$ volts) or by bombardment of certain nuclei with fast particles of the heavy isotope of hydrogen. As sources of α-particles of sufficiently high energy, only the naturally radioactive elements have hitherto been available. In the two other cases, for accelerating elementary particles it is necessary to have recourse to the use of very considerable amounts of energy. With the remaining hitherto known methods for the production of elementary particles rich in energy, which have been used directly, or indirectly through the production of very hard Röntgen rays, for the production of neutrons and generally for the initiation of nuclear reactions, there came to be used an acceleration of the desired particles in high vacuum. This method indeed produces definite speeds, but only at the expense of very heavy outlay in the matter of electro-technical apparatus for building up an increase in the current density of the accelerated particles, and also gives a greater absolute yield from the nuclear reactions. The output attained in this way probably corresponds, at best, to that of a few grams of radium. The method of repeated secondary acceleration by means of high frequency alternating fields (Cyclotron) certainly produces greater absolute yields than those just stated, but necessitates however a great increase in the expense of apparatus (extremely large magnets).

The present invention therefore proposes to allow the nuclear reactions to take place under completely different conditions, namely, in the gas phase, under a mean numerical concentration of more than 10^{19} molecules of the gas per cubic centimetre, and preferably under a concentration corresponding to a pressure of one atmosphere at normal temperature of 18^o C. 70 Since in this case, a selective acceleration of elementary particles is not possible, the attainment of a thermal equilibrium with very high temperatures (greater than $10^{7\,o}$ C.) is the objective. For reasons of energy consumption such conditions can only be maintained by extraordinarily high momentary outputs and only for very short times. Accordingly, this invention contemplates the production of energies of 100 watt seconds and more during intervals of 10^{-6} second and less, corresponding to momentary outputs of 100,000 kilowatts and more.

Theoretical calculations based on experiments with exploding wires, and also observations made in connection with mercury discharges in which the number of glowing atoms could be determined with some degree of certainty, lead to the conclusion that high temperatures of the order specified occur with condenser discharges in the gaseous phase. Such operating conditions have in themselves the advantage that because of the practically complete ionisation in the discharge canal the braking action of the electron cloud falls away, and therefore still larger yields of the nuclear reactions are to be expected than have been observed hitherto with neutral atoms. It is therefore proposed for the realisation of the operating conditions set forth above, to utilise condenser discharges. For this it is necessary that

1) the gas concentration (number of molecules per cubic centimetre) be so great that thermal equilibrium can be established within the time of discharge of the condenser.

2) the momentary output, which is given by the size and charging voltage of the condenser, be made so great that the equilibrium temperature becomes established at the desired level.

The experimenter is at liberty to increase the action of the individual extremely short condenser discharge (duration of 10^{-6} second), after the lapse of a certain time which might be approximately of the order of magnitude of 10^{-3} second by allowing a further condenser discharge to traverse the gas. In this way it is possible to intensify the total effect of the method within the limits imposed by the thermal resistance of the discharge vessel used. A discharge rate of 5 discharges per second is probably about as high a rate as can normally be expected to be endured by a glass vessel.

The deciding factors given by these two conditions, viz., gas concentration and the size and charging voltage of the condensers, can be calculated for each individual process.

This calculation has been carried out for the production of neutrons by means of condenser discharge in heavy hydrogen gas. It gives, for about 1 atmosphere pressure, C=50,000 cm. V=10^5 volts (C being the capacity of the condenser and V being the charging voltage) and with a discharge rate of 5 discharges per second, an efficiency which is equivalent to about 50 gms. Ra + Be. Similar results are obtained when using a mixture of heavy and light hydrogen gas.

The method is naturally not limited to the production of neutrons but is equally applicable to a great number of nuclear reactions which may be carried out in this manner on a large scale, for example, the production of helium. For this purpose a discharge of the nature described above may be effected in a mixture of lithium vapour and light hydrogen, the resulting reaction being typified by the following equations:

$$^{7}_{3}\mathrm{Li} + ^{1}_{1}\mathrm{H} = ^{4}_{2}\mathrm{He}; \qquad ^{6}_{3}\mathrm{Li} + ^{1}_{1}\mathrm{H} = ^{4}_{2}\mathrm{He} + ^{3}_{2}\mathrm{He}$$

The pressures and outputs used are the same as in the above described reaction for the production of neutrons by condenser discharges in heavy hydrogen gas.

It is also possible to obtain helium indirectly through neutron irradiation in accordance with the following reaction formula:

$$^{10}_{5}\mathrm{B} + ^{1}_{0}\mathrm{n} = ^{4}_{2}\mathrm{He} + ^{7}_{3}\mathrm{Li}$$

For this purpose the vessel in which the neutron producing discharge takes place requires to be lined on the inside with a substance containing boron and hydrogen, e.g., $B(OCH_3)_3$ or the discharge vessel has to be arranged adjoining an outer flask filled with such substance.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:-

1. Method of carrying out nuclear reactions in which the energy requisite for activating the elementary particles to be caused to participate in a desired reaction is produced in a gas discharge under a mean gas concentration of more than 10^{19} molecules per cubic centimetre, and energies of 100 watt seconds and more during intervals of 10^{-6} second and less are produced, corresponding to momentary outputs of 100,000 kilowatts and more.

2. Method as claimed in claim 1 wherein the reaction is carried out under a gas concentration which corresponds to a pressure of one atmosphere at normal temperature of 18^o C.

3. Method as claimed in claim 1 for producing neutrons, wherein heavy hydrogen gas or a mixture of light and heavy hydrogen gas is utilised as reagent gas.

[See document photos on p. 4331.

This patent did not name any specific inventors, but Nikolaus Riehl was probably the inventor, or at least one of the inventors.

The patent reported that this high-voltage fusion neutron generator had a neutron output comparable to a 50-gram radium-beryllium source, which produces approximately $7.6 \cdot 10^8$ neutrons/second.

The patent also reported that this fusion neutron generator could produce five pulses per second, each with a duration of 10^{-6} second.

Thus the pulses would produce approximately $1.5 \cdot 10^8$ neutrons per pulse, or a neutron intensity of $1.5 \cdot 10^{14}$ neutrons/second during each pulse.]

PATENT SPECIFICATION

Convention Date (Germany): Feb. 9, 1937.

508,233

Application Date (in United Kingdom): Feb. 7, 1938. No. 3845/38.

Complete Specification Accepted: June 28, 1939.

COMPLETE SPECIFICATION

Method for Carrying out Nuclear Reactions

We, DEGEA AKTIENGESELLSCHAFT (AUERGESELLSCHAFT), of 16—19, Rotherstrasse, Berlin, O.17, Germany, a German Company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Artificial nuclear reactions are initiated by the bombardment of nuclei with light elementary particles. With the use of charged particles (protons, α particles) energies of 10^5 to 10^7 volts are necessary for overcoming the coulombic repulsion powers, in order to ensure a sufficient yield for the penetration of the particles into the bombarded nucleus.

Such a repulsion does not exist for neutrons, so that neutrons of small speed can penetrate into nuclei and produce reactions, as experiments actually show.

Unfortunately, there are no direct sources producing neutrons; they arise, if nuclei, for example, Be, are irradiated with α-particles of high energies (about 10^6 volts) or γ-rays very rich in energy (about 2.10^6 volts) or by bombardment of certain nuclei with fast particles of the heavy isotope of hydrogen. As sources of α-particles of sufficiently high energy, only the naturally radioactive elements have hitherto been available. In the two other cases, for accelerating elementary particles it is necessary to have recourse to the use of very considerable amounts of energy. With the remaining hitherto known methods for the production of elementary particles rich in energy, which have been used directly, or indirectly through the production of very hard Röntgen rays, for the production of neutrons and generally for the initiation of nuclear reactions, there came to be used an acceleration of the desired particles in high vacuum. This method indeed produces definite speeds, but only at the expense of very heavy outlay in the matter of electro-technical apparatus for building up an increase in the current density of the accelerated particles, and also gives a greater absolute yield from the nuclear reactions. The output attained in this way probably corresponds, at best, to that of a few grams of radium. The method of repeated secondary acceleration by means of high frequency alternating fields (Cyclotron) certainly produces greater absolute yields than those just stated, but necessitates however a great increase in the expense of apparatus (extremely large magnets).

The present invention therefore proposes to allow the nuclear reactions to take place under completely different conditions, namely, in the gas phase, under a mean numerical concentration of more than 10^{19} molecules of the gas per cubic centimetre, and preferably under a concentration corresponding to a pressure of one atmosphere at normal temperature of 18° C. Since in this case, a selective acceleration of elementary particles is not possible, the attainment of a thermal equilibrium with very high temperatures (greater than 10^{7}° C.) is the objective. For reasons of energy consumption such conditions can only be maintained by extraordinarily high momentary outputs and only for very short times. Accordingly, this invention contemplates the production of energies of 100 watt seconds and more during intervals of 10^{-6} second and less, corresponding to momentary outputs of 100,000 kilowatts and more.

Theoretical calculations based on experiments with exploding wires, and also observations made in connection with mercury discharges in which the number of glowing atoms could be determined with some degree of certainty, lead to the conclusion that high temperatures of the order specified occur with condenser discharges in the gaseous phase. Such operating conditions have in themselves the advantage that because of the practically complete ionisation in the discharge canal the braking action of the electron cloud falls away, and therefore still larger yields of the nuclear reactions are to be expected than have been observed hitherto with neutral atoms. It is therefore proposed for the realisation of the operating conditions set forth above, to utilise condenser discharges. For this it is necessary that

1) the gas concentration (number of molecules per cubic centimetre) be so great

[Price 1/-]

that thermal equilibrium can be established within the time of discharge of the condenser.

2) the momentary output, which is given by the size and charging voltage of the condenser, be made so great that the equilibrium temperature becomes established at the desired level.

The experimenter is at liberty to increase the action of the individual extremely short condenser discharge (duration of 10^{-6} second), after the lapse of a certain time which might be approximately of the order of magnitude of 10^{-3} second by allowing a further condenser discharge to traverse the gas. In this way it is possible to intensify the total effect of the method within the limits imposed by the thermal resistance of the discharge vessel used. A discharge rate of 5 discharges per second is probably about as high a rate as can normally be expected to be endured by a glass vessel.

The deciding factors given by these two conditions, viz., gas concentration and the size and charging voltage of the condensers, can be calculated for each individual process.

This calculation has been carried out for the production of neutrons by means of condenser discharge in heavy hydrogen gas. It gives, for about 1 atmosphere pressure, C=50,000 cm. V=10^5 volts (C being the capacity of the condenser and V being the charging voltage) and with a discharge rate of 5 discharges per second, an efficiency which is equivalent to about 50 gms. Ra+Be. Similar results are obtained when using a mixture of heavy and light hydrogen gas.

The method is naturally not limited to the production of neutrons but is equally applicable to a great number of nuclear reactions which may be carried out in this manner on a large scale, for example, the production of helium. For this purpose a discharge of the nature described above may be effected in a mixture of lithium vapour and light hydrogen, the resulting reaction being typified by the following equations:

$$^{7}_{3}Li + {}^{1}_{1}H = {}^{4}_{2}He; \quad {}^{6}_{3}Li + {}^{1}_{1}H = {}^{4}_{2}He + {}^{3}_{2}He$$

The pressures and outputs used are the same as in the above described reaction for the production of neutrons by condenser discharges in heavy hydrogen gas.

It is also possible to obtain helium indirectly through neutron irradiation in accordance with the following reaction formula:

$$^{10}_{5}B + {}^{1}_{0}n = {}^{4}_{2}He + {}^{7}_{3}Li.$$

For this purpose the vessel in which the neutron producing discharge takes place requires to be lined on the inside with a substance containing boron and hydrogen, e.g., $B(OCH_3)_3$, or the discharge vessel has to be arranged adjoining an outer flask filled with such substance.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Method of carrying out nuclear reactions in which the energy requisite for activating the elementary particles to be caused to participate in a desired reaction is produced in a gas discharge under a mean gas concentration of more than 10^{19} molecules per cubic centimetre, and energies of 100 watt seconds and more during intervals of 10^{-6} second and less are produced, corresponding to momentary outputs of 100,000 kilowatts and more.

2. Method as claimed in claim 1 wherein the reaction is carried out under a gas concentration which corresponds to a pressure of one atmosphere at normal temperature of 18° C.

3. Method as claimed in claim 1 for producing neutrons, wherein heavy hydrogen gas or a mixture of light and heavy hydrogen gas is utilised as reagent gas.

Dated this 7th day of February, 1938.

BARON & WARREN,

231, Strand, London, W.C.2,

Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1939.

Figure D.624: Auergesellschaft. U.K. Patent GB 508,233. Method for Carrying Out Nuclear Reactions. Filed 7 February 1937. Issued 28 June 1939.

Hartmut Kallmann and Ernst Kuhn. U.S. Patent 2,251,190. Method of Producing Neutrons. Filed 16 March 1938. Issued 29 July 1941.

This invention relates to a method for the production of neutrons, particularly by the interaction of deuterons.

In order to obtain neutrons with the aid of ions with relatively slight acceleration (for instance 300 kv.) the nuclear reaction

$$D + D = He_3 + n \tag{D.12}$$

is employed. The procedure in this connection is to bombard a layer containing heavy hydrogen nuclei with heavy hydrogen ions or deuterons. For the layer containing hydrogen, use is often made of ice, sal ammoniac, phosphoric acid and similar substances in which ordinary hydrogen is replaced by heavy hydrogen. These layers very rich in hydrogen have the disadvantage that they conduct heat and electricity poorly and are therefore easily destroyed by ionic bombardment. It would be better if more resistant layers were used, for instance, metallic layers. That is possible, however, only when metals that contain large amounts of dissolved or adsorbed hydrogen are employed. These are a few such metals, but they have the disadvantage that they gradually give off hydrogen in the vacuum. It would be still better therefore if substances could be used that contain hydrogen adsorbed only on the surface or in a surface layer but give it off to the outside less easily. These substances placed in the ion stream give only a small output of neutrons when impinged on vertically since the thickness of the adsorbed hydrogen layer is very small in comparison with the range of the ions projected into the metal. Nuclear processes can occur therefore only in a fractional portion of the path of the ions. In case, however, the path of the ions is maintained as nearly as possible entirely within the thin hydrogen layer, a large neutron output is obtained with the aid of these thin adsorbed hydrogen layers.

A principal purpose of the invention is the provision of a highly efficient method for the production of neutrons by the interaction of deuterons. According to the invention this is attained by allowing the stream of ions to impinge on the layer at an angle—preferably in as grazing a manner as possible.

The adsorption layer containing hydrogen need not consist of pure hydrogen. It might under certain conditions be more advantageous if the adsorption layer consists of gases or vapors containing hydrogen, for instance, methane or water. This is particularly satisfactory when these substances are adsorbed especially strongly.

The body impinged on by the ions is preferably made of a substance that strongly adsorbs the molecules containing heavy hydrogen and at the same time possesses only a slight retarding capacity for the impinging ions. Carbon and beryllium have been found useful for these reasons. It is especially desirable to employ substances that adsorb the molecules containing hydrogen in as thick a layer as possible. This can be accomplished for instance by using, as adsorption body, a substance that is porous or roughened at least at the surface.

The surface of the adsorbing body is heated up by the energy of the impinging ions. In this way the giving off of the adsorbed substance is promoted. It is, therefore, advisable to cool the adsorbing body. This cooling has the advantage, moreover, that at low temperature the adsorbed layer adheres much more firmly. A reduction of the temperature of only 10^oC., for instance from 20^oC. room temperature to 10^oC., can produce a considerable improvement. In many cases, it is advisable to use solid carbon dioxide or even liquid air for the cooling.

The adsorbed layer can be produced in the usual way, for instance by taking up heavy hydrogen or molecules containing heavy hydro gen from the surroundings, for instance from the gas chamber; but it may also be produced by bombarding the surface with heavy hydrogen ions. It is advisable to free the surface intended for the adsorption of heavy hydrogen as far as possible from other adsorbed molecules, such as ordinary hydrogen, for example, by heating in vacuum.

The replacement of the hydrogen given off during the ion bombardment can be accomplished, for instance, by simultaneous or subsequent bombardment with ions containing heavy hydrogen. This bombardment can be accomplished, for instance, with advantage from a different direction, for example, from the back or at a more acute angle from the front, than the bombardment for producing neutrons. The replacement of the heavy hydrogen may be accomplished, for example, by diffusion or by adsorption from the surroundings.

The principles of the invention are illustrated in the accompanying drawing in which:

Fig. l is a diagrammatic representation of apparatus embodying the principles of the invention; and

Fig. 2 is a partial diagrammatic representation of a modified embodiment of the invention.

In Fig. 1 a beam of high velocity ions of heavy hydrogen 14 is produced by the device described in copending application Serial No. 234,504 of Kuhn and Kallmann, filed October 11, 1938. In this device a beam of negative ions 4 generated at cathode 1 and focussed at 2 by electrode 16 is transformed into a beam of positive heavy hydrogen ions of increased velocity by means of the transforming electrode 5, supported in space 3 by tube 7 and insulator 15. A low pressure is maintained in 3 by means of a pump (not shown) connected at 8. A stream of heavy hydrogen is supplied to channel 6 through tube 7. The high velocity beam of heavy hydrogen ions obtained in this manner passes through apertured member 9 into cathode 10 where they impinge at a grazing angle on the target 11. The high velocity heavy hydrogen ions in the beam react with heavy hydrogen adsorbed on the surface of 11 to produce neutrons.

In the form shown in Fig. 2, a supply of heavy hydrogen is maintained on target 11 by diffusion into 11 of a substance 13 containing heavy hydrogen which is maintained in capsule 12.

[See document photos on pp. 4334–4335.]

Patented July 29, 1941 2,251,190

UNITED STATES PATENT OFFICE

2,251,190

METHOD OF PRODUCING NEUTRONS

Hartmut Israel Kallmann, formerly known as Hartmut Kallmann, Berlin-Charlottenburg, and Ernst Kuhn, Berlin, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany

Application March 10, 1939, Serial No. 261,156
In Germany March 16, 1938

16 Claims. (Cl. 250—84)

This invention relates to a method for the production of neutrons, particularly by the interaction of deuterons.

In order to obtain neutrons with the aid of ions with relatively slight acceleration (for instance 300 kv.) the nuclear reaction

$$D+D=He_3+n$$

is employed. The procedure in this connection is to bombard a layer containing heavy hydrogen nuclei with heavy hydrogen ions or deuterons. For the layer containing hydrogen, use is often made of ice, sal ammoniac, phosphoric acid and similar substances in which ordinary hydrogen is replaced by heavy hydrogen. These layers very rich in hydrogen have the disadvantage that they conduct heat and electricity poorly and are therefore easily destroyed by ionic bombardment. It would be better if more resistant layers were used, for instance, metallic layers. That is possible, however, only when metals that contain large amounts of dissolved or adsorbed hydrogen are employed. These are a few such metals, but they have the disadvantage that they gradually give off hydrogen in the vacuum. It would be still better therefore if substances could be used that contain hydrogen adsorbed only on the surface or in a surface layer but give it off to the outside less easily. These substances placed in the ion stream give only a small output of neutrons when impinged on vertically since the thickness of the adsorbed hydrogen layer is very small in comparison with the range of the ions projected into the metal. Nuclear processes can occur therefore only in a fractional portion of the path of the ions. In case, however, the path of the ions is maintained as nearly as possible entirely within the thin hydrogen layer, a large neutron output is obtained with the aid of these thin adsorbed hydrogen layers.

A principal purpose of the invention is the provision of a highly efficient method for the production of neutrons by the interaction of deuterons. According to the invention this is attained by allowing the stream of ions to impinge on the layer at an angle,—preferably in as grazing a manner as possible.

The adsorption layer containing hydrogen need not consist of pure hydrogen. It might under certain conditions be more advantageous if the adsorption layer consists of gases or vapors containing hydrogen, for instance, methane or water. This is particularly satisfactory when these substances are adsorbed especially strongly.

The body impinged on by the ions is preferably made of a substance that strongly adsorbs the molecules containing heavy hydrogen and at the same time possesses only a slight retarding capacity for the impinging ions. Carbon and beryllium have been found useful for these reasons. It is especially desirable to employ substances that adsorb the molecules containing hydrogen in as thick a layer as possible. This can be accomplished for instance by using, as adsorption body, a substance that is porous or roughened at least at the surface.

The surface of the adsorbing body is heated up by the energy of the impinging ions. In this way the giving off of the adsorbed substance is promoted. It is, therefore, advisable to cool the adsorbing body. This cooling has the advantage, moreover, that at low temperature the adsorbed layer adheres much more firmly. A reduction of the temperature of only 10° C., for instance from 20° C. room temperature to 10° C., can produce a considerable improvement. In many cases, it is advisable to use solid carbon dioxide or even liquid air for the cooling.

The adsorbed layer can be produced in the usual way, for instance by taking up heavy hydrogen or molecules containing heavy hydrogen from the surroundings, for instance from the gas chamber; but it may also be produced by bombarding the surface with heavy hydrogen ions. It is advisable to free the surface intended for the adsorption of heavy hydrogen as far as possible from other adsorbed molecules, such as ordinary hydrogen, for example, by heating in vacuum.

The replacement of the hydrogen given off during the ion bombardment can be accomplished, for instance, by simultaneous or subsequent bombardment with ions containing heavy hydrogen. This bombardment can be accomplished, for instance, with advantage from a different direction, for example, from the back or at a more acute angle from the front, than the bombardment for producing neutrons. The replacement of the heavy hydrogen may be accomplished, for example, by diffusion or by adsorption from the surroundings.

The principles of the invention are illustrated in the accompanying drawing in which:

Fig. 1 is a diagrammatic representation of apparatus embodying the principles of the invention; and

Fig. 2 is a partial diagrammatic representation of a modified embodiment of the invention.

In Fig. 1 a beam of high velocity ions of heavy hydrogen 14 is produced by the device described in copending application Serial No. 234,504 of Kuhn and Kallmann, filed October 11, 1938. In this device a beam of negative ions 4 generated at cathode 1 and focussed at 2 by electrode 16 is transformed into a beam of positive heavy hydrogen ions of increased velocity by means of the transforming electrode 5, supported in space 3 by tube 7 and insulator 15. A low pressure is maintained in 3 by means of a pump (not shown) connected at 8. A stream of heavy hydrogen is supplied to channel 6 through tube 7. The high velocity beam of heavy hydrogen ions obtained in this manner passes through apertured member 9 into cathode 10 where they impinge at a grazing angle on the target 11. The high velocity heavy hydrogen ions in the beam react with heavy hydrogen adsorbed on the surface of 11 to produce neutrons.

In the form shown in Fig. 2, a supply of heavy hydrogen is maintained on target 11 by diffusion into 11 of a substance 13 containing heavy hydrogen which is maintained in capsule 12.

We claim:

1. A method for the production of neutrons which comprises bombarding a body containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal.

2. A method for the production of neutrons which comprises bombarding a body containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a grazing angle.

3. A method for the production of neutrons which comprises bombarding a body containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal while cooling the body to a temperature below room temperature.

4. A method for the production of neutrons which comprises bombarding a body containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal and replacing the adsorbed heavy hydrogen by bombardment of said body with heavy hydrogen ions.

5. A method for the production of neutrons which comprises bombarding a body containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal and replacing the adsorbed heavy hydrogen by diffusion of substances containing heavy hydrogen into the body.

6. A method for the production of neutrons which comprises bombarding a body containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal and continuously replacing the adsorbed heavy hydrogen during the bombardment.

7. A method for the production of neutrons which comprises bombarding a body comprising carbon and containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal.

8. A method for the production of neutrons which comprises bombarding a body comprising beryllium and containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal.

9. A method for the production of neutrons which comprises bombarding a body, at least the surface portion of which is porous, containing heavy hydrogen adsorbed in its surface with heavy hydrogen ions impinging thereon at a substantial angle to the normal.

10. A device for the production of neutrons comprising means for generating a beam of heavy hydrogen ions, and a body containing heavy hydrogen adsorbed in the surface thereof positioned in said beam with said surface at an acute angle to the direction of travel thereof.

11. A device for the production of neutrons comprising means for generating a beam of heavy hydrogen ions, and a body containing heavy hydrogen adsorbed in the surface thereof positioned in said beam with said surface at a grazing angle to the direction of travel thereof.

12. A device for the production of neutrons comprising means for generating a beam of heavy hydrogen ions, a body containing heavy hydrogen adsorbed in the surface thereof positioned in said beam with said surface at an acute angle to the direction of travel thereof, and means for supplying heavy hydrogen to said body.

13. A device for the production of neutrons comprising means for generating a beam of heavy hydrogen ions, and a body comprising carbon and containing heavy hydrogen adsorbed in the surface thereof positioned in said beam with said surface at an acute angle to the direction of travel thereof.

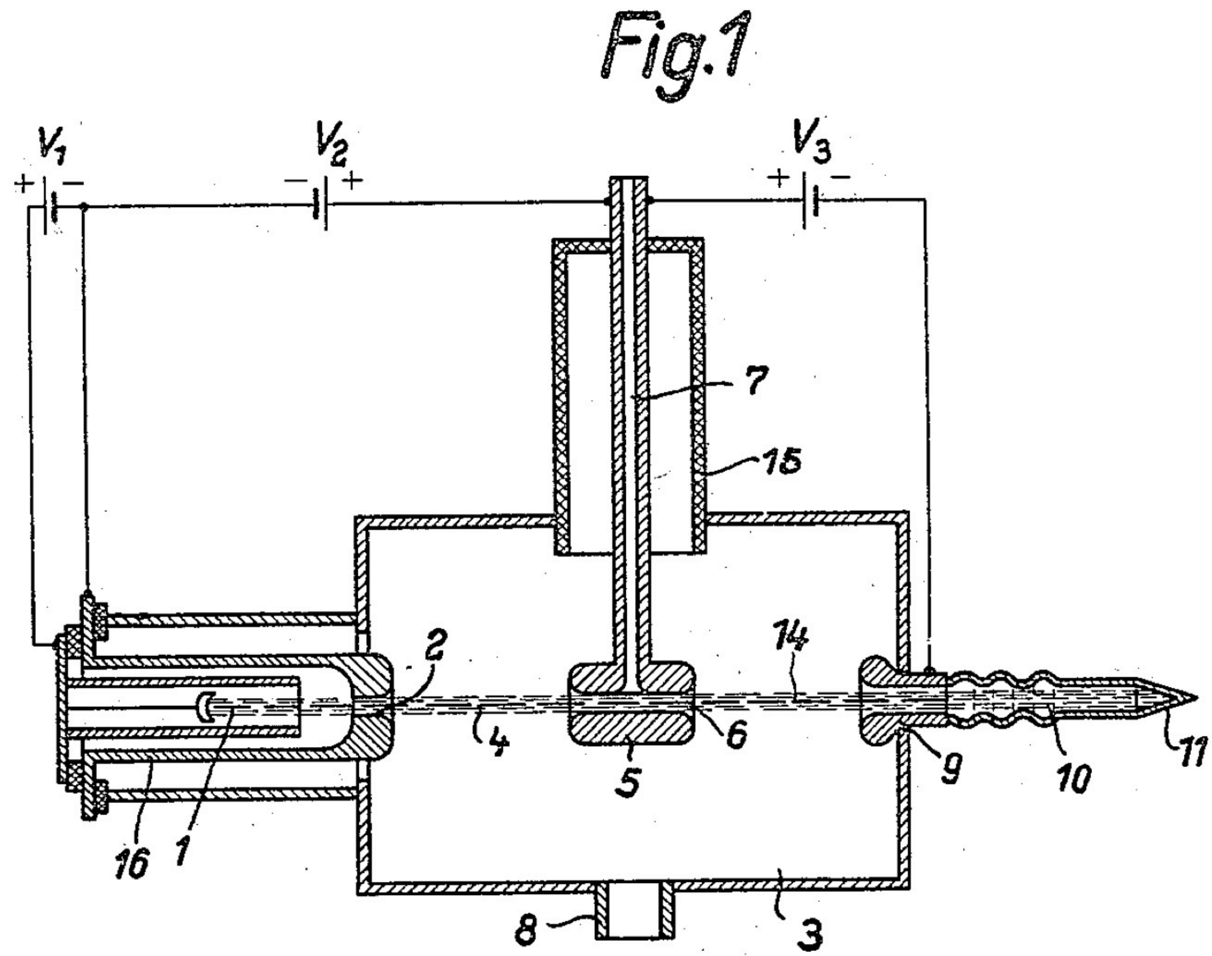
14. A device for the production of neutrons comprising means for generating a beam of heavy hydrogen ions, and a body comprising beryllium and containing heavy hydrogen adsorbed in the surface thereof positioned in said beam with said surface at an acute angle to the direction of travel thereof.

15. A device for the production of neutrons comprising means for generating a beam of heavy hydrogen ions, and a body having a porous surface and containing heavy hydrogen adsorbed in the surface thereof positioned in said beam with said surface at an acute angle to the direction of travel thereof.

16. A method for the production of neutrons which comprises bombarding a body with heavy hydrogen ions impinging on the body at a substantial angle to the normal, said body having a high adsorptive capacity for a substance containing heavy hydrogen and having a low retarding effect upon impinging heavy hydrogen and containing heavy hydrogen adsorbed in its surface.

HARTMUT ISRAEL KALLMANN,
Formerly known as Hartmut Kallman.
ERNST KUHN.

Figure D.625: Hartmut Kallmann and Ernst Kuhn, AEG and I.G. Farben. U.S. Patent 2,251,190. Method of Producing Neutrons. Filed 16 March 1938. Issued 29 July 1941.



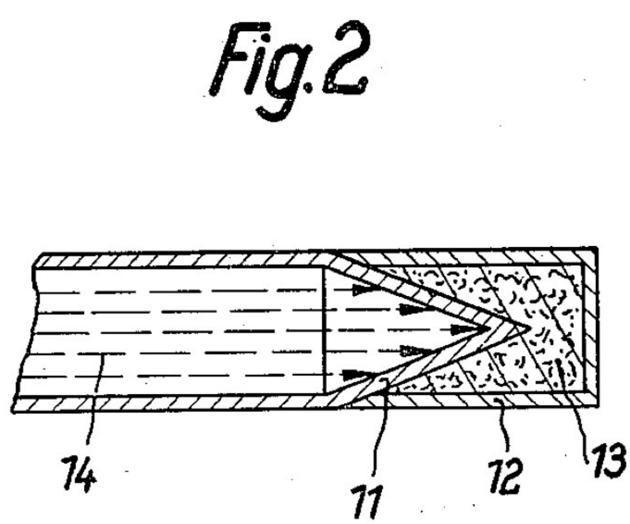


Figure D.626: High-voltage tube for generating fusion neutrons from Kallmann and Kuhn's U.S. Patent 2,251,190.

Hartmut Kallmann and Ernst Kuhn. U.S. Patent 2,288,717. Method for Investigation of Substances with the Aid of Neutrons. Filed 10 March 1939. Issued 7 July 1942.

The present invention relates to improvements in methods of, and means for, investigating objects or substances with the aid of neutrons.

It has already been suggested to investigate substances by depicting them with the aid of neutrons. This investigation may be carried out by directing a beam of neutrons through the body or substance under investigation and causing the neutrons that emerge from it to encounter a layer in which heavy charged particles or electrons (+ and -) or gamma rays are produced under the action of the impinging neutrons upon an element, contained in said layer, which is reactive toward neutrons. These particles are in turn caused to act upon a layer of fluorescent material, or an adjacent photographic layer or a combination thereof, thus depicting the investigated body or substance visibly or photographically. Neutron reactive layers particularly suited for this purpose are, for instance, such containing lithium or boron. In these two substances the following reactions take place under the influence of the impinging neutrons:

$$1.\quad n_0^1 + Li_3^6 = He_2^4 + H_1^3 \tag{D.13}$$

$$2.\quad n_0^1 + B_5^{10} = Li_3^7 + He_2^4 \tag{D.14}$$

In the lithium or lithium compounds existing in nature the contents of the effective Li_3^6 amounts only to about 10%, and in the boron and boron compounds existing in nature the contents of the effective B_5^{10} amounts only to about 20%. The main mass of these elements consists of Li_3^7, or B_5^{11}, respectively.

It is an object of the present invention to increase the sensitiveness of the above-mentioned method of depicting objects by means of neutrons. Another object of the invention is to provide improved means for depicting objects by means of neutrons.

This inventive object is attained by using as neutron reactive layer containing an element in which the neutron reactive sort of isotopes is enriched beyond the proportion corresponding to the natural distribution of this isotope in the respective element. Using the above mentioned special reactions the neutron reactive sorts of isotopes being artificially enriched are Li_3^6 or B_5^{10}. The enrichment may be accomplished by any of the known methods for separating or concentrating isotopes, i.e. diffusion, mass spectrograph, electrolysis and chemical processes.

With a given intensity of the neutron radiation the number of the emitted heavy particles and therewith the blackening of the photographic plate, or the excitation of the fluorescent screen respectively, is determined not by the thickness of the intermediate layer, but by the range of the heavy particles liberated from said layer if the thickness of said intermediate layer is larger than said range. The number of the heavy particles emitted per neutron is the greatest if within a layer adjacent to the surface the thickness of which corresponds to the range as many neutrons as possible cause the emission of heavy particles by collision with neutron reactive atomic nuclei. As in general within a layer the thickness of which being equal to the range of said particles only a small fraction of the neutrons passing through liberate heavy particles, it is extremely important, as regards the output, to provide in said layer as many neutron reactive atomic nuclei as possible. An increase of the number of the neutron reactive atomic nuclei is obtained, by artificially enriching the intermediate element with Li_3^6 or B_5^{10}, respectively, beyond the proportion of its natural distribution in the respective element.

This method can advantageously be used also in connection with intermediate layers which do not emit heavy particles, but which emit electrons or gamma rays under the action of impinging neutrons, if the mixture of isotopes of the respective element, as existing in nature, is not the most favorable one for one of said neutron reactions. Therefore, the present improved method is not restricted to boron and lithium, but it will prove advantageous with every other neutron reactive element if only a fraction of all neutrons passing through the neutron-reactive layer is being absorbed in it, or if very thin neutron-reactive layers are used, or if the neutrons in the neutron-reactive layer are also absorbed by atomic nuclei which only contribute very little to the blackening of the photographic layer, or to the excitation of the fluorescent screen respectively by the emission of particles or gamma rays. The present improved method becomes particularly important if the neutron reactive element is applied as an emulsion upon the photographic layer or upon the fluorescent screen. Such emulsions are able to contain a small concentration of the neutron reactive element only. If, therefore the element contained in the emulsion is artificially enriched with the effective sort of isotopes beyond the proportion of its nature distribution in the respective element, an extraordinarily great increase of the sensitiveness can be attained.

Also neutron reactive layers containing cadmium may be used in which the cadmium is artificially enriched with its active isotope beyond the proportion corresponding to its natural distribution in cadmium. The isotope of cadmium to be used in each instance depends upon the neutron energy employed. The choice is made by observing which gives the greatest effect.

The accompanying drawing is a diagrammatic representation of an embodiment of the invention. The neutron beam 2 emitted by the neutron source 1 passes through the investigated substance or body 3. The emerging neutrons 4 impinge upon the neutron reactive layer 5 which is enriched with the effective sort of isotopes beyond the proportion corresponding to its natural distribution in the respective elements. In this layer 5 the neutrons liberate charged particles or gamma rays which energize the adjacent layer 6 which consists of fluorescent or photo-sensitive material thus producing a visible or photographic image of the investigated substance or body 3.

[See document photos on pp. 4338–4339.

The patents of Kallmann and Kuhn are directly relevant to high-voltage fusion neutron initiators for fission bombs, but also to neutron imaging, analysis of materials, well logging, etc. These technologies have had wide-reaching influence from the postwar period to the modern world. In connection to nuclear weapons, note that in March 1939 Kallmann and Kuhn specifically described:

- The reaction $n_0^1 + Li_3^6 \rightarrow He_2^4 + H_1^3$, half of the Jetter cycle (p. 4386 of this appendix).
- The need to enrich the lithium-6 isotope from naturally occurring lithium, as Alfred Klemm did in 1942–1943 (p. 4382).

See also numerous other related patents by Kallmann and Kuhn, such as:

> U.S. Patent 2,219,033. Method and Device for Generating a Beam of Ions of High Velocity. Filed 21 October 1937. Issued 22 October 1940.

> U.S. Patent 2,188,115. Investigation of Materials with Neutrons. Filed 25 March 1937. Issued 23 January 1940.

How far did Kallmann and Kuhn or others take these technologies during the war? Note that Kallmann and Kuhn worked for AEG in Berlin.]

UNITED STATES PATENT OFFICE

2,288,717

METHOD FOR THE INVESTIGATION OF SUBSTANCES WITH THE AID OF NEUTRONS

Hartmut Israel Kallmann, Berlin-Charlottenburg, and Ernst Kuhn, Berlin, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany

Application January 31, 1940, Serial No. 316,698
In Germany March 10, 1939

17 Claims. (Cl. 250—65)

The present invention relates to improvements in methods of, and means for, investigating objects or substances with the aid of neutrons.

It has already been suggested to investigate substances by depicting them with the aid of neutrons. This investigation may be carried out by directing a beam of neutrons through the body or substance under investigation and causing the neutrons that emerge from it to encounter a layer in which heavy charged particles or electrons (+ and −) or gamma rays are produced under the action of the impinging neutrons upon an element, contained in said layer, which is reactive toward neutrons. These particles are in turn caused to act upon a layer of fluorescent material, or an adjacent photographic layer or a combination thereof, thus depicting the investigated body or substance visibly or photographically. Neutron reactive layers particularly suited for this purpose are, for instance, such containing lithium or boron. In these two substances the following reactions take place under the influence of the impinging neutrons:

1. $n_0^1 + Li_3^6 = He_2^4 + H_1^3$

2. $n_0^1 + B_5^{10} = Li_3^7 + He_2^4$

In the lithium or lithium compounds existing in nature the contents of the effective $Li_3{}^6$ amounts only to about 10%, and in the boron and boron compounds existing in nature the contents of the effective $B_5{}^{10}$ amounts only to about 20%. The main mass of these elements consists of $Li_3{}^7$, or $B_5{}^{11}$, respectively.

It is an object of the present invention to increase the sensitiveness of the above-mentioned method of depicting objects by means of neutrons. Another object of the invention is to provide improved means for depicting objects by means of neutrons.

This inventive object is attained by using as neutron reactive layer containing an element in which the neutron reactive sort of isotopes is enriched beyond the proportion corresponding to the natural distribution of this isotope in the respective element. Using the above mentioned special reactions the neutron reactive sorts of isotopes being artificially enriched are $Li_3{}^6$ or $B_5{}^{10}$. The enrichment may be accomplished by any of the known methods for separating or concentrating isotopes, i. e. diffusion, mass spectrograph, electrolysis and chemical processes.

With a given intensity of the neutron radiation the number of the emitted heavy particles and therewith the blackening of the photographic plate, or the excitation of the fluorescent screen respectively, is, determined not by the thickness of the intermediate layer, but by the range of the heavy particles liberated from said layer if the thickness of said intermediate layer is larger than said range. The number of the heavy particles emitted per neutron is the greatest if within a layer adjacent to the surface the thickness of which corresponds to the range as many neutrons as possible cause the emission of heavy particles by collision with neutron reactive atomic nuclei. As in general within a layer the thickness of which being equal to the range of said particles only a small fraction of the neutrons passing through liberate heavy particles, it is extremely important, as regards the output, to provide in said layer as many neutron reactive atomic nuclei as possible. An increase of the number of the neutron reactive atomic nuclei is obtained, by artificially enriching the intermediate element with $Li_3{}^6$ or $B_5{}^{10}$, respectively, beyond the proportion of its natural distribution in the respective element.

This method can advantageously be used also in connection with intermediate layers which do not emit heavy particles, but which emit electrons or gamma rays under the action of impinging neutrons, if the mixture of isotopes of the respective element, as existing in nature, is not the most favorable one for one of said neutron reactions. Therefore, the present improved method is not restricted to boron and lithium, but it will prove advantageous with every other neutron reactive element if only a fraction of all neutrons passing through the neutron-reactive layer is being absorbed in it, or if very thin neutron-reactive layers are used, or if the neutrons in the neutron-reactive layer are also absorbed by atomic nuclei which only contribute very little to the blackening of the photographic layer, or to the excitation of the fluorescent screen respectively by the emission of particles or gamma rays. The present improved method becomes particularly important if the neutron reactive element is applied as an emulsion upon the photographic layer or upon the fluorescent screen. Such emulsions are able to contain a small concentration of the neutron reactive element only. If, therefore the element contained in the emulsion is artificially enriched with the effective sort of isotopes beyond the proportion of its nature distribution in the respective element, an extraordinarily great increase of the sensitiveness can be attained.

Also neutron reactive layers containing cadmium may be used in which the cadmium is ar-

Figure D.627: Hartmut Kallmann and Ernst Kuhn, AEG and I.G. Farben. U.S. Patent 2,288,717. Method for Investigation of Substances with the Aid of Neutrons. Filed 10 March 1939. Issued 7 July 1942.

tificially enriched with its active isotope beyond the proportion corresponding to its natural distribution in cadmium. The isotope of cadmium to be used in each instance depends upon the neutron energy employed. The choice is made by observing which gives the greatest effect.

The accompanying drawing is a diagrammatic representation of an embodiment of the invention. The neutron beam **2** emitted by the neutron source **1** passes through the investigated substance or body **3**. The emerging neutrons **4** impinge upon the neutron reactive layer **5** which is enriched with the effective sort of isotopes beyond the proportion corresponding to its natural distribution in the respective elements. In this layer **5** the neutrons liberate charged particles or gamma rays which energize the adjacent layer **6** which consists of fluorescent or photo-sensitive material thus producing a visible or photographic image of the investigated substance or body **3**.

We claim:

1. In a method of obtaining an image of an object by directing a beam of neutrons upon the object, causing the emergent beam of neutrons to impinge upon a layer comprising an element which reacts with neutrons to produce radiation, and forming a visible image of said object by means of the resulting radiation, the improvement which consists in using a neutron-reactive layer in which the neutron-reactive element thereof has been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element.

2. In a method of obtaining an image of an object by directing a beam of neutrons upon the object, causing the emergent beam of neutrons to impinge upon a layer comprising an element which reacts with neutrons to produce radiation, and forming a visible image of said object by means of the resulting radiation, the improvement which consists in using a neutron-reactive layer in which the neutron-reactive element thereof has been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element and in which the neutron-reactive isotope-enriched element is contained in said layer in the form of an emulsion.

3. In a method of obtaining an image of an object by directing a beam of neutrons upon the object, causing the emergent beam of neutrons to impinge upon a layer comprising an element which reacts with neutrons to produce radiation of charged particles, and forming a visible image of said object by means of the resulting radiation, the improvement which consists in using a neutron-reactive layer in which the neutron-reactive element thereof has been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element.

4. The invention defined in claim 3, in which lithium which has been enriched with Li_3^6 beyond the proportion of its natural distribution in lithium constitutes the neutron-reactive element employed.

5. The invention defined in claim 3, in which boron which has been enriched with B_5^{10} beyond the proportion of its natural distribution in boron constitutes the neutron-reactive element employed.

6. A device for forming an image of the distribution of the intensity of a beam of neutrons, which comprises a layer containing an element which reacts with neutrons to produce radiation, said element having been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element, and a substance sensitive to emitted radiation.

7. A device for forming an image of the distribution of the intensity of a beam of neutrons, which comprises a layer containing an element which reacts with neutrons to produce radiation, said element having been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element, and a layer containing a substance sensitive to emitted radiation.

8. A device for forming an image of the distribution of the intensity of a beam of neutrons, which comprises a layer containing an element which reacts with neutrons to produce radiation, said element having been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element, and a layer comprising fluorescent material sensitive to emitted radiation.

9. A device for forming an image of the distribution of the intensity of a beam of neutrons, which comprises a layer containing an element which reacts with neutrons to produce radiation, said element having been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element, and a layer comprising photosensitive material sensitive to emitted radiation.

10. A device for forming an image of the distribution of the intensity of a beam of neutrons, which comprises a layer containing an element which reacts with neutrons to produce radiation of charged particles, said element having been enriched with a neutron-reactive isotope of said element in an amount greater than the proportion of its natural distribution in said element, and a substance sensitive to emitted radiation.

11. The device defined in claim 10, in which the neutron-reactive element is lithium which has been enriched with Li_3^6 beyond the proportion of its natural distribution in lithium.

12. The device defined in claim 10, in which the neutron-reactive element is boron which has been enriched with B_5^{10} beyond the proportion of its natural distribution in boron.

13. The device defined in claim 6, in which the neutron-reactive isotope-enriched element is contained in said neutron-reactive layer in the form of an emulsion.

14. A method of obtaining an image as defined in claim 1 in which the radiation is gamma radiation.

15. A method as defined in claim 1 in which the element is cadmium.

16. A device as defined in claim 6 in which the radiation is gamma radiation.

17. A device as defined in claim 6 in which the element is cadmium.

HARTMUT ISRAEL KALLMANN.
ERNST KUHN.

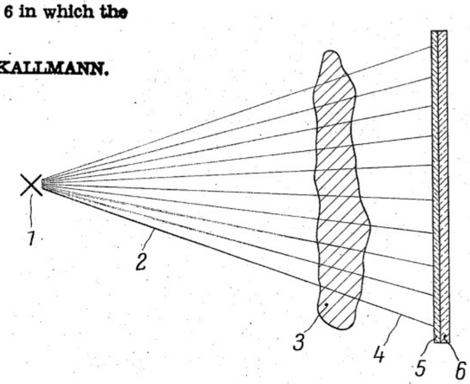


Figure D.628: Hartmut Kallmann and Ernst Kuhn, AEG and I.G. Farben. U.S. Patent 2,288,717. Method for Investigation of Substances with the Aid of Neutrons. Filed 10 March 1939. Issued 7 July 1942.

[NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)]

C.S.D.I.C. (U.K.)
S.I.R. 1096

THIS REPORT IS SECRET

Report on information obtained from PW KP/126263 Gren CHRIST,
Fest Inf Bn 1408, captured at
ECHINGHEN nr BOULOGNE 19 Sep 44

NOTES ON ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT (AEG)
HENNIGSDORF NEAR BERLIN, AND THE
FOREIGN WORKERS' COLONY

PREAMBLE

1. PW is 40 years old and has been with the German Army for three months only. He was born in CZECHOSLOVAKIA and served with the Czech Army during 1924 and 1925. Shortly after the annexation of the SUDETENLAND PW was ordered to GERMANY and was employed in the lacquer factory of the AEG HENNIGSDORF near BERLIN. Late Feb 41 he was taken from the factory to occupy a post as an interpreter and supervisor among the Czechs in the newly-established Foreign Workers' Camp of the AEG, HENNIGSDORF. From that date until Jul 44 PW has been an active and observant official of this camp. He is very cooperative and the information is considered reliable.

I. NOTES ON AEG AND EMPLOYEES

2. The AEG plant in question is located at the Southern outskirts of HENNIGSDORF (GSGS 4414. 3345/7061 and 7062). (Popl. approx. 18,000). This plant is one of ten or eleven branches of the AEG in BERLIN and ever since PW can remember new buildings have been added, and today the plant comprises an estimated area of 800 x 400 m.

TAILPIECE

62. A 2-storey ordinary wooden barrack hut 8 x 8 m has been seen by PW, and on two occasions he had the opportunity of entering the building and talking to the electrician who takes care of the equipment. This electrician did not talk of the purposes of the station, and PW believed that it was most secret, but did mention several times that a voltage of one million must be reached before great results could be expected. By the end of Jun 44 they had come up from 120000 to 420000 volts.

63. Once or twice a week two professors and an engineer arrived at the station and during each visit PW saw the four 1½ inch cables from the building to the steel mast approx 80 m away begin to glow in various colours, usually, however, changing from bluish to green, accompanied by a low hum of great intensity. The visitors stayed for 1½ to 2 hours, the test itself lasting approx 15 mins. Shortly after a test PW went to see his friend, the electrician, and heard him say that each test cost RM 24 in electricity alone. Then PW watched him cleaning spherical containers, removing heavy metal bars from each one and putting them into troughs of acid. Each container had a mirror fixed on top which stood at an angle of 45° and which turned through 90° the line of sight from a telescope some 10 feet away to the small mica covered opening at the top of each container.

64. There were four such spherical containers of different sizes and PW states that he observed that the smallest one, approx 1 m in diameter, was used that day in Jun 44. The size of the others ranged between approx 1 m to 2 m in diameter but otherwise they were identical. The cables leading from an amplifier to each one of the spheres were about the same size but the cables leading from the spheres to heavy insulator and apparently farther to the steel mast were considerably heavier from the 2 m sphere than from the 1 m sphere.

65. Upon being prompted PW suddenly remembered that the electrician at the station had used the terms cyclotron and atom splitting.

Information received in ALSOS Mission by Dr.
W. F. Colby from Scientific Branch, MIS 11-11-44

Major Smith

[See document photo on p. 4342.]

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-October 1944)

C.S.D.I.C.(U.K.)
S.I.R. 1095

THIS REPORT IS SECRET

Report on information obtained from PW KP/126263 Gren CHRIST, Fest Inf Bn 1408, captured at ECHINGHEN nr BOULOGNE 19 Sep 44

NOTES ON ALLGEMEINE ELEKTRIZITATS GESELLSCHAFT (AEG) HENNIGSDORF NEAR BERLIN, AND THE FOREIGN WORKERS' COLONY

PREAMBLE

1. PW is 40 years old and has been with the German Army for three months only. He was born in CZECHOSLOVAKIA and served with the Czech Army during 1924 and 1925. Shortly after the annexation of the SUDETENLAND PW was ordered to GERMANY and was employed in the lacquer factory of the AEG HENNIGSDORF near BERLIN. Late Feb 41 he was taken from the factory to occupy a post as an interpreter and supervisor among the Czechs in the newly-established Foreign Workers' Camp of the AEG, HENNIGSDORF. From that date until Jul 44 PW has been an active and observant official of this camp. He is very cooperative and the information is considered reliable.

I. NOTES ON AEG AND EMPLOYEES

LOCATION 2. The AEG plant in question is located at the Southern outskirts of HENNIGSDORF (GSGS 4414. 3345/7061 and 7062). (Pop. approx. 18,000). This plant is one of ten or eleven branches of the AEG in BERLIN and ever since PW can remember new buildings have been added, and today the plant comprises an estimated area of 800 x 400 m.

TAILPIECE

EXPERI-MENTAL STATION GSGS 4414/3345: 69826018

62. A 2-storey ordinary wooden barrack hut 8 x 8 m has been seen by PW, and on two occasions he had the opportunity of entering the building and talking to the electrician who takes care of the equipment. This electrician did not talk of the purposes of the station, and PW believed that it was most secret, but did mention several times that a voltage of one million must be reached before great results could be expected. By the end of Jun 44 they had come up from 120000 to 420000 volts.

63. Once or twice a week two professors and an engineer arrived at the station and during each visit PW saw the four $1\frac{1}{2}$ inch cables from the building to the steel mast approx 80 m away begin to glow in various colours, usually, however, changing from bluish to green, accompanied by a low hum of great intensity. The visitors stayed for $1\frac{1}{2}$ to 2 hours, the test itself lasting approx 15 mins. Shortly after a test PW went to see his friend, the electrician, and heard him say that each test cost RM 24 in electricity alone. Then PW watched him cleaning spherical containers, removing heavy metal bars from each one and putting them into troughs of acid. Each container had a mirror fixed on top which stood at an angle of 45° and which turned through 90° the line of sight from a telescope some 10 feet away to the small mica covered opening at the top of each container.

64. There were four such spherical containers of different sizes and PW states that he observed that the smallest one, approx 1 m in diameter, was used that day in Jun 44. The size of the others ranged between approx 1 m to 2 m in diameter but otherwise they were identical. The cables leading from an amplifier to each one of the spheres were about the same size but the cables leading from the spheres to heavy insulator and apparently farther to the steel mast were considerably heavier from the 2 m sphere than from the 1 m sphere.

65. Upon being prompted PW suddenly remembered that the electrician at the station had used the terms cyclone and atom splitting.

Information received in ALSOS Mission by Dr. W. F. Colby from Scientific Branch, MIS 11-11-44

Major Smith

Figure D.629: C.S.D.I.C. (U.K.) S.I.R. 1095 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)]

G-367. Wolfgang Ferrant. Proposal for a New Method of Releasing Nuclear Energy by a Beam of Heavy Particles. 1945. pp. 13, 21, 23–24, 35.

Unfortunately it was not possible to make use of the correct density figure for Li D in making the computation ($\rho = 1$ was merely estimated); because my books, photostats, and notes were left behind, in part, in Dresden, together with my laboratory (13–14 February) where they were burned, and in part this material was left behind in the Russian Zone. [...]

1. Suitable Substances

Our purpose was to produce, within an extensive reaction area which contains a very large number of atoms capable of reacting, a temperature or an almost entirely uncoordinated heat motion, such as prevails on the stars. At the same time, the density of the reacting material should be as great as possible.

Under these circumstances atomic reactions will occur[...]

The decision in this matter involves an additional demand we must make upon the reacting mass: the demand that this mass should be ionizable in its totality with the lowest possible expenditure of energy.

2. THE PROBLEM OF KEEPING THE WORK OF IONIZATION AT A MINIMUM

However, the choice is in fact restricted to lithium, the latter being a substance which does not carry more than three enveloping electrons. Moreover, the lithium readily combines with heavy hydrogen to form a hydride: LiD. The compound, that is the lithium D hydride, contains a total of only four electrons, so that the total work of ionization is, at worst, only a small amount.

All aside from other considerations, lithium D hydride is well suited as the choice of substance both for the "large particles" and for the recipient substance, not only because heavy hydrogen participates in the atomic reaction, but also because the lithium, likewise, participates. The following reactions are to be anticipated: ${}^2_1\mathrm{D}(\mathrm{d,n}){}^3_2\mathrm{He}$; ${}^2_1\mathrm{D}(\mathrm{d,p}){}^3_1\mathrm{H}$ and ${}^6_3\mathrm{Li}(\mathrm{d,p}){}^7_3\mathrm{Li}$; ${}^6_3\mathrm{Li}(\mathrm{d},\alpha){}^4_2\mathrm{He}$; ${}^7_3\mathrm{Li}(\mathrm{d,n}){}^4_2\mathrm{He}$.

There occurs in the reaction area a formation of charged particles α, p, but also a formation of neutrons that can easily split off. Our method, therefore, results directly in the creation of a source of neutrons of greatest intensity.

This method, consequently, has nothing to do, directly, with the splitting of the uranium atom.

Advantage will be taken, of course, of Hahn's discovery; especially when the purpose is to obtain pure energy, and not merely to obtain neutrons and an incidental supply of energy.

If the purpose is to obtain energy alone, the neutrons formed will be utilized in splitting the uranium atom; and in that manner extraordinary amounts of energy will be liberated, as a first product, by way of the neutrons.

The lithium-D-hydride, recipient, therefore, will be surrounded by a coat of uranium.

Quite possibly a special advantage could be obtained by adding a quantity of uranium D compound to the "large particles" and to the recipient mass; because in this manner a considerable amount of energy will be given off by uranium fragments located within the reaction area, and this state of affairs might possibly result in further increases of temperature within the reaction area. [...]

4. SELF HEATING

Under this subject it will be necessary to distinguish between two types of cases: Self heating of the reaction area, and self heating in the reaction field outside the reaction area proper.

1) If a very great number of atomic reactions comes about within the reaction area itself, the particles charged as a result of these reactions (α, p) will produce heat within the reaction area, increasing the latter's temperature until the entire material within the reaction area is consumed.

2) The alpha rays and protons of high energy resulting from the atomic reactions will pass through the reaction area, penetrating to the latter's "wall;" and they will penetrate much more deeply than the D and Li atoms, since the alpha rays and protons are much richer in energy.

If the alpha, p particles occur in such large numbers about the environs of the reaction area become ionized and heated, there will be formed an external reaction zone within which atomic reactions may likewise occur. Finally, the outer reaction zone will assume such dimensions that even the alpha rays and protons forming the reactions no longer leave that zone, and are compelled by the magnetic field to move along circular paths.

If an external reaction zone of this nature is developed, there will result an explosion of the entire LiD mass, since the external reaction zone is capable of enlarging itself on the strength of its own energy production.

[See document photos on pp. 4346–4350.

Wolfgang Ferrant wrote this report after the war, apparently at the behest of the U.S. Alsos Mission. The report seems to have been based on wartime work that Ferrant conducted, participated in, or was aware of, and he complained in this report that he did not have access to any wartime documents in order to more accurately reconstruct the scientific details.

In writing this report, Ferrant appears to have censored himself and/or to have been censored by U.S. officials. The report primarily focused on proposed methods for controlled fusion reactors using magnetic confinement, and it was amazingly prescient on that topic. However, the report also touched on applications to nuclear explosives, and its insights in that direction were extraordinary. Specifically, the report described:

- Using lithium deuteride as a storable solid fusion fuel with excellent physics properties.

- Harnessing a number of fusion reactions that can occur within the lithium deuteride fuel. Ferrant omitted the ${}^{6}_{3}\mathrm{Li}(\mathrm{n},\alpha){}^{3}_{1}\mathrm{H}$ reaction from his list, likely either because he wrote this report without access to any wartime papers or because he was censored or self-censored. Nonetheless, two of his research colleagues at AEG, Hartmut Kallmann and Ernst Kuhn, filed a patent featuring that reaction in 1939 (p. 4336), so the reaction would have been known to Ferrant.

- Initiating fusion reactions in the lithium deuteride by creating sufficiently high initial temperatures, pressures, and densities in the fuel.

- Creating an explosive chain reaction in which fusion reactions within a small region of the lithium deuteride produce enough radiation, heat, and pressure to induce fusion reactions in surrounding regions of the lithium deuteride.

- Producing large amounts of high-energy fusion neutrons from reactions in the lithium deuteride.

- Surrounding the lithium deuteride with a layer of uranium that would absorb the fusion neutrons, undergo fission reactions, and greatly increase the total energy that is released.

- Utilizing the fission reactions in the uranium to increase the heat and pressure and therefore the fusion reaction rate in the lithium deuteride.

All of these details are directly relevant for producing a hydrogen bomb. Ferrant's report demonstrates that all of these details were known and being actively utilized in wartime Germany.

What exactly did Ferrant work on throughout the war?

During the early part of the war, he worked at AEG in Berlin, alongside Hartmut Kallmann and Ernst Kuhn.

In this report, he mentioned working at a nuclear laboratory in Dresden. (There was at least one independent report of a nuclear laboratory in Dresden, which was apparently part of a secret Reichspost/SS collaboration on nuclear weapons—see p. 4552.) Ferrant referred to the U.S./U.K. firebombing of Dresden on 13–14 February 1945.

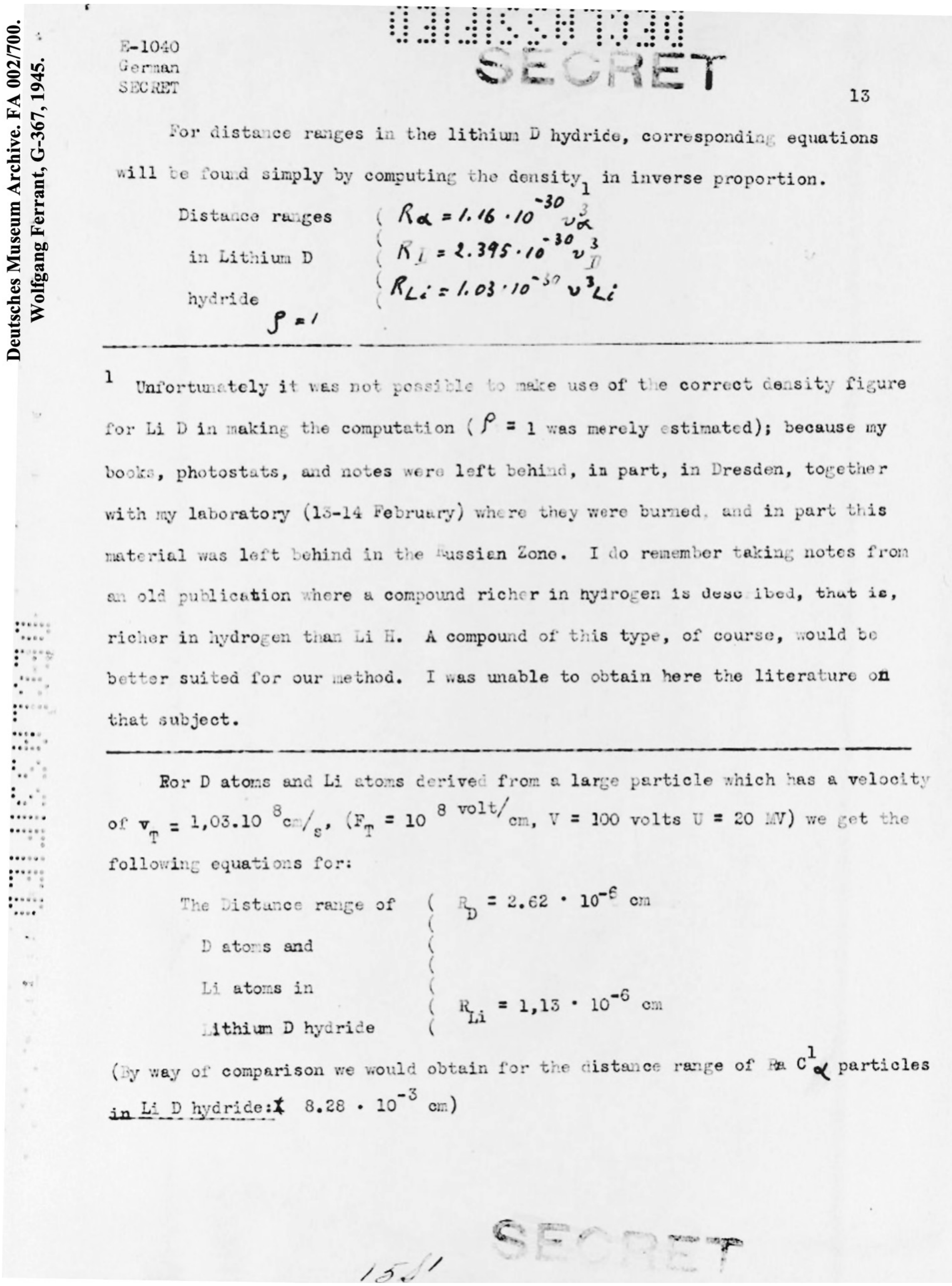
In this report, Ferrant also referenced a letter he had written in Linz in September 1945, so he apparently was working in Austria at the end of the war, or had connections there earlier in the war too. With whom did he work in Austria? AEG had its own "Bauleitung" (construction directorate) at St. Georgen/Gusen near Linz, and St. Georgen appears to have been involved in nuclear work (p. 3908). Did Ferrant work or visit there during the war?

Did Ferrant tell U.S. officials anything that is not in this report? Did he write an uncensored, more highly classified version of this report, or divulge more details in classified interrogations?

After the war, where did Ferrant work, and what did he work on?

Can additional information be located in archives, and declassified if necessary?]

Deutsches Museum Archive. FA 002/700.
Wolfgang Ferrant, G-367, 1945.



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For distance ranges in the lithium D hydride, corresponding equations will be found simply by computing the density[1] in inverse proportion.

Distance ranges in Lithium D hydride $\rho = 1$

$$\left(\begin{array}{l} R_\alpha = 1.16 \cdot 10^{-30}\, v_\alpha^3 \\ R_D = 2.395 \cdot 10^{-30}\, v_D^3 \\ R_{Li} = 1.03 \cdot 10^{-30}\, v_{Li}^3 \end{array}\right.$$

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1 Unfortunately it was not possible to make use of the correct density figure for Li D in making the computation (ρ = 1 was merely estimated); because my books, photostats, and notes were left behind, in part, in Dresden, together with my laboratory (13-14 February) where they were burned, and in part this material was left behind in the Russian Zone. I do remember taking notes from an old publication where a compound richer in hydrogen is described, that is, richer in hydrogen than Li H. A compound of this type, of course, would be better suited for our method. I was unable to obtain here the literature on that subject.

For D atoms and Li atoms derived from a large particle which has a velocity of $v_T = 1{,}03.10^{8}\ \mathrm{cm/s}$, ($F_T = 10^{8}\ \mathrm{volt/cm}$, V = 100 volts U = 20 MV) we get the following equations for:

The Distance range of D atoms and Li atoms in Lithium D hydride

$$\left(\begin{array}{l} R_D = 2.62 \cdot 10^{-6}\ \mathrm{cm} \\ R_{Li} = 1{,}13 \cdot 10^{-6}\ \mathrm{cm} \end{array}\right.$$

(By way of comparison we would obtain for the distance range of Ra C^1_α particles in Li D hydride: $\approx 8.28 \cdot 10^{-3}$ cm)

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Figure D.630: Excerpts from Wolfgang Ferrant's report G-367 (1945), revealing advanced scientific knowledge of details that are directly applicable to H-bombs [Deutsches Museum Archive FA 002/700].

Deutsches Museum Archive. FA 002/700. Wolfgang Ferrant, G-367, 1945.

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tubes $H_1^!$ $H_2^!$ $H_3^!$ ... The first of these cascade is operated with a frequency of v, and the second with a frequency of 2v. Under this procedure, the higher frequency is produced from the lower by means of frequency-doubling, so that the two cascades vibrate in dependency on one another. The frequency-doubling and the coupling of the cascades is effected in the usual, familiar manner.

V. THE TYPES OF ATOMIC PROCESS

1. Suitable Substances

Our purpose was to produce, within an extensive reaction area which contains a very large number of atoms capable of reacting, a temperature or an almost entirely uncoordinated heat motion, such as prevails on the stars. At the same time, the density of the reacting material should be as great as possible.

Under these circumstances atomic reactions will occur; and these reactions will enjoy the advantage of optimum exploitation of the energies present, since there is no possibility of energy losses from the thrusting atoms, due to the fact that all of the atoms present have as an average the same kinetic energy. Consequently it cannot happen that any of the thrusting atoms of great energy collide continually with particles possessed of lower energy, thus constantly losing energy even if no atomic reactions occur. If the mass within the reaction area is ionized, the thrusting atoms, again, are no longer capable of giving off ionization energy.

Formation of an ionized reaction area presupposes the existence of a fairly large area containing a great number of atoms which likewise are in a condition of thermic movement.

It is worth mentioning, briefly, and by way of contrast, how unfavorable conditions are when the ordinary experimental arrangement is adopted. Thus if α particles, deuterons, or protons are greatly accelerated, and these rays are

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Figure D.631: Excerpts from Wolfgang Ferrant's report G-367 (1945), revealing advanced scientific knowledge of details that are directly applicable to H-bombs [Deutsches Museum Archive FA 002/700].

Deutsches Museum Archive. FA 002/700. Wolfgang Ferrant, G-367, 1945.

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The decision in this matter involves an additional demand we must make upon the reacting mass: the demand that this mass should be ionizable in its totality with the lowest possible expenditure of energy.

2. THE PROBLEM OF KEEPING THE WORK OF IONIZATION AT A MINIMUM

However, the choice is in fact restricted to lithium, the latter being a substance which does not carry more than three enveloping electrons. Moreover, the lithium readily combines with heavy hydrogen to form a hydride: LiD. The compound, that is the lithium D hydride, contains a total of only four electrons, so that the total work of ionization is, at worst, only of small amount.

All aside from other considerations, lithium D hydride is well suited as the choice of substance both for the "large particles" and for the recipient substance, ~~xxxxxxx~~ not only because the heavy hydrogen participates in the atomic reaction, but also because the lithium, likewise, participates. The following reactions are to be anticipated: ${}^2_1D(d,n)^3_2He$; ${}^2_1D(d,p)^3_1H$ and ${}^6_3Li(d,p)^7_3Li$; ${}^6_3Li(d,\alpha)^4_2He$; ${}^7_3Li(d,n)^4_2He$.

There occurs in the reaction area a formation of charged particles α, p, but also a formation of neutrons that can easily split off. Our method, therefore, results directly in the creation of a source of neutrons of greatest intensity.

This method, consequently, has nothing to do, directly, with the splitting of the uranium atom.

Advantage will be taken, of course, of ~~xxx~~ Hahn's discovery; especially when the purpose is to obtain pure energy, and not merely to obtain neutrons and an incidental supply of energy.

If the purpose is to obtain energy alone, the neutrons formed will be utilized in splitting the uranium atom; and in that manner extraordinary amounts of energy will be liberated, as a first product, by way of the neutrons.

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Figure D.632: Excerpts from Wolfgang Ferrant's report G-367 (1945), revealing advanced scientific knowledge of details that are directly applicable to H-bombs [Deutsches Museum Archive FA 002/700].

Deutsches Museum Archive. FA 002/700. Wolfgang Ferrant, G-367, 1945.

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The lithium-D-hydride, recipient, therefore, will be surrounded by a coat of uranium.

Quite possibly a special advantage could be obtained by adding a quantity of uranium D compound to the "large particles" and to the recipient mass; because in this manner a considerable amount of energy will be given off by uranium fragments ~~xxx~~ located within the reaction area, and this state of affairs might possibly result in further increases of temperature within the reaction area. Of course, a tremendous energy is required to obtain complete ionization of the uranium atom. Unfortunately I am unable correctly to estimate at this time whether an admixture of uranium would in the end be profitable or not. 1) Because it might happen that the energies to be expended in complete ionization of the uranium admixture are of such magnitude that temperatures in the reaction area would drop to a point where the reaction could not ~~xxxxxx~~ get under way.

1) To make such forecast, it would be necessary to have on hand the requisite tables and numerical data, such as could be obtained, for instance, from the tables of nuclear physics. But these tables are no longer obtainable. This defect, I hope, will not prove highly detrimental, however, so far as the basic ideas for our method are concerned.

VI **LOCALIZATION OF THE ENERGY**

1. Extent of the Ionized Areas; Walls of the Reaction Area.

It is of the very essence of our method to concentrate the energy upon a small, but not too small area; and this purpose is achieved by making use of the "large particles."

Now the question arises whether a completely ionized reaction area is in any way stable.

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Figure D.633: Excerpts from Wolfgang Ferrant's report G-367 (1945), revealing advanced scientific knowledge of details that are directly applicable to H-bombs [Deutsches Museum Archive FA 002/700].

Deutsches Museum Archive. FA 002/700. Wolfgang Ferrant, G-367, 1945.

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Moreover, the path radii obtained are smaller than the reaction area, so that the localization of energy is actually effected.

4. SELF HEATING

Under this subject it will be necessary to distinguish between two types of cases: Self heating of the reaction area, and self heating in the reaction field outside the reaction area proper.

1) If a very great number of atomic reactions comes about within the reaction area itself, the particles charged as a result of these reactions (α, p) will produce heat within the reaction area, increasing the latter's temperature until the entire material within the reaction area is consumed.

2) The alpha rays and protons of high energy resulting from the atomic reactions will pass through the reaction area, penetrating to the latter's "wall;" and they will penetrate much more deeply than the D and Li atoms, since the alpha rays and protons are much richer in energy.

If the alpha,p particles occur in such large numbers about the environs of the reaction area become ionized and heated, there will be formed an external reaction zone within which atomic reactions may likewise occur. Finally, the outer reaction zone will assume such dimensions that even the alpha rays and protons forming the reactions no longer leave that zone, and are compelled by the magnetic field to move along circular paths. 1)

If an external reaction zone of this nature is developed, there will result an explosion of the entire Li D mass, since the external reaction zone is capable of enlarging itself on the strength of its own energy production.

1) Always understood in large quantities, since particles moving in the direction of the magnetic field strength are capable of leaving the reaction area.

SECRET

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Figure D.634: Excerpts from Wolfgang Ferrant's report G-367 (1945), revealing advanced scientific knowledge of details that are directly applicable to H-bombs [Deutsches Museum Archive FA 002/700].

G-76. G. von Droste. The Absorption Cross Section of Boron and Lithium for Thermal Neutrons. 1941.

Boron absorption cross section = 545 barns. Lithium = 55.6 barns.

G-298. Karl G. Zimmer and Otto Peter. Radiobiological Investigations with Fast Neutrons. 1944.

Biological effects were compared with 180 kV x-ray and Li + D fast neutron total body irradiations on blood, haemopoietic organs and male gonads of rats. Fast neutrons cause noticeable radiation injuries with much smaller dosages than x rays. Effects of intensity of radiation could not be detected in the range of fast neutrons investigated. Secondary radiation injuries in the blood were found for prolonged periods after radiation and speedy recovery after irradiation with neutrons cannot be expected. Urgency of further investigations and determinations of tolerance dosages are emphasized in the interest of personnel working in nuclear physics installations.

G-387. Siemens & Halske Corporation. Cost Estimates for the 1000 kV Neutron Generator for the University of Vienna. 1941–1942.

Blueprints, photographs, and cost estimates for a neutron generator for the Institute of Radioactivity Research of the University of Vienna are included in this report.

Research Work Undertaken by the German Universities and Technical High Schools for the Bevollmaechtigter fuer Hochfrequenztechnik; Independent Research on Associated Subjects [CIOS XXXI-2 p. 74]

[...]

II. PROF. SIZOO of the VRIJE UNIVERSITEIT AMSTERDAM supplied the following information regarding BÖTTCHER:

BÖTTCHER'S early work was on light alloys and he had been making X ray investigations. PROF. VON STOKAR, the former German head of Education in APELDOORN had told Prof. SIZOO that BÖTTCHER was working in Holland because a very important institute in Germany had been bombed (thought to be an S.S. institute) and BÖTTCHER apparently had great plans for rebuilding this institute in Doetinchem. STOKAR also said that BÖTTCHER was working under the auspices of a research organization controlled by GÖRING. When asked about the nature of the work, STOKAR would give very little information but did say to Prof. SIZOO "Das hängt mit neuem Waffen zusammen" (It has to do with new weapons). When asked by Prof. SIZOO why his Neutron generator must be taken by BÖTTCHER, STOKAR had inferred that the Germans were getting as many of these generators as they could; he also said that the installation of Prof. JOLIOT in PARIS (Mme. Curie Laboratory) was being used by the Germans, mentioned installations in COLOGNE and BERLIN and also said that two Neutron generators working with 1,000,000 Volts had been made in HAMBURG (MÜLLER factory) but one of them had been destroyed. Prof. SIZOO was impressed by the fact that STOKAR—a classical scholar—should know so much about the distribution of these equipments in Europe, and concluded that the S.S. placed high importance on obtaining Neutron generators.

[...] It was suggested by Prof. SIZOO that information regarding the attitude of the S.S. to the subject generally and also further information on what has been done in producing NEUTRON and CYCLOTRON generators could be obtained from the former Chief of the Röntgen dept. of PHILIPS, Dr. BOUWERS now with the OPTISCHE INDUSTRIE, OUDE DELFT.

DATE OF ASSESSMENT 14 May 1945.

ASSESSOR'S (NAME'S) F.W. Trenouth, Capt. REME. Army Group 21.

[See document photo on p. 4353.]

CIOS XXXI-2 p. 74

CONFIDENTIAL

PROF.SIZOO of the VRIJE UNIVERSITEIT AMSTERDAM
(Laressestraat 174)
Had to provide a Neutron Generator.

II. PROF. SIZOO of the VRIJE UNIVERSITEIT AMSTERDAM supplied the following information regarding BUTCHER:

BUTCHER'S early work was on light alloys and he had been making X ray investigations. PROF. VON STOKAR, the former German head of Education in APELDOORN had told Prof. SIZOO that BUTCHER was working in Holland because a very important institute in Germany had been bombed (thought to be an S.S. institute) and BUTCHER apparently had great plans for rebuilding this institute in Doetinchem. STOKAR also said that BUTCHER was working under the auspices of a research organisation controlled by GORING. When asked about the nature of the work, STOKAR would give very little information but did say to Prof. SIZOO "Das hangt mit neuem Waffen zusammen" (It has to do with new weapons). When asked by Prof. SIZOO why his Neutron generator must be taken by BUTCHER, STOKAR had inferred that the Germans were getting as many of these generators as they could; he also said that the installation of Prof. JOLIOT in PARIS (Mme. Curie Laboratory) was being used by the Germans, mentioned installations in COLOGNE and BERLIN and also said that two Neutron generators working with 1,000,000 Volts had been made in HAMBURG (MULLER factory) but one of them had been destroyed. Prof. SIZOO was impressed by the fact that STOKAR - a classical scholar - should know so much about the distribution of these equipments in Europe, and concluded that the S.S. placed high importance on obtaining Neutron generators.

Prof. SIZOO'S own opinion on the subject generally was that neither the German nor Dutch expert scientists considered the discovering of a powerful new weapon using atomic energy likely in the near future, but that the German S.S. had great faith in such a discovery eventually, thence they were trying to promote the maximum of research work in this direction. The propaganda value of the investigations was also probably very high in certain circles in Germany. Prof. SIZOO had not a very high opinion of BUTCHER'S capabilities and was certain that he had not achieved any measure of success either at LEIDEN or DOETINCHEM. It was suggested by Prof. SIZOO that information regarding the attitude of the S.S. to the subject generally and also further information on what has been done in producing NEUTRON and CYCLOTRAN generators could be obtained from the former Chief of the Rontgen dept. of PHILIPS, Dr. BOUWERS now with the OPTISCHE INDUSTRIE, OUDE DELFT.

DATE OF ASSESSMENT 14 May 1945.

ASSESSOR'S (NAME'S) F.W. Trenouth, Capt. REME. Army Group 21.

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Figure D.635: Research Work Undertaken by the German Universities and Technical High Schools for the Bevollmaechtigter fuer Hochfrequenztechnik; Independent Research on Associated Subjects [CIOS XXXI-2 p. 74]

Visit to Eindhoven, Holland, October 1944 [CIOS X-13 Appendix B]

Developments in Germany of Radiological Apparatus and Applications

Very little real information was known at Philips, Eindhoven, Holland, or in German occupied countries but the following points were notes as being potentially interesting: [...]

3. Dr. Böttcher, Research Station at Doetinchem, Holland, is stated to have collected ultra-high voltage X-ray apparatus up to 5 million volts.

4. F. Kirchner (Köln) is reported to have built a 5 million volt Van de Graaff machine.

5. Mattauch & Hahn, Kaiser Wilhelm Institut (Berlin-Dahlem) are said to have built similar machines.

The same Institute is reputed to have in operation a 2 million volt Müller Cascade generator.

6. K.W. Institut für Hirnforschung (Berlin Buch)

Dr. Karl Zimmer is known to have been working on a neutron generator of 600 k.v. and in one of his laboratories there was seen in July, 1943, a few boxes (20 x 30 x 30 cms) filled with Uranium.

It is not known whether any work was done on the separation of isotopes of Uranium.

7. Dr. W. Heisenberg, Siemens, Berlin Dahlem, said to have built special H.T. plant.

8. Dr. W. Bothe, Heidelberg & Dr. G. Herk, Siemens-Gesellschaft said to be operating several cyclotrons.

9. Dr. K. Clusius, Breslau, said to be engaged on the problem of separating isotopes of Uranium.

[See document photos on p. 4355.]

CIOS X-13 Appendix B

Appendix B

Armament Research Dept.
Halstead Place,
Halstead,
Nr.Sevenoaks, Kent.

Developments in Germany of Radiological Apparatus and Applications

Very little real information was known at Philips, Eindhoven, Holland, or in German occupied countries but the following points were notes as being potentially interesting:-

1. The Broere Foundry, situated in Amsterdam opposite the Blookers Cocoa Factory, Omval, had X-ray industrial equipment delivered early last year on the very highest priority. It was thought to be in connection with V 2 projectiles.

Similar apparatus was delivered to Warsitz Werke, Valckenierstraat 69-87. Amsterdam.

2. Ruhrstahl., Annen., Witten-Armen (Ruhr) Commisair Lindner is stated to have special X-ray plant for the examination of V 2 parts.

3. Dr. Böttcher, Research Station at Doetinchem, Holland, is stated to have collected ultra-high voltage X-ray apparatus up to 5 million volts.

4. F. Kirchner (Köln) is reported to have built a 5 million volt Van de Graaff machine.

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9. Dr. K. Clisius, Breslau, said to be engaged on the problem of separating isotopes of Uranium.

Figure D.636: Visit to Eindhoven, Holland, October 1944 [CIOS X-13 Appendix B]

CIOS XXVIII-31. *Investigation of the X-Ray Industry in Germany.* [See document photos on pp. 3991–4004.]

During the past two years, C. H. F. Müller has constructed and delivered five "neutron generators". Three of these were rated at 1.5 megavolts, one at 1.2 megavolts, and one at .9 megavolts. They have on order, but have not yet completed, one additional neutron generator rated at .9 megavolts and another rated at 2.4 megavolts. These "neutron generators", or "deuteron accelerators", accelerate ionized heavy hydrogen against a beryllium or a lithium target. The neutron output at .9 megavolts when using a beryllium target was estimated to be equivalent to the neutron output of 2 kilograms of radium plus beryllium [$3.0 \cdot 10^{10}$ neutrons/sec]; when using a lithium target, 3 kilograms [$4.6 \cdot 10^{10}$ neutrons/sec]; when using a beryllium target at 1.5 megavolts, 13 kilograms [$2.0 \cdot 10^{11}$ neutrons/sec]; when using a lithium target, 8 kilograms [$1.2 \cdot 10^{11}$ neutrons/sec].

The Phillips "cascade" circuit was used for these neutron generators. Although the electrical output of these generators could be as high as 5 ma., the ion source limited this equipment to 0.8 ma. for continuous operation, regardless of the voltage.

CIOS ER 63. [AFHRA folder 506.6202 Nr. 1–99 20 Apr–13 Jun 1945, IRIS 207658; AFHRA A5189 frames 0708–0709] [See document photo on p. 4357.]

INTERROGATION OF DR. HANS RITZ

MANAGING DIRECTOR OF C.H.F. MÜLLER AT RÖNTGENSTRASSE,

FUHLSBÜTTEL, HAMBURG

May 11, 1945

In November and December 1945, Ritz was experimenting in the manufacture of infra red tubes to be installed in a mobile set for use by the Wehrmacht. Though all three services were probably interested in his production Ritz came into contact only with the army. He was working in conjunction with the firm of A.E.G. Berlin and delivered to them and to the Wehrmacht itself. His factory is located in Greiz, Thüringen. [...]

The firm also has a factory at Freiburg in Schlesien.

Ritz also proudly stated that he had been engaged on research work connected with splitting the atom and hinted that this was far enough advanced for the Europeans to combine forces and develop this "terrific" potential energy for use in any future war with the Asiatics. The subject was not pursued owing to the complete lack of knowledge on the part of the interrogator.

Robert R. Furman to John Lansdale Jr. and Francis J. Smith. 7 June 1945. [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA] [See photo p. 4358.]

1. The interrogation of Dr. Hans Ritz revealed that Ritz was experimenting in the manufacture of infra-red tubes which was his main scientific research project. However, the following is quoted from a CIOS report of 11 May 1945 made by S. Wheeler, Captain, R. M. (It should be recalled that Müller had a small tonnage of U_3O_8). [...]

~~C O N F I D E N T I A~~ L

INTERROGATION OF DR. HANS RITZ

MANAGING DIRECTOR OF C.F.H. MULLER AT RONTGENSTRASSE,

FUHLSBUTTEL, HAMBURG

May 11, 1945

In November and December 1944, Ritz was experimenting in the manufacture of infra red tubes to be installed in a mobile set for use by the Wehrmacht. Though all three services were probably interested in his production Ritz came into contact only with the army. He was working in conjunction with the firm of A.E.G. Berlin and delivered to them and to the Wehrmacht itself. His factory is located in Greiz, Thuringen. In December he returned to Hamburg and remained in touch with Griez which carried on production until, he thinks, about April when our bombing of communications virtually paralysed it.

Ritz would at first not commit himself on the use of his infra red tubes, insisting that they could be built in to almost any kind of set and stating that his job was merely to produce them. Eventually however, he became so keen to show how advanced this type of research in Germany had become that he gave his opinion on their application. Stressing the compactness of the set whose vital part he had produced Ritz explained how tanks blind and tactically useless at night could when fitted with infra red be enabled to "see in the dark" - this by means of an infra red receiver and an infra red searchlight (thelatter either fitted to the tank or vehicle - cf. Leigh Light - or independently operated from a flank cf. "Artificial moonlight".) Ritz gave the impression that this was the actual intention of the Wehrmacht by his eagerness to convince his hearers that with a little more time this might have been a weapon for which, used for example in a night attack at the start of the counter offensive, it would have been difficult to find an immediate antidote. He assumes that if it was never used in action the reason could only be that in order to take full advantage of the element of surprise the German Army had decided to delay its appearance until sufficient had been produced to equip a large number of vehicles. Discussing other applications Ritz mentioned the detection of aircraft and Naval gunnery control at night. The latter cases did not, however, seem to interest him so deeply and it is considered that he was not, so far as his knowledge goes, working on a set destined for use by the Navy.

Range of the set when relying on radiated heat as opposed to "recording" and image illuminated by an infra red lamp is given as 10-15 Kilometers under good conditions. Ritz expressing the hope that the benefits of his work fall into the hands of the Americans and not into those of the Russians, states that the sets must still be available at Greiz (sic)

Production figures he estimates roughly as being between 50-100. A.E.G. Berlin are, according to Ritz, the big infra red people. He recommends Dr. Meyer of Berlin as a man with most expert knowledge of the subject. Kugler the Berlin director, is more the organizer. The firm also has a factory at Freiburg in Schlesien.

Ritz also proudly stated that he had been engaged on research work connected with splitting the atom and hinted that this was far enough advanced for the Europeans to combine forces and develop this "terrific" potential energy for use in any future War with the Asiatics. The subject was not pursued owing to the complete lack of knowledge on the part of the interrogator.

Informant denied all knowledge of export of infra red to Japan. He did not consider it likely that the Germans would part with any new apparatus in this line though admitted that elementary material such as was used by the Italians may well have been sent without his knowledge.

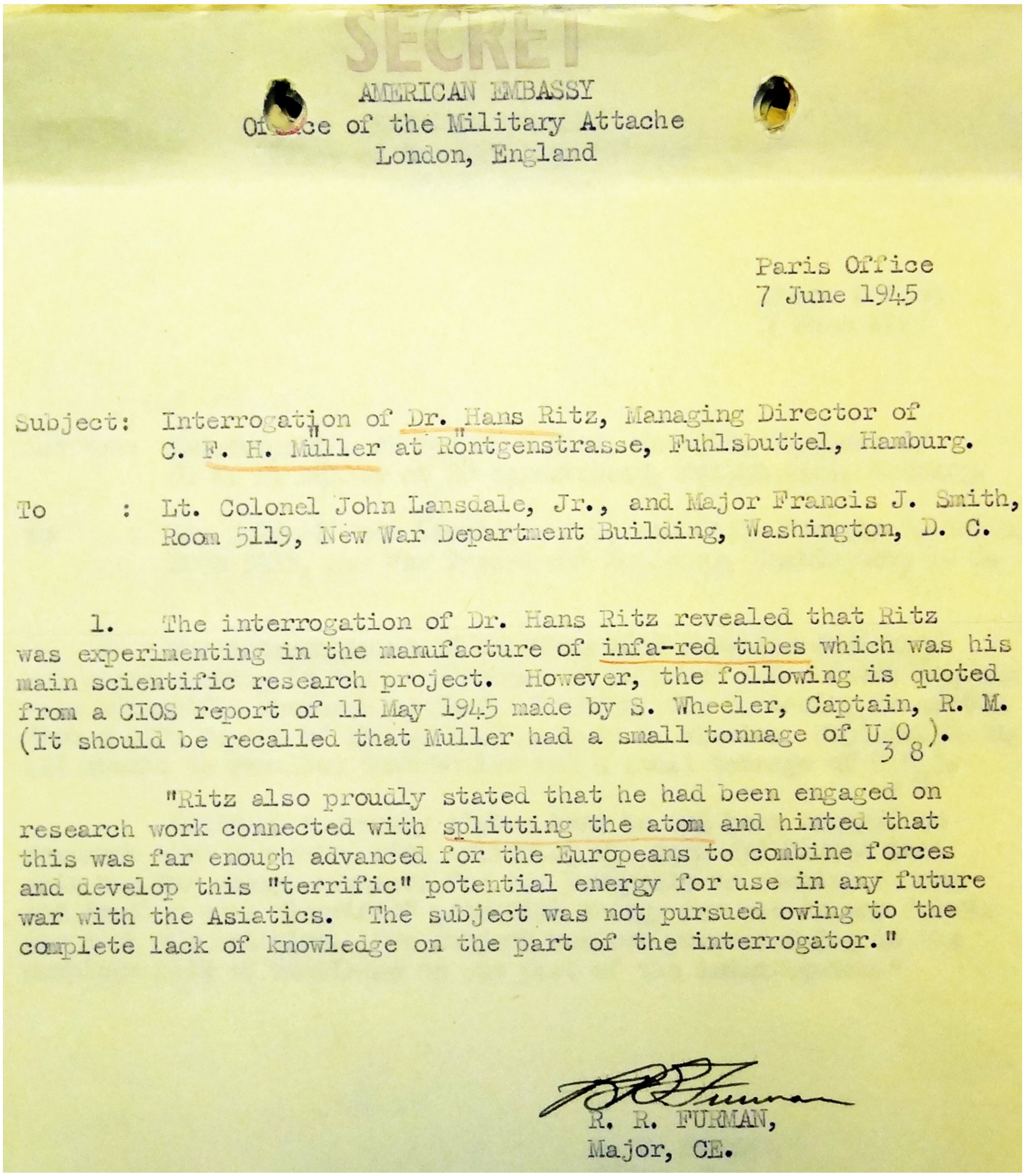
I.O.'s note. Though now inclined to co-operate with British and Americans, Ritz cannot get rid of the idea that by giving us information which we might pass on to the Russians he is stabbing Europe and Civilization in the back. Professes however to have no love for the Japs, so this appears to be the line. Probably has an exaggerated idea of the importance of his work but it is strongly recommended that he be interrogated by an expert. He is at present in custody in the factory at Fuhlsbuttel. If released he will be available at short notice.

(signed)
S. Wheeler, Capt. R.M.

CIOS ER 63, AFHRA folder 506.6202
Nr. 1-99 20 Apr--13 Jun 1945, IRIS 207658

Figure D.637: Dr. Hans Ritz, the managing director of C. H. F. Müller, admitted that the company had been making components suitable for use in nuclear weapons. [CIOS ER 63, AFHRA folder 506.6202 Nr. 1–99 20 Apr–13 Jun 1945, IRIS 207658; AFHRA A5189 frames 0708–0709].

NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Incl. TA



SECRET

AMERICAN EMBASSY
Office of the Military Attache
London, England

Paris Office
7 June 1945

Subject: Interrogation of Dr. Hans Ritz, Managing Director of C. F. H. Müller at Röntgenstrasse, Fuhlsbuttel, Hamburg.

To : Lt. Colonel John Lansdale, Jr., and Major Francis J. Smith, Room 5119, New War Department Building, Washington, D. C.

1. The interrogation of Dr. Hans Ritz revealed that Ritz was experimenting in the manufacture of infa-red tubes which was his main scientific research project. However, the following is quoted from a CIOS report of 11 May 1945 made by S. Wheeler, Captain, R. M. (It should be recalled that Muller had a small tonnage of U_3O_8).

"Ritz also proudly stated that he had been engaged on research work connected with splitting the atom and hinted that this was far enough advanced for the Europeans to combine forces and develop this "terrific" potential energy for use in any future war with the Asiatics. The subject was not pursued owing to the complete lack of knowledge on the part of the interrogator."

R. R. FURMAN,
Major, CE.

Figure D.638: Dr. Hans Ritz, the managing director of C. H. F. Müller, admitted that the company had been making components suitable for use in nuclear weapons. The company also possessed a large amount of uranium. Robert R. Furman to John Lansdale Jr. and Francis J. Smith. 7 June 1945 [NARA RG 77, Entry UD-22A, Box 169, Folder 32.32. Germ. Ind. TA].

I. G. Ludwigshafen
Ammoniaklaboratorium Oppau

An

Herrn

Dr. W i e t z e l ,

Ammon.-Labor.

Ihre Zeichen | Ihre Nachricht vom | Unsere Nachricht vom | Unser Hausruf | Unsere Zeichen | Ludwigshafen a. Rh.

Betreff

Dr. Schä/Me ~~Lu 949~~, den 16.6.43

Der Stand der Neutronenanlage in Lu 949 Anfang Juni 1943 ist folgender :

Die Leistung unserer Neutronenanlage wurde an der Herstellung von künstlich radioaktivem Phosphor $^{32}_{15}P$ geprüft. Vorteilhaft benützt man hierzu folgenden Kernprozess :

$$^{32}_{16}S + ^{1}_{0}n = ^{32}_{15}P + ^{1}_{1}H$$

Für unsere Anlage empfiehlt sich eine Bestrahlung von Schwefel in Form von CS_2 mit den schnellen Neutronen der D – D Reaktion.

$$^{2}_{1}D + ^{2}_{1}D = ^{3}_{2}He + ^{1}_{0}n$$

Dieser Kernprozess wird in dem Neutronenrohr dadurch realisiert, dass man die in einer Kanalstrahlionenquelle erzeugten Deuteronen mit einer Spannung von einigen hundert Kilovolt nachbeschleunigt und den energiereichen, durch Fokussierung gebündelten Deuteronenstrahl auf eine deuteriumhaltige Substanz, in unserem Falle eine dünne Schicht von schwerem Eis, D_2O Target genannt, fallen lässt.

Die freiwerdenden schnellen Neutronen treten aus dem Neutronenrohr aus, treffen die S – Atome des CS_2 und der dabei gebildete, in unwägbarer Menge vorliegende aktive Phosphor kann von dem CS_2 durch bekannte Methoden abgetrennt werden. Die Stärke des gewonnenen aktiven Phosphorpräparates wird mit einem Geiger-Müller-Zählrohr+), das auf die beim radioaktiven Zerfall emittierten Elektronen anspricht, gemessen.

+) Nebenher wurde noch ein Zählrohrverstärker mit Netzanschluss und einem Thyratronkippkreis in der Endstufe gebaut. Die letztere empfahl sich, da das vorhandene mechanische Zählwerk von Willichowsky -Göttingen nur bei Impulsen gleicher Grösse einwandfrei arbeitet, was durch den Kippkreis erreicht wird.

Figure D.639: This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war. [Technical Oil Mission Microfilm 119 (BM-6—Ludwigshaven), Folder LU III-2. https://www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOC_TOM-119.htm]

- 2 -

Beim ^{32}P geschieht der Zerfall mit einer Halbwertzeit von 14,3 Tagen.15 Zuverlässig messbare Bruchteile des angereicherten Präparates, das als Ammoniumphosphat vorlag, wurden auf Streifen Filtrierpapier gebracht und um den Zählrohrmantel gelegt. Die am Zählrohr in der Zeiteinheit gemessenen Ausschläge sind ein Mass für die Stärke des Präparates. Das Zählrohr gestattet Aktivitäten von etwa 5 Elektronen in der Minute noch nachzuweisen.

Bei 1 stündigem Betrieb der Anlage bei 200 KV an der Nachbeschleunigungsstrecke und 200 μA Deuteronenstrom, der, um eine bei elektrischer Messung des Stromes leicht auftretende Täuschung durch Sekundäreffekte zu vermeiden, kalorimetrisch bestimmt wurde, erhielten wir bei Bestrahlung von 0,5 Ltr CS_2 eine Präparatstärke des gebildeten aktiven Phosphors von ca 10^3 Elektronen/min. Durch Bestrahlung von grösseren Mengen CS_2 (5 - 10 Ltr.) könnte man bei 10 stündigem Betrieb Präparate von 10^5 Elektronen/min herstellen.

Es mag hier erwähnt werden, dass bei Verwendung der aktiven Phosphorpräparate als radioaktive Indikatoren manche Untersuchungen mit Präparaten von 10^4 Elektronen/min *) mit Erfolg durchgeführt werden können.

Bei Steigerung der Spannung auf 250 KV ist unter den gleichen sonstigen Bedingungen eine Steigerung der Neutronenausbeute und damit auch der Ausbeute an rad.Phosphor um 60% zu erwarten. Versuche ergaben aber vorläufig nur eine Zunahme von 30%. Dies ist darauf zurückzuführen, dass die mit flüssigem Stickstoff gekühlte D_2O - Schicht, die Belastung mit 50 Watt (250 KV,200 μA) nicht mehr aushält. Durch Verringerung der spezifischen Belastung, also eine Vergrösserung des Brennfleckes ist eine Steigerung der Gesamtbelastbarkeit zu erreichen. Sollte auch dann die Belastbarkeit eines D_2O - Targets nicht hinreichend sein, so empfielt sich die Verwendung eines Targets mit Lithiummetall, der sicher genügend belastbar ist, aber den Nachteil einer geringen Ausbeute bei den in Frage kommenden Spannungen gegenüber einem Target mit schwerem Eis hat. Beim Li-Target wird zur Neutronenerzeugung folgender Kernprozess benützt :

$$^{7}_{3}Li + ^{2}_{1}D = 2\,^{4}_{2}He + ^{1}_{0}n$$

Das Neutronenrohr wurde auch mit 320 KV und 200 μA kurze Zeit betrieben, doch liegen noch keine Ausbeutemessungen vor. Es ist gegenüber 200 KV eine Steigerung der Neutronenausbeute bei einem D_2O - Target um 150% zu erwarten. Bei diesen hohen Spannungen treten infolge der entstehenden Sekundärelektronen harte Röntgenstrahlen in einem Masse auf, sodass ohne geeigneten Schutz gegen diese Strahlung, deren Intensität die Toleranzdosisleistung überschreitet, weitere Versuche bei hohen Spannungen nicht ausgeführt werden können. Daher müsste noch ein hinreichender Schutz in Form von 1 cm dicken Pb - Schirmen angebracht werden.

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*) O.Meyerhof, P.Ohlmeyer, W.Gentner u.H.Maier, Leibnitz, Biochem.ZS. 298, 396-411, 1938 :
Studium der Zwischenreaktionen der Glykolyse mit Hilfe von radioaktivem Phosphor.

Figure D.640: This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war. [Technical Oil Mission Microfilm 119 (BM-6—Ludwigshaven), Folder LU III-2. https://www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOC_TOM-119.htm]

- 3 -

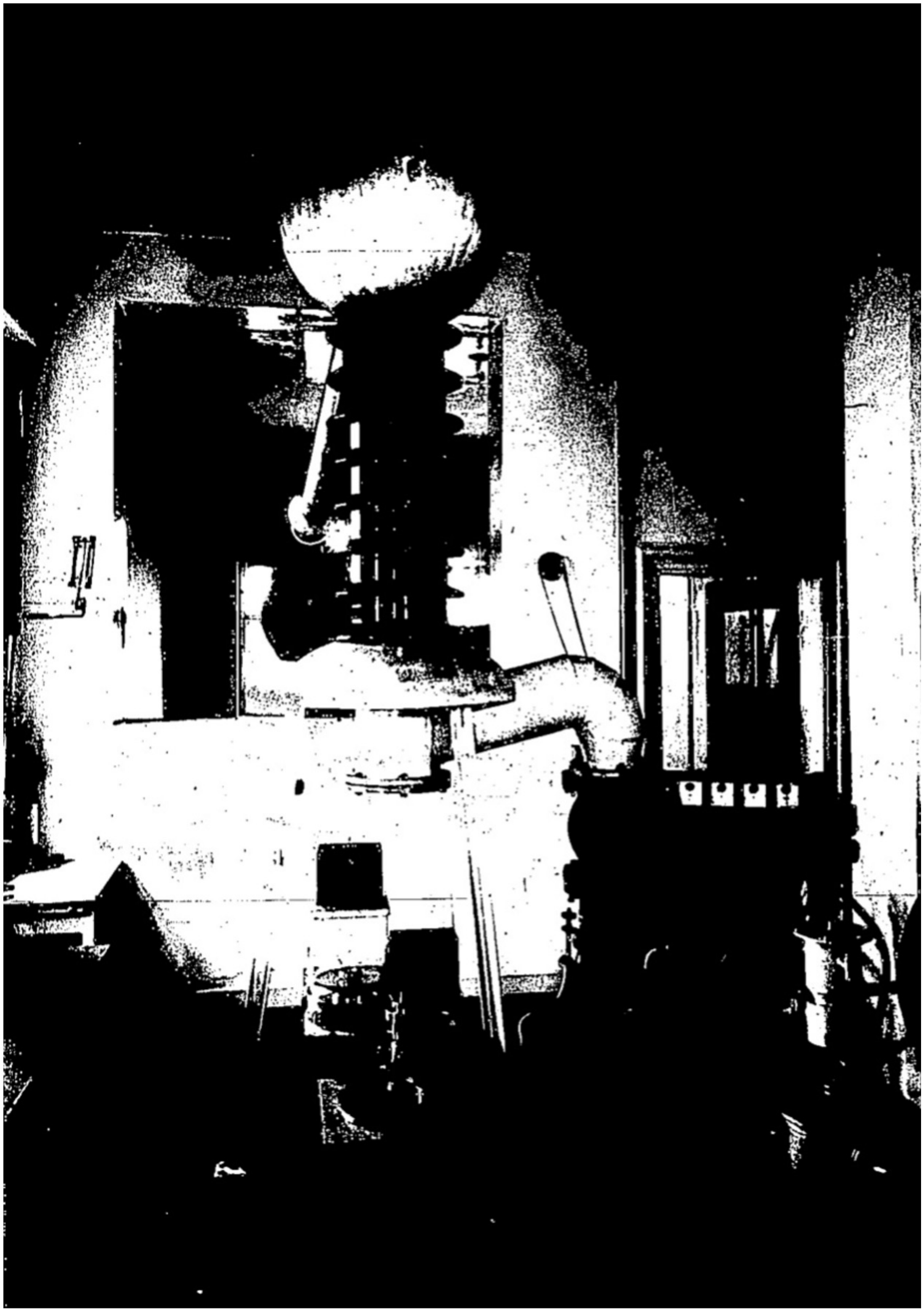
Da zu erwarten ist, dass die Spannung noch über 320 KV hinaus erhöht werden kann und da besonders auch anzunehmen ist, dass sich die Ergiebigkeit der Jonenquelle über 200 μA hinaus steigern lässt, so dürfte eine Steigerung der Leistung des Neutronengenerators um ein Mehrfaches gegenüber dem jetzt schon bei 200 KV und 200 μA erreichten Werten, die einem Rn + Be - Äquivalent von ca 3 Curie (~ 3 gr Radium) entsprechen, zu verwirklichen sein.

Schäfer

Anlagen :

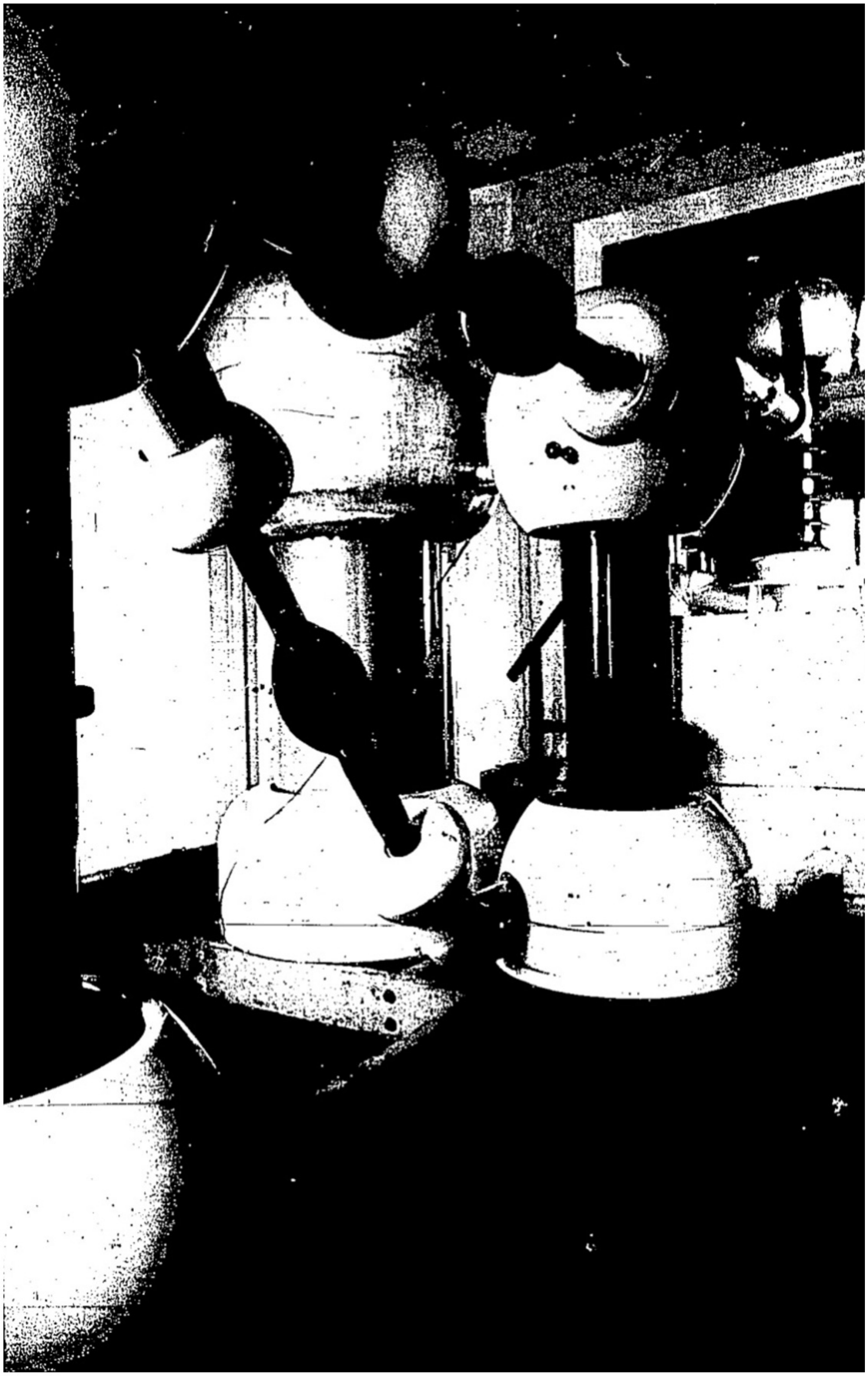
Figure D.641: This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war. [Technical Oil Mission Microfilm 119 (BM-6—Ludwigshaven), Folder LU III-2. https://www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOC_TOM-119.htm]

Technical Oil Mission Microfilm 119 (BM-6 – Ludwigshaven), Folder LU III-2.
www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOM-119-0001-0100.pdf



1.Bild Neutronenrohr.

Figure D.642: This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war. [Technical Oil Mission Microfilm 119 (BM-6—Ludwigshaven), Folder LU III-2. https://www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOC_TOM-119.htm]



2. Bild Kaskadengenerator von
Siemens & Halske 400 KV, 5m A.

Figure D.643: This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war. [Technical Oil Mission Microfilm 119 (BM-6—Ludwigshaven), Folder LU III-2. https://www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOC_TOM-119.htm]

Technical Oil Mission Microfilm 119 (BM-6 – Ludwigshaven), Folder LU III-2.
www.fischer-tropsch.org/Tom%20Reels/Linked/TOM-119-0001-0100.pdf

5. Bild. Jsoliergenerator 60 KV
30 m A auf 400 KV isoliert.

Figure D.644: This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war. [Technical Oil Mission Microfilm 119 (BM-6—Ludwigshaven), Folder LU III-2. https://www.fischer-tropsch.org/Tom%20Reels/Linked/TOM%20119%20Partial/TOC_TOM-119.htm]

Fritz Houtermans. Letter to Werner Czulius. 28 November 1944. AMPG, I. Abt. Rep. 34, Nr. 53, Bl. 1–2 [Nagel 2012a, pp. 639–640].

[...] Das beste ist zweifellos möglichst weit hinaus zu messen und mit 0,105 oder 0,106 zu extrapolieren. Den Bakkerschen Wert halte ich für zu niedrig. Ich sprach auch mit Bothe kürzlich über die Frage, wie weit, sich der Abfall von $A_c r^2$ bei grossen Entfernungen durch eine Exponentialfunktion approximieren lässt, und er sagte mir, dass er durch Rechnung gefunden habe, dass sich bei komplexem Spektrum schliesslich ein Wert von B einstellt, der wohl durch die freie Weglänge der schnellsten Neutronen bedingt isst, aber nur sehr langsam, d.h. bei sehr grossen Entfernungen. Es ist eben wie immer bei mehreren Exponentialfunktionen, z.B. beim radioaktiven Zerfall von 2 Körpern mit kurzer und langer H.W. Zeit, nur meinte er, es gehe hier noch langsamer. Welchen Wert sie für die Fluoridquelle nehmen sollen, weiss ich nicht, denn ich habe mit einer solchen Quelle nicht gearbeitet. Wenn Sie es nicht selbst messen können, würde ich aus den Tuve-Hafsad-Werten künstlicher Quellen einen aussuchen der einem primären Neutronenspektrum mit ungefähr ähnlicher oberer Grenze (ich glaube D+D, nach vorne, käme ungefähr hin) entspricht bezw. extrapolieren. Für Li + D haben wir 1/B = 10,8 cm gefunden, auch nach vorne, also ziemlich dasselbe, wie für Ra+Be, woraus man sieht, dass die Energieabhangigkeit nicht sehr viel ausmacht. Man wird also sicher auch für CaF_2 mit einem geeigneten interpolierten Wert rechnen dürfen. [...]

[...] The best is undoubtedly to measure as far as possible and to extrapolate it with 0.105 or 0.106. Bakker's value I think is too low. I also talked with Bothe about the question of how far the decay of $A_c r^2$ can be approximated by an exponential function at great distances, and he told me that for a complex spectrum he had calculated a value of B, which is probably due to the free path of the fastest neutrons, but only very slowly, i. e. at very great distances. It is just as always with several exponential functions, e.g. in the radioactive decay of two bodies with short and long half lives, he just meant, it was slower. I do not know which value you should take for the source of fluoride, because I have not worked with such a source. If you cannot measure it yourself, I have chosen one from the Tuve-Hafsad values of artificial sources which extrapolating corresponds to a primary neutron spectrum with a similar upper limit (I believe D+D, forward, approximately). For Li + D, we have found 1/B = 10.8 cm, also forward, which is quite the same as for Ra+Be, which shows that the energy dependence does not matter very much. Thus, CaF_2 may also be expected to have a suitable interpolated value. [...]

[This document demonstrates that scientists in Germany had been routinely using deuterium + deuterium and lithium + deuterium fusion reactions (in high-voltage tubes) as neutron sources for experiments during the war; they are casually mentioned alongside a much more conventional radium+beryllium neutron source. For producing neutrons, the lithium reaction would have been lithium-7 + deuterium → neutron + 2 helium-4 (alpha) particles.

A high-voltage tube containing such fusion fuel would make a good neutron initiator in a fission bomb and is apparently described in Ilyichev's March 1945 intelligence report on a German fission implosion bomb design; see pp. 4529 and 5203.

From unclassified references on nuclear weapons designs, lithium deuteride makes excellent fusion fuel in H bombs or can be used at the center of a fission bomb to provide a fusion neutron boost to greatly increase the fission efficiency and explosive yield.]

Dr.Georg Stetter
Wien 66
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zu 2/1

G-378

20839

Technische Energiegewinnung mit Hilfe
von Kernreaktionen.

Die bei Kernprozessen,also Zertrümmerungen und Umwandlungen von Atomkernen,umgesetzten Energiebeträge sind,wie bekannt, meist um mehrere Zehnerpotenzen höher als bei gewöhnlichen chemischen Prozessen,bei denen nur die Atomhülle ins Spiel kommt.

Kernprozesse wurden jedoch bisher nur als Einzelereignisse beobachtet und benützt;auch bei Verwendung starker Strahlenquellen kann die Zahl der beteiligten Atomkerne noch als abzählbar gelten. Eine technische Anwendung,also etwa unter Umsetzung wägbarer Substanzmengen,erfolgte nicht,u.zw.aus folgendem Grunde:auch für hoch exotherme Prozesse ist zu ihrer Einleitung eine so hohe,bzw.so hochwertige Energie,z.B.in Form höchstbeschleunigter Kanalstrahlen, erforderlich und andererseits die Wahrscheinlichkeit,daß im Einzelfall die gewünschte Kernreaktion nun wirklich eintritt,so gering,daß das Verfahren damit höchst unökonomisch wird.

Der Grundgedanke der in dieser Patentschrift gegebenen Anweisungen ist nun der,den Ablauf so zu leiten,daß die bei dem Einzelprozess auftretenden Vorgänge selbst benützt werden,weitere, etwa die gleichen Prozesse,auszulösen,so daß die ursprünglich von außen zugeführte Energie nur ähnlich wie eine Initialzündung wirken braucht.

2

Dabei genügt es nicht,daß bei dem ~~dem~~ benützten Einzelprozess ein oder gar mehrere zu weiteren"Zertrümmerungen" befähigte Teilchen ausgesandt werden - solche Fälle sind an sich bekannt -,sondern die Anordnung muß so getroffen sein,daß diese "Zertrümmerung auch wirklich zustande kommt,genauer gesagt,die gesamte,für eine bestimmte Anordnung geltende Wahrscheinlichkeit,daß auf jeden Einzelprozess ein weiterer folgt,muß von der Größenordnung 1 sein.

In der Durchführung haben wir im wesentlichen zu unterscheiden zwischen der Auslösung von Kernreaktionen durch ionisierende, das sind rasch bewegte geladene Teilchen,und der analogen Wirkung von (ungeladenen) Neutronen.Im ersten Falle kommt es darauf an,den bei der Ionisierung eintretenden Energieverlust zu vermeiden,das heißt,die gesamte von den Einzelteilchen abgegebene Energie muß dem System erhalten bleiben,um als Geschwindigkeit anderer Teilchen (Kerne),zumindest inder Hauptsache,für weitere Kernreaktionen ausgenützt zu werden.Dies wird ermöglicht durch höchste räumliche und zeitliche Konzentration des Vorganges;derselbe muß also auf kleinem Volumen und annähernd adiabatisch geführt werden,weil die sich einstellende sehr hohe Temperatur nur auf ganz kurze Zeit bestehen kann.Als Beispiel wird eine Hochspannungskondensatorentladung durch hochkomprimiertes Deuteriumgas genannt:energiereiche,kurzzeitige Entladung (etwa Stoßspannung von 1 Million Volt),kleine Elektroden von geringer Wärmekapazität,allenfalls auch aus zertrümmerbarem Material,Entladevolumen von einigen mm Ausdehnung bei solchem Druck,daß sich die entstehenden ionisierenden Teilchen (H^1,H^3,He^3) praktisch totlaufen.Die Anordnung ergibt eine Explosion von enormer Energieentwicklung;ein langsames Abbrennen ist allerdings nicht möglich,weil,wie schon angedeutet,Temperaturen, bei denen diese Reaktionen noch ausreichend eintreten,nicht auf längere Zeiten aufrechterhalten werden können.

Figure D.645: G-378. Georg Stetter. Technische Energiegewinnung mit Hilfe von Kernreaktionen. FA 002/0762. Deutsches Museum Archive, Munich. https://digital.deutsches-museum.de/item/FA-002-762/

3

An eine erweiterte Technische Anwendung wäre etwa durch periodisch aufeinander folgende Explosionen zu denken.

Bei den Neutronen liegt die Sache insofern anders, als diese Teilchen praktisch nicht ionisieren und daher auch auf diesem Wege keinen Energieverlust erleiden: ihre (kinetische und Massen-) Energie kommt also auch ohne besondere Maßnahmen schließlich einem neuen Kernprozeß zu gute. Andererseits ist eben wegen der mangelnden Bremsung ihre ~~XXXXXXXX~~ Reichweite so groß, daß das System (die Substanzmenge) außerordentlich groß genommen werden müßte, damit die jeweilig erzeugten Teilchen sich wenigstens in der Hauptsache darin totlaufen. Man kommt hier zu einer Verwirklichung des einleitend genannten Grundgedankens, indem man Substanzen auswählt, die einen möglichst großen Wirkungsquerschnitt für Neutronen haben; danun der Wirkungsquerschnitt für die verschiedenen Isotope eines Elementes ganz verschieden ist, hat man ein geeignetes Isotop aufzusuchen und dieses oder doch eine mit diesem Isotop angereicherte Substanz zu benützen. Ferner wird man vorzugsweise langsame (thermische) Neutronen verwenden, da man diese leichter durch geeignete Substanzen streuen, also durch Rückdiffusion immer wieder mit der reagierenden Substanz in Kontakt bringen kann. Solche Vorgänge kann man auch steuern (also langsam "abbrennen"), sei es durch Nähern oder Entfernen des streuenden Materials, sei es durch Beimengung absorbierender (aber keine Neutronen liefernder !) Substanzen; schließlich auch dadurch, daß man den oben erwähnten, durch die geometrische Anordnung bedingten Wahrscheinlichkeitsfaktor um ein Geringes kleiner als 1 wählt: die erzeugte Energie ist dann einfach proportional der Initialenergie, also etwa der von einem Radium-Berylliumpräparat gelieferten Neutronenmenge. Beispiel: Eine dünne Platte aus dem Uranisotop 235, beiderseits bedeckt von dickeren Paraffinplatten oder etwa gleich von dem Wasser eines zu heizenden

4

Dampfkessels, bestrahlt mit Radium-Be-Neutronen, bildet einen Heizkörper von ungeheurem Wärmevorrat. Der Gefahr einer Explosion kann hier schon durch die Verwendung der langsamen Neutronen vorgebeugt werden, da bei entsprechender geometrischer Anordnung der oben erwähnte Wahrscheinlichkeitsfaktor bei einer bestimmten Temperatur unter seinen kritischen Wert sinkt, so daß man geradezu auf eine bestimmte Temperatur einstellen kann.

Die Verwendung eines reinen oder doch im Verhältnis angereicherten Isotops ist schon deshalb notwendig, weil sonst die anderen Isotope die Neutronen wegfangen würden, ohne neutronenliefernden Prozeß - der weitaus häufigere Fall. Damit wär aber ein Erfolg unmöglich.

Patent-Ansprüche:

1.) Technische Energiegewinnung mit Hilfe von Atomkern-Reaktionen, dadurch gekennzeichnet, daß die räumliche Konzentration von an den Reaktionen beteiligten Atomen so gewählt wird, daß die bei dem Einzelprozeß auftretenden Vorgänge imstande sind, weitere gleich oder ähnliche Prozesse auszulösen, so daß die Kernenergie von wägbaren Substanzmengen frei wird.

2.) Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die geometrischen Abmessungen so bestimmt werden, daß die bei der Reaktion entstehenden Teilchen ihre Energie möglichst vollständig in dem vorgezeichneten Volumen abgeben.

3.) Verfahren nach Anspruch 1 und 2, dadurch gekennzeichnet, daß ein hochkomprimiertes Gas oder eine feste Substanz, beide aus leicht reagierenden Bestandteilen, verwendet werden.

4.) Verfahren nach Anspruch 1 bis 3, dadurch gekennzeichnet, daß eine hohe zeitliche Konzentration des Prozesses angewendet wird, etwa durch eine hochkondensierte elektrische Entladung, mit dem Ziele, kurzzeitig eine so hohe Temperatur zu erzeugen, daß die Reaktion von selbst bis zu Ende abläuft.

5.) Verfahren nach Anspruch 1 und 2, gegebenenfalls auch 3 und 4, dadurch gekennzeichnet, daß isotopenreine oder doch mit den wirksamen Isotopen angereicherte Substanzen verwendet werden.

6.) Verfahren nach Anspruch 1 und 2, gegebenenfalls 3 und 5, dadurch gekennzeichnet, daß neutronenstreuende und/oder absorbierende Substanzen in einstellbarer geometrischer Anordnung zur Steuerung des Reaktionsablaufes um die reagierenden Körper angeordnet sind.

7.) Abgeändertes Verfahren nach Anspruch 6, dadurch gekennzeichnet, daß neutronen-streuende, verlangsamende, oder absorbierende Substanzen den reagierenden Körpern beigemischt werden.

Figure D.646: G-378. Georg Stetter. Technische Energiegewinnung mit Hilfe von Kernreaktionen. FA 002/0762. Deutsches Museum Archive, Munich. https://digital.deutsches-museum.de/item/FA-002-762/

G-378. Georg Stetter. Technische Energiegewinnung mit Hilfe von Kernreaktionen. FA 002/0762. Deutsches Museum Archive, Munich. https://digital.deutsches-museum.de/item/FA-002-762/ This early 1939 draft of a patent application covered both fusion and fission reactions. A key section on fusion is given below. In reviewing this patent draft, Karl Wirtz raised concerns that the fusion claims were too similar to Brasch and Lange's German Patent 662036 [AMPG 34/29]. The final patent application deleted the fusion claims and polished the fission claims (see p. 3390). Stetter and his fellow researchers were heavily involved in both the wartime fission and fusion programs (pp. 3390–3393, 4368–4383, 4834–4846, 5038). [See document photos on pp. 4366–4367.]

In der Durchführung haben wir im wesentlichen zu unterscheiden zwischen den Auslösung von Kernreaktionen durch ionisierende, das sind rasch bewegte geladene Teilchen, und der analogen Wirkung von (ungeladenen) Neutronen. Im ersten Falle kommt es darauf an, den bei der Ionisierung eintretenden Energieverlust zu vermeiden, das heißt, die gesamte von den Einzelteilchen abgegebene Energie muß dem System erhalten bleiben, um als Geschwindigkeit anderer Teilchen (Kerne), zumindest in der Hauptsache, für weitere Kernreaktionen ausgenützt zu werden. Dies wird ermöglicht durch höchste räumliche und zeitliche Konzentrationen des Vorganges; derselbe muß also auf kleinem Volumen und annähernd adiabatisch geführt werden, weil die sich einstellende sehr hohe Temperatur nur auf ganz kurze Zeit bestehen kann. Als Beispiel wird eine Hochspannungskondensatorentladung durch hochkomprimiertes Deuteriumgas genannt: energiereiche, kurzzeitige Entladung (etwa Stoßspannung von 1 Million Volt), kleine Elektroden von geringer Wärmekapazität, allenfalls auch aus zertrümmerbarem Material, Entladevolumen von einigen mm Ausdehnung bei solchem Druck, daß sich die entstehenden ionisierenden Teilchen (H^1, H^3, He^3) praktisch totlaufen. Die Anordnung ergibt eine Explosion von enormer Energieentwicklung; ein langsames Abbrennen ist allerdings nicht möglich, weil, wie schon angedeutet, Temperaturen, bei denen diese Reaktionen noch ausreichend eintreten, nicht auf längere Zeiten aufrechterhalten werden können.

An eine erweiterte technische Anwendung wäre etwa durch periodisch aufeinander folgende Explosionen zu denken.

In the main we have to differentiate between the induction of nuclear reactions by ionizing, that is rapidly moving charged particles, and the analogous effect of (uncharged) neutrons. In the first case, it is important to avoid the loss of energy occurring during ionization, that is, the total energy released by the individual particles must be retained by the system, as speed of other particles (nuclei), at least in the main, for further nuclear reactions to be exploited. This is made possible by highest spatial and temporal concentrations of the process; the same must therefore be performed on a small volume and approximately adiabatically, because the very high temperature condition can exist only for a very short time. As an example, a high-voltage capacitor discharge by highly compressed deuterium gas is considered: high-energy, short-term discharge (about 1 million volts surge), small electrodes of low heat capacity, if necessary also from fissile material, discharge volume of a few mm expansion at such pressure that the resulting ionizing particles (H^1, H^3, He^3) practically run into each other. The arrangement results in an explosion of tremendous energy development. However, a slow burning off is not possible because, as already indicated, temperatures at which these reactions still sufficiently occur cannot be maintained for longer periods of time.

An advanced technical application would be to think about successive periodical explosions.

Assistant Chief of Staff, G-2, Department of the Army, Washington, DC. Lintner, Karl Rudolf Josef. 6 April 1954. [NARA RG 330, Entry A1-1B, Box 103, Folder Lintner, Karl]

According to information received in Aug 1949 from an untested source, one Dr. Karl LINTNER was assistant to Prof Karl PRZIBAM at the Second Institute of Physics in Vienna. Source declared PRZIBAM to be pro-Russian and believed without being sure that he was in Moscow early 1949. PRZIBAM had been carrying out infra-red research for the Russians. During the war, the nuclear physicists of the Second Institute of Physics in Vienna engaged in a research project of releasing high amounts of energy through nuclear reactions of the lithium hydrite crystal *Li H*. The research was carried out mainly by Dr. Karl LINTNER under the supervision of Prof. Dr. Georg K. F. STETTER. The project failed because according to source, it was impossible to procure strong enough electrodes and equipment sufficiently resistant to heat.

[See document photo on p. 4371.

What lithium and hydrogen isotopes and what reactions did Stetter's group consider? Did they originate the "Jetter cycle" (see p. 4386)?]

Robert A. Snedeker, CIC Sub-Det "C" (Vienna). Agent Report. Dr. Georg Stetter's Patent Concerning Production of Atomic Energy, Technical Intelligence, Vienna. 29 September 1953. [NARA RG 319, Entry A1-134B, Box 749, Folder 23 Nov 95 Georg Stetter XA001081]

On 23 September 1953, Dr. Karl Lintner, Second Physical Institute of the University of Vienna, was interviewed by Informant 1063 and stated the following:

Source [Lintner] was Dr. Georg STETTER's assistant in the Second Physical Institute during World War II, when STETTER was working on the splitting of the lithium nucleus. STETTER intended to have certain processes patented, in connection with splitting nuclei, but Source is unaware of the result of this intention. All of STETTER's research material and notes fell into the hands of the Soviets in 1945 and to Source's knowledge STETTER has not concerned himself with nuclear research since that date. Source considers STETTER the best nuclear physicist in Austria. STETTER, before obtaining a position with the Second Physical Institute, University of Vienna, was affiliate with the United Austrian Iron and Steel Works and the Austrian Nitrogen Works.

[See document photo on p. 4371.

Note that Stetter applied or intended to apply for a patent on his fusion approaches. Was that just the deleted early 1939 patent sections on p. 4368, or did he write additional, more detailed patent drafts? Can any of his group's material be found in Russian archives?]

Air Intelligence Report No. 100-13/1-100, Significant Developments and Trends in Aircraft and Aircraft Engines, Antiaircraft Guided Missiles (15 June 1946). p. 93. NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001–3100.

DECLASSIFIED
Authority NND 765059

g. Heavy Hydrogen Bomb. In Germany a letter was picked up by the American censors. It had been written by a German desirous of exchanging information for an opportunity to go to the United States. The writer professed knowledge of "heavy water" research in Germany and of an "even more deadly weapon than the atomic bomb".

Immigration of Austrian Scientists to Soviet Zone. NARA RG 319, Entry A1-134A, Box 31, Folder 02/006 430.

DECLASSIFIED
Authority NND983021
By SL NARA Date 8/18

K SCHINTLMEISTER, Dr Josef Peter - USSR. Born 18 June 1908. Nuclear physicist. Listed on National Scientific Intelligence Requirements - Nuclear Energy - USSR, 23 July 1947. Reportedly anti-communist and had requested that he brought into contact with British. Released as Chief of Physics Institute because of NSDAP membership. Formerly associated with ORTNER, STETTER, MATTAUCH, CZULIUS and JENTSCHKE. During war, succeeded in isolating Transuranen to Transuranen 104. In summer of 1945, subject with other members of Radium Institute, fled to Thumersbach. In 1946 he accepted Soviet employment and was taken to Moscow. In September 1948 he reportedly contacted JOLIOT CURIE on problems of extracting plutonium. Censorship intercept indicates subject is currently interested in lithium hydride bombs, originally begun with STETTER.

Figure D.647: Examples of postwar U.S. intelligence about wartime work on the German H-bomb [NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001–3100. NARA RG 319, Entry A1-134A, Box 31, Folder 02/006 430.].

Robert A. Snedeker, CIC Sub-Det "C" (Vienna). Agent Report. Dr. Georg Stetter's Patent Concerning Production of Atomic Energy, Technical Intelligence, Vienna. 29 September 1953. NARA RG 319, Entry A1-134B, Box 749, Folder 23 Nov 95 Georg Stetter XA001081.

DECLASSIFIED
Authority NND007017

On 23 September 1953, Dr. Karl Lintner, Second Physical Institute of the University of Vienna, was interviewed by Informant 1063 and stated the following:

Source was Dr. Georg STETTER'S assistant in the Second Physical Institute during World War II, when STETTER was working on the splitting of the lithium nucleus. STETTER intended to have certain processes patented, in connection with splitting nucleii, but Source is unaware of the result of this intention. All of STETTER'S research material and notes fell into the hands of the Soviets in 1945 and to Sources's knowledge STETTER has not concerned himself with nuclear research since that date. Source considers STETTER the best nuclear physicist in Austria. STETTER, before obtaining a position with the Second Physical Institute, University of Vienna, was affiliated with the United Austrian Iron and Steel Works and the Austrian Nitrogen Works.

(F-3)

NARA RG 330, Entry A1-1B, Box 103, Folder Lintner, Karl.

DECLASSIFIED
Authority NND 013039

AGENCY REMARKS

According to information received in Aug 1949 from an untested source, one Dr. Karl LINTNER was assistant to Prof Karl PRZIBAM at the Second Institute of Physics in Vienna. Source declared PRZIBAM to be pro-Russian and believed without being sure that he was in Moscow early 1949. PRZIBAM had been carrying out infra-red research for the Russians. During the war, the nuclear physicists of the Second Institute of Physics in Vienna engaged in a research project of releasing high amounts of energy through nuclear reaction of the lithium hydrite crystal *Li H*. The research was carried out mainly by Dr. Karl LINTNER under the supervision of Prof. Dr. Georg K. F. STETTER. The project failed because according to source, it was impossible to procure strong enough electrodes and equipment sufficiently resistant to heat.

Assistant Chief of Staff, G-2
Department of the Army
Washington 25, D. C.

SIGNATURE

SECRET

6. MOIC-S-4412, dated 11 May 1949, Subject: "Schintlmeister Josef Dr., Nuclear Scientists Currently in the USSR," indicated that SUBJECT collaborated with Prof. Georg Stetter on the problem of releasing the energy or accomplishing the atomic fission of the Lithium Hydrite (LiH) crystal. SUBJECT was listed as an assistant at the University of Vienna, Physics Institute II. His political orientation was uncertain. Information in this report was obtained from Prof. Stetter.

Figure D.648: Examples of postwar U.S. intelligence about wartime work on the German H-bomb [NARA RG 319, Entry A1-134B, Box 749, Folder 23 Nov 95 Georg Stetter XA001081. NARA RG 330, Entry A1-1B, Box 103, Folder Lintner, Karl.].

Russian Department of the Archives of the State Cooperation of Atomic Energy (OOFR), Österreich 2, pp. 302–304, Gutachten von Kokin zur Annotation einer Aussage von Dr. Rober [Kober], 21 August 1945.

Prof. Stetter aus Wien, der sich mit dem Zerfall des Kernes von Lithium-Hydrid [...] beschäftige, hat entdeckt, dass diese Reaktion nicht stabil ist, das heisst, dass sie sich nach dem Anfang automatisch weiter fortsetzt, dabei wird eine ausserordentlich grosse Energie des Kernes freigesetzt, und die ganze Versuchseinrichtung explodiert (Versuch auf dem Erprobungsgelände). Prof. Bethe schätzt diese Reaktion als Quelle der Sonnenenergie ein, außerdem bringt diese Reaktion eine Wende in der Technik der Sprengstoffe, weil die Stärke der Explosion 10^6-mal größer ist als bei Nitroglyzerin. Diese Reaktion wurde in vielen Instituten untersucht, unter Teilnahme der Professoren Gerlach und Tomaschek—in München. Prof. Stetter aus Wien hat eine Theorie entwickelt, dass diese Reaktion bei der Temperatur 10^6 ^{o}C beginnen soll. Falls diese Theorie richtig ist, ist eine Versuchsanlage, die diese Energie zum praktischen Zweck benutzen darf, leicht zu bauen. [...] Dr. Rober [Kober] bittet um Erlaubnis, such damit zu beschäftigen und wies darauf hin, dass AEG schon einige Patente in dieser Frage hat.

Prof. Stetter from Vienna, who is concerned with the disintegration of the nucleus of lithium hydride, has discovered that this reaction is not stable, that is, that it continues automatically after the beginning; exceptionally large energy of the nucleus is released, and the whole experimental facility explodes (experiment at the test site). Prof. Bethe regards this reaction as a source of solar energy. In addition, this reaction brings about a change in the technique of explosives because the strength of the explosion is 10^6 times greater than in the case of nitroglycerin. This reaction was studied in many institutes, with the participation of professors Gerlach and Tomaschek—in Munich. Prof. Stetter from Vienna has developed a theory that this reaction should begin at the temperature of 10^6 ^{o}C. If this theory is correct, a test facility that can use this energy for practical purposes is easy to build. [...] Dr. Rober [Kober] asks permission to do so, and pointed out that AEG has already patented this issue.

[Again, which specific isotopes and reactions were considered? The general description sounds like the autocatalytic Jetter cycle (p. 4386). What experiments were done? What were the “many institutes” that also participated in this research? What exactly did Walther Gerlach and Rudolf Tomaschek do? Kober was known as a radar expert—what if any involvement with nuclear research did he have before or after the war? The existing AEG patent was that of Brasch and Lange (p. 4320).]

Immigration of Austrian Scientists to Soviet Zone. [NARA RG 319, Entry A1-134A, Box 31, Folder 02/006 430]

K SCHINTLMEISTER, Dr Josef Peter—USSR. Born 15 June 1908. Nuclear physicist. Listed on National Scientific Intelligence Requirements—Nuclear Energy—USSR, 23 July 1947. Reportedly anti-communist and had requested that be brought into contact with British. Released as Chief of Physics Institute because of NSDAP membership. Formerly associated with [Gustav] ORTNER, [Georg] STETTER, [Josef] MATTAUCH, [Werner] CZULIUS, and [Willibald] JENTSCHKE. During war, succeeded in isolating Transuranen to Transuranen 104. In summer of 1945, subject with other members of Radium Institute, fled to Thumersbach. In 1946 he accepted Soviet employment and was taken to Moscow. In September 1948 he reportedly contacted JOLIOT CURIE on problem of extracting plutonium. Censorship intercept indicates subject is currently interested in lithium hydride bombs, originally begun with STETTER.

[See document photo on p. 4370.

If Josef Schintlmeister really produced and identified transuranic elements through element 104 during the war, that long predates the recognized historical achievement of that milestone in 1969 in the United States. What evidence is this based on, and can it still be found? If transuranic elements were produced, was that in a cyclotron, a fission reactor, or by other methods?]

Friedrich Berkei. 1944 (probably). Page from laboratory notebook [Karlsch 2005, p. 330].

[This document is shown on the following page. Friedrich Berkei was a member of Kurt Diebner's research group. Virtually all of the rest of Berkei's notes were taken away from him after the war. This surviving page shows an amazingly comprehensive list of fusion reactions.]

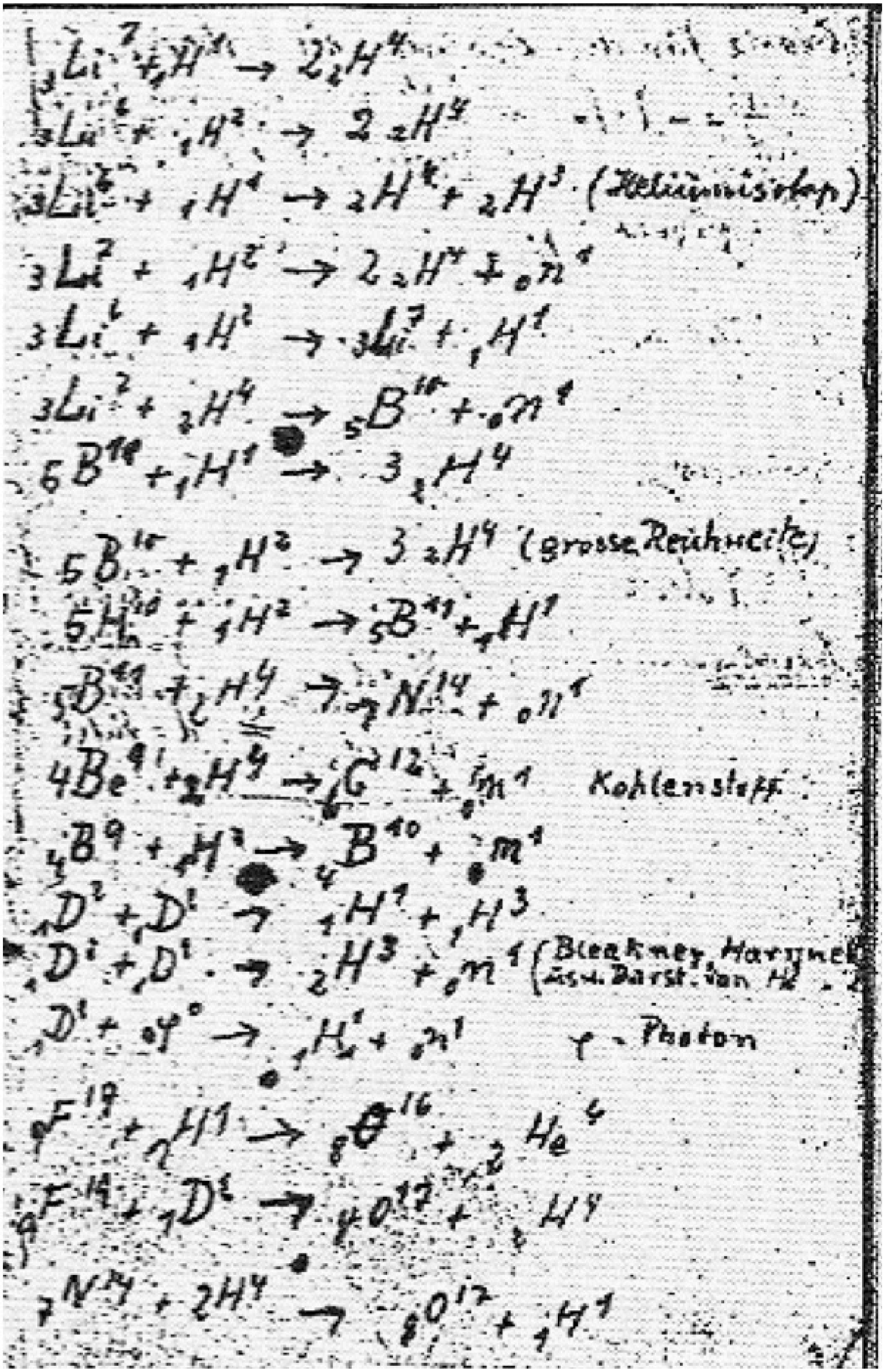


Figure D.649: Friedrich Berkei. 1944 (probably). Page from laboratory notebook systematically listing fusion reactions. [Courtesy of Rainer Karlsch]

Hans Thirring. 1946. *Die Geschichte der Atombombe*. Vienna: Neues Österreich. pp. 130–134, 138–139.

Es liegt deswegen die Idee nahe, ob man nicht die so schwer herstellbaren und deswegen immer nur in geringen Mengen zur Verfügung stehenden Stoffe U-235 and Plutonium in irgendeiner Weise "strecken" könnte, oder ob man nicht die bisherige Atombombe als eine Art "Zündpille" zur Einleitung weiterer Kernprozesse an anderen Stoffen verwenden könnte. [...]

The idea is therefore whether one might not be able in any way to "stretch" the substances U-235 and plutonium, which are so difficult to produce and therefore can only be produced in small quantities, or whether one might not be able to use the original atomic bomb as a kind of "sparkplug" to initiate further nuclear processes in other substances. [...]

Die Energie, die dem gestoßenen Deuteron verliehen wird, beträgt allerdings nur einen kleinen Bruchteil, höchstens etwa 1/25 der Energie des ursprünglichen Sprengstückes, aber diese Energie kann immerhin groß genug sein, damit das getroffene Deuteron, wenn es mit einem anderen Deuteron zusammenstößt, mit diesem die sogenannte d-d-Reaktion ausführt, die durch die Gleichung gegeben ist

The energy given to the destroyed deuteron is, however, only a small fraction, at most about 1/25 of the energy of the original explosive, but this energy can still be large enough for the deuteron to fuse when it collides with another deuteron, in the so-called d-d reaction, which is given by the equation

$$ {}^{2}_{1}\mathrm{H}\,(d,n)\,{}^{3}_{2}\mathrm{He} $$

In Worten ausgedrückt: zwei Deuteronen stoßen zusammen (daher der Name d-d-Reaktion) und vereinigen sich zu dem Heliumisotop ${}^{3}_{2}\mathrm{He}$, während gleichzeitig ein Neutron ausgestoßen wird. [...]

Expressed in words: two deuterons collide (hence the name d-d reaction) and fuse to form the helium isotope ${}^{3}_{2}\mathrm{He}$, while a neutron is simultaneously emitted. [...]

Eine andere Substanz, in der gegebenenfalls auch durch Zündung mittels einer Atombombe ein thermischer Kernkettenprozeß hervorgerufen werden könnte, ist das Lithiumhydrid (LiH), in dem sich bei einer Temperatur von Milliarden Graden der folgende Prozeß abspielen könnte

Another substance, in which a thermal nuclear chain reaction could be induced by an atom bomb, is lithium hydride (LiH), in which the following process can take place at a temperature of billions of degrees

$$ {}^{7}_{3}\mathrm{Li}\,(p,\alpha)\,{}^{4}_{2}\mathrm{He} $$

Die Gleichung bedeutet: Beim Aufprall eines Protons auf einen Lithiumkern $^7_3$Li entsteht ein Zwischenkern der Masse 8 und der Ladung 4, der in zwei mit großer Wucht auseinanderfliegende α-Teilchen zerfällt.

The equation means that when a proton collides with a lithium nucleus $^7_3$Li, an intermediate nucleus of mass 8 and charge 4 is formed, which breaks up into two alpha particles which separate with great energy.

[...] die Energie, die man durch Bildung von Helium aus LiH gewinnen kann, fast dreimal so groß wie die bei der Kernspaltung aus der gleichen Menge von U-235 erzeugte. Dabei ist nun Lithium ein gar nicht so seltenes Element, so daß man in einer "Superatombombe" ungefähr ebensoviel Tonnen Lithiumhydrid verwenden könnte, als man jetzt Kilogramm Plutonium verwendet, derart, daß sich eine Wirkung ergäbe, die wiederum einige tausendmal gegenüber der bisher bekannten gesteigert werden könnte. Gott gnade jenem Lande, über dem eine Sechstonnenbombe von Lithiumhydrid zur Explosion gebracht wird!

The energy which can be obtained by the formation of helium from LiH is almost three times as great as that produced by nuclear fission from the same quantity of U-235. In this case, lithium is not a rare element, so that in a "super atom bomb" it would be possible to use on the order of tons of lithium hydride compared to kilograms of plutonium [for fission], in such a way as to produce an effect several thousand times as large as before. God have mercy on the country over which a six-ton bomb of lithium hydride is made to explode!

Sofern die Idee überhaupt realisierbar ist, würde in solch einer Superatombombe die bisherige Uranbombe oder Plutoniumbombe nur die Rolle einer "Zündpille" spielen. [...]

If the idea is realizable at all, the former uranium bomb or plutonium bomb would only play the role of a sparkplug in such a super atom bomb. [...]

[Thirring was correct that lithium hydride would make an excellent solid fuel for a hydrogen bomb, and that such a bomb could be thousands of times more powerful than a fission bomb (megatons instead of kilotons of explosive yield). However, the specific isotopes and reaction that he proposed (^{7}Li + ^{1}H) are too difficult to use for fusion, because of the strong repulsion between the three positive charges in the lithium nucleus and the one positive charge in the hydrogen nucleus.

By using ^{6}Li, ^{2}H (deuterium), and two coupled nuclear reactions, the Jetter cycle (p. 4386) avoids that problem. Did scientists consider that possibility during the war?

Note that Thirring gave an extremely specific example of a fusion bomb: "a six-ton bomb of lithium hydride." Thirring was in direct contact with scientists who worked in the wartime German nuclear program. Why did he choose such a specific mass for a fusion bomb? Was there wartime work on a six-ton lithium hydride (lithium deuteride?) bomb? Immediately after the war, several other scientists and engineers mentioned wartime work on a mysterious six-ton bomb–see pp. 4388–4401 and 5411.]

[...] Man weiß seit fast einem Vierteljahrhundert, daß es α-strahlende Substanzen gibt, die etwas anderes sind als die bekannten α-Strahler der drei radioaktiven Familien. Sehr eingehende Messungen mit verfeinerten Appareten sind am Physikalischen Institut der Wiener Universität und am Wiener Radiuminstitut vorgenommen worden und ergaben, daß es eine ganze Gruppe von sieben neuen α-Strahlern mit verschiedener Reichweite gibt, die bisher keinem Isotop irgendeines der bekannten Elemente zwischen Nr. 1 und Nr. 92 zugeschrieben werden konnten. Es ist einer Wiener Forschergruppe, die aus den Herren Schintlmeister, Jentschke, Brukl, Hernegger und Frl. Hilbert besteht, gelungen, aus Zinkblende und aus anderen sulfidischen Erzen die α-Strahler anzureichern, aber die gewonnenen Mengen sind noch nicht groß genug, um mit Hilfe von Röntgen-spektralaufnahmen die chemische Natur festzustellen. Es wäre möglich, daß es sich um Transurane handelt, und zwar um andere und langlebigere als Neptunium und Plutonium, weil diese infolge ihrer Kurzlebigkeit schon längst nicht mehr im natürlichen Zustand auf der Erde vorkommen, sondern nur künstlich hergestellt werden können. Weil nun jedes Element mit einer Kernladung von 90 und darüber zur Kernspaltung neigt, ist mit Warscheinlichkeit anzunehmen, daß diese noch nicht identifizierten α-Strahler—falls sie wirklich Transurane sind—entweder selber Stoffe sind, in denen Kernkettenreaktionen eintreten können, oder als Ausgangsmaterial zur Heranzüchtung solcher Stoffe dienen können. Substanzen dieser Art würden dann sowohl für die Atomwaffe als auch für die reine Energiegewinnung das Uranmonopol brechen.

[...] It has been known for almost a quarter of a century that there are alpha-emitting substances that are different from the known alpha emitters of the three radioactive families. Very detailed measurements with refined equipment have been made at the Physics Institute of the University of Vienna and at the Vienna Radium Institute, and showed that there is a whole group of seven new alpha-emitters with different ranges which have hitherto not been associated with any isotope of any of the known elements between no. 1 and 92. It is a Viennese research group consisting of Schintlmeister, Jentschke, Brukl, Hernegger, and Frl. Hilbert, who succeeded in enriching the alpha emitters from zincblende and other sulphide ores, but the quantities obtained are not yet large enough to be combined with help of Roentgen spectral recordings to determine the chemical nature. It is possible that they are transuranics, and others are more durable than neptunium and plutonium, because, as a result of their short-livedness, they are no longer present in the natural state on the earth, but can be produced only in a manner which is artificial. Since every element with a nuclear charge of 90 or over tends to undergo nuclear fission, it is probable that these unidentified alpha-emitters, if they are really transuranics, are themselves substances in which nuclear chain reactions can occur, or as starting materials for the production of such substances. Substances of this kind would then break the uranium monopoly both for nuclear weapons and for pure energy production.

[Thirring provided more information about Schintlmeister's possible experiments with transuranic elements. Apparently Schintlmeister used the energies (range) of emitted alpha particles to try to identify the specific isotopes that emitted those alpha particles. If only isotopes from naturally occurring samples were analyzed, there should be no transuranic elements, and any results indicating that there were would presumably be spurious. Did the analyzed samples come from an artificial source, such as a cyclotron or fission reactor?]

Hans Thirring. Undated (circa 1971). In den nächsten zehn Jahren muss es zwischen den Supermächten USA, UdSSR, China, England und Frankreich zu einer allgemeinen Abrüstung kommen. Sondersammlung der Österreichischen Zentralbibliothek für Physik (ZBP), Universität Wien, Nachlass Broda, Box 24, File 55, Fiche 54.

Schon vor 25 Jahren wußte ich, daß man Wasserstoffbomben erzeugen wird, die eine zehntausendfache Sprengkraft der Hiroshima-Bombe haben würden. In den Jarhren 1951–1967 haben fünf Staaten an diesem Projekt gearbeitet und Megatonnenbomben erzeugt; es sind bereits genügend Bomben vorhanden, um die ganze Welt in einen chaotischen Zustand unvorstellbaren Ausmaßes bringen zu können. [...]

25 years ago, I knew that hydrogen bombs, which could have ten thousand times the explosive force of the Hiroshima bomb, would be produced. In the years 1951–1967 five countries worked on this project and produced megaton bombs; there are already enough bombs to turn the whole world into a chaotic state of unimaginable proportions. [...]

Im Juli 1946 diskutierte ich über das Problem der Entwicklung noch stärkerer Vernichtungswaffen mit meinem Kollegen Jentschke, einem jungen österreichischen Physiker, jetzt Generaldirektor des CERN in Genf. Jentschke war als reiner Physiker nicht so sehr von der Wichtigkeit der Kernvernschmelzung überzeugt; aber ich als Physiker und Politiker wußte, daß das Gelingen dieser Experimente (zur Herstellung der Wasserstoffbombe) leider von welthistorischer Bedeutung sein wird.

In July 1946, I discussed the problem of the development of even more powerful weapons of destruction with my colleague Jentschke, a young Austrian physicist, now General Manager of CERN in Geneva. Jentschke, as a pure physicist, was not so much convinced of the importance of nuclear fusion; but as a physicist and politician I knew that the success of these experiments (for the production of the hydrogen bomb) would unfortunately be of historical importance.

Im Herbst 1946 veröffentlichte ich mein Buch, “Die Geschichte der Atombombe”. [...]

In the autumn of 1946 I published my book, *The History of the Atomic Bomb.* [...]

Die meisten Leute fanden die darin beschriebene historische Entwicklung sehr interessant, aber über die Berechnungen der Lithiumhydrid-Reaktion lasen sie, als zu wissenschaftlich, einfach hinweg. [...]

Most people found the historical development described therein very interesting, but they simply ignored the calculations of the lithium hydride reaction as too scientific. [...]

Im Studienjahr 1946/47 war ich Dekan an der Universität Wien und sprach in einem Seminar, das ich damals hielt, über die Möglichkeit, daß nicht nur die Amerikaner sondern auch die Russen sehr bald über Wasserstoffbomben verfügen könnten.

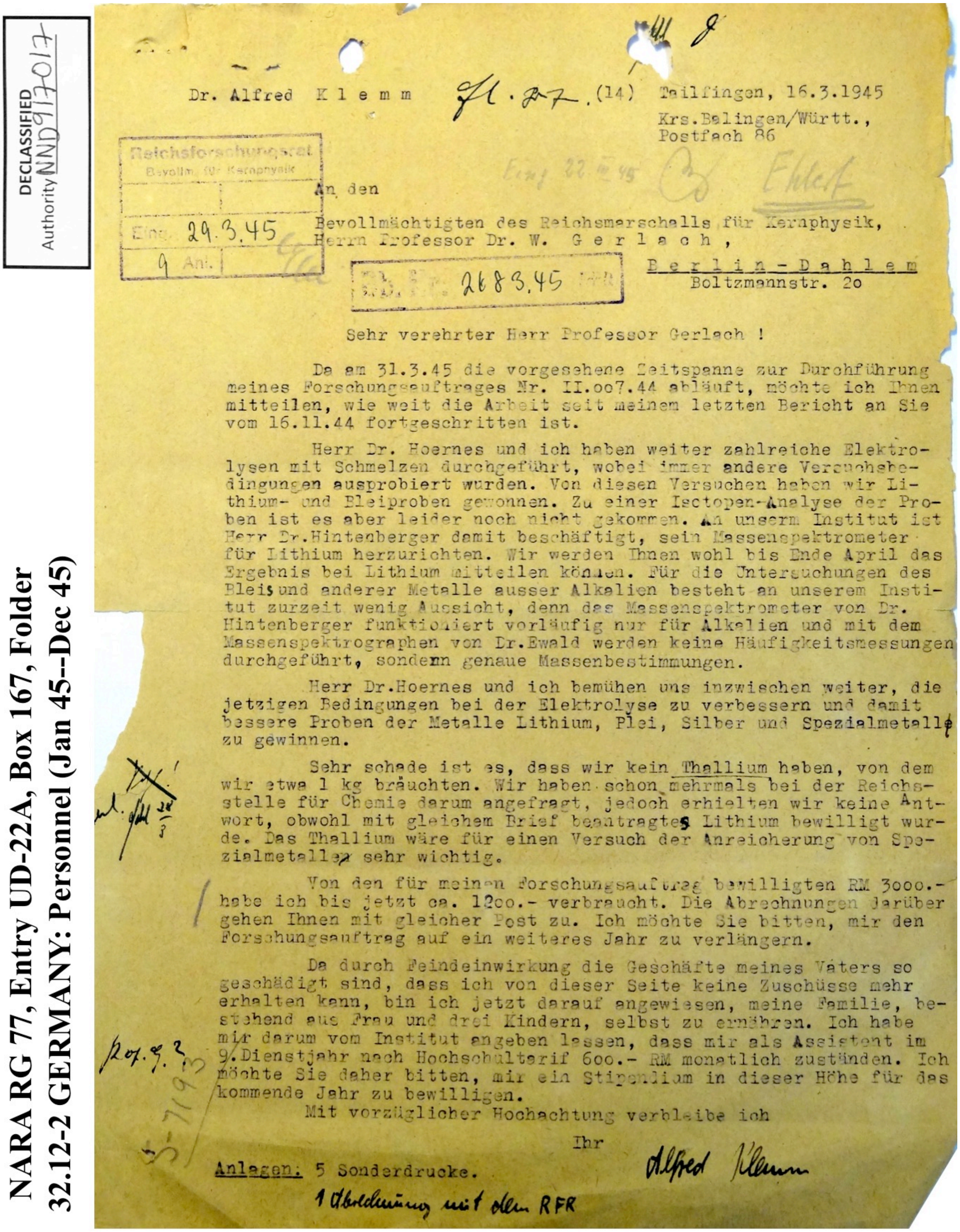
In the academic year 1946/47, I was a dean at the University of Vienna, and I spoke in a seminar I held at the time about the possibility that not only the Americans, but also the Russians, could soon have hydrogen bombs.

[Thirring acknowledged that an important source for his book was Willibald Jentschke, who was a member of Georg Stetter's research group during the war.

Does the information in Thirring's book accurately convey what the Austrian nuclear scientists knew (or did not know) during the war, or were any important details omitted?

How much involvement did Thirring himself have with nuclear work during the war?

What other sources of information did he use for his book?]



DECLASSIFIED
Authority NND917017

NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45--Dec 45)

Dr. Alfred K l e m m (14) Tailfingen, 16.3.1945
Krs.Balingen/Württ.,
Postfach 86

Reichsforschungsrat
Bevollm. für Kernphysik
Eing. 29.3.45
9 Anl.

Eing 22 III 45

An den

Bevollmächtigten des Reichsmarschalls für Kernphysik,
Herrn Professor Dr. W. G e r l a c h ,

B e r l i n - D a h l e m
Boltzmannstr. 20

2683.45

Sehr verehrter Herr Professor Gerlach !

Da am 31.3.45 die vorgesehene Zeitspanne zur Durchführung meines Forschungsauftrages Nr. II.007.44 abläuft, möchte ich Ihnen mitteilen, wie weit die Arbeit seit meinem letzten Bericht an Sie vom 16.11.44 fortgeschritten ist.

Herr Dr. Hoernes und ich haben weiter zahlreiche Elektrolysen mit Schmelzen durchgeführt, wobei immer andere Versuchsbedingungen ausprobiert wurden. Von diesen Versuchen haben wir Lithium- und Bleiproben gewonnen. Zu einer Isotopen-Analyse der Proben ist es aber leider noch nicht gekommen. An unserm Institut ist Herr Dr.Hintenberger damit beschäftigt, sein Massenspektrometer für Lithium herzurichten. Wir werden Ihnen wohl bis Ende April das Ergebnis bei Lithium mitteilen können. Für die Untersuchungen des Bleis und anderer Metalle ausser Alkalien besteht an unserem Institut zurzeit wenig Aussicht, denn das Massenspektrometer von Dr. Hintenberger funktioniert vorläufig nur für Alkalien und mit dem Massenspektrographen von Dr.Ewald werden keine Häufigkeitsmessungen durchgeführt, sondern genaue Massenbestimmungen.

Herr Dr.Hoernes und ich bemühen uns inzwischen weiter, die jetzigen Bedingungen bei der Elektrolyse zu verbessern und damit bessere Proben der Metalle Lithium, Blei, Silber und Spezialmetalle zu gewinnen.

Sehr schade ist es, dass wir kein Thallium haben, von dem wir etwa 1 kg bräuchten. Wir haben schon mehrmals bei der Reichsstelle für Chemie darum angefragt, jedoch erhielten wir keine Antwort, obwohl mit gleichem Brief beantragtes Lithium bewilligt wurde. Das Thallium wäre für einen Versuch der Anreicherung von Spezialmetallen sehr wichtig.

Von den für meinen Forschungsauftrag bewilligten RM 3000.- habe ich bis jetzt ca. 1200.- verbraucht. Die Abrechnungen darüber gehen Ihnen mit gleicher Post zu. Ich möchte Sie bitten, mir den Forschungsauftrag auf ein weiteres Jahr zu verlängern.

Da durch Feindeinwirkung die Geschäfte meines Vaters so geschädigt sind, dass ich von dieser Seite keine Zuschüsse mehr erhalten kann, bin ich jetzt darauf angewiesen, meine Familie, bestehend aus Frau und drei Kindern, selbst zu ernähren. Ich habe mir darum vom Institut angeben lassen, dass mir als Assistent im 9. Dienstjahr nach Hochschultarif 600.- RM monatlich zustünden. Ich möchte Sie daher bitten, mir ein Stipendium in dieser Höhe für das kommende Jahr zu bewilligen.

Mit vorzüglicher Hochachtung verbleibe ich

Ihr

Alfred Klemm

Anlagen: 5 Sonderdrucke.
1 Abrechnung mit dem RFR

Figure D.650: 16 March 1945 letter from Alfred Klemm to Walther Gerlach reporting successful demonstrations of lithium isotope separation [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)].

Anreicherung der schweren Isotope von Li und K durch elektrolytische Ionenwanderung in geschmolzenen Chloriden

Von ALFRED KLEMM, HEINRICH HINTENBERGER und PHILIPP HOERNES

Aus dem Kaiser-Wilhelm-Institut für Chemie, Tailfingen

(Z. Naturforschg. **2 a**, 245—249 [1947]; eingegangen am 26. Januar 1947)

Durch elektrolytische Ionenwanderung wurde an der Grenzfläche zwischen geschmolzenem LiCl mit 2 Molprozent KCl einerseits und geschmolzenem $PbCl_2$ andererseits bei einer Stromdichte von 5 A/cm² in 48 Stdn. K stark angereichert, das Mischungsverhältnis $[^7Li]/[^6Li]$ von 12,3 auf 44,3 und das Mischungsverhältnis $[^{41}K]/[^{39}K]$ von 0,0714 auf 0,0885 verschoben. Als Quotienten der Ionenwanderungsgeschwindigkeiten wurden gefunden: $w_{Li}/w_K = 1{,}156$, $w_6/w_7 = 1{,}021$ und $w_{39}/w_{41} = 1{,}016$. Faßt man diese Quotienten als Trennfaktoren einer Stufe auf, so bedeuten die angegebenen Anreicherungen eine wirksame gesamte Trennstufenzahl von 61,5 bei den Li-Isotopen und 13,4 bei den K-Isotopen. Für den Masseneffekt $\mu = \ln(w_j/w_k)/\ln(m_j/m_k)$, ($m$ = Isotopenmasse), folgt $\mu = -0{,}135$ für Li und $\mu = -0{,}32$ für K. Der große Masseneffekt und die kleine Trennstufenzahl beim K kann durch dessen geringe Konzentration erklärt werden.

Nachdem sich bei zwei Diffusionsversuchen (H diffundierte in Pd[1], Cu diffundierte in α-Ag_2S[2]) und bei einem Versuch mit elektrolytischer Ionenwanderung (Ag^+ wanderte in α-AgJ[3]) gezeigt hatte, daß die leichten Isotope in festen Körpern eine größere Beweglichkeit haben als die schweren, sollte in der vorliegenden Arbeit untersucht werden, ob der gleiche Effekt bei elektrolytischer Ionenwanderung in Schmelzen auftritt.

Im Gegensatz zu dem Überführungsversuch in α-AgJ wurde diesmal die Anreicherung der weniger beweglichen Kationen nicht im Anodenraum, sondern vor einer wandernden Grenzfläche studiert, und zwar an der Grenzfläche zwischen LiCl, das zufällig etwas KCl enthielt, einerseits und $PbCl_2$ andererseits. Die Stromrichtung war dabei so gewählt, daß die Alkali-Ionen voraus und die Blei-Ionen hinterher wanderten. Da die Alkali-Ionen eine größere Beweglichkeit haben als die Blei-Ionen, bleibt bei dieser Stromrichtung die Grenzfläche scharf, während bei der umgekehrten Stromrichtung eine Vermischung der Alkali- und Blei-Ionen eintreten würde. Für die Anreicherung der schweren Alkali-Ionen ist es belanglos, ob der mit den Alkalichloriden erfüllte Raum anodenseitig durch die Anode selbst oder durch die beschriebene wandernde Grenzfläche begrenzt ist, da in beiden Fällen jene Grenze für Chlor passierbar und für Alkalien unpassierbar ist. Ist diese Bedingung erfüllt, dann tritt bei Stromfluß der beabsichtigte Vorgang ein, daß diejenigen Alkali-Ionen zur Grenzfläche hin verschoben werden, deren Wanderungsgeschwindigkeit w_i im Chlor kleiner ist als die Geschwindigkeit w_0, mit der das Chlor durch die Grenzfläche aus dem Raum der Alkali-Ionen austritt, während sich diejenigen Alkali-Ionen, bei denen w_i größer ist als w_0, von der Grenzfläche weg verschieben. An der Grenzfläche stauen sich also die schweren und verarmen die leichten Alkali-Ionen, wobei die Gesamtkonzentration der Alkali-Ionen aus Raumladungsgründen konstant bleibt. Die Gradienten der Partialkonzentrationen sind um so größer, je größer die Stromdichte und je kleiner die Diffusionskonstante und die eventuell vorhandene Konvektion ist. Die durch Raumladungskräfte erzwungene Konstanz der Gesamtkonzentration ist bei dem Verfahren wesentlich. Nähme nämlich die Gesamtkonzentration im Stauraum infolge der Überführung zu, so würde zwar die gleiche Überschußmenge der anzureichernden Komponente in den Stauraum eintreten wie im Falle konstanter Gesamtkonzentration, aber es würde zusätzlich eine große Menge nicht angereicherten Gemisches in den Stauraum eintreten, wodurch die tatsächliche Entmischung verschlechtert würde.

Nach dem gleichen Prinzip muß die Anreicherung leichter Isotope möglich sein. Z. B. ist anzu-

[1] W. Jost u. A. Widmann, Z. physik. Chem. (B) **45**, 285 [1940].

[2] A. Klemm, Z. physik. Chem. Abt. A **193**, 29 [1943].

[3] A. Klemm, Z. Naturforschg. **2a**, 9 [1947].

Figure D.651: Alfred Klemm, Heinrich Hinterberger, and Philipp Hoernes. 1947. Anreicherung der schweren Isotope von Li und K durch elektrolytische Ionenwanderung in geschmolzenen Chloriden. *Zeitschrift für Naturforschung.* 2a:245–249. [https://doi.org/10.17617/3.GRUJYR]

Alfred Klemm, Heinrich Hinterberger, and Philipp Hoernes. 1947. Anreicherung der schweren Isotope von Li und K durch elektrolytische Ionenwanderung in geschmolzenen Chloriden. *Zeitschrift für Naturforschung.* 2a:245–249. [**https://doi.org/10.17617/3.GRUJYR**]

Anreicherung der schweren Isotope von Li und K durch elektrolytische Ionenwanderung in geschmolzenen Chloriden.

Durch elektrolytische Ionenwanderung wurde an der Grenzfläche zwischen geschmolzenem LiCl mit 2 Molprozent KCl einerseits und geschmolzenem $PbCl_2$ andererseits bei einer Stromdichte von 5 A/cm^2 in 48 Stdn. K stark angereichert, das Mischungsverhältnis $[^7Li]/[^6Li]$ von 12,3 auf 44,3 und das Mischungsverhältnis $[^{41}K]/[^{39}K]$ von 0,0714 auf 0,0885 verschoben. Als Quotienten der Ionenwanderungsgeschwindigkeiten wurden gefunden: w_{Li}/w_K = 1,156, w_6/w_7 = 1,021 und w_{39}/w_{41} = 1,016. Faßt man diese Quotienten als Trennfaktoren einer Stufe auf, so bedeuten die angegebenen Anreicherungen eine wirksame gesamte Trennstufenzahl von 61,5 bei den Li-Isotopen und 13,4 bei den K-Isotopen. Für den Masseneffekt $\mu = \ln(w_j/w_k)/\ln(m_j/m_k)$, ($m$ = Isotopenmasse), folgt μ = -0,135 für Li und μ = -0,32 für K. Der große Masseneffekt und die kleine Trennstufenzahl beim K kann durch dessen geringe Konzentration erklärt werden.

[...] Der Trennversuch und die Auswertung der Analysenergebnisse wurde von A. Klemm, die massen-spektrometrische Analyse von H. Hintenberger und die chemische Arbeit von Ph. Hoernes durchgeführt. Hrn. Prof. J. Mattauch danken wir für die Förderung der Arbeit und den Assistentinnen H. und U. Scheid für ihre gewissenhafte Mitarbeit.

Enrichment of the heavy isotopes of Li [lithium] and K [potassium] by electrolytic ion migration in molten chlorides.

By electrolytic ion migration at the boundary between molten LiCl with 2 mole percent KCl, on the one hand, and molten $PbCl_2$, on the other hand, was strongly enriched in 48 hours of K at a current density of 5 A/cm^2, the mixing ratio $[^7Li]/[^6Li]$ from 12.3 to 44.3 and the mixing ratio $[^{41}K]/[^{39}K]$ from 0.0714 to 0.0885. As quotients of the ion migration rates were found: w_{Li}/w_K = 1.156, w_6/w_7 = 1.021 and w_{39}/w_{41} = 1.016. If these quotients are taken as the separation factors of a step, the indicated enrichment means an effective total separation step number of 61.5 for the Li isotopes and 13.4 for the K isotopes. For the mass effect $\mu = \ln(w_j/w_k)/\ln(m_j/m_k)$, ($m$ = isotope mass), μ = -0.135 for Li and μ = -0.32 for K. The large mass effect and the small number of separation stages in the K can be explained by its low concentration.

[...] The separation experiment and the analysis of the results of the analysis were carried out by A. Klemm, the mass spectrometric analysis by H. Hintenberger, and the chemical work of Ph. Hoernes. We thank Prof. J. Mattauch for the support of the work and the assistants H. and U. Scheid for their conscientious cooperation.

[See document photo on p. 4382. This was a delayed publication of work that was done during the war; see for example p. 4381. Lithium has two naturally occurring isotopes: ^{6}Li (approximately 7.5% of natural lithium) and ^{7}Li (approximately 92.5% of natural lithium). Thus their naturally occurring ratio is $[^7Li]/[^6Li] \approx 92.5\%/7.5\% \approx 12.3$. Within 48 hours, Klemm's process enriched them to a ratio $[^7Li]/[^6Li] \approx 97.8\%/2.2\% \approx 44.3$. The isotopes are virtually identical chemically; the only major reason to separate them would be for nuclear reactions. What exactly was the purified ^{6}Li intended for?

During the war, Josef Mattauch was head of the physics department at the Kaiser Wilhelm Institute for Chemistry in Tailfingen where Klemm worked. Prior to the war, Mattauch was at the University of Vienna for 26 years, and thus closely connected to Georg Stetter's research group. Was the purified ^{6}Li for the Stetter group's work on fusion? If so, that could suggest that they were working on the Jetter cycle, which requires ^{6}Li.]

Alfred Klemm. 1958. Lithium in der Kerntechnik. *Angewandte Chemie* 70:1:21–24.

Lithium kann in der modernen Kerntechnik auf vielfache Weise verwendet werden, so zur Herstellung von Tritium (etwa für thermonucleare Reaktionen), als Abschirmungsmittel, zum Nachweis thermischer Neutronen, als Reaktorkühlmittel, als Moderator oder in Form von geschmolzenem LiF als Lösungsmittel für Kernbrennstoffe. Zur Anreicherung der Lithium-Isotope 6 bzw. 7 sind die Ionenwanderung in geschmolzenem LiCl und das Lithium-Amalgam-Verfahren von besonderem Interesse.

Lithium can be widely used in modern nuclear engineering, for instance to produce tritium (for thermonuclear reactions), as a shielding agent, for detecting thermal neutrons, as a reactor coolant, as a moderator, or as a molten LiF as a solvent for nuclear fuels. The ion migration in molten LiCl and the lithium-amalgam process are of particular interest for the enrichment of the lithium isotopes 6 and 7, respectively.

[This postwar article by Klemm may suggest that his wartime work was indeed intended for nuclear purposes.]

Heiko Petermann, Discussion notes with Prof. Alfred Klemm, Mainz, Saarstr. 23, Max Planck Institut für Chemie. 5 March 2004. 06131-305-223 [courtesy of Heiko Petermann].

Klemm wirkte sehr nervös und wich meinen Fragen immer wieder aus. Er war bemüht, mich so schnell wie möglich wieder los zu werden.

Klemm looked very nervous and always gave up my questions. He tried to get rid of me as soon as possible.

Klemm hat sich während des Krieges ausschließlich mit Isotopentrennung beschäftigt und war sozusagen sein 'eigener Herr'. Das von ihm entwickelte Elektrolyt-Verfahren funktionierte bei Uranhexaflorid nicht.

During the war, Klemm concentrated exclusively on isotopic separation and was, so to speak, his own master. The electrolyte process he developed did not work with uranium hexafluoride.

Klemm hatte mit Hahns Truppe wenig zu tun, da er separat arbeitete, sich selbst als 'eigen' bezeichnet

Klemm had little to do with Hahn's group, since he worked separately, calling himself 'independent'

Klemm ging mit nach Tailfingen

Klemm also went to Tailfingen

Schwerpunkt der Arbeit war die Herstellung von Li6 durch Trennung von Li7. Dies gelang im elektrolytischen Verfahren sehr gut. Ab 1942–43. Klemm wies darauf hin, dass er wohl der erste war, dem die Trennung mittels Elektrolyse gelungen sei (wissenschaftliche Priorität, siehe auch Z. f. Naturforschung 2a, S. 245 ff, 1947, unter Mitarbeit v. H. Hintenberger u. P. Hoernes)

Main focus of the work was the production of Li6 by separation of Li7. This was achieved very well in the electrolytic process. From 1942–43. Klemm pointed out that he was probably the first to achieve the separation by means of electrolysis (scientific priority, see also Z. f. Naturforschung 2a, pp. 245 ff, 1947, with the collaboration of H. Hintenberger and P. Hoernes)

Über die Tritium-Problematik wusste er Bescheid, es war aber damals nicht seine Aufgabe. (wessen denn?)

He knew about the tritium problem, but it was not his job at the time. (Whose then?)

Diskutiert wurde die Verwendung von metallischem Li7 als Reaktorkühlmittel

The use of metallic Li7 as a reactor coolant was discussed

Klemm kannte die AEG-Hochspannungsanlage und meinte Flammersfeld hat dort mit Bestrahlung von Material gearbeitet
(Vorsicht bei dieser Aussage, sie passt zwar, doch es ist nicht klar ob Klemm da nicht einiges bezüglich der Hochspannungsanlage des KWI f. Chemie durcheinanderbringt, ich fasse brieflich nach—hp)

Klemm knew the AEG high voltage installation and said Flammersfeld worked there with irradiation of material
(Caution with this statement, it fits, but it is not clear whether Klemm was referring in part to the high-voltage plant of the KWI for Chemistry disagrees, I will get the correspondence after—hp)

Klemms Vater gehörte die Dietrichsche Verlagsbuchhandlung. 1946 entstand dann als Ableger der Verlag der Zeitschrift für Naturforschung, die seitdem A. Klemm leitet.

Klemm's father owned the book publisher Dietrich. In 1946, the publishing house of the Zeitschrift fúr Naturforschung (Journal of Natural Research), which has been headed by A. Klemm since then, was founded.

Brieflich dürfte er präziser sein, denn der Besuch hat ihn in erheblichste Unruhe gestürzt.

In correspondence he might be more precise, for the visit has plunged him into considerable disquiet.

Vielleicht lässt sich aus seinem Archiv noch ein Schätzchen heben.

Perhaps one can pick up a clue from his archive.

Nachtrag: Mit Antwortschreiben v. 4.4.04 notierte er handschriftlich, daß er Li6 im Grammbereich produzierte. Gegen Kriegsende hat er es 'weggeworfen'.

Addendum: With a reply from v. 4.4.04 he noted in handwriting that he produced Li6 in the gram range. He "threw it away" at the end of the war.

Er bestätigte weiterhin, daß die Tritiumproblematik (Zerfall Li6 in Tritium) bereits vor 1945 diskutiert wurde.

He also confirmed that the tritium problem (disintegration of Li6 into tritium) was already discussed before 1945.

[If Klemm's wartime work was for purely scientific reasons, why was he so nervous to discuss it 60 years later, and shortly before his death?

Klemm twice confirmed that scientists were working on tritium during the war. Who and where? Was his ^{6}Li bombarded with neutrons to produce tritium during the war? The knowledge of that reaction during the war, as shown by both Klemm and also Kallmann and Kuhn (p. 4336) may help demonstrate that the Jetter cycle (p. 4386) originated in the German-speaking world during the war.

An amount of ^{6}Li "in the gram range" (one gram? several grams?) would be extremely useful for fusion boosting of a fission bomb, or for producing a similar amount of tritium for the same purpose.

If Klemm's work was performed during 1942–1943, planning for fusion reactions must have begun early in the war. If Klemm's work was perfected at that time, was his ^{6}Li purification process transferred to other locations and scaled up later in the war?

If the gram-range amount of ^{6}Li was difficult to create and was produced for purely scientific reasons, why would Klemm "throw it away" at the end of the war? If he did throw it away, does that suggest that he knew its real purpose was much more serious? Or did he not throw it away—was it transferred to the German nuclear program, or seized by Allied forces, or hidden to protect it?]

Pavel V. Oleynikov. 2000. German Scientists in the Soviet Atomic Project. *Nonproliferation Review* 7:2:1–30.

After 1950, Hertz moved to Moscow where, together with Werner Schuetze, he started to work on analysis of lithium and purification of tritium.

Documents about German scientists who helped the Soviet Union develop an atomic bomb. 29 October 2019. [**https://www.mbs.news/2019/10/documents-about-german-scientists-who-helped-the-soviet-union-develop-an-atomic-bomb.html**]

Manfred von Ardenne, the scientific director of the A kurulan institute, established in another sanatorium in the USSR, was also awarded the Stalin Prize twice in 1947 for inventing the electronic microscope and in 1953 for obtaining the lithium 6 isotope necessary for the creation of nuclear warheads.

[After the war, Gustav Hertz, Werner Schuetze, and Manfred von Ardenne separated lithium isotopes and produced tritium for the Soviet hydrogen bomb project. Was their expertise in that area derived from work they did during the war to separate lithium isotopes and produce tritium for the German nuclear program?]

https://www.cia.gov/readingroom/docs/CIA-RDP82-00457R004500650007-8.pdf

Ulrich Jetter. 1950. Die sogenannte Superbombe. *Physikalische Blätter* (1950) 6:199-205.

Die beiden Reaktionen... "gehen" ungewöhnlich gut: das leichte Lithiumisotop hat einen sehr großen Wirkungsquerschnitt gegenüber der D-D-Reaktion eine tiefere Energieschwelle und bei gleicher Temperatur die rund hundertfache Ausbeute. Sofern also genügend Tritonen oder Neutronen zugegen sind, wird der Zyklus

$$\begin{array}{ccc} \mathrm{n} + {}^{6}\mathrm{Li} & \longrightarrow & {}^{4}\mathrm{He} + \mathrm{Tr} \\ \uparrow & & \downarrow \\ \mathrm{n} + {}^{4}\mathrm{He} & \longleftarrow & \mathrm{D} + \mathrm{Tr} \end{array} \tag{D.15}$$

die Hauptreaktion bilden.

The two reactions... "go" [together] unusually well: the light lithium isotope has a very large cross section over the DD reaction, a lower energy threshold and at the same temperature a hundredfold yield, so if sufficient tritons or neutrons are present, the cycle

$$\begin{array}{ccc} \text{neutron} + \text{lithium-6} & \longrightarrow & \text{helium-4} + \text{tritium} \\ \uparrow & & \downarrow \\ \text{neutron} + \text{helium-4} & \longleftarrow & \text{deuterium} + \text{tritium} \end{array} \tag{D.16}$$

will become the main reaction.

[This reaction uses lithium-6 deuteride and is the main reaction in modern hydrogen bombs. It was not demonstrated by the United States and Soviet Union until the 1950s.

Due to Allied restrictions on research in Germany and Austria after the war, it seems likely that this paper was based on wartime research. Where and when was that research done, and by whom? Can this paper be connected to wartime research by Georg Stetter's group or other groups on lithium-based fusion reactions? Ulrich Jetter (German, 1914–??) studied at the University of Stuttgart 1931–1941, worked at the Kaiser Wilhelm Institute for Metal Research 1941–1945, and served as an editor for *Physikalische Blätter* 1945–1951 [Jetter 1954]. Could Jetter's 1950 article, 1952 book, and 1954 article (Fig. D.652) on the scientific details of H-bombs have been based on information he learned during the war? Did Jetter do nuclear research during the war, or did he interact with other scientists who did? Lithium is a metal; was lithium fusion research being done at the KWI for Metal Research during the war?

Alternatively, could Jetter's article be based on wartime research that he learned about after the war in his capacity as an editor at the journal? Or does the paper truly demonstrate an insight that only came to Jetter, and only in 1950?

Note that Jetter was invited to Washington, D.C. as a "cultural exchange fellow" in 1951, before the U.S. produced and tested its first H-bombs.]

Die sogenannte Superbombe

Von Dr.-Ing. Ulrich Jetter, Stuttgart

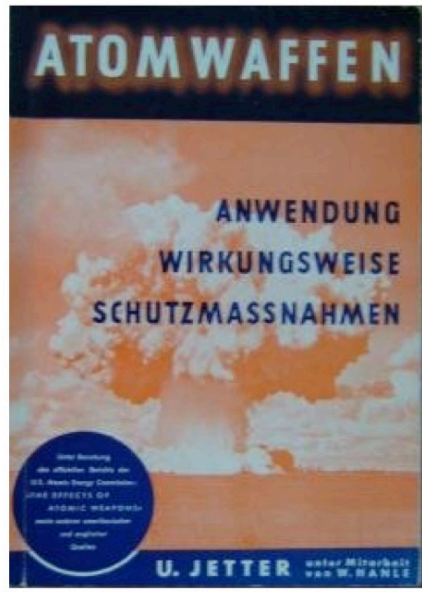
„Es ist Teil meiner Verantwortung als Oberbefehlshaber der Streitkräfte, dafür zu sorgen, daß unser Land in der Lage ist, sich gegen jeden möglichen Angreifer zu verteidigen.

Demgemäß habe ich die Kommission für Atomenergie angewiesen, ihre Arbeit an Atomwaffen aller Art fortzusetzen, mit Einschluß der sogenannten Superbombe.

Wie alle andere Arbeit auf dem Gebiet der Atomwaffen wird auch diese Tätigkeit jetzt und in Zukunft auf einer Basis fortgeführt, die mit den allgemeinen Zielen unseres Programms für Frieden und Sicherheit übereinstimmt." Präsident Truman, 1. 2. 1950.

Wenn eine Regierung bekannt gibt, sie wolle Geschütze mit $39^3/_8$ Zoll Kaliber bauen, dann läßt sich herausfinden, wie groß das Kaliber in Zentime-

1950 *Physikalische Blätter* article



1952 book, *Nuclear Weapons: Use, Mode of Action, Protective Measures*

1954 *Physikalische Blätter* article

Ulrich Jetter

Mitarbeiter des Instituts für Demoskopie Allensbach. Physik und Sozialwissenschaften. * 1914. Nach Abitur 2 Jahre Industriearbeit. 1935/40 Stud. d. Physik in Stuttgart. 1937/38 Foreign Exchange Fellowship Passadena, Master of Science. 1939 Dipl.-Ing. 1941 Dr.-Ing. TH Stuttgart. Bis 1945 KWI für Metallforschung, Militär- und Wetterdienst, Funk-Meßgeräte-Entwicklung. 1945/51 Schriftleiter Phys. Blätter. 1951 Cultural Exchange Fellow Washington und Ann Arbor. Ab 1951 Inst. f. Demoskopie.

Die Zeitgenossen der Wasserstoffbombe

Denkbar jäh und unter wahrhaft dramatischen Umständen sind die Atomwaffen vor einem knappen Jahrzehnt der Öffentlichkeit bekannt ge-

Figure D.652: Ulrich Jetter worked on mysterious research programs for the German government during the war, published a book and articles on the scientific details of H-bombs after the war, and was invited to Washington, D.C. as a "cultural exchange fellow" before the U.S. produced and tested its first H-bombs [Jetter 1950, 1952, 1954].

Major Edmund Tilley to Lt. Col. P. M. Wilson. Secret Missiles. EPES/FIAT, Control Commission for Germany, British Element, 13 July 1946 [TNA FO 1031/57].

1. Lt. F.T. GUTMANN, of 2940th Engineer Technical Intelligence Team (R), U.S. Army, has just returned from Austria with three of SCHULZ-KAMPFHENKEL's assistants, all of the Forschungsstaffel.

2. Lt. GUTMANN went into the Russian Zone in Austria and saw a gendarme, Anton KÄSTNER, in EURATSFELD near AMSTETTEN, in Lower Austria. KÄSTNER told Lt. GUTMANN of a new radio-active bomb, weighing six tons. This bomb has no fins and is lowered by parachute. KÄSTNER himself claims to have been connected only with the fuze part of this new secret missile.

3. Colonel PETERSEN was said to have been in charge of this secret missile at OKW. KÄSTNER claimed that Colonel PETERSEN's papers and documents were left by him at Kloster ANDECHS in AMMERSEE, Upper Bavaria. Colonel PETERSEN is presumed to be in Spain.

4. A Hauptmann (Captain) SORG is said to have been Colonel PETERSEN's Chief Administrative Officer and also in charge of organization. SORG is still living at UTTING on the AMMERSEE.

5. Lt. GUTMANN believed that this new radio-active bomb may not be unconnected with the "Wärmesuchgerät" described by SCHULZ-KAMPFHENKEL. This must be a very secret instrument, for SCHULZ-KAMPFHENKEL did not tell any of the Americans about its existence and would not reveal it to us at OBERURSEL until a high pressure was exerted on him. He continues to call it "Wärmesuchgerät", which means heat searching or finding instrument, but he describes it as an aircraft instrument for measuring temperatures on the ground during the flight of the aircraft. If this were all, the instrument would be called "Wärmemessgerät" or "Temperaturmessgerät".

6. SCHMITTHÜSEN has been indicated as the man in the Forschungsstaffel who knows most about this "Wärmesuchgerät". I shall interrogate him with Lt. GUTMANN on Monday, 15th July. He is likely to prove stubborn for I saw him for a moment outside FIAT and asked him to prepare immediately a list of all hideouts for Top Secret documents. He did not know that we had found the boxes at HARBURG which he himself had dug into the ground. He was informed smilingly that 20 years behind barbed-wire were awaiting him if he continued to deny such well-known facts. He quickly agreed to let me have a complete list by Monday.

7. PILLEWIZER is the glacier expert of the Forschungsstaffel. He has written two reports for us at Lt. GUTMANN's request. The most significant sentence at the beginning of the second report, on the activities of the Forschungsstaffel in Lappland in 1944, reads as follows:

"In July 1944 a small group of the Forschungsstaffel was sent to Northern Finland in order to demonstrate, by practical experiment, the feasibility of quick map-making in the swamps and primeval forests of Lappland, i.e. to make maps quickly for topographical evaluation of hardly explored territory."

The rest of the report explains more fully the real purpose of this expedition for the work was started in VUOTSO and PARKKINA, both in the Arctic Circle, and was continued there after the Germans had evacuated all Southern Finland. Later they photographed the SAARENPAEAE area in West Lappland (ENONTOEKICE area). It is hardly likely that such an important and secret group of scientists could have been left in the Arctic Circle as late as November 1944. After completion of the work PILLEWIZER returned with his group, via NARWIK and OSLO, to Germany, where he arrived in mid-December 1944.

This expedition may have served the same purpose as other expeditions of SCHULZ-KAMPF-HENKEL, i.e. obtaining data of the effect of new deadly weapons or submitting data to enable the High Command to carry out such experiments with such missiles.

8. Lt. GUTMANN, who has not had much sleep for the last few days, will give me a copy of his report on this new missile on Monday and I shall show it to you before I go to DUSTBIN with Lt. GUTMANN.

[See document photos on pp. 4390–4391.

The six-ton bomb was specifically described as radioactive, which might mean a dirty bomb of conventional explosives releasing radioactive material, a fission bomb, or a hydrogen bomb. There was no apparent reason to make a six-ton dirty bomb—the same material could have been packaged into several smaller bombs that would have been much easier to deliver. There was also no apparent reason to make a six-ton fission bomb—the U.S. Gadget was approximately three tons without its fins or bomb casing, and the German fission bomb reported to have been tested in Thuringia in March 1945 was approximately two tons (p. 4529). In contrast, an early hydrogen bomb would be fairly much required by fundamental physical principles to be very large, since it would need to contain enough fission fuel, enough fusion fuel, enough conventional explosives to implode the fission fuel, and the structure necessary for the fission fuel to ignite the fusion fuel. Therefore the reported six-ton bomb seems to best match the description of a hydrogen bomb.

Note that Hans Thirring, who was in close contact with Austrian scientists who had worked on the wartime German nuclear program, specifically mentioned "a six-ton bomb of lithium hydride" (or perhaps lithium deuteride?); see p. 4376.

It sounds as if a German team was scouting locations in northern Finland in which to test the six-ton radioactive bomb. Seeking such a remote test location is further evidence that the bomb was a hydrogen bomb, with an explosive yield much higher than a fission bomb, making it too large to be safely or secretly tested closer to more populated regions.

The capabilities and intended functions of the "Wärmesuchgerät" are unclear from this document. It may have been a heat-seeking missile guidance system, an infrared vision system for night-time flying, or a semi-automated terrain mapping system, among other possibilities. Or since the "Wärmesuchgerät" seems to have been closely associated with the six-ton radioactive bomb and with the German team selecting a test site, perhaps the "Wärmesuchgerät" was intended to measure the explosive yield of the bomb from a safe distance in a remote territory without permanent emplacements of diagnostic instruments.

Can Lt. F. T. Gutmann's more detailed report on the six-ton radioactive bomb be located in archives, declassified, and released?

For information on Edmund Tilley, see pp. 4940–4941.]

TNA (Kew) FO 1031/57 General 'Top Secret' Tube Alloys Etc. Intelligence Reports

TOP SECRET

Enemy Personnel Exploitation Section
FIELD INFORMATION AGENCY TECHNICAL
Control Commission for GERMANY (BE)
B.A.O.R.

005-37

13th July 1946

SUBJECT : Secret Missiles.

Ref. EPES/447.

FROM : Major E. TILLEY.

TO : Lt.Col. P.M. WILSON.

1. Lt. F.T. GUTMANN, of 2940th Engineer Technical Intelligence Team (R), U.S. Army, has just returned from Austria with three of SCHULZ-KAMPFHENKEL's assistants, all of the Forschungsstaffel.

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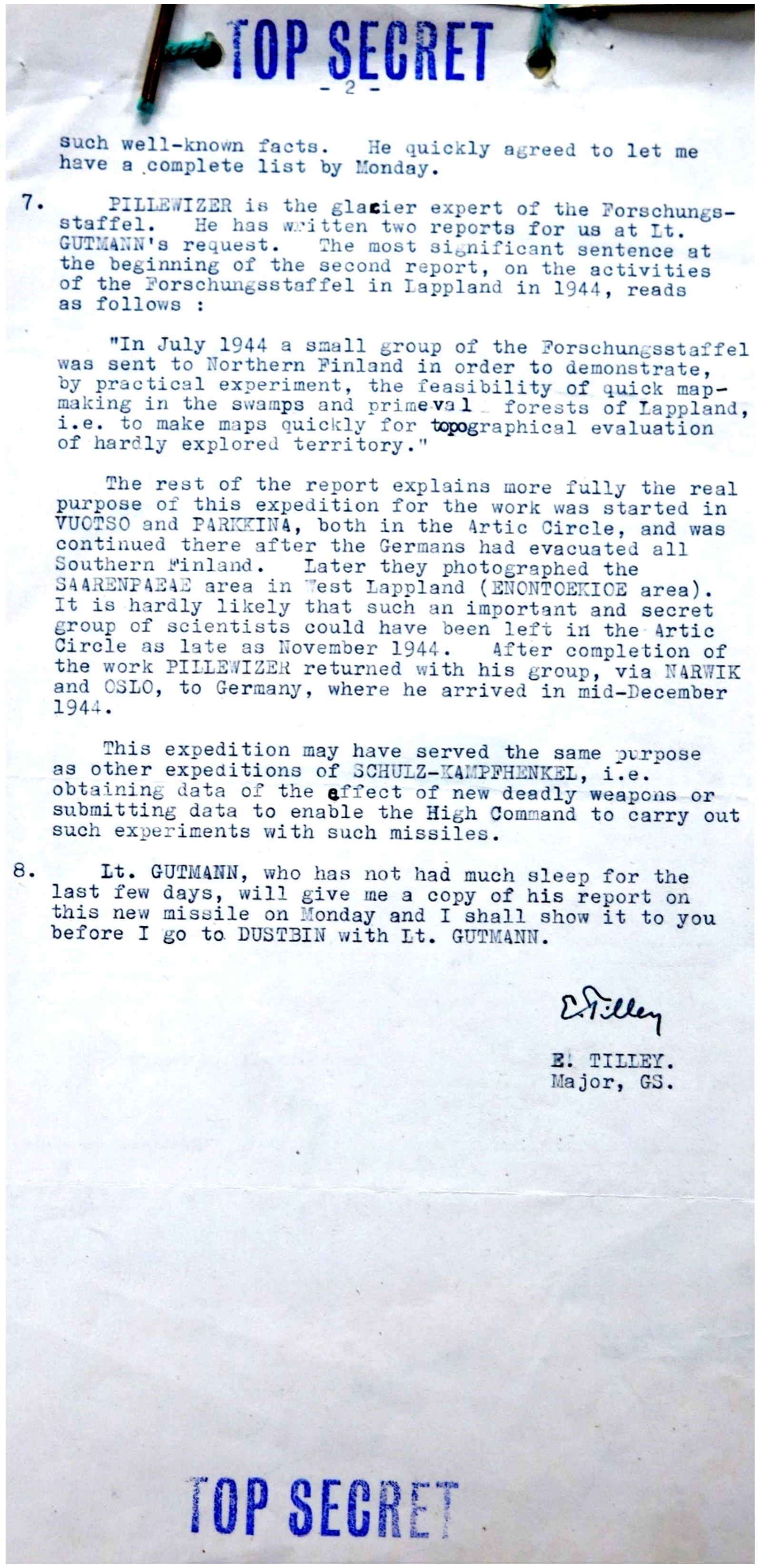
TOP SECRET .../TO SHEET 2...

Figure D.653: 6-ton radioactive bomb that must be dropped with a parachute (∼megaton yield), and a planned test site in northern Finland. Edmund Tilley to P. M. Wilson. Secret Missiles. EPES/FIAT, Control Commission for Germany, British Element, 13 July 1946 [TNA (Kew) FO 1031/57].

TNA (Kew) FO 1031/57 General 'Top Secret' Tube Alloys Etc. Intelligence Reports



TOP SECRET

- 2 -

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The rest of the report explains more fully the real purpose of this expedition for the work was started in VUOTSO and PARKKINA, both in the Artic Circle, and was continued there after the Germans had evacuated all Southern Finland. Later they photographed the SAARENPAEAE area in West Lappland (ENONTOEKIOE area). It is hardly likely that such an important and secret group of scientists could have been left in the Artic Circle as late as November 1944. After completion of the work PILLEWIZER returned with his group, via NARWIK and OSLO, to Germany, where he arrived in mid-December 1944.

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E. Tilley

E. TILLEY.
Major, GS.

TOP SECRET

Figure D.654: 6-ton radioactive bomb that must be dropped with a parachute (∼megaton yield), and a planned test site in northern Finland. Edmund Tilley to P. M. Wilson. Secret Missiles. EPES/FIAT, Control Commission for Germany, British Element, 13 July 1946 [TNA (Kew) FO 1031/57].

Notes on an Interrogation of Edmund Sorg at Dustbin. 7 August 1946 [TNA FO 1031/112].

REGARDING SPECIES OF V-2s

[...] I have never seen any plans of the steps in development of the V-2. I had nothing to do with the V-2 either personally or officially. When I mentioned 10–12 types of V-2 it is only personal supposition.

REGARDING ATOM BOMBS

I have never heard of the existence of atom bombs in connection with the German Wehrmacht. I can thus give no information as to whether the V1 was to have an atomic charge.

REGARDING V-1s WITH POISON GAS, BIOLOGICAL or BACTERIOLOGICAL CHARGES

I have never heard of V-1s being loaded with poison gas, biological matters or bacteria.

REGARDING 6 TON BOMBS

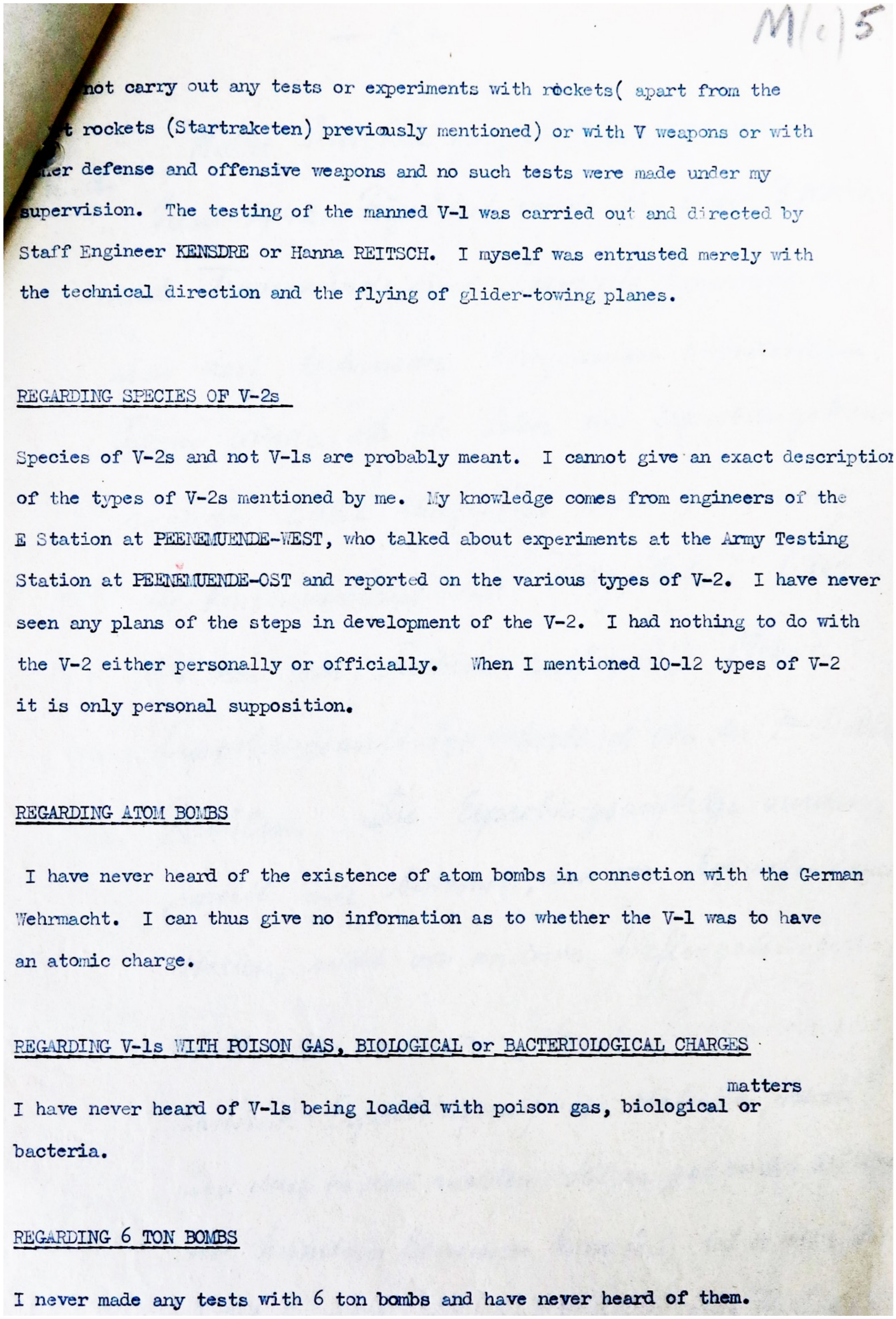
I never made any tests with 6 ton bombs and have never heard of them.

REGARDING USE OF POISON GAS, BIOLOGICAL MEANS and BACTERIA IN ROCKETS &c.

I have no knowledge of the use of poison gas, biological or bacteriological means in rockets, other missiles or in planes.

[Elsewhere in this file at The National Archive (UK), Major Tilley provided evidence that Sorg had detailed personal knowledge of many of the things he denied, such as V-2 rocket information. See p. 4942 for another example. Thus the fact that Sorg denied German atomic bombs, six-ton bombs, biological weapons, multiple types of large rockets, etc. is much less important than the fact that Sorg's Allied interrogators seemed convinced of the reality of those weapons, over a year after the war had ended. What other information did Allied officials have about those weapons from interrogations, captured documents, and/or capture hardware?]

TNA (Kew) FO 1031/112 Sorg V2



M(c)5

not carry out any tests or experiments with rockets(apart from the t rockets (Startraketen) previously mentioned) or with V weapons or with er defense and offensive weapons and no such tests were made under my supervision. The testing of the manned V-1 was carried out and directed by Staff Engineer KENSDRE or Hanna REITSCH. I myself was entrusted merely with the technical direction and the flying of glider-towing planes.

REGARDING SPECIES OF V-2s

Species of V-2s and not V-1s are probably meant. I cannot give an exact descriptio of the types of V-2s mentioned by me. My knowledge comes from engineers of the E Station at PEENEMUENDE-WEST, who talked about experiments at the Army Testing Station at PEENEMUENDE-OST and reported on the various types of V-2. I have never seen any plans of the steps in development of the V-2. I had nothing to do with the V-2 either personally or officially. When I mentioned 10-12 types of V-2 it is only personal supposition.

REGARDING ATOM BOMBS

I have never heard of the existence of atom bombs in connection with the German Wehrmacht. I can thus give no information as to whether the V-1 was to have an atomic charge.

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I have never heard of V-1s being loaded with poison gas, biological matters or bacteria.

REGARDING 6 TON BOMBS

I never made any tests with 6 ton bombs and have never heard of them.

Figure D.655: Notes on an Interrogation of Edmund Sorg at Dustbin. 7 August 1946 [TNA FO 1031/112].

TNA (Kew) FO 1031/112 Sorg V2

Edmund SORG

h/1

16 Aug. 1946

PROF. WAGNER - ~~BAENDER~~ Tape PARASCHUTE (Bänderfallschirm) - 6 TON BOMB - NAMES & ADDRESSES

I never had anything to do with Prof. WAGNER. He is not known to me. I heard about the Me 323 accident in the course of a discussion with directors of depts. No precise details were given. A survivor of this aircraft accident in FRIEDRICHSHAFEN was present at the later tests carried out by Dept. E 5 with Me 323. in LAERZ He mentioned nothing about a 6 ton bomb, however. Large Baenderfallschirm) parachute tests were probably carried out on Lake CONSTANCE. I do not know the name of the survivor. He spoke about the accident on the LAERZ airfield.

Experiments with Tape parachutes (Baenderfallschirme) were then undertaken by Dept. E 5 in LAERZ. Three releases (Abwurfe) were carried out with heavy bodies (metal plates screwed together) with Me 323. The releases were carried out on the target field (Abwurfplatz) MIROW with Me 323 and exact measurements were made. I saw the experiment quite by chance on the LAERZ Flying Field, but did not participate. The body released from the aircraft reached a certain speed, then an auxiliary parachute opened by means of a time release and the opened in its turn the large (Baenderfallschirm). I can remember having heard that at least one of the releases went wrong and the parachute did not open. The purpose of the experiment, so far as I knew, was the testing of parachutes for heavy loads, probably for aircraft as emergency parachutes. I never heard of a 6 ton bomb in connection with this experiment. If there is any connection, the pilot of the Me 323 who made the flights, Staff Engineer (Stabsing.) MUELLER, I believe, must know about it. I do not know MUELLER's address. I myself had nothing to do with the entire experiment. Yet there must most certainly be details of the type of experiment, the execution and results, among the E-Station records in RECHLIN. I sorted the records in KAUFBEUREN in June 1945 at the Air Pool with Interrogation Unit, and noticed that weekly and monthly reports of every dept. of the E-Station in RECHLIN as well as of the other E-Stations over a period of 3 years were to be found in the records. The details of the experiment, mentioned above will be given in detail in the weekly reports.

Figure D.656: Edmund Sorg. 16 August 1946 [TNA FO 1031/112].

TNA (Kew) FO 1031/112 Sorg V2

-2-

sons unknown to SORG, on 6 May 45. We may therefore assume m the major was dealing with documents in the ANDECHS monastery nd possibly tried to escape . SORG exhumed the body of the major in March 46 on the grounds that he had to produce proof for the major's widow of her husbands death so that she could draw on her life insurance. This exhumation coincides with the return of Colonel PETERSEN from the United Kingdom where he had been interrogated. We may therefore assume that there was a discussion between Colonel PETERSEN and Captain SORG concerning the exact location of various documents and that the body was disinterred on the assumption that this valuable list of caches might still be in the clothing of the body of the major. Only months later SORG mentioned ~~xxxxxxxxx~~ casually that the major's sergeant was shot with him and disinterred in March 46. Previously SORG had stated that only one person, aside from himself, knew all the hiding places of these documents, viz, the major.

Both SORG and Colonel PETERSEN claim to have revealed all their secrets to the Americans and British. Neither of them has admitted hiding documents in Kloster ANDECHS; therefore we may safely assume that both of them are still in possession of secrets which, for reasons best known to themselves, they are still withholding from us.

In the following paragraphs all particulars about the documents hidden by SORG in the Spring of 1945 are being presented. Any discrepancies between his original oral statements and his written statements will be put down.

Total of Boxes Hidden in Various Places.

According to SORG's written statement a total of 25 boxes were hidden by him in Southern Germany in February 1945 and were listed on the sheet which he entrusted to Major GROSSHOLZ la of Colonel PETERSEN. During his first interrogation at DUSTBIN,

Figure D.657: Major Edmund Tilley to Lt. Col. P. M. Wilson. October 1946 [TNA FO 1031/112].

TNA (Kew) FO 1031/112 Sorg V2

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(NOTE: SORG states that it is possible that he has made an error in the distribution of the boxes in the various hiding places and that for example there may have been 13 boxes hidden at KIRSCHLACH and only 2 at HAUNSHOFFEN. He cannot remember the names of the owners of the properties at FISCHEN, MITTERFISCHEN and HAUNSHOFEN, but he can indicate exactly the buildings concerned.)

Contents of the Boxes.

SORG refuses to admit any knowledge of the contents until after he had collected the boxes and ...... the contents under supervision of American officers, originally he refused to acknowledge the accuracy of the information that he had hidden V-2 documents but finally agreed that documents on V-2 fuzes were included in the lot. He states that he cannot remember the details of the rough classification but that those details should be available at A.P.W.I.U. in KAUFBEUREN. He does, however, remember that the contents of all the boxes comprise records of the E-Stellen (testing stations) at RECHLIN (E-2, E-3, E-4, E-5, E-6, E-7,) at TARNEWITZ, PEENEMÜNDE and of the HQ Staff of all the E-Stellen. He also remembers that 2flat ammunition boxes contained the records of the E-7 Stellen (on Luftwaffe bombs and fuzes, probably also on a 6-ton bomb which he himself tested). Unfortunately SORG cannot give us from memory a detailed list of all the boxes and exactly what each one contained.

Figure D.658: Major Edmund Tilley to Lt. Col. P. M. Wilson. October 1946 [TNA FO 1031/112].

Major Edmund Tilley to Lt. Col. P. M. Wilson. October 1946 [TNA FO 1031/112].

The general background of this brief report on the hiding by SORG of documents of the E-Stellen (testing stations) at RECHLIN, TARNEWITZ, TRAVEMÜNDE, WERNEUCHEN, UDETFELD, PEENEMÜNDE, GOTENHAFEN (GYDNIA) was given in a memorandum by the undersigned to Lt-Col. P.M. Wilson on 6 Oct 46. Information was received in Austria late summer 46 that a Captain SORG had hidden V-2 documents in Kloster ANDECHS on the Ammersee in Spring 45 and that Captain SORG was the administrative officer of Colonel PETERSEN.

[...] the return of Colonel PETERSEN from the United Kingdom where he had been interrogated. [...] Both SORG and Colonel PETERSEN claim to have revealed all their secrets to the Americans and British. Neither of them has admitted hiding documents in Kloster ANDECHS; therefore we may safely assume that both of them are still in possession of secrets which, for reasons best known to themselves, they are still withholding from us. [...]

SORG refuses to admit any knowledge of the contents until after he had collected the boxes [...] He also remembers that 2 flat ammunition boxes contained the records of the E-7 Stellen (on Luftwaffe bombs and fuzes, probably also on a 6-ton bomb which he himself tested). Unfortunately SORG cannot give us from memory a detailed list of all the boxes and exactly what each one contained.

[Based on (still classified) evidence they had already seen, Allied interrogators were convinced that the six-ton radioactive bomb had reached the point of testing before the end of the war. Thus that weapon was much more than a paper design or a long-term project. This information is consistent with other reports that a German hydrogen bomb could have been deployed later in 1945 or in 1946 if the war had continued. For information on Edmund Tilley, see pp. 4940–4941.]

Allen Dulles. 14 March 1944. [Princeton University Library, Allen Dulles Papers, Series 4, Subseries 4K: Telegrams d'etat, 1942–1945, 1942–1943, MC019.09_c44.pdf, https://findingaids.princeton.edu/catalog/MC019-09_c44].

Source 840. (1) 600 technicians doing research on rocket direction in high frequency lab in Gatow near Berlin. 300 rockets said to be ready for use one month ago. Length 15 to 17 meters, weight of explosive 4 to 6 tons. Rocket consists of over 1000 parts including two batteries. Remaining difficulty is deviation up to 500 meters radius over 230 km.

[This OSS intelligence report came from someone involved in developing rocket guidance systems. That source stated they were working on rockets that were larger than a standard A-4 (V-2), 15–17 meters long instead of the standard 14 meters, and that were designed to accommodate a special explosive warhead weighing up to 6 tons instead of the standard 1-ton warhead.]

J. P. E. Peters. Interrogation of Dipl. Ing. Hermann Zumpe at F.I.A.T. (Main) on 7th November, 1946. [TNA AIR 40/2832]

[...] 2. On 22nd October, 1946, ZUMPE presented himself at the headquarters of F.I.A.T. (Forward) in Berlin with the request that passage be provided for himself and his family to the British Zone of Germany. It transpired that ZUMPE had been working for the Russians in the GEMA Buildings, Wendelschlossstrasse, 3, Berlin-Kopenick, but did not wish to move to Russia with that organisation.

3. ZUMPE was interrogated by the Intelligence Department, Air Division, CCG. (BE), and was then evacuated by air to F.I.A.T. (Main), where he is at present lodged in "Dustbin". [...]

14. ZUMPE also had in hand a new project for a rocket motor on the same principles as the new C2, but developing a thrust of 50 tons for use in a 26 ton rocket of the A4 type. This project was still in the early stages; the only decision made was that the maximum weight allowable for the motor, fuels, and shell was 20 tons, leaving 6 tons for the warhead. He claims that he can complete the calculations for this project in 4–6 weeks. [...]

16. ZUMPE states that it was impossible to gain access to departments other than the one in which he worked, as his pass was clearly marked with the department for which it was valid, and even the Russian officers on the unit were not allowed to enter buildings with which they were not directly concerned. [...]

[The Soviets apparently found plans for the German 6-ton bomb and conscripted German engineers to recreate methods (especially the rocket mentioned by Dulles above) to deliver it.]

Nazis Were Working On 100-Ton Rocket. ***The Courier-Mail*** **(Brisbane, Australia). 5 December 1946 p. 1.** [**https://trove.nla.gov.au/newspaper/article/49363386**]

NEW YORK, December 4.—When the war ended the Nazis were building a 100-ton rocket with which to strike at the United States.

This has been revealed by the brilliant German scientist, Wernher von Braun, who invented the V2 rocket.

Von Braun is now in the United States working with American experts on rocket experiments.

The super-rocket, he said, was on the drawing-board when Germany was over-run. It would have carried an explosive charge of six tons, and would have been capable of travelling thousands of miles.

He claimed that the V2 rocket failed in only about 5 per cent of its tests in Germany.

Von Braun and his associates from Germany are being kept at work under the utmost secrecy by the Army as they help to train American ordnance men, industrialists, and scientists from leading American universities in the secrets of rocket bombs.

U.S. Gain

An estimate that German and Austrian scientists had saved the United States more than £235 million in basic research in rockets alone was disclosed by the War Department in announcing that 730 additional experts were to be brought to the United States.

Former enemy brain-power, the department said, had advanced American research in several fields by from two to 10 years.

Already 270 former enemy scientists are at work in the United States. They include the former chief designer for the Messerschmitt aircraft works and the technical director of the Nazis' Peenemunde rocket proving ground. They came to the United States voluntarily.

The scientists are being paid on contract, the maximum being £975 annually, plus 37/ daily expense allowance. This is considerably less than the salaries paid to American civil service workers doing comparable work.

The work of the foreign scientists covers the fields of electronics, supersonics, guided missiles, jet propulsion, and fuels.

["100-ton rocket" was a name sometimes used by the Peenemünde engineers for the A-9/A-10. Usually the expected payload of the A-9/A-10 is given as 1 ton. That could be stretched to 2 tons without much trouble. A German rocket design capable of carrying a 6-ton payload is unknown in the official histories. Was this a different version of the A-9/A-10, or a different rocket entirely?

Because of the extreme difficulty of accommodating a 6-ton payload on a rocket, that would have been attempted only if the payload could not be made smaller. Conventional explosives, chemical weapons, biological weapons, or a radioactive dirty bomb could be made as small as desired, and delivered on multiple rockets if necessary. Even a fission bomb would only weigh 2–3 tons. This must have been a weapon whose physical constraints at that time required it to be no smaller than 6 tons—presumably a hydrogen bomb.]

Nazi Scientists Work On U.S. Rocket Experiment. *Newcastle Morning Herald and Miners' Advocate* (NSW, Australia). 5 December 1946 p. 3.
[https://trove.nla.gov.au/newspaper/article/133178482]

NEW YORK, Dec. 4.—Before the war ended the Nazis were building a 100-ton rocket to strike the United States. This was revealed by the brilliant German scientist Wernher von Braun, who invented the V2 rocket, and who is now in the United States.

Von Braun is at present working with American experts on rocket experiments.

He said the Nazis' super-rocket was on the drawing board when Germany was overrun. It would have carried an explosive charge of six tons and be capable of travelling thousands of miles.

Von Braun claimed the V2 failed in only about five per cent of its tests in Germany.

Von Braun and his associates from Germany are being kept at work under the utmost secrecy by the army as they help to train American ordnance men, and industrialists and scientists from leading American Universities in the secrets of rocket bombs.

Saved U.S. Millions

A statement issued by the War Department in Washington said it was estimated that German and Austrian scientists had saved the United States more than 750 million dollars (£A234 1/2 millions) in basic research in rockets alone.

The department announced that about 730 additional experts would be brought to the United States.

The statement said that former enemy brainpower had advanced American research in several fields two to ten years. The number of experts put to work since September 1945 had grown to 270, and the total would be increased to about 1000 as soon as transportation arrangements were completed.

The scientists and technicians include the former Chief Designer for the Messerschmitt Aircraft Works and the Technical Director of the Nazis' Peenemunde rocket-proving ground. They came to the United States voluntarily.

Nazis Planned Rocket to Hit U.S. *New York Times.* 4 December 1946.

Wernher von Braun, 34-year-old German scientist who invented the deadly V-2 supersonic rocket, revealed today that before the war ended the Nazis were building a 100-ton rocket to strike at the United States.

Von Braun told reporters that the 100-ton rocket was on the drawing board when the Allies overran Europe. He said it would have carried a "pay-load" of six tons and would have traveled thousands of miles to strike the United States.

Eugen Sänger and Irene Bredt. 1944. *Über einen Raketenantrieb für Fernbomber.* UM 3538. Ainring: Deutsche Luftfahrtforschung. English translation 1952. *A Rocket Drive for Long Range Bombers.* CGD-32, C-84296. Technical Information Branch, Buaer Navy Department. pp. 148, 152.

As an example of area attack with single propulsion and full turn, we use the attack on New York at a range of 6500 km. For c=4000 m/sec, the bomb load is 6 tons, and the detailed attack runs as follows: the motor starts to work 36 seconds after the take-off at 12 km. distance from the take-off point, and consumes the total fuel supply of 84 tons in the next 336 sec. At the end of the climb process, the aircraft reaches a velocity of 6370 m/sec, an altitude of 91 km, a distance of 736 km. from the point of take-off, and a weight of 16 tons. Using only its store of potential and kinetic energy, the bomber flies on to the point of bomb release, 5550 km. from the take-off point, and 950 km. in front of the target. At this point, which is reached 1150 sec. after take-off, the velocity has decreased to 6000 m/sec, and the stationary altitude to 50 km. After the bomb release the weight is 10 tons. Then the aircraft goes into a turn and in 330 sec. goes through a turn-spiral 1000 km. in diameter until it has reached the direction for the return flight to the home base. During turning, the altitude is greatly decreased in order to develop the aerodynamic forces necessary for the turn. At the end of the turn path, the velocity is still 3700 m/sec. and the corresponding stationary altitude is 38 km. The supersonic glide-path in the direction of the home base goes over 5450 km. in 2600 sec. and ends 100 km. before the home base at an altitude of 20 km. and velocity 300 m/sec. Subsonic glide and landing are completed in customary fashion. The whole flight lasts 4755 sec.

[The Sänger-Bredt Silbervogel space plane was designed to bomb New York or other targets in the United States. Historians have dismissed the Silbervogel as merely a paper design that was never seriously considered or built. However:

- Eugen Sänger and Irene Bredt completed and submitted a 900-page proposal giving details of the Silbervogel design and development program to the German government in 1941 [Myhra 2002].
- Wind tunnel models of Silbervogel are known to have been constructed and tested (p. 5689).
- At least one photograph exists of a full-sized Silbervogel engine that had been constructed for testing no later than 1944 (p. 5690).
- In January 1946, five Canadian aerospace experts reported that while visiting a German research station, they viewed "a rocket motor 10 times larger than those used on V-2s." That description could match either the Silbervogel motor or the A-10 booster rocket motor (p. 5552).
- Detailed orbital calculations were performed in 1944 to find the best trajectory for the Sänger-Bredt vehicle to reach New York (pp. 5691–5693).
- An article published in the 30 October 1944 *Daily Mail* reported that the Germans in occupied France had been constructing a "huge ramp" that was "intended as a launching place for flying

bombs, which... would wreck New York." The size of the ramp, the reference to flying bombs, and the claimed target of New York seem consistent with the Silbervogel launch catapult (p. 5694).

- U.S. Army Air Forces Colonel Donald Putt, in charge of overseeing all German rocket scientists and related equipment and information rounded up at the end of the war, reported in March 1946: "Test model was made that carried one man and had landing gear, although it is not known if this model ever flew; it is known, however, that test runs were made on its engine." Thus according to an authority with arguably the best access to the available information, the Silbervogel engine was constructed and tested, a Silbervogel vehicle complete with cockpit and landing gear was constructed, its engine was operational, and postwar U.S. officials were left wondering if flight tests of the Silbervogel may have even been conducted (p. 5695). What German witnesses and documents was this information based on? What became of the prototype Silbervogel vehicle—was it destroyed by the Germans, removed by the Americans, or removed by the Soviets?

- A lengthy and detailed October 1946 article in *Harper's Magazine* stated that the Silbervogel system "was never completed merely because of the war's quick ending" (p. 5572).

- A 1957 U.S. Air Force report stated: "The boost-glide concept was... partially tested by the Germans in the early 1940's" (p. 5697).

In the part of their 1944 report quoted on the previous page, Sänger and Bredt specifically discussed using the Silbervogel to deliver a six-ton bomb to New York. That agrees with several other independent sources that mentioned a special six-ton bomb (pp. 4376, 4388–4400, 5411). Six tons of conventional explosive would not do even remotely enough damage to justify the enormous amount of money, labor, materials, time, and energy involved in developing a systems such as Silbervogel to deliver the bomb to a U.S. target, especially under wartime conditions when all of those resources were critically needed and in short supply. The whole approach would have made sense only if the six-ton bomb was nuclear, and indeed some of the sources specifically stated that it was nuclear—in fact, apparently a full-fledged hydrogen bomb.

Moreover, some sources indicated that much of the work related to the six-ton or hydrogen bomb was conducted in Austria, and Sänger was Austrian. Between his professional connections and his payload delivery method, it seems quite reasonable that Sänger would have had some contact with the scientists who were working on the actual bomb.

While most wartime papers on Sänger's work were destroyed or were captured and remain inaccessible in archives, some of the letters he wrote to Hermann Oberth after the war confirm that he was quite interested in fusion reactions [Oberth 1984, Vol. 1, pp. 199–200, 213–216].]

G. Ward Price. Fly-bombs Were Meant for U.S.: Huge Ramp Found. *Daily Mail.* 30 October 1944.

Immense concrete works on top of a hill in Artois, near Saint Omer, were intended as a launching place for flying bombs, which, the Germans boasted, would wreck New York.

Thousands of workmen were employed in tunnelling and building a cylindrical cupola on top of the hill, 250ft. in diameter.

Lorries, and even trains, could drive right into the heart of the hill.

German engineers told local French people that when the vast machinery was installed and ready to fire, the district would have to be evacuated for six miles around.

Frequent attacks by the R.A.F. kept on delaying work until the Allied advance from Normandy obliged all the enemy engaged on it to pack up hurriedly.

Footnote.—A German U-boat commander recently told naval cadets at Esjberg, Denmark, that Germany was preparing a new secret weapon for use against America. He said that U-boat crews would play a decisive part in the use of the weapon.

[The six-mile radius suggests that the bomb would have had that blast radius. A 6-mile or 10-km blast radius corresponds to an explosive energy of at least $(10,000/85.5)^3 \approx$ 1,600,000 tons of TNT equivalent, or at least 1.6 megatons. This is well beyond the kiloton-ranges of fission bombs, as the German scientists knew from basic calculations of fission energies, and suggests that they were developing much more powerful hydrogen (H) or fusion bombs. Other sources from around the same time also mentioned the exact same 10-kilometer/6-mile blast radius (pp. 4404 and 4405).

This site sounds like a launching sled track for the Sänger-Bredt Silbervogel space plane, or possibly a slightly smaller launching track for the winged A-9 rocket. For more discussion on track-launched rockets, see Section E.3. Also see the article on p. 5057 that mentions development of a catapult-launched atomic bomb delivery system in Norway.]

Bruno Spampanato. 1974. *Contromemoriale.* Rome: Centro Editoriale Nazionale. pp. 917, 1116. [Spampanato (1902–1960) was a journalist and politician who was a longtime supporter of Mussolini and very well connected with high-ranking Italian officials. After the war, he wrote a multivolume memoir that preserved information from a huge number of sources that otherwise might have been lost or forgotten. Here he quoted two wartime sources that both appear to have been describing a nuclear weapon with a megaton-level yield. One of them even gave the exact same 10-kilometer/6-mile blast radius as other sources from that time (pp. 4403 and 4405).]

Qualche cosa del genere ci ha detto Goffredo Coppola ch'era stato in Germania a un congresso scientifico in rappresentanza del Governo: e tornava allora. Ci vediamo al Plaza con lui ed Enrico Santamaria. Coppola ci dice qualche cosa che rasenta i limiti della fantasia. Ma tutto si può sospettare di Coppola, Rettore Magnifico dell'università di Bologna, fuorché si occupi di fotomontaggi come Theil, o di altra propaganda razionale. Il prof. Coppola ci dice quanto gli hanno confidato degli scienziati che hanno fama mondiale per i loro studi.

Questo ci disse Coppola il 16 febbraio 1945: "I tedeschi hanno trovato il mezzo per disintegrare l'atomo. E una scoperta elettronica. La disintegrazione avviene a cicli successivi e prende aree vastissime di decine di chilometri. Nei laboratori si lavora in pieno". [...]

Tra gl'italiani il più a contatto coi più alti ambienti militari tedeschi era il Maresciallo [Rodolfo] Graziani. E proprio Graziani nella sua autodifesa dinanzi alle Assise Speciali di Roma [1948] depose: "Ognuno può dire quello che vuole sulla faccenda delle armi segrete; ma sta di fatto che le armi segrete in Germania c'erano: c'erano nel modo più assoluto e c'era un rinnovamento in tutta l'aviazione con apparecchi a reazione, e ne avevano già in gran numero, migliaia. Non sono riusciti a metterli in funzione perché in quel momento è cominciata a mancare la benzina, e in seguito ci sono stati i bombardamenti a tappeto fatti dagli anglo-americani sugli impianti delle industrie. Stavano per realizzare anche l'antiradar per le segnalazioni e avrebbero potuto ricominciare la guerre dei sommergibili. C'era la V-1 e c'era la V-2, ma si arrivava fino alla V-10 che distruggeva nel raggio di dieci chilometri ogni elemento di vita".

Something like this was said to us by Goffredo Coppola, who had been in Germany at a scientific congress representing the government and then came back. We met at the Plaza with him and Enrico Santamaria. Coppola told us something that borders on the limits of fantasy. But everything can be suspected of Coppola, the Magnificent Rector of the University of Bologna, except that he deals in fakes like Theil, or other intellectual propaganda. Prof. Coppola told us what he had been confidentially told by scientists who are world-renowned for their studies.

This Coppola told us on 16 February 1945: "The Germans have found the means to disintegrate the atom. And an electronic discovery. The disintegration occurs in successive cycles and covers vast areas of tens of [square] kilometers. In the laboratories work is at full capacity." [...]

Among the Italians the most in contact with the highest German military circles was Marshal [Rodolfo] Graziani. And it was Graziani himself in his self-defense before the Special Court in Rome [1948] who testified: "Everybody can say what they want about the matter of secret weapons; but the fact is that secret weapons in Germany were there: they were there in the most absolute way and there was a renewal in the whole aviation with jet aircraft, and they already had them in large numbers, thousands of them. They were not able to put them into operation because at that time there began to be a shortage of gasoline, and later there was the carpet bombing done by the Anglo-Americans on the plants of industries. They were also going to make anti-radar for signaling and they could have started the submarine wars again. There was the V-1 and there was the V-2, but it went all the way up to the V-10 which destroyed within a ten-kilometer radius every element of life."

Germans Timed Atom Bomb for October. *Evening Standard* (London). 7 August 1945.

The Germans had an atom bomb which would have been ready by October.

A colossal blast effect was claimed for the German bomb. It was said it would wipe out everything inside a radius of six miles, said B.U.P. today.

The German atomic plans were uncovered four months ago, when an Allied search party walked into a small silk factory at Celle, north of Hanover.

A laboratory of two rooms was buried away in the heart of the factory. A famous research scientist [Wilhelm Groth] was still at work. He was flown to Britain the same day.

This man, with others, had been working on the Atom bombs for months. The Nazi Government poured out money on it. Apparently they had not asked for immediate results.

Nazis Five Months from Completion of Atomic Bomb. *Pittsburgh Press.* 7 August 1945 p. 14.

21ST ARMY GROUP HEADQUARTERS, Germany, Aug. 7 (UP)—Germany was within five months of completing her own atom bomb when the European war ended.

A British task force four months ago discovered that German scientists almost had completed work on the bomb in a two-room laboratory in the heart of a small silk factory north of Hannover.

The bomb, it was calculated, would wipe out everything within a radius of six miles.

A famous German research scientist [Wilhelm Groth, in] charge of the experiments was flown immediately to Britain at the time. He estimated his work would have been completed by October.

He said the German Government had given him unlimited funds and equipment and had not demanded any immediate results.

[Also reported in:

6-Miles Radius Bomb. *Toronto Daily Star.* 7 August 1945. p. 1.

6-Miles Radius Bomb. *Madera Tribune* (Madera, California). 7 August 1945. p. 1.

Bomba de 10 Kilómetros. *ABC* (Madrid). 8 August 1945.

These articles all mentioned a bomb with a 6-mile blast radius. Completely independent sources from around the same time also gave the same 10-kilometer/6-mile blast radius (pp. 4403 and 4404). As already noted, a 10-kilometer/6-mile blast radius would correspond to at least a ~1.6 megaton explosion, which would suggest a hydrogen bomb and not a simple fission bomb. Wilhelm Groth, a very talented physicist who along with Paul Harteck had played a major role in numerous aspects of the German nuclear program since early 1939, stated that Germany was five months away from completing such weapons. If true, that was a feat that the U.S. and U.S.S.R. did not actually accomplish until the 1950s.]

Air Intelligence Report No. 100-13/1-100, Significant Developments and Trends in Aircraft and Aircraft Engines, Antiaircraft Guided Missiles (15 June 1946). pp. 3, 90–93. [NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001–3100]

[...] b. Russia is known to have acquired German technicians and V-weapon production and experimental sites. [...] In addition, German developments in the atomic energy field and the possibilities for use of this energy as a guided missile warhead are known to the Russians.

(3) Step rockets. This type of rocket had been considered by the Germans who anticipated ranges of 3,000 miles or more with successors of the V-2. Such a rocket would consist of a main body containing the demolition charge and control units and two or more detachable sections containing propulsion units. These sections would be dropped from the missile as they were exhausted in flight. Such a rocket in the hands of the Russians would make the transpolar routes probable tactical approaches. [...]

e. Russian Atomic Energy. The development of atomic weapons and guided rocket projectiles go hand in hand. It was the Germans who realized that the rocket was "the ideal vehicle for atomic warhead" and it has been established that they intended the A-4 (V-2) rocket to be such a vehicle. In the construction of a long-range rocket, space allotted to payload is of necessity reduced to a minimum by the increase in space allotted to fuel. Adaptability of the atomic warhead to such a missile can be fully appreciated because the ratio of destructive power to unit weight is far in excess of conventional explosives and a radical increase in the destructive power is not accompanied by a similar increase in volume of the warhead.

Little is known concerning the Russian activity with regard to atomic energy. [...]

g. Heavy Hydrogen Bomb. In Germany a letter was picked up by the American censors. It had been written by a German desirous of exchanging information for an opportunity to go to the United States. The writer professed knowledge of "heavy water" research in Germany and of an "even more deadly weapon than the atomic bomb".

h. German Heavy Hydrogen Bomb. During 1943 the Germans were experimenting with the production of "heavy water" in Norway. Their installation at Rjukan, Norway was deemed important enough at that time to warrant a visit from the heavy bombers of the Eighth Air Force. It was evident that the Germans recognized the potentialities of "heavy water" as a source of Heavy Hydrogen and were taking advantage of the abundance of electric power available in Norway for the production of this substance.

The war brought the German activity in connection with "heavy water" to a close but the question can now be posed, "Have the Russians obtained German personnel formerly employed in the project and if so will they exploit them in an effort to devise an atomic weapon which requires none of the radio active minerals so closely guarded throughout the world?" If the Russians are successful in this attempt, they will have within their grasp the new atomic weapon which is reported to have made the Uranium bomb obsolete. Research in the United States confirms the comparison of the Heavy Hydrogen bomb to the Uranium bomb.

[See document photos on pp. 4408–4409.

How exactly did U.S. intelligence know that Germany intended to build an atomic bomb, intended to deliver it via rocket, and made "developments" that fell into Russian hands?

No significant information about H-bombs was public until fall 1946 (pp. 4375–4379), so the German letter writer's knowledge apparently came directly from wartime work.

Can this letter be located now?]

b. Russia has apparently stepped up her exploitation of captured German facilities and personnel for the production of German jet-propelled aircraft. It is known that the Junkers and Siebel aircraft factories and the BMW aircraft-engine plants are being used by the Russians for production of this type aircraft and turbojet engines. Description of the aircraft reportedly produced, plus knowledge of the latest types of German aircraft produced in these factories prior to V-E Day, point to Russian production of the "JU-287" Bomber (509 miles per hour) and the "HE-162" and ME-262" aircraft.

c. France is known to be experimenting with several new jet-propelled aircraft and with commercial air transports having increased capacity. These include the large 108-passenger conventional four-engine transport (SE 2010) presently under development, the "NC 260" high speed jet-propelled commercial transport, the "NC 270" turbojet, and the "Nord 1600" jet-propelled military aircraft.

The trend in French aircraft development since the March 1946 report now appears to be in improving and re-establishing French commercial air transport, with military development as a secondary consideration due to the great reduction in military appropriations. This development can be expected to incorporate the latest research in the fields of jet-propulsion as soon as France has reached a more stabilized economy and a more settled political outlook.

d. Sweden has shown no new trends in aircraft or aircraft engine development since the March 1946 report. At that time successful purchase of the latest jet-propelled aircraft and engines from neighboring nations to build a modern, if modest, air force was being expedited by Sweden. Some native research, which has not progressed beyond the experimental stage, has been conducted on jet and turbojet engines.

2. Antiaircraft Artillery.

a. Great Britain has stated her policies for antiaircraft development for the next ten years. These policies include research and development for AA for the next two years with a long term policy for continued AA development along conventional lines until this research has resulted in a better means of destroying sonic speed aircraft flying in excess of 45,000 feet. Standardization, where possible, between Army and Navy weapons is planned, as is the organization of a nucleus force of regular troops supported by a readily conscriptable force of volunteers.

- 2 -

TOP SECRET

b. Russia, like other major powers, has shown a tendency to develop larger caliber AA guns. It has also been reported, but not confirmed, that the Soviets are manufacturing radar jamming equipment. A greater flexibility for antiaircraft defense has been provided by the recent reorganization of the Soviet Armed Forces.

c. German developments for increasing AA effectiveness by increasing muzzle velocity and a discussion of German anti-RCM (Radar Countermeasures) devices is outlined, due to the probable use of these advances by other countries.

d. Sweden and France appear to be in a better position to develop an adequate AA defense than most of the other smaller countries due to the experienced Bofors firm in Sweden and French knowledge of Allied and German AA equipment and methods of operation.

e. Fifteen other nations studied show no significant native developments or trends in the field of antiaircraft artillery.

f. Japanese shortcomings in AA development show that the value of antiaircraft artillery was not realized in time to develop it. The lack of coordination between Army and Navy and the lack of properly trained technical personnel to produce modern equipment helped to retard AA development once its value was realized.

3. Guided Missiles.

a. Great Britain is working closely with the United States in the development of her guided missile program. As a consequence, the British are running into similar problems relative to radar guidance, telemetering, fuel combustion, radio signal attenuation, and the means to be used in determining the point of separation of the missile and its boost device. In addition to their own development program, Britain is exploiting German guided missile technical personnel to the maximum. The close working liaison of Britain and the U. S. should allow each nation to profit by the other's mistakes and thus accelerate guided missile development in each country.

b. Russia is known to have acquired German technicians and V-weapon production and experimental sites. She has also acquired Britain for guided missile control experiments. With this combination the Russian potential for development of a guided missile program is great. In addition, German developments in the atomic energy field and the possibilities for use of this energy as a guided missile warhead are known to the Russians.

c. Other nations have shown almost universal interest in atomic energy but little as yet in the research or development of guided missiles.

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Air Intelligence Report No. 100-13/1-100, Significant Developments and Trends in Aircraft and Aircraft Engines, Antiaircraft Guided Missiles (15 June 1946). NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001-3100

Suiza has acquired the manufacturing right from Rolls-Royce for the production of the "Derwent", under license.

4. U.S.S.R.

a. Significant Designs and Trends of Russian Aircraft.

(1) The trend of the U.S.S.R., since March 1946 has been to exploit German equipment and to utilize the knowledge of German scientists. A list of Russian aircraft together with the main characteristics of aircraft known to be under development and those operational, including obsolete and obsolescent aircraft, are shown in Annex No. II. These charts do not include foreign aircraft operated by the Russians; many of which have superior performance to similar Russian types. As can be seen from Annex No. II, operational aircraft are conventional, with relatively low speeds and low critical altitudes as compared to U. S. types. The Russians have no turbo supercharger operational except those installed on the "M-30" and "M-42" diesel engine models. The problems encountered by Russia, so far, in the design of turbos has been the metallurgical requirements necessary to counteract the high temperatures encountered around the turbine blades. If the Russians utilize the knowledge of German turbine blade design, this problem should be easily overcome.

(2) Recent information has indicated that the Russians are operating the Siebel and Junkers aircraft factories and BMW Jet Engine Plants. The Junkers factory is possibly manufacturing the German "Ju-287" bomber for the Russians. This bomber was in the flight test stage at the end of hostilities. It is fitted with from two to six jet units depending on the power of the units installed. The Germans expected to attain the high speed of 509 miles per hour at sea level and 537 miles per hour at 16400 feet altitude with this bomber. Other characteristics of this bomber were ranges of 985 miles with 8800 lb. bomb load, 1175 miles with 6600 lb. bomb load and 1325 miles with 4400 lb. bomb load. With the Junkers Plant available for the manufacture of airframes and the BMW plant for power units considerable progress should be made by the Russians. At the present time, the Russians are reported to have on order from these three German factories 6000 aircraft. These may well include the "He-162", the "Me-262" and the "Ju-287".

(3) The outstanding aircraft the Siebel Company was developing was the "DFS-346", a supersonic research aircraft with expected speed of about 1700 miles per hour at 50 - 100,000 feet altitude. This experimental aircraft, if perfected, would do much to hasten the Russian development of aircraft capable of operating in the transonic and supersonic speed ranges.

(4) This flight information, together with the available wind tunnels which may have been removed from the Russian Zone of Germany into Russia proper, could decrease the lag in Russian aircraft development. The highest speed wind tunnel known to be in Russian hands is at Dresden. This tunnel possesses a Mach No. 1 test speed, but the test section is so small it could not be of too much value. The most valuable tunnel for high speed research is the .92 Mach number tunnel at Berlin having an 8.8 foot diameter throat which could be used for testing relatively large models. All other wind tunnels in the Russian zone are of low speed.

(5) It is known that several four engine bombers are under development by Russia as well as some jet bombers and fighters. It is not known how much progress has been made on Russian designed aircraft. Nothing is known of a fully developed Russian jet unit so it may well be that the first Russian jet aircraft will be Russian built but of German design.

5. Sweden

a. Development and Trend of Swedish Aircraft and Engines.

(1) No new native Swedish aircraft or engine development is known although the Swedes are manufacturing under

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Figure D.659: Air Intelligence Report No. 100-13/1-100, Significant Developments and Trends in Aircraft and Aircraft Engines, Antiaircraft Guided Missiles (15 June 1946). [NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001–3100]

b. Indicators of Future Activity. Research upon guided missiles is predicated upon developments in the following fields:

(1) New Fuels. Research is divided between fuels for antiaircraft rockets and fuels for long-range rockets. Those for antiaircraft rockets must be capable of indefinite storage yet available for immediate use. Fuels for long-range rockets can be chemicals of temporary stability, prepared and used on a prearranged schedule. The Russians may follow the American and British course of fuel development and design their rocket propulsion devices around a mono-fuel, such as gasoline. They may continue to exploit the field of German fuels which included combinations of organic hydrocarbons and commercially prepared oxidizing agents.

(2) Control Devices. Four broad systems are now under consideration: single radar control by the British, two radar control by the U. S., self-homing (favored by the Germans), and a television plus radio-link system commonly recognized as the most promising form of missile control. Russian periodicals must be watched for evidence of activity or interest in these fields.

(3) Step Rockets. This type of rocket had been considered by the Germans who anticipated ranges of 3,000 miles or more with successors to the V-2. Such a rocket would consist of a main body containing the demolition charge and control units and two or more detachable sections containing propulsion units. These sections would be dropped from the missile as they were exhausted in flight. Such a rocket in the hands of the Russians would make the transpolar routes probable tactical approaches.

(4) Atomic Warheads. This step will work the final development of missiles for operational use.

c. North Polar Regions. The north polar region is not deemed important as a launching position for guided missiles but it may assume prominence as a location for radar remote control posts, weather stations, early warning radars, and counter-measure sites. Across this area lie

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the great circle paths between Eurasia and the United States. It is significant that the important paths pass over Iceland or Alaska.

d. Estimate of the Situation. The operations "Musk-Ox" and "Frostbite" clearly demonstrate that our strategists recognize the potentialities of the north polar region.

e. Russian Atomic Energy. The development of atomic weapons and guided rocket projectiles go hand in hand. It was the Germans who realized that the rocket was "the ideal vehicle for atomic warhead" and it has been established that they intended the A-4 (V-2) rocket to be such a vehicle. In the construction of a long-range rocket, space allotted to payload is of necessity reduced to a minimum by the increase in space allotted to fuel. Adaptability of the atomic warhead to such a missile can be fully appreciated because the ratio of destructive power to unit weight is far in excess of conventional explosives and a radical increase in the destructive power is not accompanied by a similar increase in volume of the warhead.

Little is known concerning the Russian activity with regard to atomic energy. Recent developments in the detection of radio-active material in the upper atmosphere resulting from the explosion of the three atomic bombs indicate that Russian atom bomb tests could be detected. This could be accomplished by examination of the upper airs known to have originated in or near Russian territory. An increase in radio-active material would indicate experimentation with atomic explosives. The validity of these experiments on the examination of upper airs will be more fully shown following the Crossroads experiment.

f. Polar Chart. Annex I shows possible great circle routes across the polar regions.

4. Other Nations

a. Atomic Bomb and Guided Missile Activity. The problem of how to obtain food in the various sections of the world has, during the past several months, far outweighed the problems of technical advancement in the field of guided missiles, electronics, and atomic energy. Occasionally, there have appeared items in the news which indicate that research on new branches of science is proceeding. From these bits of information an attempt is made to assemble a clear picture of future trends. The news must be carefully scrutinized and the fantastic separated from the possible before a hypothesis concerning the trend of research and development can be formulated. In many cases the inferences contained in these reports serve as a "straw in the wind." It is pointed out that in some

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Air Intelligence Report No. 100-13/1-100, Significant Developments and Trends in Aircraft and Aircraft Engines, Antiaircraft Guided Missiles (15 June 1946). NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001-3100

cases the "fantastic" becomes a hard reality as in the case of the late Professor Goddard in his original rocket experiments in New Mexico.

b. Argentinian Guided Missiles. With the fall of Germany and its occupation by the Allies, it was assumed that German research on V-weapons was successfully halted. A speculative report from Argentina points out that the Argentinian Army received data from Germany concerning the manufacture of propulsion fluid used in making rocket bombs. In addition to this report of transfer of information, there remains a second possibility that former German scientific personnel, having been successful in evading capture by the Allies, may have found a haven in Argentina.

c. Atom Bomb Production. There have been no reports to date which would indicate that an atom bomb project similar to the one at Oak Ridge is under construction in any other part of the world. There are reports concerning advancements in atomic energy which indicate that a search is being made for materials other than Uranium which can be used in the production of more lethal and devastating weapons.

d. Uranium Control. The movement of various nations to place their Uranium deposits under rigid governmental control has attracted widespread attention. Restrictions may insure the owner of such deposits that the ores will not be exported for use by an aggressive nation, but do not prevent enterprising individuals from devising a similar bomb from other fissionable materials, i.e., "heavy water".

e. Uranium Deposits. The deposits of Uranium ore are widely dispersed and, as a result, available to many nations. The exploitation of these deposits and the refining of Uranium ore for experimental uses is limited at the present time to those nations financially capable of such an undertaking.

f. Atomic Dust. Reports indicate that the preparation of atomic bombs from Uranium yields additional materials which may be of military value. Most interesting of these is the "atomic dust" which is believed to be the "red mist". Mention of "red mist" has been made recently in the news from Europe as being a new atomic weapon. It is thought that the "red mist" may be a radio-active dust emitting powerful radiation. The possibilities for this type of weapon being used to deny entry to or use of wide areas to any enemy during maneuvers and its anti-personnel effect upon camps, industrial areas, and cities are not to be overlooked.

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g. Heavy Hydrogen Bomb. In Germany a letter was picked up by the American censors. It had been written by a German desirous of exchanging information for an opportunity to go to the United States. The writer professed knowledge of "heavy water" research in Germany and of an "even more deadly weapon than the atomic bomb".

h. German Heavy Hydrogen Bomb. During 1943 the Germans were experimenting with the production of "heavy water" in Norway. Their installation at Rjukan, Norway was deemed important enough at that time to warrant a visit from the heavy bombers of the Eight Air Force. It was evident that the Germans recognized the potentialities of "heavy water" as a source of Heavy Hydrogen and were taking advantage of the abundance of electric power available in Norway for the production of this substance.

The war brought the German activity in connection with "heavy water" to a close but the question can now be posed, "Have the Russians obtained German personnel formerly employed in the project and if so will they exploit them in an effort to devise an atomic weapon which requires none of the radio active minerals so closely guarded throughout the world?" If the Russians are successful in this attempt, they will have within their grasp the new atomic weapon which is reported to have made the Uranium bomb obsolete. Research in the United States confirms the comparison of the Heavy Hydrogen bomb to the Uranium bomb.

i. United Kingdom. It is reported that a 1,000,000 volt cyclotron and a mass spectrograph are under construction at Melbourne University in Australia. England has allocated $11,200,000 for atomic energy research and a former R.A.F. airfield is being converted to laboratories for atomic research. On 1 March 1946 the Director of Atomic Energy Group assumed his duties. This group was organized to formulate policies with regard to atomic energy.

j. Scandinavian Countries. Sweden proposes that seven million Kronor be set aside for atomic research. She possesses both a cyclotron and deposits of Uranium ore. A Scandinavian conference has been called by Norway, Sweden, and Denmark to discuss the future plans for application and use of atomic energy. Dr. Niels Bohr, outstanding nuclear physicist from Denmark, has received $125,000 for the continuation of his work and has declined invitations to travel outside of that country.

k. France. France has appointed a committee to formulate plans concerning the control of atomic energy. The immediate object of this committee is the establishment of small research plants.

l. Spain. It is reported that Spain has been mining Uranium. This country was recently the center of attention due to concern over reports that German nuclear physicists were employed in atomic bomb research. It is believed that these news reports were Communist inspired and aimed at diverting public attention from Russian activity.

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Figure D.660: Air Intelligence Report No. 100-13/1-100, Significant Developments and Trends in Aircraft and Aircraft Engines, Antiaircraft Guided Missiles (15 June 1946). [NARA RG 38, Entry 98C, Box 11, Folder TSC # 3001–3100]

Kurt Diebner, 1962, *Kerntechnik* 4:3:89–93. Nuclear explosive design with numerous concentric spherical shells, likely based on wartime work.

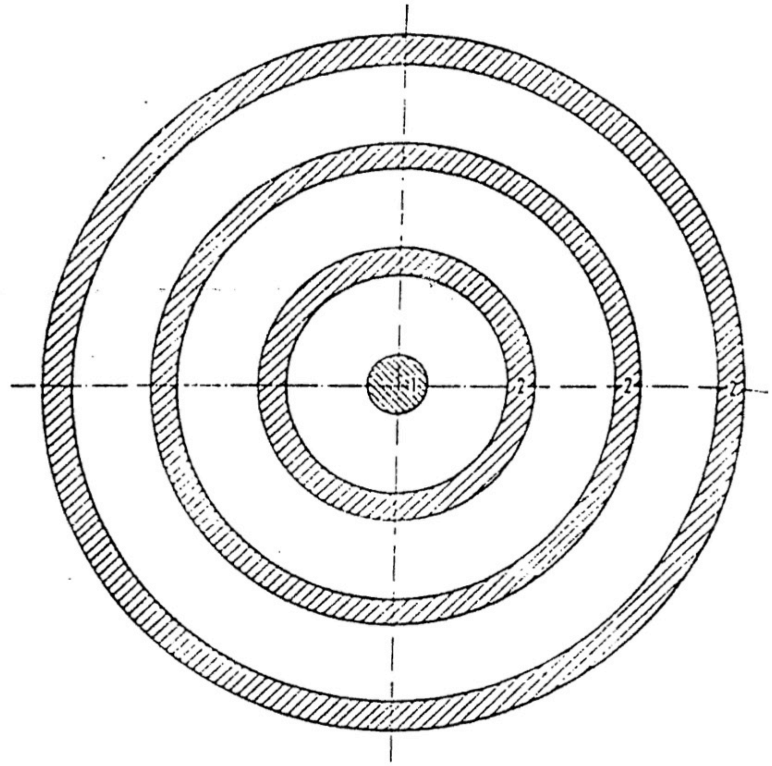

Abb. 3: Eine der Abb. 2 entsprechende schematische Anordnung mit einer Folge von ineinandergefügten Sprengstoffschalen (2) zur Verstärkung des Effektes; (1) bedeutet wieder den Fusionsreaktionsraum

Friedwardt Winterberg, 1981, *The Physical Principles of Thermonuclear Explosive Devices.* Winterberg worked very closely with Diebner after the war.

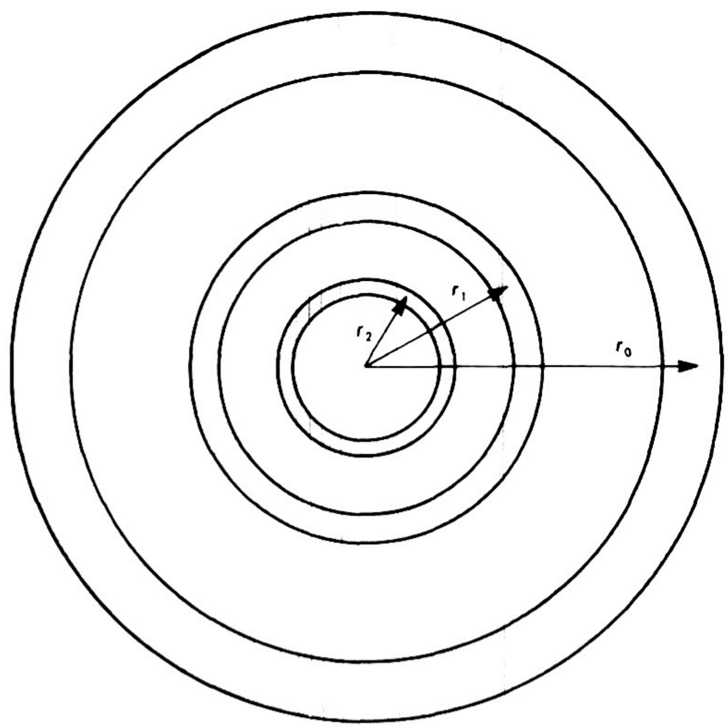

Figure 7. The implosion velocity can be raised through the subsequent collision of several concentric shells of decreasing mass.

Figure D.661: Top: Diagram from Kurt Diebner, likely based on wartime work [Diebner 1962]. Bottom: Diagram from Friedwardt Winterberg, who worked very closely with Diebner after the war [Winterberg 1981]. These diagrams illustrate nuclear explosive designs with a large number of concentric spherical shells to increase the implosion velocity, but they may also represent a key step toward a sloika H-bomb design that implodes alternating layers of fission and fusion fuel.

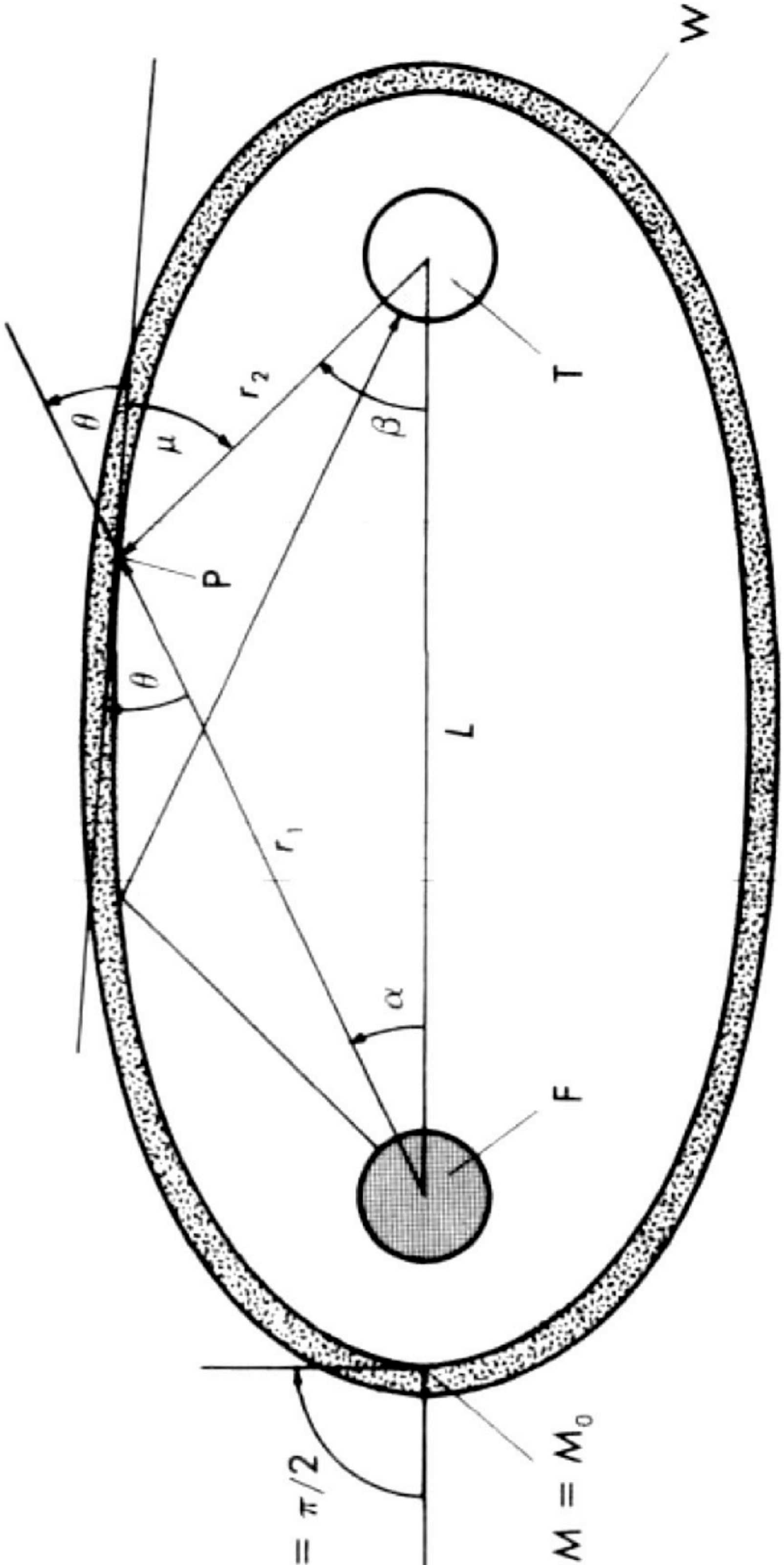

Figure 4. In the Prandtl-Meyer ellipsoid shock wave focusing principle, only one fission bomb F is used to induce a spherical implosion onto the thermonuclear explosive T by shock wave reflection from the wall inside the ellipsoidlike cavity. P is the point where the incoming wave intersects with the wall; M is the Mach number of the hypersonic flow associated with the diverging wave at P; θ is the angle between the wall slope and the incoming ray; r_1 and r_2 are the rays of the shock wave.

Figure D.662: Diagram from Friedwardt Winterberg, who worked very closely with Kurt Diebner after the war, showing a fission-fusion H-bomb design that appears to be deeply steeped in pre-war German hydrodynamic theory (Ludwig Prandtl, Theodor Meyer, Ernst Mach, etc.) and not derivative of the Teller-Ulam H-bomb design used in the United States [Winterberg 1981].

Friedwardt Winterberg. 1981. ***The Physical Principles of Thermonuclear Explosive Devices.*** **New York: Fusion Energy Foundation.**

[Friedwardt Winterberg (1929–) worked very closely with Kurt Diebner after the war. In 1981, Winterberg published a book of nuclear explosive designs that appear to have been heavily based on the wartime work of Diebner and others in the German nuclear program. In particular, Winterberg presented two diagrams that appear to be especially relevant for the history of H-bomb designs [Goncharov 1996a, 1996b; Chuck Hansen 1988, 2007; Rhodes 1995; Sublette 2019; Wellerstein and Geist 2017].

1. Page 4410 shows two similar versions of a nuclear explosive design with a large number of concentric spherical shells. The top version is from Diebner, quite likely based on wartime programs with which he was involved [Diebner 1962]. The bottom version is from Winterberg [Winterberg 1981]. In both of these postwar publications, Diebner and Winterberg made the point that such a design could be useful to increase the implosion velocity. However, using a large number of concentric spherical shells is also a critical feature of the sloika H-bomb approach, which implodes alternating layers of fission and fusion fuel. Thus these postwar diagrams might be clues that the wartime German H-bomb program was working toward a sloika design.

2. Page 4411 presents another diagram from Winterberg. The diagram depicts a fission-fusion H-bomb design that appears to be deeply steeped in prewar German hydrodynamic theory (Ludwig Prandtl, Theodor Meyer, Ernst Mach, etc.) and not directly derivative of the Teller-Ulam H-bomb design that was developed in the United States after the war [Winterberg 1981]. Yet like the Teller-Ulam design, the design shown by Winterberg was intended to function as a two-stage (fission explosion, then fusion explosion) thermonuclear bomb, or a three-stage (fission, fusion, fission) bomb if the outer casing were fissionable. For evidence that this ellipsoidal design originated in the wartime German program, see p. 4415.

Either a sloika multi-layered implosion design or an ellipsoidal two-stage design for an H-bomb could have used the lithium deuteride fusion fuel mentioned in other German documents (see pp. 4319–4387).

In principle, either design could have had a weight consistent with the 6-ton bomb mass reported in documents such as those on pp. 4376, 4388–4401, and 5411.

Likewise, if either a sloika or a two-stage design worked as intended, it could have had a megaton-level explosive yield, which would also be consistent with the 6-mile blast radius reported in documents such as those on pp. 4403–4405.]

Is either a large spherical sloika design or an ellipsoidal two-stage design what Werner Grothmann meant by "a third" German nuclear bomb design that was under development during the war, that was apparently quite different than the fission bombs with which Grothmann was more familiar, and that "must have looked like a swollen bomb" (see p. 4310)?

Charles Chamberlain. Germans Failed to Split Atom: Experiments With Heavy Water Futile. *Council Bluffs Nonpareil* (Council Bluffs, Iowa). 9 February 1946 p. 1. https://www.newspapers.com/article/the-daily-nonpareil/1957966/

Another atom scientist in the British occupation zone of Germany—Prof. Paul Harteck of the Kaiser Wilhelm institute of physics in Berlin—said that the light rays thrown out during the enormous explosion of an atomic bomb added greatly to the destructive force.

'The splitting of the atom causes a temperature of more than 10,000,000 degrees and aerial allure which destroy everything,' Harteck said.

This frees an amount of light which is beyond the visible spectrum. Only a few people know that the reflection of beams of light on solid bodies also exerts a mechanical pressure. This pressure is so small where our normal light is concerned that it is not noticed. The amount of light freed by an atomic bomb is so great it destroys walls.

[On the basis of his wartime work, Harteck was apparently describing the key to radiation implosion in H-bombs. Compare Harteck's description above with the description below from Kenneth Ford, one of the American H-bomb scientists. Harteck was brought to the United States to work after the war (p. 5039).]

Kenneth W. Ford. 2015. *Building the H-Bomb: A Personal History.* World Scientific Publishing. pp. 67, 70.

Let me explain what was special about the radiation-implosion idea (the 1951 insight of Edward Teller and Stan Ulam that replaced the unattainable runaway Super with the successful equilibrium Super). [...]

The energy in a given volume of radiation goes as the fourth power of the temperature. [. . .] If you increase the radiation temperature by a factor of ten, the radiant energy increases by a factor of ten thousand (10 to the 4th power). [. . .] The energy of one cubic meter of radiation at a temperature of 30 million K is, in the units favored by weaponeers, 15 kilotons. And its pressure is correspondingly elevated, to 2 billion atmospheres. [. . .]

At ordinary temperature, radiation is like the pixie dust that was visible only to Tinker Bell and her band of fairies. At the temperatures characteristic of nuclear explosions, radiation is "stuff," full of enormous energy and capable of pushing like a giant piston.

Walther Gerlach. Notebooks 1943/44 and 1944 [Deutsches Museum Archive NL 080/270-66 and NL 080/270-67].

[See document photo on p. 4415.

Walther Gerlach kept a series of small notebooks for scientific notes to himself. They are now in the Deutsches Museum Archive in Munich. Since these notebooks served simply as scientific reminders for Gerlach, they do not contain detailed explanations, as formal laboratory notebooks would. However, they also do not contain any random artistic doodles such as some people make during meetings. Everything in them appears to have had a specific scientific purpose for Gerlach.

Notizbuch 1943/44 [Deutsches Museum Archive NL 080/270-66] is a small orange notebook covering the period 10 November 1943 to March 1944. On the final page, Gerlach drew an ellipsoid remarkably similar to Friedwardt Winterberg's postwar diagram of a hydrogen bomb on p. 4411. On the same page, Gerlach also included nuclear reactions involving deuterium and sketches of converging shock waves [Karlsch 2005, pp. 205, 321, 333].

Notizbuch 1944 [Deutsches Museum Archive NL 080/270-67] is a small dark red notebook that apparently began in March 1944; it is not clear when the final entry was made, but that was likely sometime in 1944 or possibly early 1945. Entries in the notebook show that Gerlach had scientific discussions (although the notebook does not give the scientific details) with Kurt Diebner, Siegfried Flügge, Wilhelm Groth, Fritz Houtermans, and other scientists on nuclear topics, including specifically the use of lithium.

After the war, Kurt Diebner wrote about bombs employing fusion reactions (pp. 4298–4305) and worked closely with the young Friedwardt Winterberg. Edward Teller apparently tried to recruit Siegfried Flügge to help develop the U.S. hydrogen bomb (p. 5042). Wilhelm Groth was reported to have been working on a megaton-level bomb during the war, which is consistent with the physics of hydrogen bombs but not fission bombs (p. 4405). Fritz Houtermans was the first scientist to propose and analyze the fusion reactions in stars (p. 1553).

While these surviving notes from Gerlach are cryptic and certainly not conclusive, they do suggest the existence of a wartime program that was very active by March 1944 and that involved the use of deuterium, lithium, and both fusion and fission reactions in an ellipsoidal hydrogen bomb design highly similar to that on p. 4411. Any more detailed documents on such a program would have been either destroyed by the Germans at the end of the war or captured by Allied countries and still buried in their classified archives.]

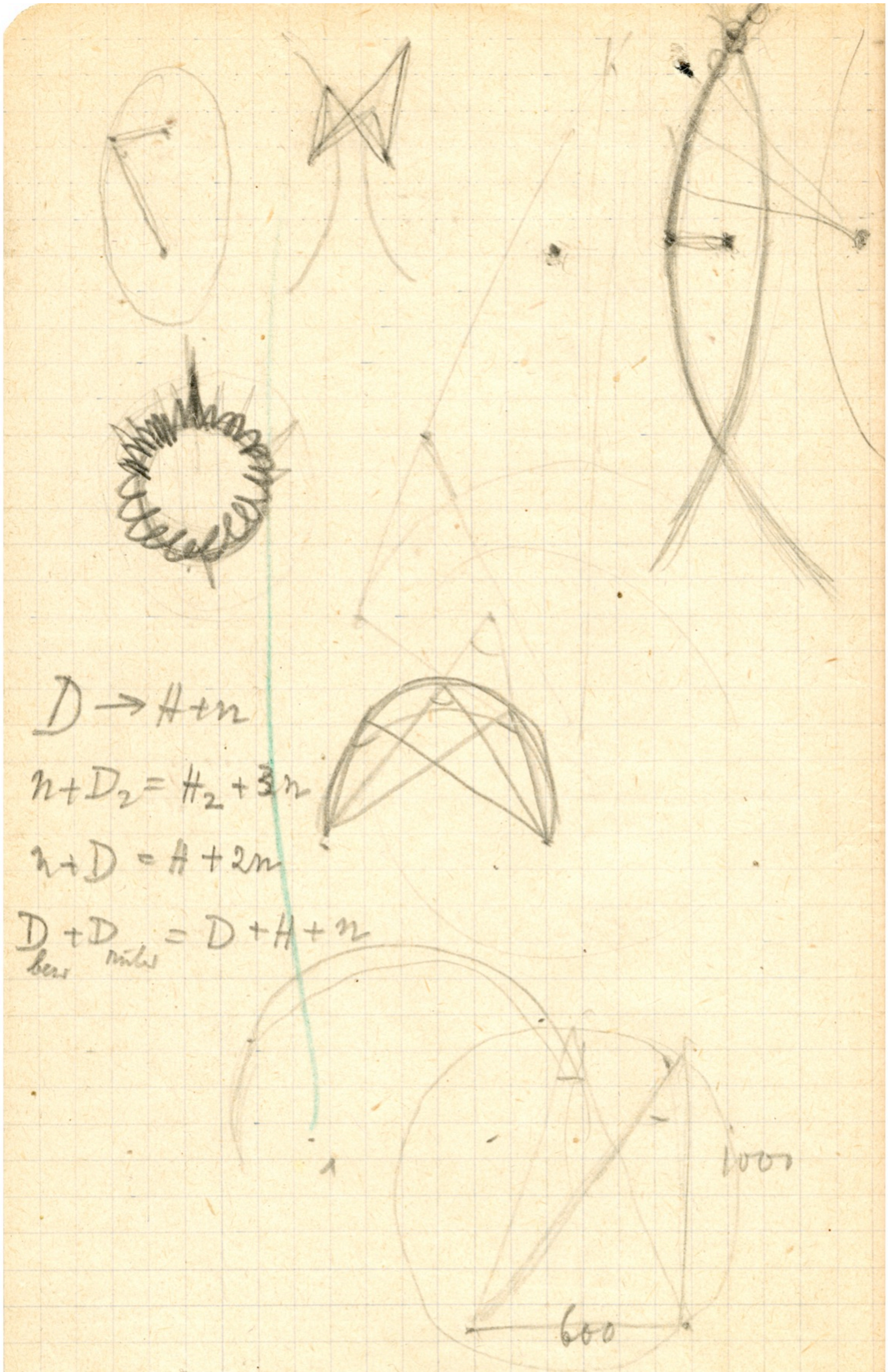

Figure D.663: March 1944 diagram from Walther Gerlach showing an ellipsoid (upper left) in conjunction with nuclear reactions involving deuterium and converging shock waves. Compare it to Fig. D.662 [Karlsch 2005, pp. 205, 321, 333; Deutsches Museum Archive, NL 080/270-66].

Ronald Richter's 1951–1957 Paperclip file [NARA RG 330, Entry A1-1B, Box 134, Folder Richter, Ronald W. Dr.].

[Ronald Richter (Austrian, 1909–1991) conducted research in Germany during the war, but he is mainly remembered for the highly publicized failure of an experimental fusion reactor project he led for Argentinian president Juan Perón during the period 1949–1952. Scientists and historians have spent the decades since then debating whether Richter was a willful charlatan, a misunderstood genius, or something else entirely.[14]

After the failed project in Argentina, Richter applied for admission to the United States under the Paperclip program, was denied, and lived the rest of his life in obscurity.

Richter's Paperclip file is rather lengthy and includes many pages written by him, or written by U.S. government interviewers about him, regarding his then past, present, and intended future research projects. As illustrated by the excerpts on pp. 4418–4427, these documents list a large number of extremely advanced and insightful ideas in applied physics, including (but not limited to):

- Magnetic-confinement plasma fusion reactors.
- Non-Maxwellian plasma fusion systems not in thermodynamic equilibrium.
- Advanced "aneutronic" fusion reactions (proton + boron-11, proton + lithium-6, helium-3 + helium-3, etc.) that would produce fewer unwanted neutrons than the simplest fusion reactions (deuterium + deuterium and deuterium + tritium).
- Traveling-wave direct electric converters to extract the output energy from fusion reactors in the form of more efficient electromagnetic waves instead of less efficient heat.
- Advanced fission reactors.
- Nuclear propulsion systems for various types of vehicles.
- Supersonic combustion ramjets (scramjets).
- Dual-mode scramjet/rocket engines.
- Quantum vacuum energy or zero-point energy.
- Gravitational theories and grand unified theories.

[14] See for example: Ehrenberg 1958a, 1958b; Paul-Jürgen Hahn 2003; Karlsch and Petermann 2007; Nagel 2002; Richter 1991; Thirring 1955.

Upon hearing all of these ideas, the Director of the Office of International Affairs at the U.S. Atomic Energy Commission, John Hall, was "quite impressed with the knowledge, theories and work of Dr. Richter" and "stated that Dr. Richter is thinking in the year 1970" (i.e., at least 14 years in the future, p. 4418).

While all of the ideas listed by Richter were extremely clever and worthy of study, detailed theoretical and/or experimental physics investigations would have shown that some of them (such as advanced aneutronic fusion reactions and highly non-Maxwellian plasma fusion reactors [Rider 1995, 1997]) were not practical even under the best possible conditions. There is no evidence that Richter conducted competent theoretical or experimental investigations of the topics that he listed, or that he ever discovered the fundamental physical limitations on some of them. Richter's apparent inability to carry out proper theoretical or experimental physics work was likely one of the primary causes of the failure of the Argentinian fusion project.

Richter's Paperclip file also lists his job history. From his graduation in 1935 until his move to Argentina in 1948, Richter changed research jobs extremely frequently, often after only a few months at each. He worked in labs all over the German-speaking world on a wide variety of projects, and interacted with countless stellar German and Austrian scientists. From reading Richter's job history, one gets the strong impression that Richter was probably discovered to be scientifically incompetent at each job and was quickly dismissed, only to land at another job. Military research and development projects were often overstretched and eager for additional personnel in wartime Germany, so they may not have asked as many questions about Richter's previous employment as they should have before hiring him each time. Yet precisely because those projects were so eager for personnel, Richter must presumably have demonstrated great incompetence to be fired so swiftly by each project.

It is possible that Richter was gifted at thinking of new physics ideas even though he was incapable of properly pursuing them. However, that possibility seems remote, since even conceiving of such ideas requires physical insight and understanding that Richter apparently never demonstrated in his jobs.

Thus by far the most likely explanation is that Richter appropriated the many intriguing research ideas he listed from much more competent scientists with whom he interacted in wartime Germany. In the Paperclip documents, Richter himself listed interactions with or knowledge of the work of Manfred von Ardenne, Adolf Busemann, Abraham Esau, Siegfried Flügge, Josef Mattauch, Max Steenbeck, Kurt Tank, and others. Von Ardenne, Busemann, Esau, Flügge, Mattauch, and Steenbeck appear to have played roles in a program to develop an H-bomb, among other wartime projects.

Therefore, Richter's lists of ideas may offer a rare and valuable glimpse into otherwise quite mysterious wartime research projects. If that explanation is correct, scientists in wartime Germany conceived detailed ideas for research projects that still remained cutting-edge topics many decades after the war, and they may have even made significant progress on some of those topics. At the very least, Richter's documents demonstrate that historians need to do much more work to investigate the true extent and accomplishments of highly advanced research and development programs in wartime Germany.]

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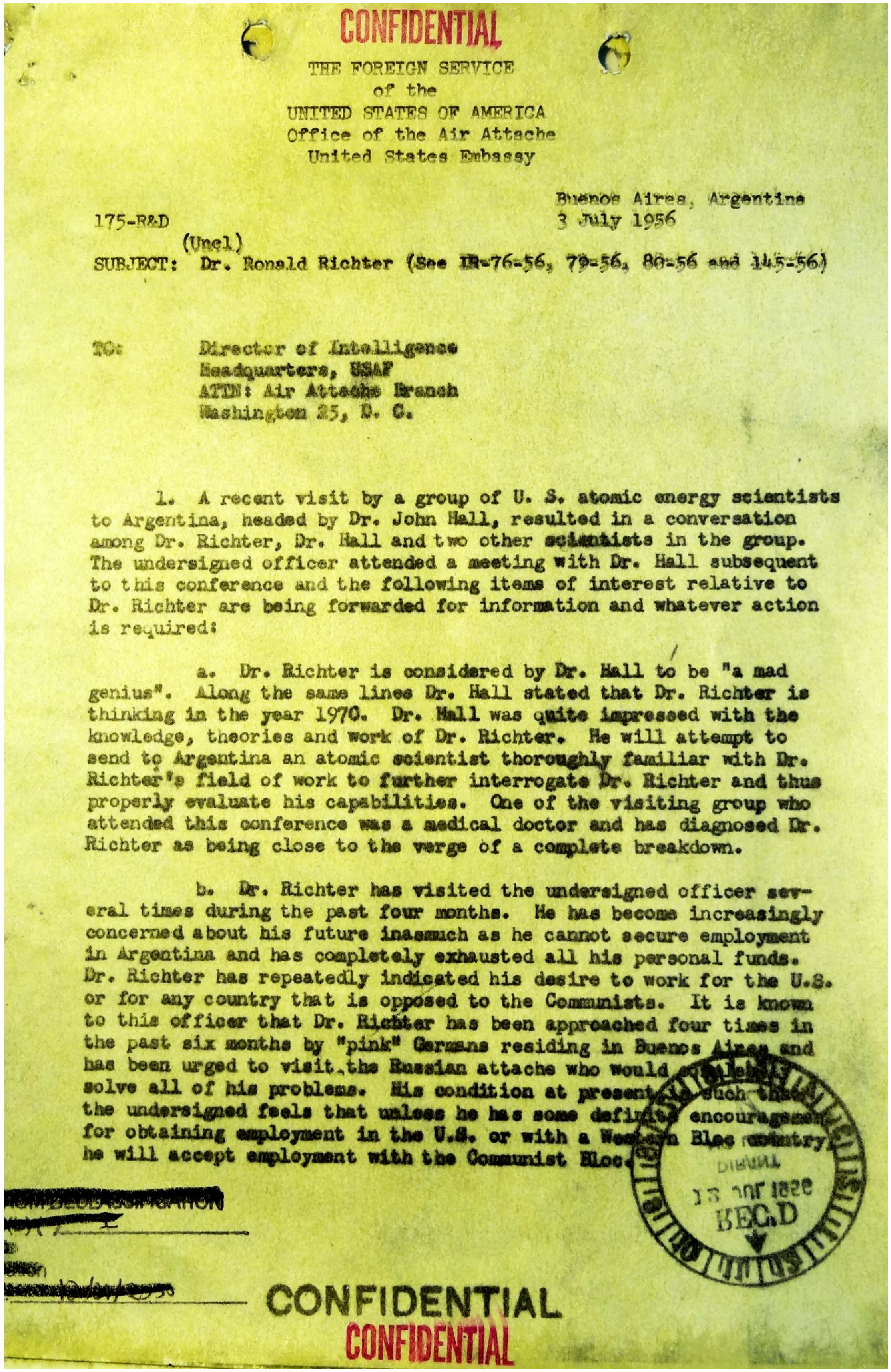
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THE FOREIGN SERVICE
of the
UNITED STATES OF AMERICA
Office of the Air Attache
United States Embassy

Buenos Aires, Argentina
3 July 1956

175-R&D

SUBJECT: (Uncl) Dr. Ronald Richter (See IR-76-56, 79-56, 80-56 and 145-56)

TO: Director of Intelligence
Headquarters, USAF
ATTN: Air Attache Branch
Washington 25, D. C.

1. A recent visit by a group of U. S. atomic energy scientists to Argentina, headed by Dr. John Hall, resulted in a conversation among Dr. Richter, Dr. Hall and two other scientists in the group. The undersigned officer attended a meeting with Dr. Hall subsequent to this conference and the following items of interest relative to Dr. Richter are being forwarded for information and whatever action is required:

a. Dr. Richter is considered by Dr. Hall to be "a mad genius". Along the same lines Dr. Hall stated that Dr. Richter is thinking in the year 1970. Dr. Hall was quite impressed with the knowledge, theories and work of Dr. Richter. He will attempt to send to Argentina an atomic scientist thoroughly familiar with Dr. Richter's field of work to further interrogate Dr. Richter and thus properly evaluate his capabilities. One of the visiting group who attended this conference was a medical doctor and has diagnosed Dr. Richter as being close to the verge of a complete breakdown.

b. Dr. Richter has visited the undersigned officer several times during the past four months. He has become increasingly concerned about his future inasmuch as he cannot secure employment in Argentina and has completely exhausted all his personal funds. Dr. Richter has repeatedly indicated his desire to work for the U.S. or for any country that is opposed to the Communists. It is known to this officer that Dr. Richter has been approached four times in the past six months by "pink" Germans residing in Buenos Aires and has been urged to visit the Russian attache who would completely solve all of his problems. His condition at present is such that the undersigned feels that unless he has some definite encouragement for obtaining employment in the U.S. or with a Western Bloc country he will accept employment with the Communist Bloc.

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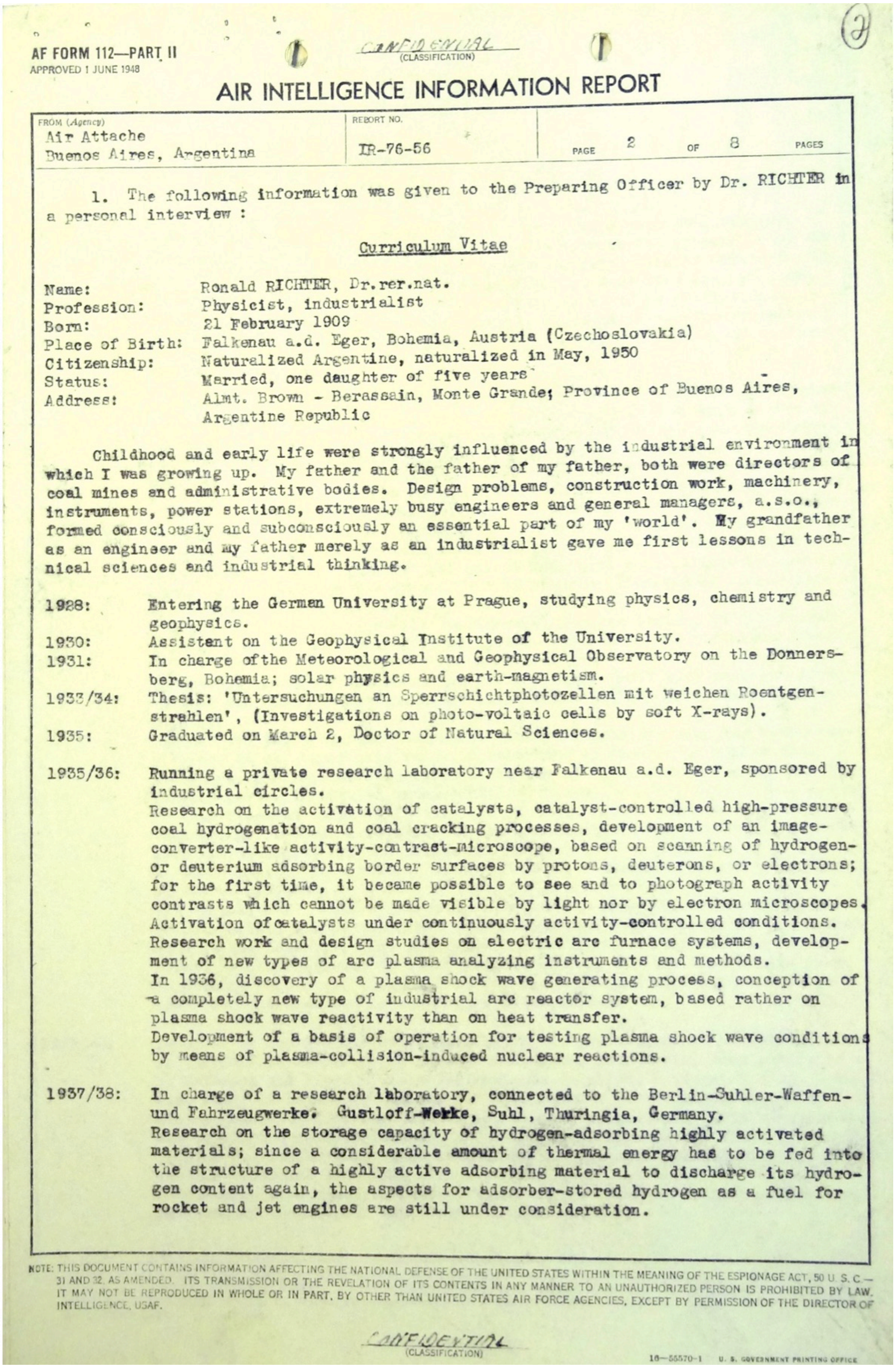
NARA RG 330, Entry A1-1B, Box 134, Folder Richter, Ronald W. Dr.

Figure D.664: Ronald Richter's 1951–1957 Paperclip file lists a large number of extremely advanced ideas in plasma fusion and related areas of physics, likely originating from much more competent scientists with whom Richter interacted in wartime Germany [NARA RG 330, Entry A1-1B, Box 134, Folder Richter, Ronald W. Dr.].



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AIR INTELLIGENCE INFORMATION REPORT

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1. The following information was given to the Preparing Officer by Dr. RICHTER in a personal interview :

Curriculum Vitae

Name:	Ronald RICHTER, Dr.rer.nat.
Profession:	Physicist, industrialist
Born:	21 February 1909
Place of Birth:	Falkenau a.d. Eger, Bohemia, Austria (Czechoslovakia)
Citizenship:	Naturalized Argentine, naturalized in May, 1950
Status:	Married, one daughter of five years
Address:	Almt. Brown - Berassain, Monte Grande; Province of Buenos Aires, Argentine Republic

Childhood and early life were strongly influenced by the industrial environment in which I was growing up. My father and the father of my father, both were directors of coal mines and administrative bodies. Design problems, construction work, machinery, instruments, power stations, extremely busy engineers and general managers, a.s.o., formed consciously and subconsciously an essential part of my 'world'. My grandfather as an engineer and my father merely as an industrialist gave me first lessons in technical sciences and industrial thinking.

1928: Entering the German University at Prague, studying physics, chemistry and geophysics.

1930: Assistant on the Geophysical Institute of the University.

1931: In charge ofthe Meteorological and Geophysical Observatory on the Donnersberg, Bohemia; solar physics and earth-magnetism.

1933/34: Thesis: 'Untersuchungen an Sperrschichtphotozellen mit weichen Roentgenstrahlen', (Investigations on photo-voltaic cells by soft X-rays).

1935: Graduated on March 2, Doctor of Natural Sciences.

1935/36: Running a private research laboratory near Falkenau a.d. Eger, sponsored by industrial circles.
Research on the activation of catalysts, catalyst-controlled high-pressure coal hydrogenation and coal cracking processes, development of an image-converter-like activity-contrast-microscope, based on scanning of hydrogen- or deuterium adsorbing border surfaces by protons, deuterons, or electrons; for the first time, it became possible to see and to photograph activity contrasts which cannot be made visible by light nor by electron microscopes.
Activation ofcatalysts under continuously activity-controlled conditions.
Research work and design studies on electric arc furnace systems, development of new types of arc plasma analyzing instruments and methods.
In 1936, discovery of a plasma shock wave generating process, conception of a completely new type of industrial arc reactor system, based rather on plasma shock wave reactivity than on heat transfer.
Development of a basis of operation for testing plasma shock wave conditions by means of plasma-collision-induced nuclear reactions.

1937/38: In charge of a research laboratory, connected to the Berlin-Suhler-Waffen- und Fahrzeugwerke. Gustloff-Werke, Suhl, Thuringia, Germany.
Research on the storage capacity of hydrogen-adsorbing highly activated materials; since a considerable amount of thermal energy has to be fed into the structure of a highly active adsorbing material to discharge its hydrogen content again, the aspects for adsorber-stored hydrogen as a fuel for rocket and jet engines are still under consideration.

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Figure D.665: Ronald Richter's 1951–1957 Paperclip file lists a large number of extremely advanced ideas in plasma fusion and related areas of physics, likely originating from much more competent scientists with whom Richter interacted in wartime Germany [NARA RG 330, Entry A1-1B, Box 134, Folder Richter, Ronald W. Dr.].

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Considerable improvement in the analysis and generation of plasma shock waves.
Due to a lack of counter sensitivity and owing to a very poor counter geometry (one cannot place the counter tubes near to the extremely hot arc plasma zone), still no correct nuclear raction data could be obtained when analyzing a shock-wave-controlled non-Maxwellian deuterium high pressure plasma, development of a tele-analyzing method, based on excitation-energy-discriminating ultra-violet-sensitive proportional counter tubes, the ultraviolet photons being excited by plasma-collision-induced nuclear reactions.

1939/41: At the outbreak of World War II, I joined the research staff of the Junkers Flugzeug-und Motorenwerke, A.G., Dessau, Germany, research work on the excitation of mechanical resonance (fluttering) oscillations near the critical speed of flight, series of test flights and nose dives mainly with the proto-type Ju-88, in 1941, under research contract of the German Air Ministry, Forschungsfuehrung des Reichsluftfahrtministeriums, Abteilung LC 1.
Head of an Air Ministry sponsored research laboratory at Darmstadt,Germany.
Development of methods and instruments for testing material strength under extreme mechanical and thermodynamic conditions, based on the excitation of photoelectrically analyzed mechanical resonance oscillations by means of sound and ultra-sound waves; analysis of structural damage by micro-vibrations and by corrosion.
The same analyzing device will considerably improve testing of structural stability on nuclear power reactor systems (corrosion and radiation damage).

In contact with Prof. Busemann and Prof. Dirksen, both were research directors at the Luftfahrtforschungsanstalt Hermann Goering near Braunschweig, Germany.
Research on jet operation analyzers, vibration problems near the sound barrier and in the supersonic range, development of supersonic wind-tunnel analyzers, analysis of structural stability of intensely heated up and extremely fast spinning jet turbine blades, a.s.o.
By this research contact, in the fall of 1942, Prof. Busemann invited me to transfer my research laboratory to the Luftfahrtforschungsanstalt, to work with him on rocket and supersonic projects.
At that time, by intervention of the Gestapo, I had to stop research work on secret projects.
(In August, 1937, when I had entered Germany to have discussions with an industrialist, the Gestapo took away my Czechoslovakian passport and issued me a Nansen passport, thus giving me the status of a stateless person by force; as a consequence of these strange events, all the time I have spent in Germany before and during World War II, I found myself being likewise sponsored and shadowed by the German authorities).

1942/43: In order to improve the detectability of shock-wave-induced nuclear reactions in the fall of 1942,- using nuclear mass data, just having been published by Mattauch and Fluegge, Kernphysikalische Tabellen, Springer Verlag, Berlin, 1942,- I developed nuclear reaction schemes, based on the chain-reacting consumption of the lithium and boron isotopes; the basic conception was to start a self-reproducing shock-wave-ignited reaction chain by jetting lithium or lithium-6-enriched lithium into a powerful non-Maxwellian, neutron-producing deuterium high pressure plasma.
Development of a reaction scheme, based on the combined chain-reacting consumption of the lithium and boron isotopes.

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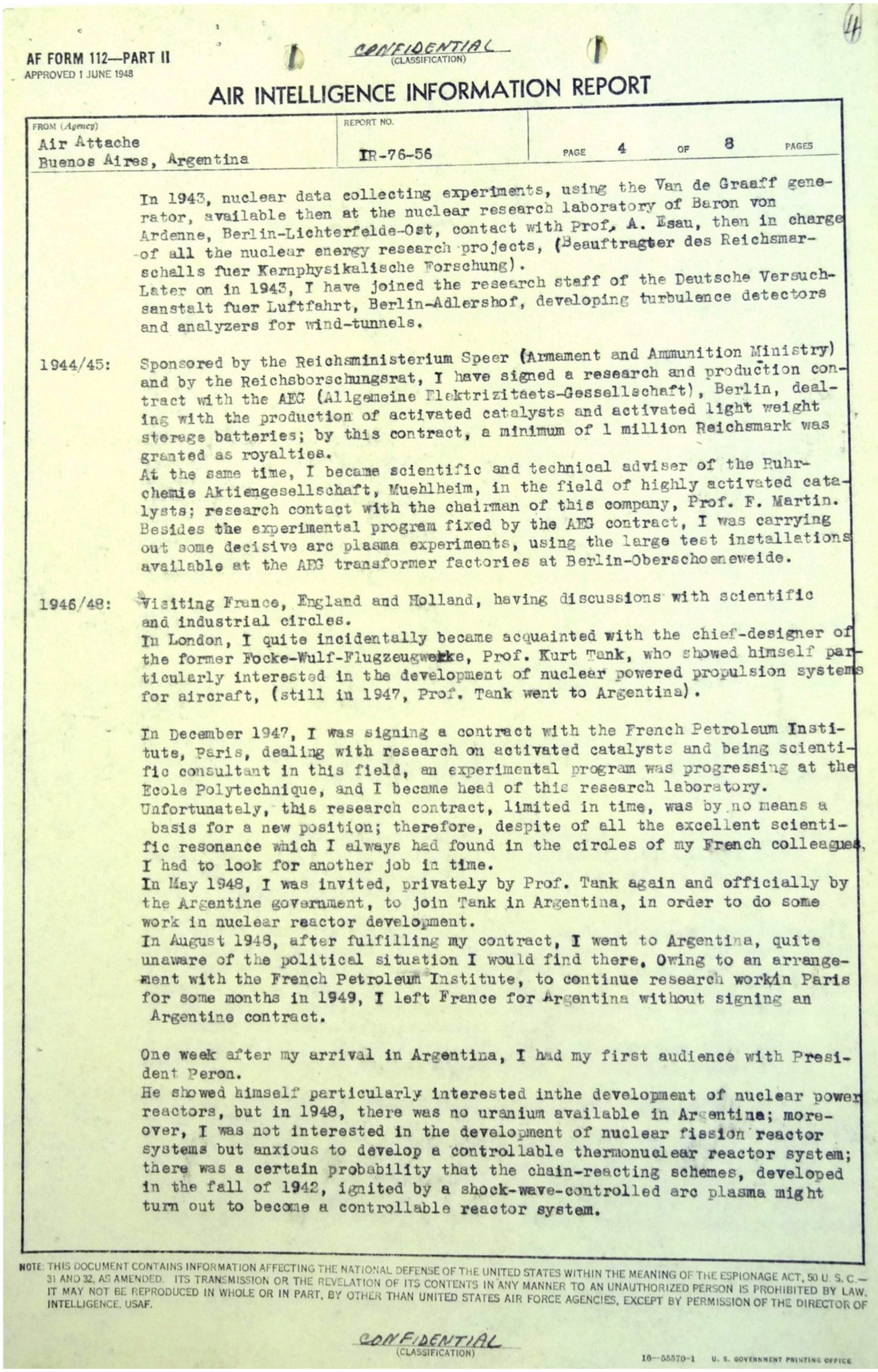

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In 1943, nuclear data collecting experiments, using the Van de Graaff generator, available then at the nuclear research laboratory of Baron von Ardenne, Berlin-Lichterfelde-Ost, contact with Prof. A. Esau, then in charge of all the nuclear energy research projects, (Beauftragter des Reichsmarschalls fuer Kernphysikalische Forschung).
Later on in 1943, I have joined the research staff of the Deutsche Versuchsanstalt fuer Luftfahrt, Berlin-Adlershof, developing turbulence detectors and analyzers for wind-tunnels.

1944/45: Sponsored by the Reichsministerium Speer (Armament and Ammunition Ministry) and by the Reichsborschungsrat, I have signed a research and production contract with the AEG (Allgemeine Elektrizitaets-Gessellschaft), Berlin, dealing with the production of activated catalysts and activated light weight storage batteries; by this contract, a minimum of 1 million Reichsmark was granted as royalties.
At the same time, I became scientific and technical adviser of the Ruhrchemie Aktiengesellschaft, Muehlheim, in the field of highly activated catalysts; research contact with the chairman of this company, Prof. F. Martin. Besides the experimental program fixed by the AEG contract, I was carrying out some decisive arc plasma experiments, using the large test installations available at the AEG transformer factories at Berlin-Oberschoeneweide.

1946/48: Visiting France, England and Holland, having discussions with scientific and industrial circles.
In London, I quite incidentally became acquainted with the chief-designer of the former Focke-Wulf-Flugzeugwerke, Prof. Kurt Tank, who showed himself particularly interested in the development of nuclear powered propulsion systems for aircraft, (still in 1947, Prof. Tank went to Argentina).

In December 1947, I was signing a contract with the French Petroleum Institute, Paris, dealing with research on activated catalysts and being scientific consultant in this field, an experimental program was progressing at the Ecole Polytechnique, and I became head of this research laboratory.
Unfortunately, this research contract, limited in time, was by no means a basis for a new position; therefore, despite of all the excellent scientific resonance which I always had found in the circles of my French colleagues, I had to look for another job in time.
In May 1948, I was invited, privately by Prof. Tank again and officially by the Argentine government, to join Tank in Argentina, in order to do some work in nuclear reactor development.
In August 1948, after fulfilling my contract, I went to Argentina, quite unaware of the political situation I would find there, Owing to an arrangement with the French Petroleum Institute, to continue research workin Paris for some months in 1949, I left France for Argentina without signing an Argentine contract.

One week after my arrival in Argentina, I had my first audience with President Peron.
He showed himself particularly interested inthe development of nuclear power reactors, but in 1948, there was no uranium available in Argentina; moreover, I was not interested in the development of nuclear fission reactor systems but anxious to develop a controllable thermonuclear reactor system; there was a certain probability that the chain-reacting schemes, developed in the fall of 1942, ignited by a shock-wave-controlled arc plasma might turn out to become a controllable reactor system.

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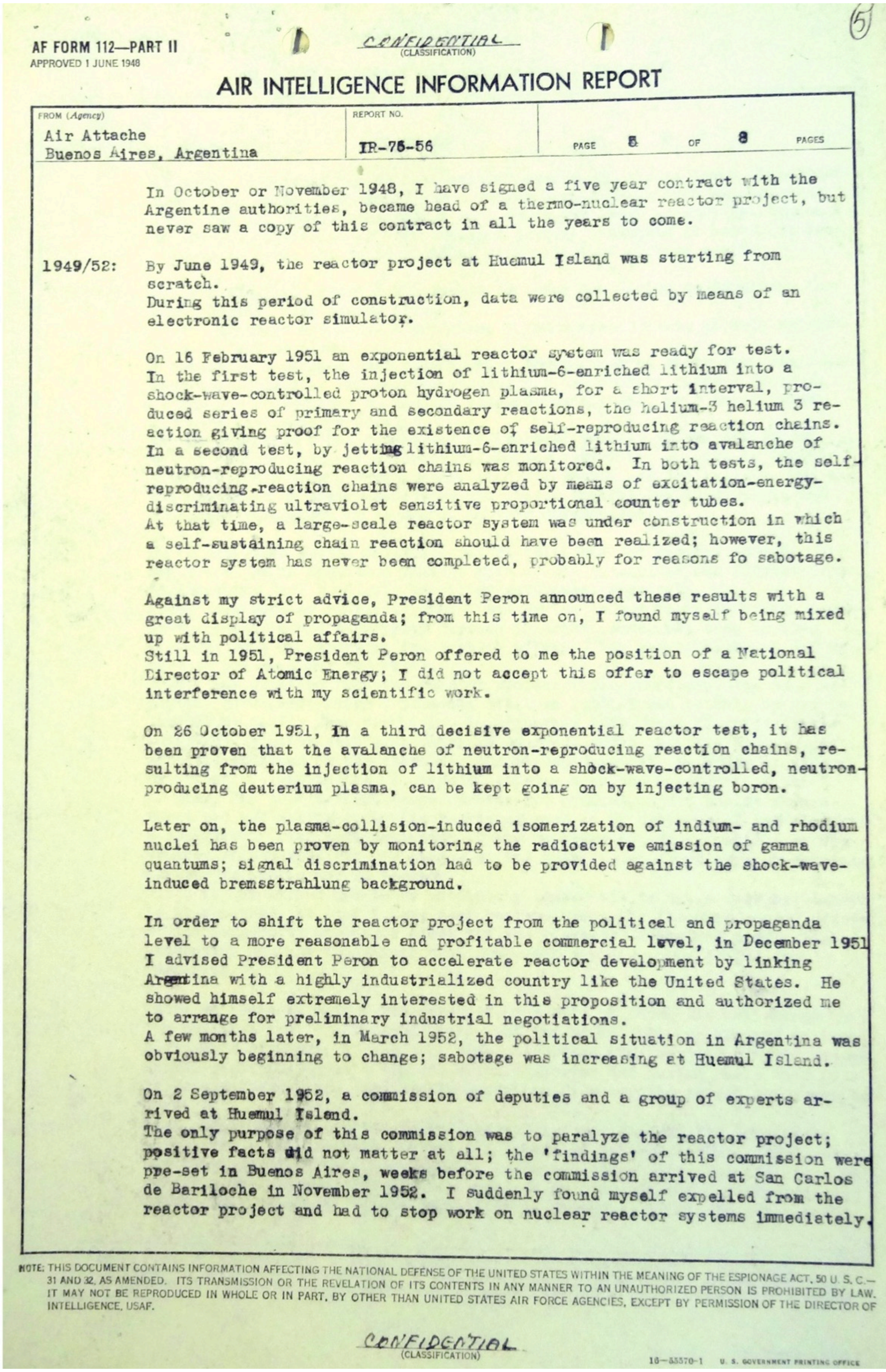

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In October or November 1948, I have signed a five year contract with the Argentine authorities, became head of a thermo-nuclear reactor project, but never saw a copy of this contract in all the years to come.

1949/52: By June 1949, the reactor project at Huemul Island was starting from scratch.
During this period of construction, data were collected by means of an electronic reactor simulator.

On 16 February 1951 an exponential reactor system was ready for test. In the first test, the injection of lithium-6-enriched lithium into a shock-wave-controlled proton hydrogen plasma, for a short interval, produced series of primary and secondary reactions, the helium-3 helium 3 reaction giving proof for the existence of self-reproducing reaction chains. In a second test, by jetting lithium-6-enriched lithium into avalanche of neutron-reproducing reaction chains was monitored. In both tests, the self-reproducing reaction chains were analyzed by means of excitation-energy-discriminating ultraviolet sensitive proportional counter tubes.
At that time, a large-scale reactor system was under construction in which a self-sustaining chain reaction should have been realized; however, this reactor system has never been completed, probably for reasons fo sabotage.

Against my strict advice, President Peron announced these results with a great display of propaganda; from this time on, I found myself being mixed up with political affairs.
Still in 1951, President Peron offered to me the position of a National Director of Atomic Energy; I did not accept this offer to escape political interference with my scientific work.

On 26 October 1951, in a third decisive exponential reactor test, it has been proven that the avalanche of neutron-reproducing reaction chains, resulting from the injection of lithium into a shock-wave-controlled, neutron-producing deuterium plasma, can be kept going on by injecting boron.

Later on, the plasma-collision-induced isomerization of indium- and rhodium nuclei has been proven by monitoring the radioactive emission of gamma quantums; signal discrimination had to be provided against the shock-wave-induced bremsstrahlung background.

In order to shift the reactor project from the political and propaganda level to a more reasonable and profitable commercial level, in December 1951 I advised President Peron to accelerate reactor development by linking Argentina with a highly industrialized country like the United States. He showed himself extremely interested in this proposition and authorized me to arrange for preliminary industrial negotiations.
A few months later, in March 1952, the political situation in Argentina was obviously beginning to change; sabotage was increasing at Huemul Island.

On 2 September 1952, a commission of deputies and a group of experts arrived at Huemul Island.
The only purpose of this commission was to paralyze the reactor project; positive facts did not matter at all; the 'findings' of this commission were pre-set in Buenos Aires, weeks before the commission arrived at San Carlos de Bariloche in November 1952. I suddenly found myself expelled from the reactor project and had to stop work on nuclear reactor systems immediately.

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3. Professional Field or Occupation: Include specialized fields of work or interest.

experimental and applied physics,

analysis of stress and vibration under extreme thermodynamic and mechanical conditions (hypersonic flight conditions, radiation corrosion, a.s.o.),

development of new materials of construction for rocket and jet motors, nuclear propulsion systems, a.s.o., to be produced in shock-wave- and ultra-sound-controlled arc melting furnaces,

high-pressure plasma physics and plasma implosion analysis, shock-wave physics and chemistry, interested in rocket and jet plasma analysis, solar plasma physics,

analysis of nuclear reactions in chain-reacting fission and fusion plasma zones,

development and testing of plasma-type, pulsation-controlled fission and fusion reactor systems,

development and testing of propulsion reactor systems,

experimental approaches to new concepts,

development and testing of highly-turbulent, magnetic-field-controlled fission and fusion plasma systems,

experimental approach to solar flare conditions and to the explosion-tendency of the solar plasma, ultraviolet excess analysis,

excitation of space structure by pulsation-controlled plasma implosion, testing the limitations of quantum mechanics and quantum dynamics,

experimental approach to the unified field theory and to the velocity of propagation of gravity, a.s.o.

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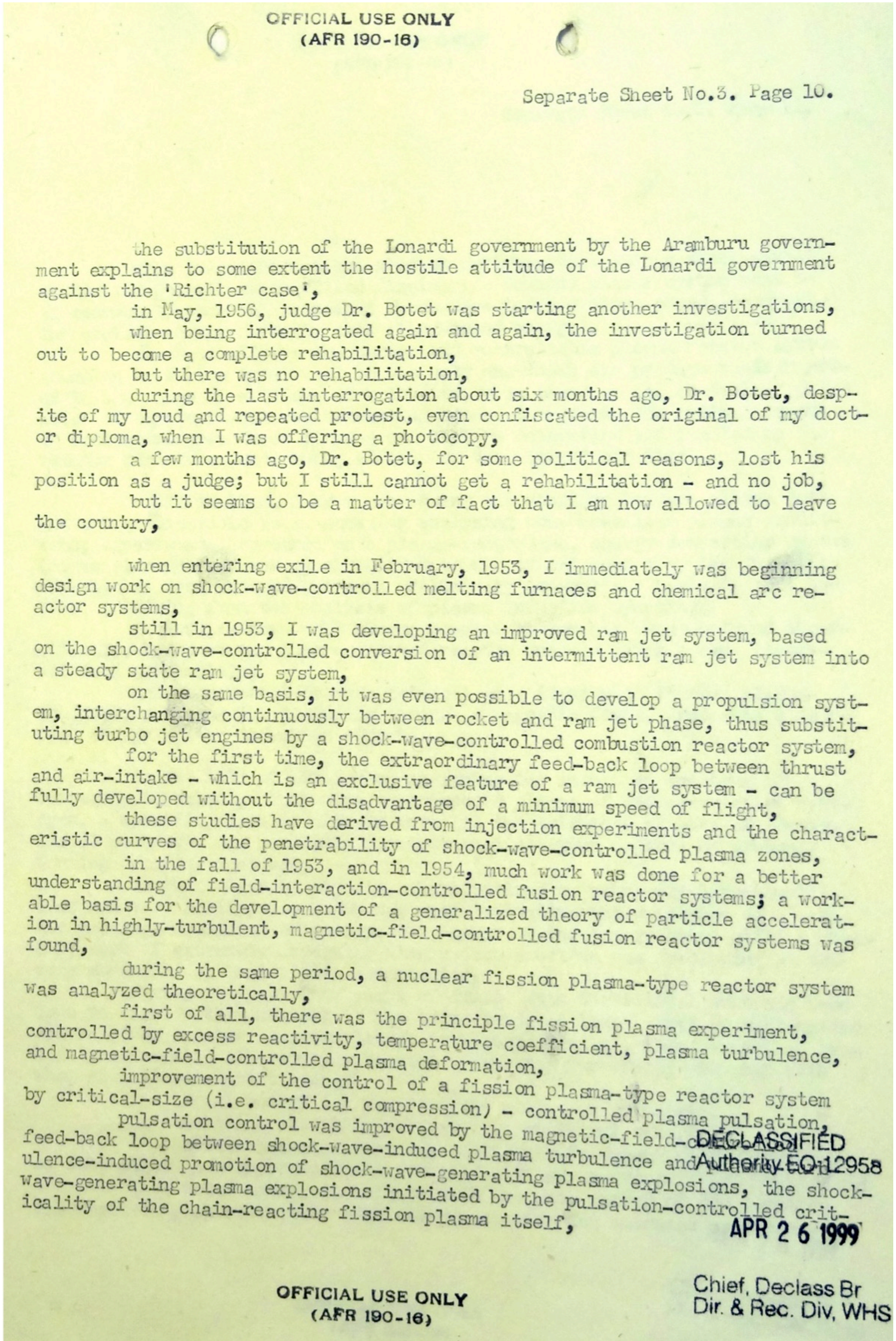

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the substitution of the Lonardi government by the Aramburu government explains to some extent the hostile attitude of the Lonardi government against the 'Richter case',

in May, 1956, judge Dr. Botet was starting another investigations,

when being interrogated again and again, the investigation turned out to become a complete rehabilitation,

but there was no rehabilitation,

during the last interrogation about six months ago, Dr. Botet, despite of my loud and repeated protest, even confiscated the original of my doctor diploma, when I was offering a photocopy,

a few months ago, Dr. Botet, for some political reasons, lost his position as a judge; but I still cannot get a rehabilitation - and no job,

but it seems to be a matter of fact that I am now allowed to leave the country,

when entering exile in February, 1953, I immediately was beginning design work on shock-wave-controlled melting furnaces and chemical arc reactor systems,

still in 1953, I was developing an improved ram jet system, based on the shock-wave-controlled conversion of an intermittent ram jet system into a steady state ram jet system,

on the same basis, it was even possible to develop a propulsion system, interchanging continuously between rocket and ram jet phase, thus substituting turbo jet engines by a shock-wave-controlled combustion reactor system,

for the first time, the extraordinary feed-back loop between thrust and air-intake - which is an exclusive feature of a ram jet system - can be fully developed without the disadvantage of a minimum speed of flight,

these studies have derived from injection experiments and the characteristic curves of the penetrability of shock-wave-controlled plasma zones,

in the fall of 1953, and in 1954, much work was done for a better understanding of field-interaction-controlled fusion reactor systems; a workable basis for the development of a generalized theory of particle acceleration in highly-turbulent, magnetic-field-controlled fusion reactor systems was found,

during the same period, a nuclear fission plasma-type reactor system was analyzed theoretically,

first of all, there was the principle fission plasma experiment, controlled by excess reactivity, temperature coefficient, plasma turbulence, and magnetic-field-controlled plasma deformation,

improvement of the control of a fission plasma-type reactor system by critical-size (i.e. critical compression) - controlled plasma pulsation,

pulsation control was improved by the magnetic-field-c[...] feed-back loop between shock-wave-induced plasma turbulence and [...]ulence-induced promotion of shock-wave-generating plasma explosions, the shock-wave-generating plasma explosions initiated by the pulsation-controlled criticality of the chain-reacting fission plasma itself,

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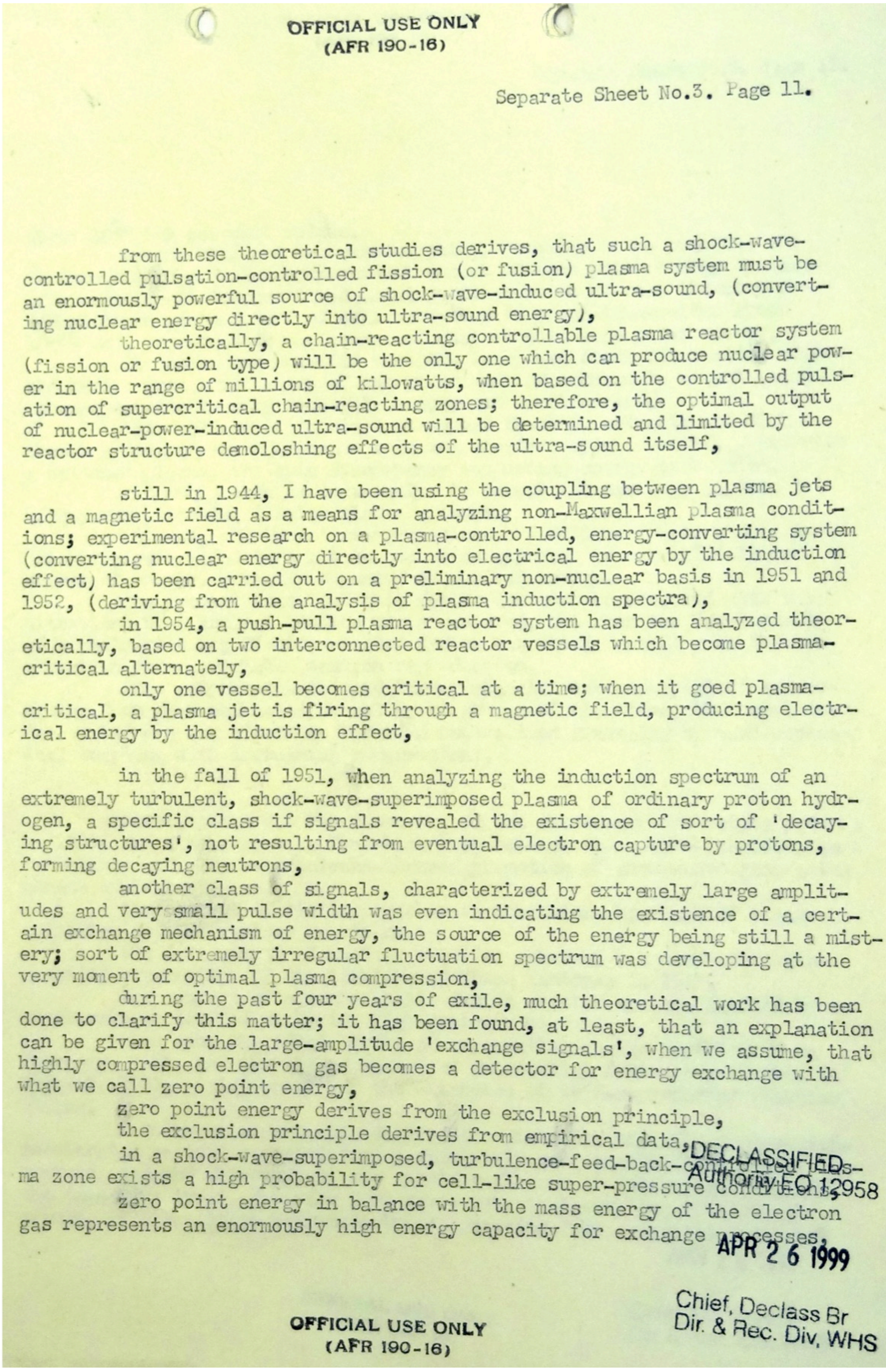

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from these theoretical studies derives, that such a shock-wave-controlled pulsation-controlled fission (or fusion) plasma system must be an enormously powerful source of shock-wave-induced ultra-sound, (converting nuclear energy directly into ultra-sound energy),

theoretically, a chain-reacting controllable plasma reactor system (fission or fusion type) will be the only one which can produce nuclear power in the range of millions of kilowatts, when based on the controlled pulsation of supercritical chain-reacting zones; therefore, the optimal output of nuclear-power-induced ultra-sound will be determined and limited by the reactor structure demoloshing effects of the ultra-sound itself,

still in 1944, I have been using the coupling between plasma jets and a magnetic field as a means for analyzing non-Maxwellian plasma conditions; experimental research on a plasma-controlled, energy-converting system (converting nuclear energy directly into electrical energy by the induction effect) has been carried out on a preliminary non-nuclear basis in 1951 and 1952, (deriving from the analysis of plasma induction spectra),

in 1954, a push-pull plasma reactor system has been analyzed theoretically, based on two interconnected reactor vessels which become plasma-critical alternately,

only one vessel becomes critical at a time; when it goed plasma-critical, a plasma jet is firing through a magnetic field, producing electrical energy by the induction effect,

in the fall of 1951, when analyzing the induction spectrum of an extremely turbulent, shock-wave-superimposed plasma of ordinary proton hydrogen, a specific class if signals revealed the existence of sort of 'decaying structures', not resulting from eventual electron capture by protons, forming decaying neutrons,

another class of signals, characterized by extremely large amplitudes and very small pulse width was even indicating the existence of a certain exchange mechanism of energy, the source of the energy being still a mistery; sort of extremely irregular fluctuation spectrum was developing at the very moment of optimal plasma compression,

during the past four years of exile, much theoretical work has been done to clarify this matter; it has been found, at least, that an explanation can be given for the large-amplitude 'exchange signals', when we assume, that highly compressed electron gas becomes a detector for energy exchange with what we call zero point energy,

zero point energy derives from the exclusion principle,

the exclusion principle derives from empirical data,

in a shock-wave-superimposed, turbulence-feed-back-controlled plasma zone exists a high probability for cell-like super-pressure conditions,

zero point energy in balance with the mass energy of the electron gas represents an enormously high energy capacity for exchange processes.

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about 10^{10} kwh per unit volume,

on the basis of exchange coupling, it seems to be possible to 'extract' a compression-proportional amount of zero point energy by means of a magnetic-field-controlled exchange fluctuation between the compressed electron gas and sort of cell structure in space (dimensions about 10^{-13} cm), representing the source of what we call zero point energy,

it seems even possible that the large-amplitude fluctuation signals derive from a mechanism of energy-conversion unknwon to us yet which becomes detectable only in highly compressed electron gas,

(it would be of interest to repeat these experiments not with a proton hydrogen plasma - proton spin and electron spin identical - but with a helium-4 plasma, the spin discrepancy supporting energy extraction,

it would also be worth-while to search for exchange signals in high-power pulsating fission plasma systems),

in case, all these interpretations are fully correct, plasma implosion analysis might turn out to become an approach to a completely new source of energy, probably superior to nuclear energy,

the present status of this matter can best be compared with the situation, when nuclear fission was discovered, but when the development of a chain-reacting fission reactor system was still depending on the realization of controllable neutron reproduction,

(the compression-induced 'decay signals' can be explained as resulting from wave-mechanical coupling of groups of electrons, the repulsive forces between the electrons becoming neutralized gradually by wave-mechanical coupling with increasing compression),

first, there was the discovery of the shock-wave-generating process in 1936, the discovery of a feed-back loop between shock-wave-induced plasma turbulence and plasma-turbulence-induced promotion of shock-wave-generating plasma explosions,

the concept of testing shock-wave conditions by means of plasma-collision-induced nuclear reactions,

the development of nuclear reaction schemes, based on the chain-reacting consumption of the lithium and boron isotopes in 1942,

the concept of a controllable fusion reactor system, ignited by a shock-wave-controlled deuterium high-pressure plasma,

then came the first series of exponential fusion experiments in February, 1951, and the second series of exponential fusion experiments in October, 1951, giving proof for the existence of self-reproducing reaction chains,

from these experiments derived the discovery of field-interaction-accelerated particles, initiating a completely new conce[illegible] reactor systems, and the discovery of two specific classes of fl[illegible]s, the 'decaying type', deriving from wave-mechanical coupling of electron groups, and the 'large-amplitude-type', deriving from a possible exchange

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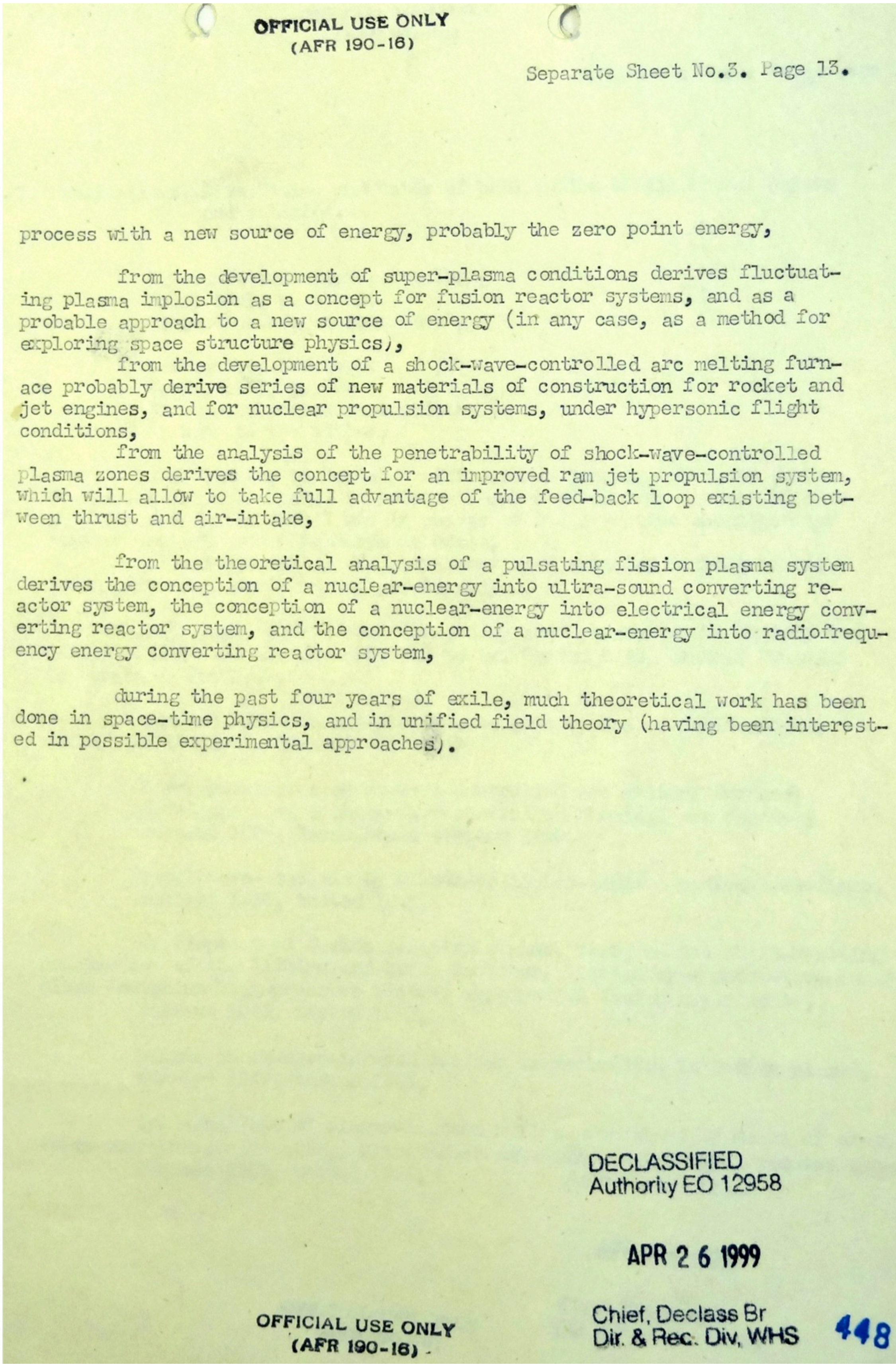

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process with a new source of energy, probably the zero point energy,

from the development of super-plasma conditions derives fluctuating plasma implosion as a concept for fusion reactor systems, and as a probable approach to a new source of energy (in any case, as a method for exploring space structure physics),

from the development of a shock-wave-controlled arc melting furnace probably derive series of new materials of construction for rocket and jet engines, and for nuclear propulsion systems, under hypersonic flight conditions,

from the analysis of the penetrability of shock-wave-controlled plasma zones derives the concept for an improved ram jet propulsion system, which will allow to take full advantage of the feed-back loop existing between thrust and air-intake,

from the theoretical analysis of a pulsating fission plasma system derives the conception of a nuclear-energy into ultra-sound converting reactor system, the conception of a nuclear-energy into electrical energy converting reactor system, and the conception of a nuclear-energy into radiofrequency energy converting reactor system,

during the past four years of exile, much theoretical work has been done in space-time physics, and in unified field theory (having been interested in possible experimental approaches).

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NARA RG 330, Entry A1-1B, Box 134,
Folder Richter, Ronald W. Dr.

Figure D.673: Ronald Richter's 1951–1957 Paperclip file lists a large number of extremely advanced ideas in plasma fusion and related areas of physics, likely originating from much more competent scientists with whom Richter interacted in wartime Germany [NARA RG 330, Entry A1-1B, Box 134, Folder Richter, Ronald W. Dr.].

D.10 Possible October 1944 Test Explosion on the Baltic Coast

[There may have been a test explosion on the Baltic coast in October 1944, as reported by multiple sources:

- In August 1944, a German prisoner of war reported that "experiments are conducted on an estate in Pomerania [on the Baltic coast] and it is alleged that this explosive is capable of destroying everything in a radius of several kilometers." (p. 4434).
- On 20 October 1944, the U.S. physicist and intelligence analyst Philip Morrison mentioned "recent reports of Baltic explosions" that were being investigated by the Manhattan Project as possible tests of a German atomic bomb (p. 4437).
- A 21 October 1944 OSS intelligence report described the October test: "The Germans have completed a weapon which is founded on the principle of the disintegration of matter (Atomzertruemmerung). Experiments have been performed which have proved conclusive[...] The radius of action is supposed to be about three kilometers" (pp. 4440–4443).
- A 19 January 1945 U.S. military intelligence summary covering many areas of advanced German research included a subject heading for "ATOMIC BOMB," under which it mentioned "close surveillance of the area in which tests are alleged to have taken place" (p. 4444). While the report did not state a specific time or location for those alleged tests, it focused largely on the most recent work being conducted on the Baltic coast, suggesting that the tests occurred in late 1944 on the Baltic coast.
- In May 1945, German prisoner of war Friedrich Olmes said that there had been "experiments with the atom-splitting bomb" and that "practical experiments were conducted on the Baltic coast" (p. 4446).
- A 19 August 1945 U.S. Army Air Forces intelligence report entitled "Investigations, Research, Developments, and Practical Use of the German Atomic Bomb" presented testimony by Rudolf Zinsser, a German pilot captured by U.S. forces, that in October 1944 he flew near the massive explosion of a new German bomb on or near the Baltic coast, describing in detail a very large mushroom cloud and severe electrical disturbances (p. 4448). After further investigation, rather than dismissing Zinsser's report, the United States decided to upgrade it from Secret to Top Secret in October 1945 (p. 4462).
- In consistent public testimony from 1945 until his death in 2007, Italian military correspondent Luigi Romersa stated that by a special arrangement between Benito Mussolini and Adolf Hitler, on 12 October 1944 he witnessed the massive explosion of a new German bomb on the Baltic coast (apparently Rügen island), had to wait in a bunker for many hours afterward for the site to become less dangerous (short radioactive half-lives?), and then had to wear a special protective suit when inspecting the leveled test site afterward (pp. 4468–4478).
- Werner Grothmann stated in 2000–2002 interviews that there was a successful atomic bomb test in October 1944 (p. 4480).
- In a 13 March 2005 television interview, Elisabeth Mestlin stated that she observed a massive explosion on Rügen from a neighboring island on 12 October 1944 (p. 4479).

Some of the major sources and details are summarized in Table D.4.]

		Primary sources for October 1944 test						
		German PW Aug. 1944	**Morrison Oct. 1944**	**Olmes May 1945**	**Zinsser Aug. 1945**	**Romersa 1955--2005**	**Grothmann 2000--2002**	**Mestlin 2004**
Details	**Test date**	Preparing for test as of ~July 1944	First half of October 1944	Sometime near the end of the war	Early October 1944	11:45 a.m. on 12 October 1944	First half of October 1944	12 October 1944
	Test location	Near an estate in Pomerania (Baltic coast)	Baltic coast	Baltic coast	Baltic coast	Rügen island on Baltic coast	Location would provoke negative public reaction [Baltic coast is tourist area]	Rügen island on Baltic coast
	People who were involved	Military	Military	SS, military, scientists (implied)	Military	Army Ordnance Office, SS	SS, Himmler, Kammler, Gerlach, Post Office, Diebner, Flügge	Military
	Blast	Expected blast radius of kilometers	Suspiciously large explosion(s)	Blast kilometers wide	Bright fireball, mushroom cloud, shockwave that grew to >9 km wide	Blinding flash; heat and shockwave in bunker 2 km away; mushroom cloud; vaporized animals, trees, buildings	Successful nuclear test, possibly ~3 kilotons	Violent explosion, big dust cloud, visible from kilometers away
	Radio-activity	Development related to use of heavy water		Demonstrated atom splitting	Ionized glowing mushroom cloud, severe radio interference	Had to remain inside bunker for over 5 hours after explosion, then wear protective suit to visit test site	Nuclear fission	
	Device design	New weapon that was an extremely powerful explosive and was extremely secret	Possibly an atomic bomb test	Atomic bomb with ~1 kg of fuel	Atomic bomb	Atomic disintegration (i.e., fission) bomb mounted above the ground	> 1 m dia. sphere Very heavy Aluminum case A little U-235 for test More U-235 for deployment Ignition by special system Tested on a stand	Something that produced an extraordinarily large explosion

Table D.4: Details about possible October 1944 test explosion from primary sources.

AFHRA A1260 frame 0951

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ROCKET FILE

REMOTE-CONTROL ROCKET BOMBS:

A prisoner has heard that current tests of the remote-controlled rocket bombs are being carried out on the Island of Ruegen, which has been made a prohibited area and completely evacuated. His version of the range for these projectiles is 500 (??) km., and he dates the moment for launching an attack with them upon England at the end of the year.

Source: P/W report, #B-488, 11 November 1943.

Figure D.674: Rocket File [AFHRA A1260 frame 0951]

Rocket File [AFHRA A1260 frame 0951]

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Source: P/W report, #B-488, 11 November 1943.

[See p. 4430. Although the entire island of Rügen was not evacuated during the war, significant parts of it, such as the Bug peninsula on the northwestern side, were indeed evacuated and tightly controlled by the German military, which is apparently what this prisoner of war was referring to.]

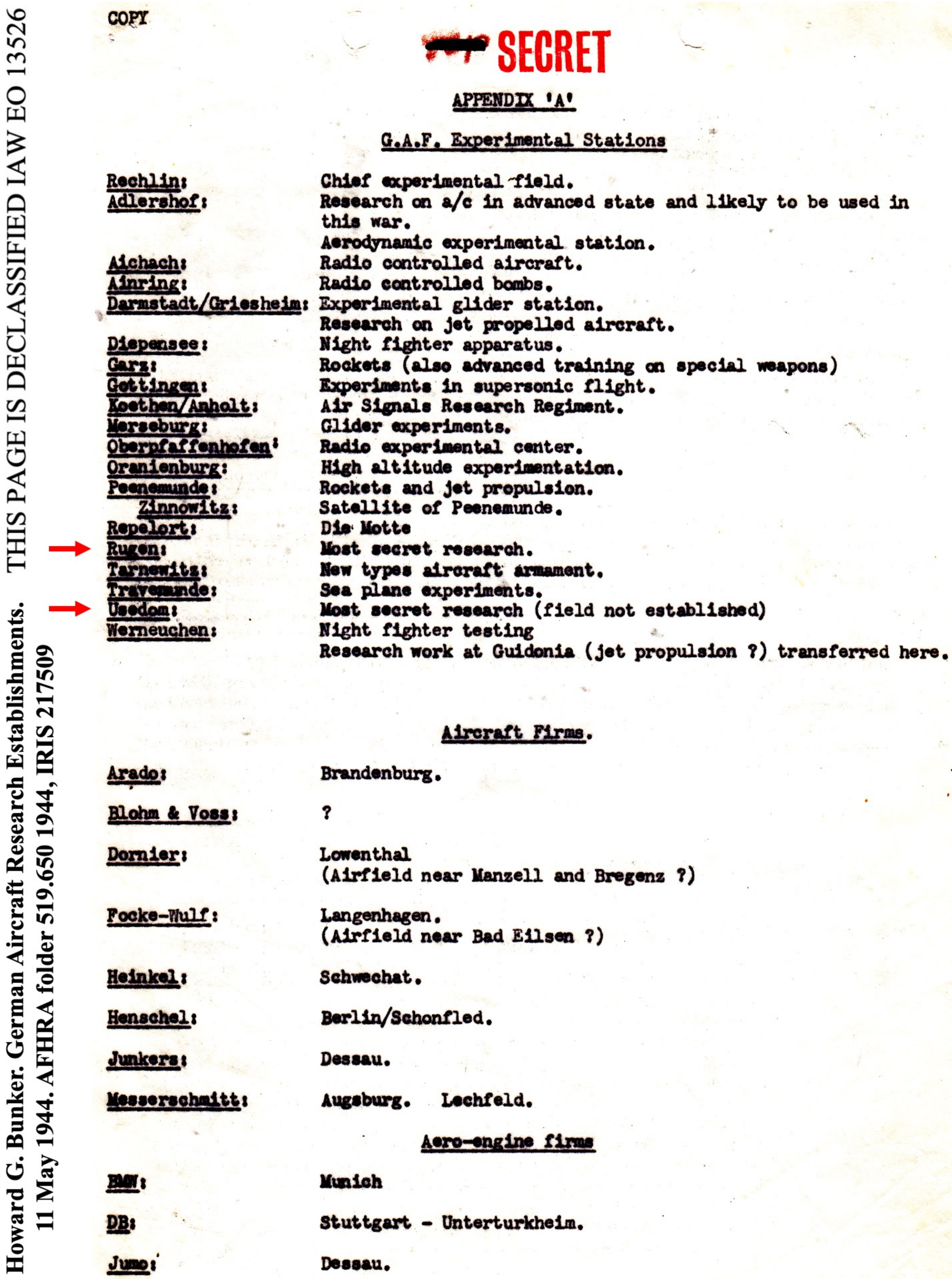
Howard G. Bunker. German Aircraft Research Establishments. 11 May 1944. [AFHRA folder 519.650 1944, IRIS 217509; AFHRA A5729 frame 1148] [Colonel/General Howard Bunker was involved at the highest levels with intelligence/transfer of German technologies and with U.S. nuclear weapons: https://www.af.mil/About-Us/Biographies/Display/Article/107565/major-general-howard-g-bunker/]

APPENDIX 'A'

G.A.F. Experimental Stations

Rechlin:	Chief experimental field.
Adlershof:	Research on a/c in advanced state and likely to be used in this war.
	Aerodynamic experimental station.
Aichach:	Radio controlled aircraft.
Ainring:	Radio controlled bombs.
Darmstadt/Griesheim:	Experimental glider station.
	Research on jet propelled aircraft.
Diepensee:	Night fighter apparatus.
Garz:	Rockets (also advanced training on special weapons)
Göttingen:	Experiments in supersonic flight.
Koethen/Anhalt:	Air Signals Research Regiment.
Merseburg:	Glider experiments.
Oberpfaffenhofen:	Radio experimental center.
Oranienburg:	High altitude experimentation.
Peenemünde:	Rockets and jet propulsion.
Zinnowitz:	Satellite of Peenemunde.
Repelort:	Die Motte
Rügen:	Most secret research.
Tarnewitz:	New types aircraft armament.
Travemünde:	Sea plane experiments.
Usedom:	Most secret research (field not established)
Werneuchen:	Night fighter testing
	Research work at Guidonia (jet propulsion ?) transferred here.

[See document photo on p. 4432. What research occurring on Rügen island and Usedom peninsula (adjacent to Peenemünde) was considered "most secret," even more secret than the listed work on rockets, missiles, and jets? Could that "most secret research" have been associated with the upcoming possible atomic test on the Baltic coast in October 1944 and the production and testing of possible atomic bomb components on Usedom (see p. 4308)?]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Howard G. Bunker. German Aircraft Research Establishments.
11 May 1944. AFHRA folder 519.650 1944, IRIS 217509

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APPENDIX 'A'

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Tarnewitz:	New types aircraft armament.
Travemunde:	Sea plane experiments.
Usedom:	Most secret research (field not established)
Werneuchen:	Night fighter testing
	Research work at Guidonia (jet propulsion ?) transferred here.

Aircraft Firms.

Arado:	Brandenburg.
Blohm & Voss:	?
Dornier:	Lowenthal (Airfield near Manzell and Bregenz ?)
Focke-Wulf:	Langenhagen. (Airfield near Bad Eilsen ?)
Heinkel:	Schwechat.
Henschel:	Berlin/Schonfled.
Junkers:	Dessau.
Messerschmitt:	Augsburg. Lechfeld.

Aero-engine firms

BMW:	Munich
DB:	Stuttgart - Unterturkheim.
Jumo:	Dessau.

Figure D.675: Howard G. Bunker. German Aircraft Research Establishments. 11 May 1944. [AFHRA folder 519.650 1944, IRIS 217509; AFHRA A5729 frame 1148]

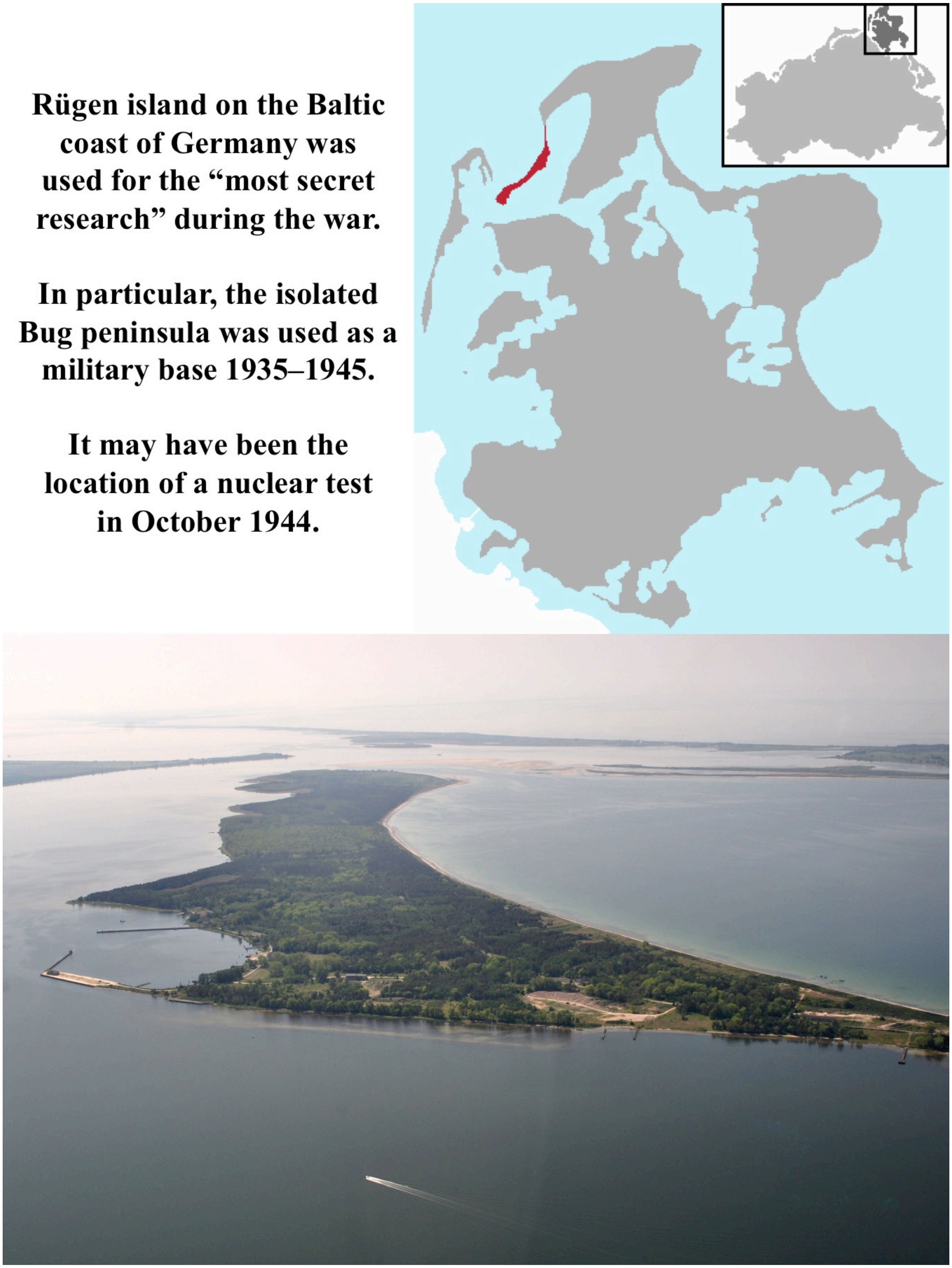


Figure D.676: Rügen island on the Baltic coast of Germany was used for the "most secret research" during the war (pp. 4431–4432). In particular, the isolated Bug peninsula was used as a military base 1935–1945. It may have been the location of a nuclear test in October 1944.

Baltimore Branch Office, Manhattan Engineer District. 4 August 1944 [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)]

Subject: Positive Intelligence Secured from Prisoners of War at Camp Reynolds, Pa., Relative to "Secret Weapon"

Summary of Information:

The following information has been received from what is believed to be a reliable source relative to use by the Germans of a secret weapon.

"According to informant, the Germans are at present working on an extremely secret explosive. Informant knows very little about it and states that it has something to do with 'Heavy Water' (Schweres Wasser). Experiments are conducted on an estate in Pomerania and it is alleged that this explosive is capable of destroying everything in a radius of several kilometers."

Prisoner of war Schaeffer stated the following relative to a secret weapon.

"One of the weapons which the Germans are relying on has something to do with Heavy Water. It is a shell or an explosive and has the effect of collapsing the lungs of persons in a large area. Informant says he personally saw victims' mouths filled with blood, on the Russian front as a result of this weapon."

[See document photo on p. 4435. This report summarizes information from two different captured Germans. The unnamed first prisoner of war mentioned the production of "an extremely secret explosive" using "heavy water"—the production of plutonium for fission bombs. He also said such bombs should have a blast radius of several kilometers and were to be tested on the Baltic coast.

The second prisoner of war, Schaeffer, mentioned nuclear explosives whose production involved heavy water. He also mentioned fuel-air explosives that could be as small as artillery shells and would create a shock wave capable of destroying the lining of the lungs of people exposed to the blast. He said he had seen such fuel-air explosives actually employed on the Russian front. Schaeffer appeared to confuse nuclear explosives and fuel-air explosives (incorrectly connecting heavy water with fuel-air explosives), likely because of the extreme secrecy around both projects and the fact that both were intended to produce powerful explosions.

For more information fuel-air explosives, see pp. 544–563, 2627–2635.]

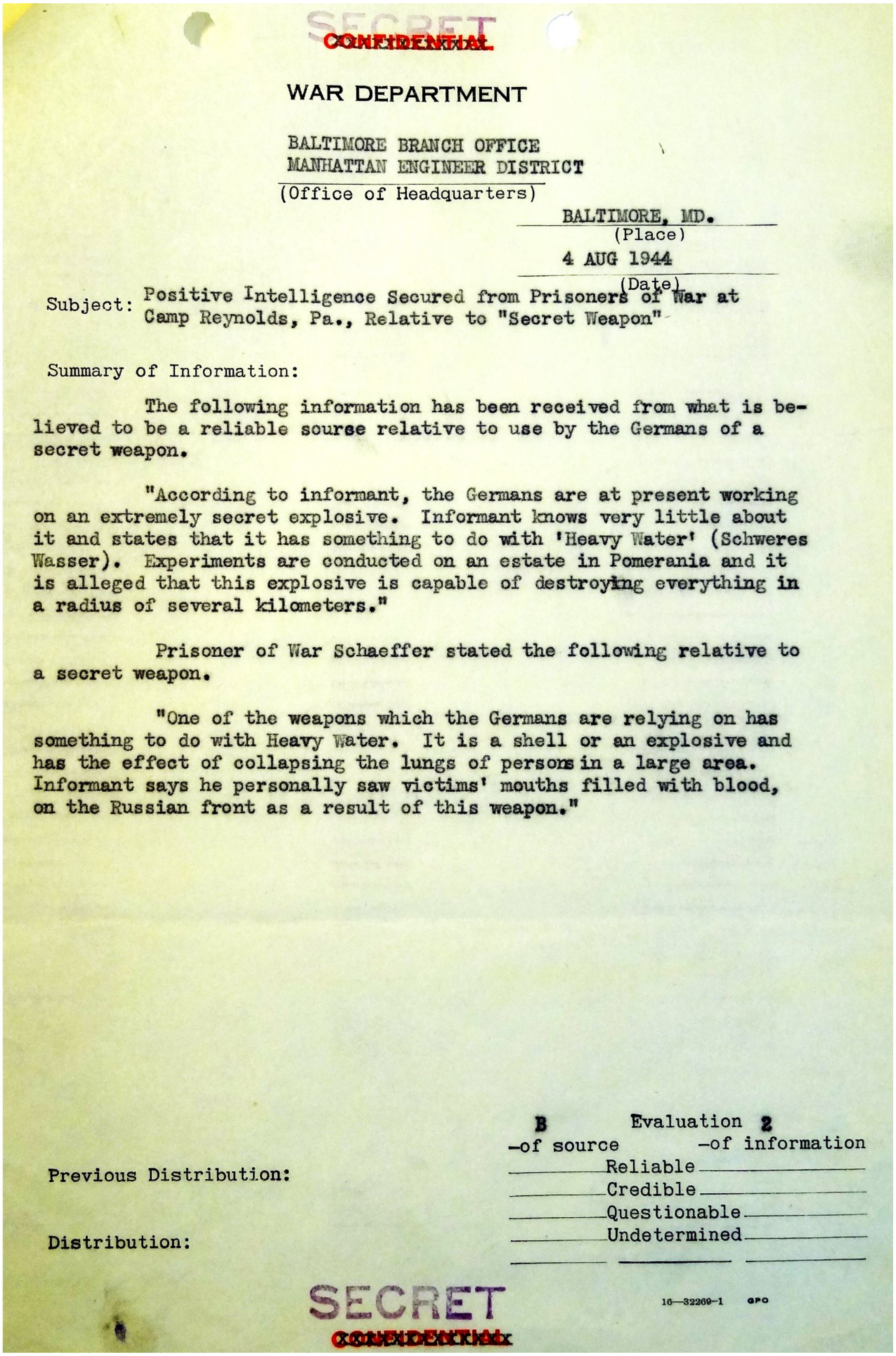
OSS London. 5 December 1944. Report T-2805-a. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]

<u>GERMANY</u> : <u>ATOMIC PHYSICS</u>

<u>Heavy Water Experimental Station</u>.

Heavy water experiments are being carried out at the Dräger Werke, Lübeck, which is reported to be the largest gas factory in Germany. The plant's experimental station is connected with the experimental station at Peenemünde.

[See document photo on p. 4099.]



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WAR DEPARTMENT

BALTIMORE BRANCH OFFICE
MANHATTAN ENGINEER DISTRICT
(Office of Headquarters)

BALTIMORE, MD.
(Place)

4 AUG 1944
(Date)

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B Evaluation 2
–of source –of information
Reliable
Credible
Questionable
Undetermined

Previous Distribution:

Distribution:

16—32269-1 GPO

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NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July-Oct. 44)

Figure D.677: Baltimore Branch Office, Manhattan Engineer District. 4 August 1944. Subject: Positive Intelligence Secured from Prisoners of War at Camp Reynolds, Pa., Relative to "Secret Weapon" [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

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NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 Germany: Summary Reports (1945-1946)

file

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THIS DOCUMENT CONSISTS OF 1 PAGE(S)
NO. 1 OF 3 COPIES, SERIES A

20 October 1944

Subject: Loose Ends.

To: Mr. Joseph Volpe

From: Dr. P. Morrison

There a number of things to be done by the Washington office which have not yet been done.

1. We need a final report on the installation at Watten. This is such an extraordinary enterprise that we must be sure that it was not designed for something in our field.

2. The questions for Mr. Baker should be answered.

3. The recent reports of Baltic explosions should be covered by Major Calvert as usual.

4. The deBoer matter is still open. Has Alsos contacted J. H. de Boer at Eindhoven? This should be done if it is still possible.

P. Morrison

Cy #3 destroyed
P.K.

JV

SECRET

Figure D.678: Philip Morrison to Joseph Volpe. 20 October 1944. Subject: Loose Ends [NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 Germany: Summary Reports (1945–1946)].

Philip Morrison to Joseph Volpe, 20 October 1944, Loose Ends [NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 Germany: Summary Reports (1945–1946)]

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[See document photo on p. 4436.

Dr. Philip Morrison (U.S., 1915–2005), a Manhattan Project physicist, was stationed in the United States but specifically tasked with analyzing Allied intelligence data on the German nuclear program. Morrison's publicly available documents indicate that up through 1945, he believed the German nuclear program was much more advanced and dangerous than better-known investigators such as Samuel Goudsmit and Boris Pash seemed to.

Regarding the specific points in the memo above:

1. Even months after the Allied invasion of France, Morrison and other Allied officials were both awed ("extraordinary") by the rocket-launching installation at Watten and worried that some of its features seemed to indicate it involved nuclear payloads for the rockets.

2. "Mr. Baker" was Niels Bohr, who was famously quite concerned about the progress of the wartime German nuclear program.

3. In October 1944, there were "recent reports of Baltic explosions" that were being investigated by the Manhattan Project as possible tests of a German atomic bomb. That information agrees well with the other sources in this section that reported the apparent test of an atomic bomb on the Baltic coast in October 1944. Morrison's comment also makes it clear that Allied officials thought the German nuclear program could be sufficiently advanced to test an atomic bomb, and that U.S. Army Major Horace Calvert had a "usual" procedure for collecting and analyzing such data. Can the relevant Allied intelligence reports be located and declassified now?

4. Manhattan Project intelligence analysts were actively seeking information on the German nuclear program from the Dutch intelligence network, and Samuel Goudsmit was involved in at least some of those contacts, including with the physical chemist Dr. Jan Hendrik de Boer (Dutch, 1899–1971). See pp. 4878–4899.]

Wolfgang Ebsen. 2007. Der Interrogations-Report des Rudolf Zinsser. [Karlsch and Petermann 2007, pp. 160–161]

Im Oktober 1944 erhielt auch der Physiker Philip Morrison, er gehörte zum Stab von General Groves, beunruhigende Nachrichten. Er schilderte seine diesbezüglichen Erlebnisse 1990 in einem Interview mit dem amerikanischen Autor Thomas Powers: "Ich las den Bericht über die Vernehmung deutscher Offiziere, die eine purpurfarbene pilzförmige Wolke nahe Peenemünde gesehen haben wollten. Wir hielten dies für wenig glaubwürdig, dennoch waren wir beunruhigt. Ich sandte den Sicherheitsberatern ein Memorandum und erklärte, Präsident Roosevelt möge sich nicht mit Churchill in London treffen, da wir einen Angriff mit einer Atombombe auf die britische Hauptstadt befürchteten. Ich hörte jeden Abend und jeden Morgen BBC, um sicherzugehen, dass London noch existiert. Die V2 hätte gerade einmal für den Transport einer kleinen nuklearen Bombe gereicht."[21]

21 Interview von Thomas Powers mit Philip Morrison vom 22.3.1990, Verwendung mit freundlicher Genehmigung.

In October 1944, physicist Philip Morrison, a member of General Groves's staff, also received disturbing news. He described his experiences in 1990 in an interview with the American author Thomas Powers: "I read the report about the interrogation of German officers who claimed to have seen a purple mushroom-shaped cloud near Peenemünde. We didn't think this was very credible, but we were still worried. I sent a memorandum to the security advisers saying that President Roosevelt should not meet Churchill in London because we feared an atomic bomb attack on the British capital. I listened to the BBC every night and every morning to make sure that London still existed. The V2 would have been just enough to transport a small nuclear bomb."[21]

21 Interview by Thomas Powers with Philip Morrison on 22 March 1990, used with kind permission.

OSS Report No. FF-83. 21 October 1944. Atom Smashing Secret Weapon. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44).]

1. The Germans have completed a weapon which is founded on the principle of the disintegration of matter (Atomzertruemmerung). Experiments have been performed which have proved conclusive. The effect of this weapon is like that of a thunderbolt, naturally much magnified.

2. It would be possible to direct the effect of this weapon in any given direction. Possibly it is a question of a sort of projectile rather than of a weapon properly so-called. The radius of action is supposed to be about three kilometers. The devastation produced by this weapon is said to be such that Hitler plans to use it only in the air, against planes, for example. Nevertheless, the Germans say that in case of necessity they will not hesitate to use it on the ground as well. This weapon seems to be ready, in fact, for use upon the battlefield, but it still exists only in the form of a model. Germany needs—and this appears to be absolutely certain—a delay of at least three months. Practically speaking, it seems that only within five months could the weapon be ready for use.

3. Different conversations which have taken place with industrial leaders in charge of concentration of production of German war material give the impression that Germany has unlimited confidence in the use of this weapon, which is to bring them certain victory.

4. Herr Schneider, one of the directors of the German factories called Deutsche Waffen u. Munitions-fabrik (a combine representing some fifteen factories and 250,000 workers) declared with a smile: “We shall gain the victory by new weapons, we are absolutely sure of that. Just now it is simply a case of gaining time, because the new arms will not be ready before three or four months. Bombing cannot keep us from building them. Our important factories where the assembly is carried out are all subterranean. An immense quantity of accessories is made in small lots everywhere throughout the country, so that bombing cannot interrupt the production. Our troops may retire within our frontiers. That does not matter, for nothing will be able to stand up for any length of time against these new weapons and we shall resume our overwhelming advance.”

5. Directors of certain other factories have shown the same inveterate optimism, aroused by the confidence which they have in the effects of these new weapons.

6. Names of certain industrialists with whom the interviews took place:

> Herr [Adolf] Schneider—Director of the Deutsche Waffen und Munitions-Fabrik. His German title is Wehrwirtschaftsbeauftragter (Superintendent of Armament Production) in the region of the Duchy of Baden and Wurtemberg. He has charge of the plants of the Karlsruhe region.
>
> Director Dr. Buesse, who directs the DWM factories at Karlsruhe.
>
> Dr. Quandt, Administrator of a part of the DWM combine of factories.

[See document photos on pp. 4442–4443.

Deutsche Waffen- und Munitionsfabriken (DWM) was a massive German company (founded in the nineteenth century) that produced explosives, weapons, and other equipment. It had enormous amounts of support and funding from the German government and political contacts at the highest levels [https://zkm.de/en/from-the-munitions-factory-to-a-culture-factory]. During the war, it made extensive use of slave labor and underground facilities. As noted in this OSS report, it had fifteen factories and 250,000 workers.

Adolf Schneider (German, 1899–1979, https://historisches-lexikon.li/Schneider,_Adolf) was a senior manager of DWM during the war and a leading industrialist before, during, and after the war.

"Dr. Buesse" was another senior manager of DWM and may have been a member of the Busse family of weapons makers.

"Dr. Quandt" would have been either Günther Quandt (German, 1881–1954, https://www.deutsche-biographie.de/gnd124997821.html), who was the owner of DWM during the war, or his son Herbert Quandt (1910–1982, https://www.deutsche-biographie.de/sfz103954.html).

"Directors of certain other factories" were also interviewed but not explicitly named here.

According to all of these very well-informed and highly placed individuals, Germany had developed a secret weapon that used atomic disintegration (fission) to create an explosion with a blast radius of three kilometers and effects like a thunderbolt but much magnified—i.e., blinding light, intense heat, and a shock wave extending out to that radius. As of the final report date of 21 October 1944, a prototype of the weapon had been successfully tested.

More nuclear weapons were expected to be ready within five months, or by March 1945. Adolf Schneider, who was in charge of so many facilities and people and therefore in a position to know, explained how German nuclear weapons were being mass-produced: "Our important factories where the assembly is carried out are all subterranean. An immense quantity of accessories is made in small lots everywhere throughout the country, so that bombing cannot interrupt the production."

What OSS source(s) had access to all of these important individuals and could get them to speak so candidly?

Where are the transcripts and reports on postwar Allied interrogations of Günther Quandt, Herbert Quandt, Adolf Schneider, "Dr. Buesse," and the other factory directors regarding the German nuclear weapons program and other advanced programs?

Where are the reports on postwar Allied inspections of the many underground facilities manufacturing components for nuclear weapons, as described in this wartime OSS report?]

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FOIA(b)3

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SIRA/L

Original Report No. FF-835

Report from Paris

O S S L O N D O N

Distribution:		Information Date	: 23 August 1944
G-2 FAAA		Report Date	: "Recent"
A-2 USSTAF		Dissemination Date	: 21 October 1944
EWD			
X-2			
USEmb(G)Bartlett		Value	: B-4
WASH		Source	

GERMANY: AIR-MILITARY-TECHNICAL

Atom Smashing Secret Weapon.

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Declassified
Authority: 25353
By: Alan Lipton Date: 12-14-2004

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)

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NND 951210
By HMN/AL Date 12/14/04

Figure D.679: OSS Report No. FF-83. 21 October 1944. Atom Smashing Secret Weapon [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

~~SECRET~~ Original No. FF-83- Page 2

4. Herr Schneider, one of the directors of the German factories called Deutsche Waffen u. Munitions-fabrik (a combine representing some fifteen factories and 250,000 workers) declared with a smile: "We shall gain the victory by new weapons, we are absolutely sure of that. Just now it is simply a case of gaining time, because the new arms will not be ready before three or four months. Bombing cannot keep us from building them. Our important factories where the assembly is carried out are all subterranean. An immense quantity of accessories is made in small lots everywhere throughout the country, so that bombing cannot interrupt the production. Our troops may retire within our frontiers. That does not matter, for nothing will be able to stand up for a ny length of time against these/new weapons and we shall resume our overwhelming advance."

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Director Dr. Buesse, who directs the DWM factories at Karlsruhe.

Dr. Quant, Administrator of a part of the DWM combine of factories.

JHM/jd

~~SECRET~~

NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2
GERMANY: US Wartime Positive Int. (July–Oct. 44)

Figure D.680: OSS Report No. FF-83. 21 October 1944. Atom Smashing Secret Weapon [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-2 GERMANY: US Wartime Positive Int. (July–Oct. 44)].

Headquarters, United States Strategic Air Forces in Europe, Office of the Director of Intelligence, An Evaluation of German Capabilities in 1945. The Commanders Intelligence Digest. 19 January 1945. [AFHRA folder 519.635 1945 Intelligence Digest; AFHRA A5729 electronic version pp. 255 onward and 561 onward; NARA RG 319, Entry UD-1041, Box 27, Folder 925497]].

1. In the following paragraphs are listed the actual or potential weapons which the Germans may use against USSTAF operations in 1945. For the most part they include the so-called V weapons. No consideration is given to those for which there is lacking evidence of possible use for some time to come. [...]

2. V-2:

[...] The V-2, or rocket projectile, with a warhead of approximately one ton, and a current range of 225 miles, is being fired at London at the rate of 180/250 per month, and against Continental ports at the rate of approximately 300 per month.

[...] Larger rockets (68 feet in length as against 45 feet) are known to exist, and may appear in small quantities during the year. They would have a considerably larger warhead. [...]

7. ATOMIC BOMB: Close check of every report, and close surveillance of the area in which tests are alleged to have taken place lead to the conclusion that such bombs are not a likelihood in 1945.

[See document photos on pp. 5406–5408.

Point 1 suggests that there was significant evidence for each of the weapons listed thereafter.

Point 2 proves that rockets 50% longer than the V-2 (21 m vs. 14 m), and with a warhead "considerably larger" than one ton (suitable for an atomic bomb?), were "known to exist."

Point 7 suggests U.S. knowledge of multiple alleged German atomic bomb tests prior to January 1945, in a particular area or areas under close Allied surveillance. This likely means the Baltic coast (which was being closely monitored for activities at Peenemünde and other locations), and might therefore include the October 1944 test. It might also refer to a failed test in the North Sea in autumn 1943 (pp. 4480, 5057, 5080).]

Theodor Soucek. 2001. *Mein Richter, mein Henker.* Malmö, Sweden: Bright Rainbow.

[Soucek (1919–20??) was born in Graz, Austria and served throughout the war as an officer. After the war he returned to Austria and helped run one of the "ratlines" for people fleeing Austria and Germany; in that context he sheltered and became well acquainted with Armin Dadieu, a scientist and former senior official from Graz. Soucek's memoirs were written near the end of his life and mix what he had actually seen with what he had heard or believed, so one must be quite cautious in using them, but they contain several intriguing passages that align well with independent sources. For more information, see pp. 4659–4670.]

In diesem Zusammenhang erzählte ich Dadieu von einer außerordentlichen Begegnung mit einem hochrangigen ungarischen General, als ich mich—noch verwundet—im gleichen Zugabteil auf der Bahnfahrt von Berlin nach Wien Mitte Januar 1945 befand. [...]

Mir gegenüber hatte ein älterer, weißhaariger Herr Platz genommen, der sich mir im Laufe der Reise nach vertraulichem und angeregtestem Gespräch als hochrangiger ungarischer General vorstellte.

Nach mehr als einer Stunde Bahnfahrt wandte sich der General überraschend und vertraulich zu mir:

"Schauen Sie, lieber junger Freund, Sie sind für mich ein frontbewährter Offizier und offenbar bedingungslos Ihrer Nation und der Verteidigung Europas verschworen, dazu noch Schriftsteller von höchstem Verantwortungsbewußtsein zur Rettung vor dem Kommunismus. So kann ich Ihnen von meinem Besuch als Vertreter der ungarischen Regierung in Berlin erzählen, weil man uns mit anderen verbündeten Regierungsvertretern der Achsenmächte in den letzten Tagen die jüngsten Entwicklungen der deutschen Geheimwaffen vorführte.

Wir wurden an der Ostsee in ein Sperrgebiet der Wehrmacht geflogen und es geschah folgendes: Als Zielgebiet zeigte man uns eine vielleicht 20–25 km entfernte kleine Insel und beschoß diese mit einer neuartigen Bombe, aus einem Flugzeug abgeworfen. Diese Bombe wirkte so beispiellos, daß von der Insel nichts mehr zu sehen war, sie war im Wasser verschwunden![4]

Mit dieser neuen Waffe werden Sie den Krieg gewinnen, Deutschlands Sieg ist nicht mehr aufzuhalten. Ich gratuliere Ihnen!"

Das waren seine Worte.

4 [...] Der "Schwedische Beobachter" bericht vom Verschwinden einer Insel nach Beschuß durch eine deutsche Sonderwaffe.

In this context, I told Dadieu about an extraordinary encounter with a high-ranking Hungarian general when I was—still wounded—in the same train compartment on the train ride from Berlin to Vienna in mid-January 1945. [...]

An elderly, white-haired gentleman had taken a seat opposite me, who introduced himself to me as a high-ranking Hungarian general during the course of the journey after a confidential and animated conversation.

After more than an hour's train ride, the general turned to me surprisingly and confidentially:

"Look, dear young friend, you are for me a front-line officer and obviously unconditionally sworn to your nation and the defense of Europe, in addition to being a writer of the highest sense of responsibility to save us from communism. So I can tell you about my visit to Berlin as a representative of the Hungarian government, because in the last few days we were shown the latest developments in German secret weapons together with other allied government representatives of the Axis powers.

We were flown to a Wehrmacht restricted area on the Baltic Sea and the following happened: We were shown a small island perhaps 20–25 km away as a target area and bombarded it with a new type of bomb, dropped from an airplane. This bomb had such an unprecedented effect that nothing could be seen of the island, it had disappeared into the water![4]

With this new weapon you will win the war, Germany's victory can no longer be stopped. I congratulate you!"

Those were his words.

4 [...] The "Swedish Observer" reports on the disappearance of an island after bombing by a German special weapon.

Harry K. Lennon. 23 May 1945. SUBJECT: Addition to Preliminary Report on OLMES, Friedrich. [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)]

The following information was given by OLMES, after he had recovered his notebook buried in the LUENEBURGER HEIDE. [...]

2. The experiments with the atom-splitting bomb had almost been brought to conclusion. The proven effect of a one kilogram bomb is to cause a crater of 18 miles wide. Only 8–10 more weeks work would have been required to put the bomb into the operational stage.

3. Laboratory experiments were conducted in DANZIG and BERLIN. Practical experiments were conducted on the Baltic coast. [...]

[See document photo on p. 4447.

Olmes stated that "practical experiments" with an "atom-splitting bomb" "were conducted on the Baltic coast," corroborating information from the other sources in this section.

Intriguingly, he apparently obtained that information from documents, people, or personal experience he had found in the Lüneburger Heide, an area just south of Hamburg that several other independent sources said contained factories producing atomic bombs or major components for them (pp. 4214–4220).]

S E C R E T

HEADQUARTERS TWELFTH ARMY GROUP
Mobile Field Interrogation Unit No.4
APO 655

23 May 45

SUBJECT: Addition to Preliminary Report on OLMES, Friedrich.

TO : Chief CIB, G-2 Section, HQ 12 Army Group, APO 655, US Army.

The following information was given by OLMES, after he had recovered his notebook buried in the LUENEBURGER HEIDE.

1. German Development of Atom-splitting bomb.

1.The following German scientists were instrumental in the development of an atom-splitting bomb:
a. Prof. HEISENBERG, recipient of the 1932 NOBEL prize in physics. BERLIN-DAHLEM, Kaiser Wilhelm Institut for Physik, the "brains" of the project .
b. Prof. PASQUAL JORDAN, physics lecturer at the BERLIN university.
c. Prof. HAHN, Director of the Kaiser Wilhelm Institut fuer physikalische Chemie, BERLIN.
d. Dr. STRASSNER, assistant to Prof. HAHN.
e. Prof. KOSSEL, lecturer at the Technische Hochschule in DANZIG. X-ray and electronics specialist.
f. Prof. GERTHSEN, BERLIN University. Developed the German super microscope.
g. Baron MANFRED von ARDENNE, BERLIN LICHTERFELDE. Amateur scientist. No scientific tng, but considered a genius.
h. Dr. ULRICH NEUBERT, Luftfahrts Forschungs Insitiut, BRAUNSCHWEIG: Private address: 1 Saarstrasse, BRAUNSCHWEIG. Specialist in cumbustion engines.

2. The experiments with the atom-splitting bomb had almost been brought to conclusion. The proven effect of a one kilogram bomb is to cause a crater of 18 miles wide. Only 8-10 more weeks work would have been required to put the bomb into the operational stage.

3. Laboratory experiments were conducted in DANZIG and BERLIN. Practical experiments were conducted on the Baltic coast.

4. OLMES knows all the above named scientists personally. He claims to know the principle of the atom-splitting bomb fairly well and would be able to explain it to an expert.

5. HITLER was very impatient for the experiments to come to a conclusion. He had BORMANN call up Prof. HEISENBERG daily to inquire about the progress.

6. The above named scientists were afraid of the responsibility of putting into operation a wpn of such horrifying proportions. They deliberately stalled and had false reports given to HITLER. Some of their assistants were involved in the plot of 20 Jul 1944.

7. Through scientist friends in SWITZERLAND and SWEDEN the German scientists were fairly well informed about atom-splitting experiments in other countries, including the USA. They know that the other countries were far behind GERMANY in that respect.

8. The germans thought that the Russians were particularly eager to find out about the atom-splitting bomb. Orders were given that under no circumstances any plans should fall in Russian hands.

9. Although plans for the escape of some atom-splitting specialists to JAPAN had been vaguely mentioned, OLMES thinks that all of the scientists were opposed to such a project.

NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45--Dec 45)

Figure D.681: Harry K. Lennon. 23 May 1945. SUBJECT: Addition to Preliminary Report on OLMES, Friedrich [NARA RG 77, Entry UD-22A, Box 167, Folder 32.12-2 GERMANY: Personnel (Jan 45–Dec 45)].

Interrogation of Zinsser, Rudolph G. Papers attached: Memo of 17 July 1945, 609th CIC Detachment [AFHRA C5094 frames 1546–1552].

Re: Subject & 1 incl. thereto; Miscellaneous Interviews, Abstract: Contains Biographical Information on Rudolph G. Zinsser

[...] 1. SUMMARY

Subject was investigated because of his appearance under suspicious circumstances at the Signal Intelligence Section project which is being conducted at Bad Kissingen. Interrogation of subject revealed that he was formerly the director of a German research project, Code Name DERNA, whose purpose was the development of a fully automatic, self-steering anti-aircraft rocket. Subject stated that he is willing to develop this device for the American authorities.

2. INVESTIGATION

Subject ZINSSER, Rudolph G. was born 6/9/13 in Vienna of Austrian parents. Subject became an engineer at the Technische Hochschule in Darmstadt in 1933–1935 and later took his doctorate degree at University J. W. Goethe in Frankfurt 1935–1939.

In 1939 subject entered the Luftwaffe and served in Norway, France, Italy and Africa. Subject was discharged from the Luftwaffe late in 1944 because of wounds received in combat. Highest rank attained was Oberleutnant. [...]

Previous to his discharge from the Luftwaffe subject stated that he was granted space at the Luftkriegs Academy, Berlin/Gatov, to work on above mentioned rocket-steering device. He left the academy in September 1944 having secured financial backing from the Flugzeugwerk Siebl in Halle and opened his own laboratory at Jibka in the Sudeten. [...]

On the 26 April subject stated that the factory was evacuated to the vicinity of Bad Aussee and that at the present time he does not know what happened to his equipment or personnel. [...]

[See document photos on pp. 4449–4450.]

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CONFIDENTIAL

HEADQUARTERS
609 C.I.C. DETACHMENT

17 July 1945

MEMORANDUM TO THE OFFICER IN CHARGE

Subject: Investigation of ZINSSER, Rudolph G.

1. SUMMARY

Subject was investigated because of his appearance under suspicious circumstances at the Signal Intelligence Section project which is being conducted at Bad Kissingen. Interrogation of subject revealed that he was formerly the director of a German research project, Code Name DERNA, whose purpose was the development of a fully automatic, self - steering anti - aircraft rocket. Subject stated that he is willing to develop this device for the American authorities.

2. INVESTIGATION

Subject ZINSSER, Rudolph G. was born 6/9/13 in Vienna of Austrian parents. Subject became an engineer at the Technische Hochschule in Darmstadt in 1933 - 1935 and later took his doctorate degree at University J.W.Goethe in Frankfurt 1935 - 1939.

In 1939 subject entered the Luftwaffe and served in Norway, France, Italy and Africa. Subject was discharged from the Luftwaffe late in 1944 because of wounds received in combat. Highest rank attained was Oberleutnant.

Subject stated that while in Africa he was ordered by his commanding officer to return to Erding, near Munich, and develop a special bomb-sight for use against fast moving ground targets. Subject stated that this work was completed in September 1942 and that the bomb-sight was successfully used. Production of the bomb-sight was by Ziess Jena and Ziess Ikon factories and fifty-three (53) were completed.

Previous to his discharge from the Luftwaffe subject stated that he was granted space at the Luftkriegs Academy, Berlin/Gatov, to work on above mentioned rocket-steering device. He left the academy in September 1944 having secured financial backing from the Flugzeugwerk Siebl in Halle and opened his own laboratory at Jibka in the Sudeten. Here he financed his work through the sale of small radio transmitters to the Wehrmacht. Subject stated that during this time he and his assistants developed some working models of the rocket steering device.

On the 26 April subject stated that the factory was evacuated to the vicinity of Bad Aussee and that at the present time he does not know what happened to his equipment or personnel. Orders were left by him to destroy the test models of the steering device. At this time Zinsser stated that he returned to Roding, near Nurnberg, and attempted to contact the American authorities. Subject stated that he feels certain that the report turned in to the authorities at Roding did not accurately describe his project since no one there spoke German.

3. Zinsser was advised to return to Roding and to remain there pending further developments.

4. AGENTS NOTE

Since a project of this type is of such a highly technical nature it is not possible for this agent to make any evaluation of possible value of the project. Suggest that a further investigation of this project be conducted by appropriate technical authorities.

Enclosed is a brief description of the project as outlined by Zinsser.

W. A. Currie
Special Agent, CIC

Dist:
1 Cy CO 609 CIC Detachment
1 Cy CIB
1 Cy IPW Section

AFHRA folder 570.620-1 17 July 1945

Figure D.682: W. A. Currie. 17 July 1945. Subject: Investigation of ZINSSER, Rudolph G. [AFHRA folder 570.620-1 17 July 1945; AFHRA C5094 frames 1546–1552].

Target. SMC

Major Marcus, Ops 538

1. Tech/IntellTech/Intell 25 Aug.
Air Document USAFE 1945
Research (main)
Center,
USAFE
(Rear)
59 Weyman
W1 London

1. Herewith for your file papers which were in the hand of Capt. Worthman. He started to the target and due to transportation returned to St. Germain

2. Capt. Giles has obtained the complete information on the target so it was not necessary for Capt. Worthman to follow through.

3. Lt Col. Warburg has been informed that the subject person can be released.

LOYD K. PEPPLE,
Colonel, Ordnance.

Incls:
Incl 1 - Interrogation Report of Rudolph G. Zinsser.

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AFHRA folder 570.620-1 17 July 1945

4494A

HEADQUARTERS
NINTH AIR FORCE

FILE NO. INFORMAL ROUTING SLIP

NOTE: Use this slip for comment in connection with papers attached. Number notes consecutively. Draw a line full width of paper below each note. Initial each note. File this slip with retained copy of papers.

SUBJECT: INTERROGATION OF ZINSSER, Rudolph G.

PAPERS ATTACHED: Memo, dtd 17 Jul 609th CIC Det, re: Subject & 1 incl thereto

NO.	DATE	FROM	TO	NOTES or CORRESPONDENCE
1	18 Jul 1945	609th CIC Det	INTERROGATION P W	Forwarded for your information. L.L.L. L.L.L.
2	19 Jul	Hq Air PW Inter Unit, USSTAF, APO 696	Hq USSTAF Main, Att: Lt Col Werner.	Forwarded for your information. TGB T.G.B.

Figure D.683: Loyd K. Pepple. 25 August 1945 [AFHRA folder 570.620-1 17 July 1945; AFHRA C5094 frames 1546–1552].

A.P.W.I.U. [Air Force Prisoner of War Interrogation Unit] (Ninth Air Force) 96/1945. 19 August 1945. Investigations, Research, Developments, and Practical Use of the German Atomic Bomb. [NARA RG 38, Entry 98C, Box 9, Folder TSC # 2601–2700; NARA RG 77, Entry UD-22A, Box 171, Folder 32.60-2 Germany: Summary Reports (1945–1946); AFHRA B-5737 electronic version pp. 340–345]

2. Dr. EDSE, well known chemist, wrote:
At the Institute for Physical Chemistry of the Hamburg University I worked on problems concerning nuclear physics under the direction of Prof. Dr. P. HARTECK, and engaged in investigations of behavior and properties of the so-called trans-uraniums, already mentioned by HAHN and STRASSMANN in Berlin, and by JOLIOT-CURIE in Paris. [...]

9. Furthermore the improvement and application of ultra-centrifuge, thermo-diffusion, and distillation had its effect on the success of these experiments. For this reaction the material to be split must have the form of a liquid, a gas, or a solution; UF_6 was used which will melt at 69.2^o C. under light over-pressure. This is advantageous as Fluor (UF_6) has not isotope. In this manner only the uranium isotopes are separated. [...]

14. When Germany was at this stage of the game, the war broke out in Europe. At first investigations on this disintegration of ${}^{235}_{92}U$ were somewhat neglected because a practical application seemed too far off. Later, however, this research continued, especially in finding methods of separating isotopes. Needless to say that the center of gravity of Germany's war effort at that time lay on other tasks.

15. Nevertheless the atomic bomb was expected to be ready toward the end of 1944, if it had not been for the effective air attacks on laboratories engaged in this uranium research, especially on the one at Rjuken in Norway, where heavy water was produced. It is mainly for this reason that Germany did not succeed in using the atomic bomb during the war. [...]

17. [...] The disintegration of one kg ${}^{235}_{92}U$ delivers an amount of energy of $\frac{1000}{235} \cdot 160 \cdot 23 \cdot 10^6$ kg cal $= 1.6 \cdot 10^{10}$ kg cal, whereas one kg of TNT only delivers 1000 kg cal when detonating. Out of this follows that an atomic bomb of 3 lbs ${}^{235}_{92}U$ has the same effect as a bomb of 20,000 tons of TNT. [...]

47. A man named ZINSSER, a Flak rocket expert, mentioned what he noticed one day: In the beginning of Oct. 1944 I flew from Ludwigslust (south of Lubeck), about 12 to 15 km from an atomic bomb test station, when I noticed a strong, bright illumination of the whole atmosphere, lasting about 2 seconds.

48. The clearly visible pressure wave escaped the approaching and following cloud formed by the explosion. This wave had a diameter of about 1 km when it became visible and the color of the cloud changed frequently. It became dotted after a short period of darkness with all sorts of light spots, which were, in contrast to normal explosions, of a pale blue color.

49. After about 10 seconds the sharp outlines of the explosion cloud disappeared, then the cloud began to take on a lighter color against the sky covered with a gray overcast. The diameter of the

still visible pressure wave was at least 9000 meters while remaining visible for at least 15 seconds.

50. Personal observations of the colors of the explosion cloud found an almost blue-violet shade. During this manifestation reddish-colored rims were to be seen, changing to a dirty-like shade in very rapid succession.

51. The combustion was lightly felt from my observation plane in the form of pulling and pushing. The appearance of atmospheric disturbance lasted about 10 seconds without noticeable climax.

52. About one hour later I started with an He 111 from the A/D [aerodrome] at Ludwigslust and flew in an easterly direction. Shortly after the start I passed through the almost complete overcast (between 3000 and 4000 meter altitude). A cloud shaped like a mushroom with turbulent, billowing sections (at about 7000 meter altitude) stood, without any seeming connections, over the spot where the explosion took place. Strong electrical disturbances and the impossibility to continue radio communication as by lightning, turned up.

53. Because of the P-38s operating in the area Wittenberg-Merseburg I had to turn to the north but observed a better visibility at the bottom of the cloud where the explosion occurred. Note [by U.S. Captain Freiberger]: It does not seem very clear to me why these experiments took place in such crowded areas.

[See document photos on pp. 4454–4459.

Paragraph 15 clearly states that the German nuclear weapons program was so advanced that the bomb would have been ready for use by the end of 1944, and that timetable was only slowed by Allied attacks. For independent sources that confirmed that fact, see pp. 5068, 5077, and 5119.

Rudolf Edse's calculation in paragraph 17 agrees well with modern calculations of the amount of U-235 required per ton of explosive yield (p. 5190). Of the roughly 180 MeV of energy released by each uranium fission, Edse appears to have assumed that approximately l60 MeV would be deposited within a short enough distance to directly contribute to the explosion, which would have been a very plausible assumption for him to make. How much did Edse actually know about nuclear weapons? What exactly did he work on, both during and after the war?

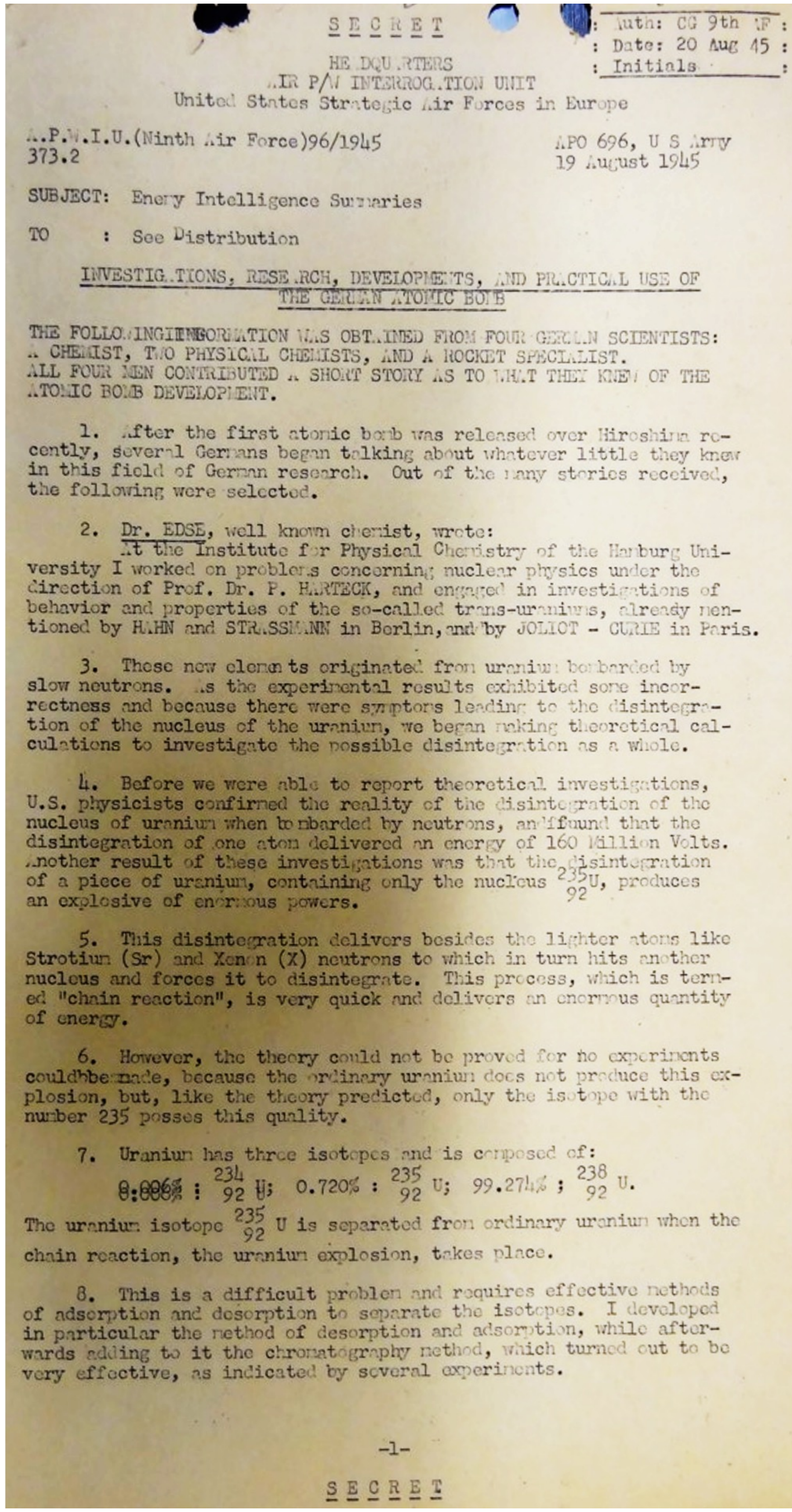
Rudolf Zinsser said he took off from Ludwigslust, flew toward the east, and turned to the north (to avoid Allied aircraft going to/from Berlin). That suggests he was somewhere along the Baltic coast, likely in the vicinity of Rügen, when he observed the test. If that was the case, Zinsser took off from a "crowded area" (Ludwigslust) but observed the test site in a much less populated area on the Baltic coast, which is well known to have been filled with test areas for everything from rockets to biological agents. His U.S. interrogator does not seem to have understood that initially, judging by the appended final note from Captain Helenes Freiberger.

Although Zinsser did not admit it, he had most likely been ordered to make multiple flights over the test area in order to make visual observations of the atomic bomb test, and quite possibly to carry cameras or measuring equipment. One flight at the right place and time might have simply been an extraordinary coincidence (and quite improbable, considering that it would have been a high-security area), but two flights shows deliberate intent to observe the test, especially coupled with his highly detailed description.

Zinsser provided many details about the nuclear explosion—such as the strong electromagnetic disturbances, the behavior of the blast wave and the debris cloud over time, and the colors of the cloud—that are scientifically correct and would not have been known to the public (or even many specialists), even after the bombings of Hiroshima and Nagasaki. Moreover, Zinsser had been in custody and under interrogation going back to at least 17 July 1945, well before Hiroshima and Nagasaki. Thus all the details that Zinsser described regarding the explosion strongly support the veracity of his story and the conclusion that what he observed was a nuclear test and not the test of some other sort of weapon. See especially p. 4461.

After two months of further Allied interrogation of Zinsser and investigation of any corroborating evidence, Zinsser's claims were not dismissed. Rather, they were actually upgraded to Top Secret—see p. 4462. Allied officials must have found their postwar investigation of German nuclear weapons tests to be very convincing indeed. Where are the follow-on reports about Zinsser, the other evidence, and the tests? Can they be located and declassified?]

AFHRA Folder 533.619-5 1945



S E C R E T

: Auth: CG 9th AF :
: Date: 20 Aug 45 :
: Initials :

HEADQUARTERS
AIR P/W INTERROGATION UNIT
United States Strategic Air Forces in Europe

A.P.W.I.U.(Ninth Air Force)96/1945
373.2

APO 696, U S Army
19 August 1945

SUBJECT: Enemy Intelligence Summaries

TO : See Distribution

INVESTIGATIONS, RESEARCH, DEVELOPMENTS, AND PRACTICAL USE OF THE GERMAN ATOMIC BOMB

THE FOLLOWINGINFORMATION WAS OBTAINED FROM FOUR GERMAN SCIENTISTS: A CHEMIST, TWO PHYSICAL CHEMISTS, AND A ROCKET SPECIALIST. ALL FOUR MEN CONTRIBUTED A SHORT STORY AS TO WHAT THEY KNEW OF THE ATOMIC BOMB DEVELOPMENT.

1. After the first atomic bomb was released over Hiroshima recently, several Germans began talking about whatever little they knew in this field of German research. Out of the many stories received, the following were selected.

2. Dr. EDSE, well known chemist, wrote:
At the Institute for Physical Chemistry of the Hamburg University I worked on problems concerning nuclear physics under the direction of Prof. Dr. P. HARTECK, and engaged in investigations of behavior and properties of the so-called trans-uraniums, already mentioned by HAHN and STRASSMANN in Berlin, and by JOLIOT - CURIE in Paris.

3. These new elements originated from uranium bombarded by slow neutrons. As the experimental results exhibited some incorrectness and because there were symptoms leading to the disintegration of the nucleus of the uranium, we began making theoretical calculations to investigate the possible disintegration as a whole.

4. Before we were able to report theoretical investigations, U.S. physicists confirmed the reality of the disintegration of the nucleus of uranium when bombarded by neutrons, and found that the disintegration of one atom delivered an energy of 160 Million Volts. Another result of these investigations was that the disintegration of a piece of uranium, containing only the nucleus $^{235}_{92}U$, produces an explosive of enormous powers.

5. This disintegration delivers besides the lighter atoms like Strotium (Sr) and Xenon (X) neutrons to which in turn hits another nucleus and forces it to disintegrate. This process, which is termed "chain reaction", is very quick and delivers an enormous quantity of energy.

6. However, the theory could not be proved for no experiments couldbbe made, because the ordinary uranium does not produce this explosion, but, like the theory predicted, only the isotope with the number 235 posses this quality.

7. Uranium has three isotopes and is composed of:
0.006% : $^{234}_{92}U$; 0.720% : $^{235}_{92}U$; 99.274% ; $^{238}_{92}U$.
The uranium isotope $^{235}_{92}U$ is separated from ordinary uranium when the chain reaction, the uranium explosion, takes place.

8. This is a difficult problem and requires effective methods of adsorption and desorption to separate the isotopes. I developed in particular the method of desorption and adsorption, while afterwards adding to it the chromatography method, which turned out to be very effective, as indicated by several experiments.

-1-

S E C R E T

Figure D.684: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program. [AFHRA Folder 533.619-5 1945]

AFHRA Folder 533.619-5 1945

SECRET

9. Furthermore the improvement and application of ultra-centrifuge, thermo-diffusion, and distillation had its effect on the success of these experiments. For this reaction the material to be split must have the form of a liquid, a gas, or a solution; UF_6 was used which wil will melt at 69.2° C. under light over-pressure. This is advantageous as Fluor (UF_6) has no isotope. In this manner only the uranium isotopes are separated.

10. Heavy water or hydrogen served as pattern for the methods of separating isotopes because these isotopes could easily be produced. The separation by the method of chromatography was applied to $CuSO_4$ in a solution of ammonia and water. The heavy water is produced by electrolysis of a solution of NaOH in water. The light hydrogen, having a greater tendency to escape than deuterium, is enriched as D_2O in the remaining solution which contains only heavy water when this process is repeated several times. This electrolysis, however, requires a large amount of energy. Therefore, cheap water power must serve as main source of energy (Norske Hydro, Norway).

11. Having recognized the behavior of the nucleus of uranium, it seemed simple to construct a so-called atomic bomb. However, we did not want this destroying effect but tried to find a way to control the disintegration of the nucleus of uranium bombarded by neutrons.

12. We had several plans but I do not know whether they will work. The importance of this energy or rather its source, may be seen in the fact that 1 kg $^{235}_{92}$U delivers the same amount of energy as the combustion of 1600 tons of gasoline.

13. The risk of the atomic bomb may lay in its enormous explosive power which may, perhaps, destroy our planet, for the theory says that it is possible that other nuclei will disintegrate. This disintegration is probably induced by the particles of the disintegrated uranium.

14. When Germany was at this stage of the game, the war broke out in Europe. At first investigations on this disintegration of $^{235}_{92}$U were somewhat neglected because a practical application seemed too far off. Later, however, this research continued, especially in finding methods of separating isotopes. Needless to say that the center of gravity of Germany's war effort at that time lay on other tasks.

15. Nevertheless the atomic bomb was expected to be ready toward the end of 1944, if it had not been for the effective air attacks on laboratories engaged in this uranium research, especially on the one at Rjukon in Norway, where heavy water was produced. It is mainly for this reason that Germany did not succeed in using the atomic bomb in this war.

16. The disintegration of the nucleus of uranium follows seven equasions, not enumerated in this report, but in the first step the neutron enters the nucleus and forms a new nucleus which is unstable and disintegrates spontaneously while yielding atoms. The neutron enters the heavy nucleus easily because it carries no electric charge.

17. The light nuclei are always radio-active and can be identified by their radiation (half period, B-spectra). The disintegration of one kg $^{235}_{92}$U delivers an amount of energy of $\frac{1000}{235} \cdot 160 \cdot 23 \cdot 10^6$ kg cal $= 1.6 \cdot 10^{10}$ kg cal, whereas 1 kg of TNT only delivers 1000 kg cal when detonating. Out of this follows that an atomic bomb of 3 lbs $^{235}_{92}$U has the same effect as a bomb of 20,000 tons of TNT.

18. The explosion of uranium will be induced by bombarding the nucleus by neutrons which are produced by a so-called neutron source. Mistures of radium salts and beryllium in suitable containers are used as neutron sources. Radium emits alpha - particles of carbon of mass 12 and neutrons are produced according to the equasion:

$$^{9}_{4}Be + ^{4}_{2}He \text{ --- } ^{12}_{6}C + ^{1}_{0}n \quad (^{4}_{2}H = \text{alpha}).$$

-2-

SECRET

Figure D.685: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program. [AFHRA Folder 533.619-5 1945]

AFHRA Folder 533.619-5 1945

SECRET

19. Before the explosion the neutrons have to be kept away from the uranium. This is done by surrounding the neutron source by a hydrogen containing medium. The neutrons do not penetrate a layer of 20cm water or parafine because their energy is exhausted by their collisions with the protons that have the same size as the neutron. Hereby slow neutrons are produced entering a proton nucleus leading to a denterium nucleus.

20. Through, thermal neutrons will penetrate through thin layers of water but then retain only thermal energy. These neutrons are important in very many nuclear reactions, for these nuclei possess a larger cross section for such neutrons. After dropping the bomb by airplane, and in order that the uranium bomb explode, this water - or parafine - coat between the uranium and the neutron source will have to be removed. To prevent an early explosion by means of counter action, I propose to launch the atomic bomb by a rocket.

21. During my engagement in Hamburg I intended to investigate the attractive problems of nuclear physics because many discoveries may still be made and the enormous quantity of energy in the nuclei promises an enormous evolution in producing energy for human consumption. Already 35 cyclotrons were built in the U.S. at that time, whereas in Germany just one existed.

22. It is of the utmost importance to mankind to continue research and investigations in this field of utilising the energy of the nuclei of these chemical elements for building up large sources of energy. Moreover, it is more or less mandatory to use other elements for the atomic bomb or engine because the $^{235}_{92}$U is one hundred times as scarce as mercury. Therefore all uranium will be exhausted soon.

23. Dr. EDSE concludes his resume' about the atomic bomb with an incomplete list of sources of uranium, dated 1934:

Country		Content of U	Demand
Africa (Katanga)	Uranium - pecherz	3%	50%
Canada	"		25%
Joachimsthal (Bohemia)	"		50%
U.S.A. (Colo.)	Carnotite	1%	? %

24. Dr. HARRIES tells of the atomic developments in Germany, the following: A substantial part of the German nuclear research was located in the Wuerzburg area at the Kaiser Wilhelm Institut (K.W.I.) for Physical Chemistry. Dr. HAHN at Tailfingen, Dr. DAELLENBACH, who planned to build a cyclotron according to his own ideas in that vicinity, and also Dr. HEISENBERG of the K.W.I. for Physics, were all to be brought to the Wuerzburg area.

25. Dr. Gustav HERTZ, according to the latest reports, is in Moscow and heads an institute for nuclear research there, along with a group of his own co-workers.

26. Prof. HERTZ was a student of Prof. RUBENS, Berlin. In the twenties he started his work on excitation and ionization of atoms, which earned him, together with James FRANCK, the NOBEL PRIZE in 1926. In the same year HERTZ became professor of experimental physics at Halle and in 1928 he went in the same capacity to the Technische Hochschule (Institute of Technology) in Berlin-Charlottenburg. Because he was not a pure aryan, Prof. HERTZ lost his professorship in 1935 and was made director of a Siemens & Halske research laboratory. There he remained until the Russians came.

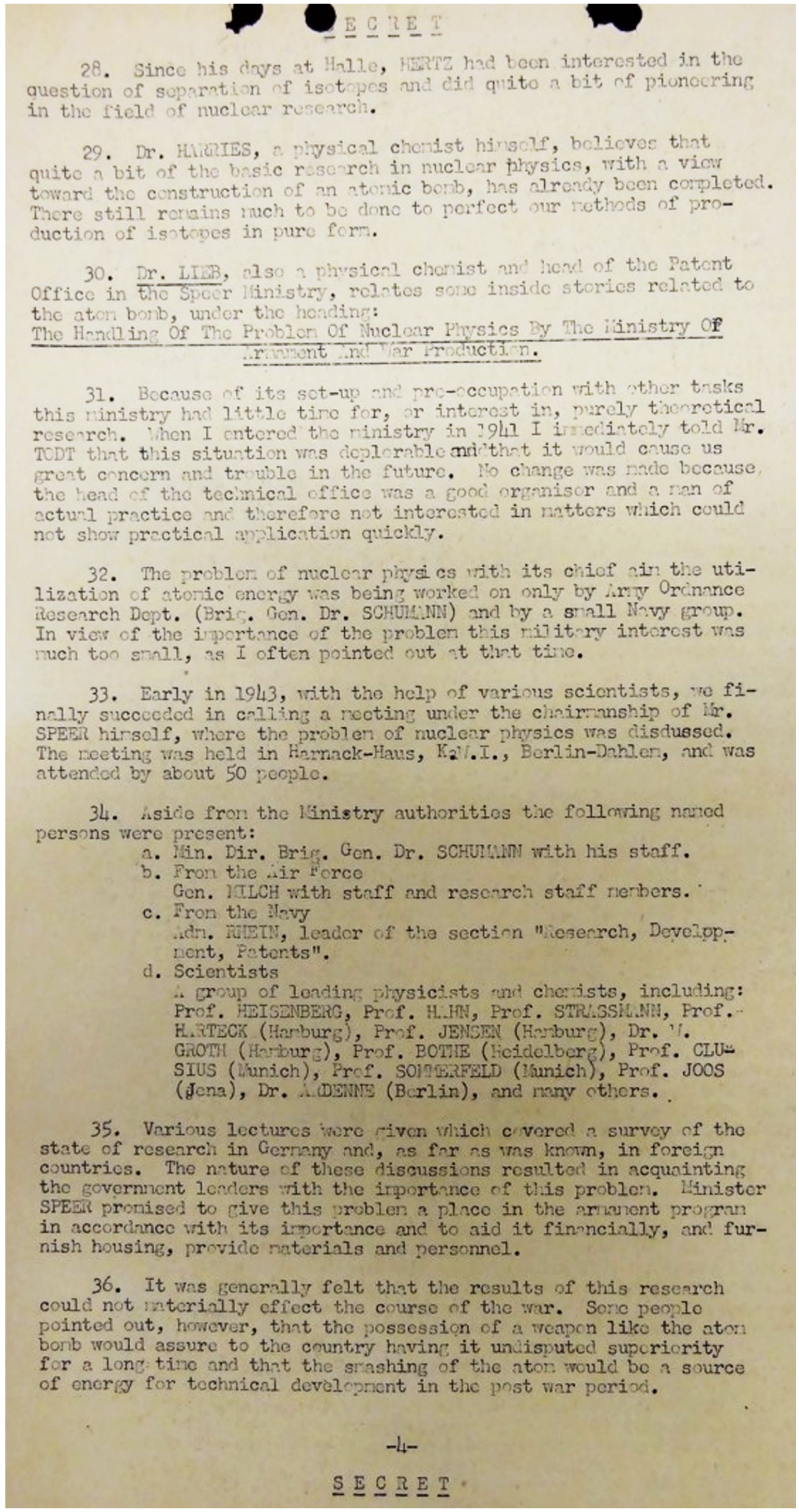
27. Until Prof. HERTZ came to Siemens he did not pay much attention to nuclear physics, but once with Siemens he became absorbed in this problem. One of his co-workers was sent to America before the war to familiarize himself with the cyclotron work being done there. Siemens, in the mean time started to build a cyclotron, but it was a failure.

-3-

SECRET

Figure D.686: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program. [AFHRA Folder 533.619-5 1945]

AFHRA Folder 533.619-5 1945



SECRET

28. Since his days at Halle, HERTZ had been interested in the question of separation of isotopes and did quite a bit of pioneering in the field of nuclear research.

29. Dr. HARRIES, a physical chemist himself, believes that quite a bit of the basic research in nuclear physics, with a view toward the construction of an atomic bomb, has already been completed. There still remains much to be done to perfect our methods of production of isotopes in pure form.

30. Dr. LIEB, also a physical chemist and head of the Patent Office in the Speer Ministry, relates some inside stories related to the atom bomb, under the heading:
The Handling Of The Problem Of Nuclear Physics By The Ministry Of Armament And War Production.

31. Because of its set-up and pre-occupation with other tasks this ministry had little time for, or interest in, purely theoretical research. When I entered the ministry in 1941 I immediately told Mr. TODT that this situation was deplorable and that it would cause us great concern and trouble in the future. No change was made because the head of the technical office was a good organiser and a man of actual practice and therefore not interested in matters which could not show practical application quickly.

32. The problem of nuclear physics with its chief aim the utilization of atomic energy was being worked on only by Army Ordnance Research Dept. (Brig. Gen. Dr. SCHUMANN) and by a small Navy group. In view of the importance of the problem this military interest was much too small, as I often pointed out at that time.

33. Early in 1943, with the help of various scientists, we finally succeeded in calling a meeting under the chairmanship of Mr. SPEER himself, where the problem of nuclear physics was disdussed. The meeting was held in Harnack-Haus, K.W.I., Berlin-Dahlem, and was attended by about 50 people.

34. Aside from the Ministry authorities the following named persons were present:

a. Min. Dir. Brig. Gen. Dr. SCHUMANN with his staff.
b. From the Air Force
Gen. MILCH with staff and research staff members.
c. From the Navy
Adm. RHEIN, leader of the section "Research, Developpment, Patents".
d. Scientists
A group of leading physicists and chemists, including: Prof. HEISENBERG, Prof. HAHN, Prof. STRASSMANN, Prof. HARTECK (Hamburg), Prof. JENSEN (Hamburg), Dr. W. GROTH (Hamburg), Prof. BOTHE (Heidelberg), Prof. CLUSIUS (Munich), Prof. SOMMERFELD (Munich), Prof. JOOS (Jena), Dr. ARDENNE (Berlin), and many others.

35. Various lectures were given which covered a survey of the state of research in Germany and, as far as was known, in foreign countries. The nature of these discussions resulted in acquainting the government leaders with the importance of this problem. Minister SPEER promised to give this problem a place in the armament program in accordance with its importance and to aid it financially, and furnish housing, provide materials and personnel.

36. It was generally felt that the results of this research could not materially effect the course of the war. Some people pointed out, however, that the possession of a weapon like the atom bomb would assure to the country having it undisputed superiority for a long time and that the smashing of the atom would be a source of energy for technical development in the post war period.

-4-

SECRET

Figure D.687: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program. [AFHRA Folder 533.619-5 1945]

AFHRA Folder 533.619-5 1945

SECRET

37, As time went on, the interest of SPEER in this project gradually lessened because of the many more pressing and immediate tasks. Research on uranium was such that it was truely given a place in the armament program, but no way was found to expedite the development quickly so that it could be utilized. As I learned from various talks with Prof. HEISENBERG, it was not the fault of our leaders but that the reason was more that science itself did not feel that it was possible to obtqin immediate results.

38. Under the second heading Dr. Lieb announces how the uranium research stood early in 1943. With the attempt to achieve the change of one element to another by artificial means as distinguished from the spontaneous changes which occur with radium, it was found that uranium was especially well suited for this purpose.

39. Next they made trans-uraniums from uranium, the nuclei thereof consisting of uranium nucleus with an addition of neutrons. In this work certain manifestations were observed (splitting up products) permitting the conclusion that in the building up process (trans-uraniums) a part of the uranium decomposed.

40. French scientists (JOLIOT-CURIE) demonstrated this fact and in America, through calulations, a theory was established explaining the observed effects. Through the analytical endeavors of Nobel prize winners HAHN and STRASSMANN the correctness of the theoretical investigations were accurately shown and later the mechanics of the chemical reaction were clarified.

41. The result was that only one type of uranium was suited for this splitting up process, e.g. isotopic form of uranium, present in the proportion of 1 to 1000 in uranium coming from pitchblend (U3O8). It was further established that once the falling apart (disintegration process has started it continues spontaneously without outside influence and with extraordinary rapidity. This fact was the reason for the exceptional practical significance in this research because one noticed that with the disintegration of the uranium gigantic sources of energy sprang up. With a comparative small ignition energy it was possible to release, through this spontaneous disintegration, the entire energy contained in the uranium atom.

42. This knowledge resulted in feverish activity all over the world. As main difficulty was encountered the isolation of the usable isotopic form that existed in the ratio 1 to 1000 in the already rare uranium. For this purpose one had to develop many completely new methods requiring an immense amount of material and work. The methods used in different parts of the world varied, and at the time of the discussions it could not be determined which of the proposed methods was the best.

43. Other endeavours sought to harness the powers of the explosive-like disintegration so that the freed energy would become a continuous source of energy that could be utilized, for example, as power for engines. The government and military representatives, present at the meeting, were told of the extraordinary practical significance of this work while it was constantly emphasized that the requirements of the war and those of the post-war period made the immediate and broad commitment of personnel and material for the atom research impossible.

44. One of the lectures given at one of those meetings, surveyed the state of research as of that time in the following words: The isolation of the isotopes-uranium 239 is now made via a gaseous phase, as hexa-flouride, for example. More ways were tried that require a great deal of material, complicated apparatus, and very able workers. These requirements cannot, at this time, be fulfilled, except piecemeal. On theother hand, and particularly in the U.S, they can proceed with this work with practically limitless resources.

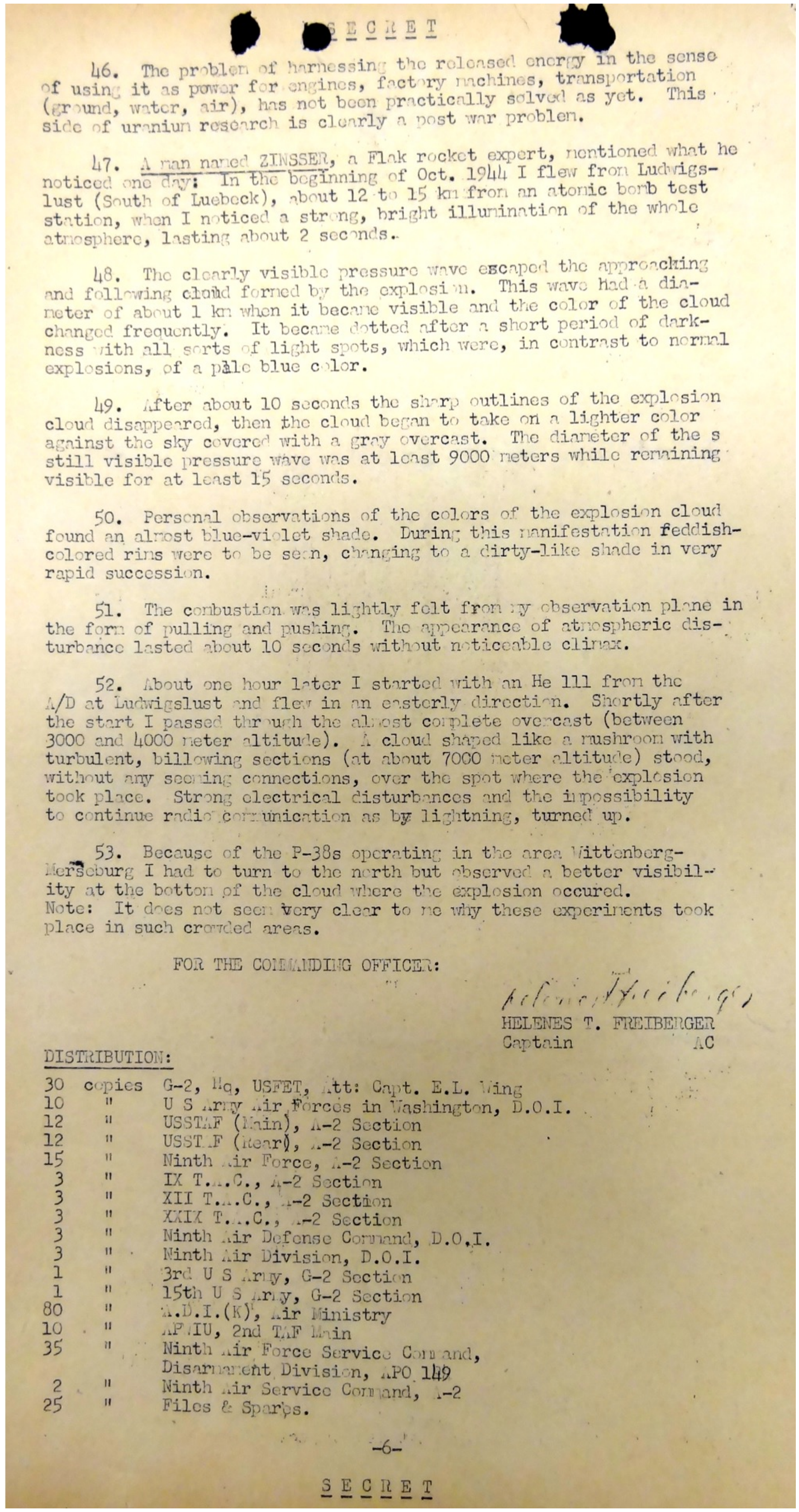
45. The problem of producing an atomic esplosion can be computed theoretically while practically it can be done on a very small scale. The bombardment of the uranium-isotope with neutrons from Beryllium causes a chain of the disintegrating atom. The effect is like that of the best explosive multiplied many thousand times. One could not even dream of producing a suitable projectile in Germany at this time.

-5-

SECRET

Figure D.688: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program. [AFHRA Folder 533.619-5 1945]

AFHRA Folder 533.619-5 1945



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46. The problem of harnessing the released energy in the sense of using it as power for engines, factory machines, transportation (ground, water, air), has not been practically solved as yet. This side of uranium research is clearly a post war problem.

47. A man named ZINSSER, a Flak rocket expert, mentioned what he noticed one day: In the beginning of Oct. 1944 I flew from Ludwigslust (South of Luebeck), about 12 to 15 km from an atomic bomb test station, when I noticed a strong, bright illumination of the whole atmosphere, lasting about 2 seconds.

48. The clearly visible pressure wave escaped the approaching and following cloud formed by the explosion. This wave had a diameter of about 1 km when it became visible and the color of the cloud changed frequently. It became dotted after a short period of darkness with all sorts of light spots, which were, in contrast to normal explosions, of a pale blue color.

49. After about 10 seconds the sharp outlines of the explosion cloud disappeared, then the cloud began to take on a lighter color against the sky covered with a gray overcast. The diameter of the s still visible pressure wave was at least 9000 meters while remaining visible for at least 15 seconds.

50. Personal observations of the colors of the explosion cloud found an almost blue-violet shade. During this manifestation reddish-colored rims were to be seen, changing to a dirty-like shade in very rapid succession.

51. The combustion was lightly felt from my observation plane in the form of pulling and pushing. The appearance of atmospheric disturbance lasted about 10 seconds without noticeable climax.

52. About one hour later I started with an He 111 from the A/D at Ludwigslust and flew in an easterly direction. Shortly after the start I passed through the almost complete overcast (between 3000 and 4000 meter altitude). A cloud shaped like a mushroom with turbulent, billowing sections (at about 7000 meter altitude) stood, without any seeming connections, over the spot where the explosion took place. Strong electrical disturbances and the impossibility to continue radio communication as by lightning, turned up.

53. Because of the P-38s operating in the area Wittenberg-Mersburg I had to turn to the north but observed a better visibility at the bottom of the cloud where the explosion occured.
Note: It does not seem very clear to me why these experiments took place in such crowded areas.

FOR THE COMMANDING OFFICER:

Helenes T. Freiberger

HELENES T. FREIBERGER
Captain AC

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-6-

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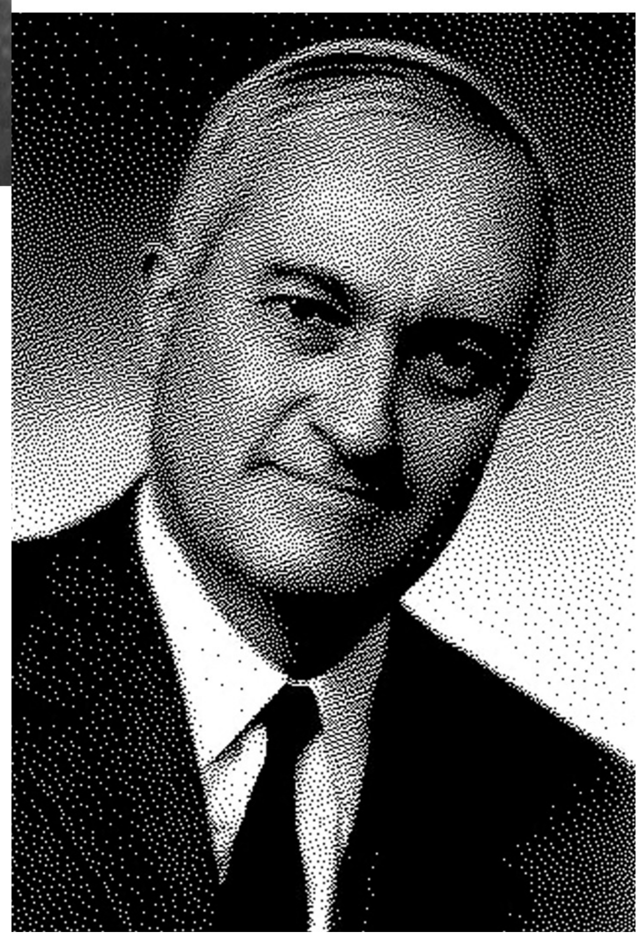
Figure D.689: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program. [AFHRA Folder 533.619-5 1945]

Rudolf Edse
(1913–1998)



Rudolf Zinsser
(1916–1995)

Figure D.690: Rudolf Zinsser reported observing an apparent atomic bomb test near the Baltic coast in October 1944. U.S. documents state that Rudolf Edse worked on the German atomic bomb program.

R. J. Ritter, ed. Inside the Mushroom Cloud. *Newsletter for America's Atomic Veterans.* July 2013, pp. 3–10. National Association of Atomic Veterans. https://naav.com/archives/2013_07_NAAV_Newsletter.pdf

At the instant of the initial nuclear detonation, the fission process generates & emits Alpha (a) & Beta (b) particles, Gamma (g) & X-rays (x), and Electro-Magnetic Pulse (EMP), from within the boiling fireball, after which cooler air is drawn into the center of the rising "toroidal" formation, which itself begins to cool into the familiar mushroom-cloud shape & appearance as it begins to rise to higher altitudes. EMP is the root cause of electronic instrumentation and communication device failures, shortly thereafter, and in close proximity, to the nuclear weapon detonation event. [...]

The distribution of radiation in the mushroom cloud varies with the total yield of the explosion, the type of weapon, the fusion/fission ratio, the burst altitude, the terrain type, and the prevailing weather patterns. Generally it can be said that lower-yield (Kiloton-range) explosions have about 90% of radioactivity in the mushroom head and 10% in the (heat-chute) stem, while Megaton-range detonations tend to have most of the radioactivity in the lower third of the mushroom cloud.

At the instant of detonation, the (fission process) fireball is formed, and the ascending, roughly spherical, mass of hot incandescent gases changes shape due to atmospheric friction and cools its surface by energy radiation, thus turning from a sphere to a violently swirling annular vortex. A (*Rayleigh-Taylor*) instability is formed at the boundary between the hot fireball and the surrounding cooler air. This will then cause turbulence and forms a vortex, which sucks air into its center, creating after-winds and thus cooling itself. As it begins to cool, the speed of its swirling motion begins to slow down, and may stop entirely during later phases. The vaporized parts of the weapon, and other materials, then condense into visible dust (and water vapor mist) forming the cloud; while the white-hot vortex core becomes yellow, then red, then loses any visible incandescence. [...]

The initial colors of some radioactive clouds can be red, or reddish brown, due to the presence of nitrogen dioxide and nitric acids, which are formed from the combination of nitrogen, oxygen, and atmospheric moisture. In the high temperature, high radiation environment of the blast, ozone is also formed. It is estimated that each Megaton of yield produces about 5,000 tons of nitrogen oxides...

Yellow and orange hues are also described. And a reddish hue is later obscured by the white color of water vapor (condensing in the fast flowing air as the fireball begins to cool) and the dark color of smoke and debris that is sucked into the strong updraft. The ozone will give the blast its characteristic corona & discharge like smell. [...]

The intense radiation in the first seconds after a nuclear blast may cause an observable aura of fluorescence, that emits an eerie blue-violet-purple glow of ionized oxygen and nitrogen at some distance from the fireball, surrounding the rapidly forming radioactive cloud. The light is best visible during the night or just before daylight, or just after sundown. The brightness then decreases rapidly, becoming barely visible in 20 to 45 seconds.

S. D. Felkin. 9 October 1945. [NARA RG 38, Entry 98C, Box 9, Folder TSC # 2601–2700]

SECRET.

A.P./W.I.U. (9th. AIR FORCE) REPORT NO. 96/1945.

Will all recipients of the above report please note that it has now been upgraded to TOP SECRET.

S. D. Felkin
Group Captain

[By spring 1945, the U.S. Alsos Mission concluded that Germany never even made a serious attempt to develop an atomic bomb during the war, yet Zinsser's testimony about an apparently successful October 1944 German atomic bomb test was given wide circulation and credence in U.S. military intelligence circles several months later, in August 1945. That fact suggests that U.S. intelligence officials had good reasons to doubt the conclusions of the Alsos Mission.

Moreover, the fact that the Zinsser report was then **upgraded** from Secret to Top Secret in October 1945 suggests that intelligence about German atomic bomb tests became more credible, not less credible, with further time and investigation. What new information did U.S. intelligence learn about the German atomic bomb program and/or Zinsser between August and October 1945 that prompted them to increase the classification level of Zinsser's report?]

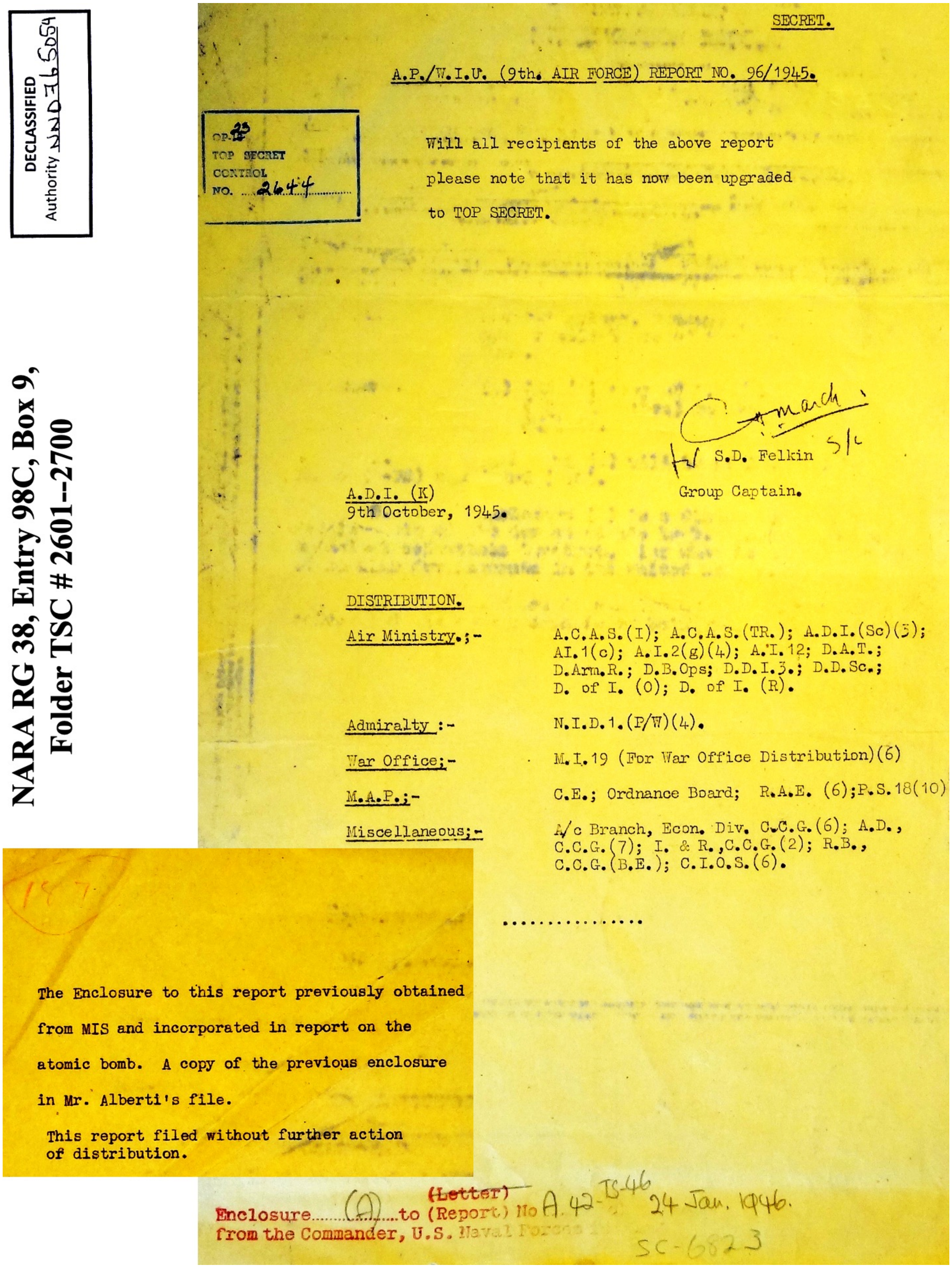
Loose memo with no title, date, or signature [NARA RG 38, Entry 98C, Box 9, Folder TSC # 2601–2700]

The Enclosure to this report previously obtained from MIS and incorporated in report on the atomic bomb. A copy of the previous enclosure in Mr. Alberti's file. This report filed without further action or distribution.

[MIS was the Military Intelligence Service. This note appears to have originally been attached to a report, but what report and what enclosure does it reference?

"Mr. Alberti" would have meant Jack H. Alberti, a Naval Intelligence investigator who was one of the first to board the U-234 submarine in May 1945, who conducted many of the interrogations of its passengers and crew, and who was in charge of cataloging and processing its cargo. Alberti also performed the same functions for other captured German submarines (pp. 4912–4927). Does this loose memo suggest that Alberti obtained information from U-234 (or other German submarines) that was related to the Zinsser report about the German atomic bomb program? If so, what information?

See document photos on p. 4463.]



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OP-23
TOP SECRET
CONTROL
NO. 2644

Will all recipients of the above report please note that it has now been upgraded to TOP SECRET.

A.D.I. (K)
9th October, 1945.

for S.D. Felkin
Group Captain.

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M.A.P.;-	C.E.; Ordnance Board; R.A.E. (6);P.S.18(10)
Miscellaneous;-	A/c Branch, Econ. Div. C.C.G.(6); A.D., C.C.G.(7); I. & R.,C.C.G.(2); R.B., C.C.G.(B.E.); C.I.O.S.(6).

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187

The Enclosure to this report previously obtained from MIS and incorporated in report on the atomic bomb. A copy of the previous enclosure in Mr. Alberti's file.

This report filed without further action of distribution.

Enclosure (A) to (Letter) (Report) No A 42-TS-46 24 Jan. 1946.
from the Commander, U.S. Naval Forces
SC-6823

Figure D.691: Top: S. D. Felkin. 9 October 1945. Bottom: Loose memo [NARA RG 38, Entry 98C, Box 9, Folder TSC # 2601–2700].

Edse, Rudolf. Foreign Scientist Case File. [NARA RG 330, Entry A1-1B, Box 35, Folder Edse, Rudolf]

DATE: 9 May 1946

The following information in the case of Dr. Rudolf Edse is submitted in accordance with letter, Headquarters, Army Air Forces [...]

a. [...] Department head of Chemical Research Branch at LFA, specialist for nuclear physics, chemical basic research, powdered rockets, and thermodynamics.

b. [...] Has written report on possibilities of atomic research at Wright Field.

c. [...] Because of his work on the production of isotopes related to atomic research, he might be employed along similar lines in this country. [...]

D. L. PUTT
Colonel, Air Corps
Deputy Commanding General
Intelligence (T-2)

Date 26 September 45 [...]

BASIC PERSONNEL RECORD

Arrived: 20 Sept. 1945

I. Name: EDSE, Rudolf [...]

XV. Remarks: Worked on atomic bomb (see attached report)

[The same 19 August 1945 report that included Rudolf Zinsser's description of an October 1944 German atomic bomb test also included information from Rudolf Edse, who said that he had worked on the German nuclear program, and that it had had the goal of having an atomic bomb ready by late 1944 (p. 4451).

The Foreign Scientist Case File ("Paperclip" file) for Rudolf Edse reaffirms that he did work on the German atomic bomb. It also indicates that he gave detailed descriptions of his work for Germany and how he could do similar work for the United States, although those details are not in the files. Edse was brought to the United States in 1945 (much sooner than many other Paperclip scientists) and given lifetime employment in the United States. He does not appear to have ever again mentioned the German nuclear work.

See document photos on pp. 4465–4466.]

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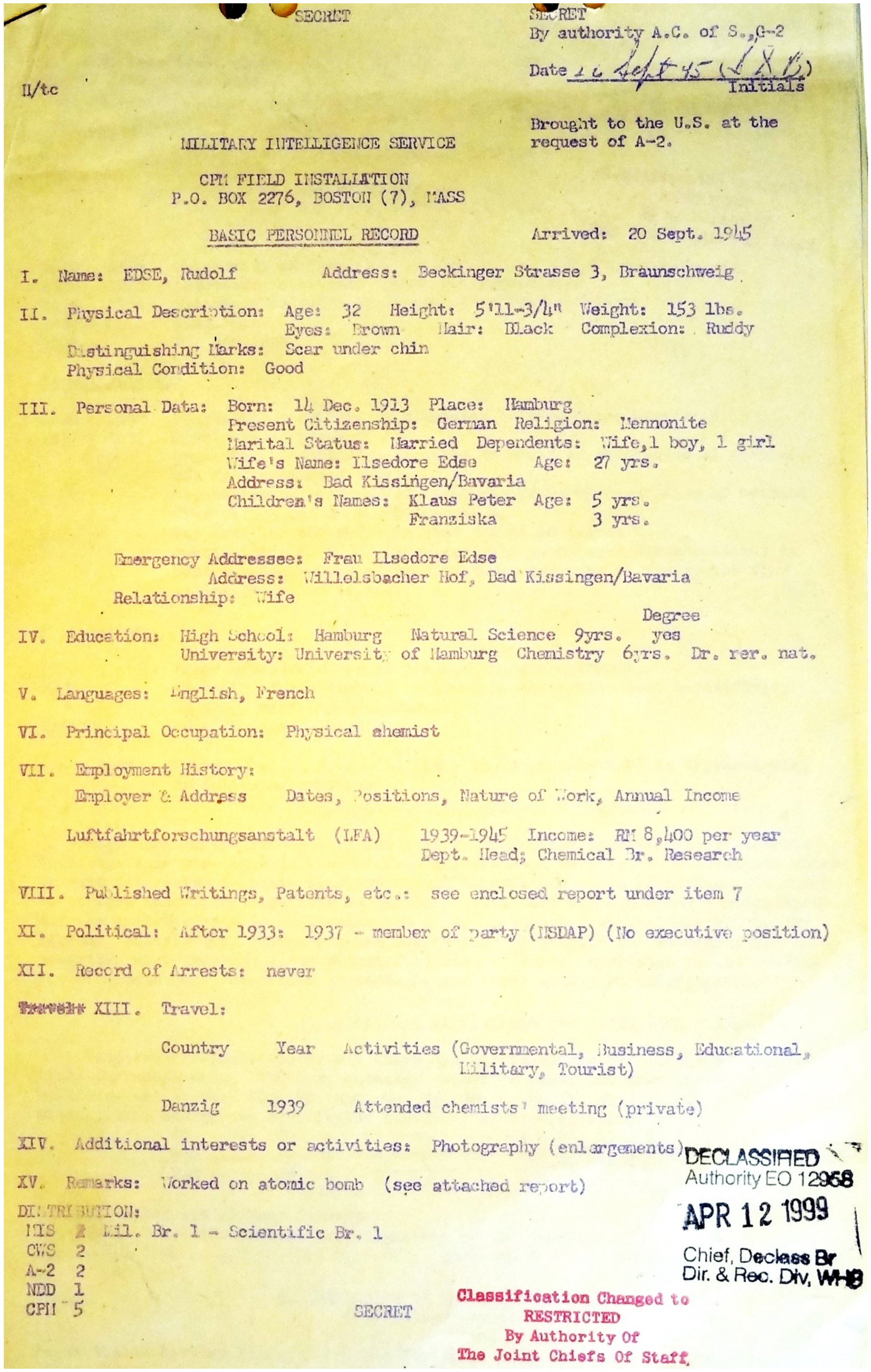
NARA RG 330, Entry A1-1B, Box 35, Folder Edse, Rudolf



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Date 16 Sept 45 (initials)
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MILITARY INTELLIGENCE SERVICE

CPM FIELD INSTALLATION
P.O. BOX 2276, BOSTON (7), MASS

BASIC PERSONNEL RECORD

Arrived: 20 Sept. 1945

I. Name: EDSE, Rudolf   Address: Beckinger Strasse 3, Braunschweig

II. Physical Description: Age: 32 Height: 5'11-3/4" Weight: 153 lbs.
Eyes: Brown Hair: Black Complexion: Ruddy
Distinguishing Marks: Scar under chin
Physical Condition: Good

III. Personal Data: Born: 14 Dec. 1913 Place: Hamburg
Present Citizenship: German Religion: Mennonite
Marital Status: Married Dependents: Wife, 1 boy, 1 girl
Wife's Name: Ilsedore Edse Age: 27 yrs.
Address: Bad Kissingen/Bavaria
Children's Names: Klaus Peter Age: 5 yrs.
Franziska 3 yrs.

Emergency Addressee: Frau Ilsedore Edse
Address: Willelsbacher Hof, Bad Kissingen/Bavaria
Relationship: Wife

IV. Education: High School: Hamburg Natural Science 9yrs. Degree yes
University: University of Hamburg Chemistry 6yrs. Dr. rer. nat.

V. Languages: English, French

VI. Principal Occupation: Physical chemist

VII. Employment History:
Employer & Address   Dates, Positions, Nature of Work, Annual Income

Luftfahrtforschungsanstalt (LFA)   1939-1945 Income: RM 8,400 per year
Dept. Head; Chemical Br. Research

VIII. Published Writings, Patents, etc.: see enclosed report under item 7

XI. Political: After 1933: 1937 - member of party (NSDAP) (No executive position)

XII. Record of Arrests: never

~~Travel~~ XIII. Travel:

Country   Year   Activities (Governmental, Business, Educational, Military, Tourist)

Danzig   1939   Attended chemists' meeting (private)

XIV. Additional interests or activities: Photography (enlargements)

XV. Remarks: Worked on atomic bomb (see attached report)

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Classification Changed to
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By Authority Of
The Joint Chiefs Of Staff

Figure D.692: Edse, Rudolf. Foreign Scientist Case File. [NARA RG 330, Entry A1-1B, Box 35, Folder Edse, Rudolf]

NARA RG 330, Entry A1-1B, Box 35, Folder Edse, Rudolf

SECRET

SECRET
AUTH: C. G. ATSC
INITIALS R.W.
DATE 5/13/46

HEADQUARTERS
AIR MATERIEL COMMAND
WRIGHT FIELD, DAYTON, OHIO

DATE: 9 May 1946

The following information in the case of Dr. Rudolf Edse is submitted in accordance with letter, Headquarters, Army Air Forces, Subj: "Exploitation of German and Austrian Scientists", dated 30 April 1946 and Joint Intelligence Objectives Agency "Memorandum of Request" (J.I.O.A. 1/2/M - 26 April 1946).

1. Specialist's potential contribution of interest to the national security of the U.S.

   a. Field of fields in which prominent prior to arrival in the U.S.
   Department head of Chemical Research Branch at LFA, specialist for nuclear physics, chemical basic research, powdered rockets, and thermodynamics.

   b. Field or fields in which active since arrival in the U.S.
   Has designed test stand for powdered and liquid rockets. Has written report on possibilities of atomic research at Wright Field.

   c. Field or fields in which the specialist's services are of interest to the U.S. for exploitation.
   Chemical research in industries or universities, possibly in collaboration with government projects. Because of his work for the production of isotopes related to atomic research, he might be employed along similar lines in this country.

2. Present location of specialist.
   Analysis Division, Intelligence, T-2, AMC, Wright Field, Dayton, Ohio

3. If specialist is to continue under direct supervision of an armed service, the specific office within that service and station at which he will be located.
   Analysis Division, Intelligence, T-2, AMC, Wright Field, Dayton, Ohio

DECLASSIFIED
Authority EO 12958
APR 12 1999
Chief, Declass Br
Dir. & Rec. Div, WHS

Classification Changed to
RESTRICTED
By Authority Of
The Joint Chiefs Of Staff

SECRET

V-20878

SECRET

SECRET
AUTH: C. G. ATSC
INITIALS R.W.
DATE

4. If specialist is to work in a non-service establishment on a project under contract to an armed service, the nature of the project, and the name and location of the establishment.
   Immediate employment to continue at Wright Field. It is anticipated that the scientist will be assigned to a contractor's facility engaged in a research and developement project in the field for which the scientist is best qualified in the near future.

5. The length and terms of the proposed contract or arrangement for employment of the specialist.
   Present contract for employee's duty at Wright Field to be extended for three (3) months pending decision on long range exploitation. In any event, the contract must cover the period of time the scientist would be required to work for the government before he can be employed by industry.

6. Type of visa desired by scientist.

   Regular immigration visa

7. Type of visa recommended by this headquarters.

   Regular immigration visa

8. If immigration visa is desired and recommended, the following information is submitted.

   a. Is admission of members of immediate family desired?
   yes

   b. Names, ages, relationship and present location of immediate members whose entrance is desired.

EDSE,	Ilsedore, Maria,	Wife,	27 years old
	Claus Peter,	Son,	5 " "
	Frances,	Daughter,	3 " "

   Present Residence: Hotel Wittelsbach, Bad Kissingen, Bavaria, Germany.

As far as is known to the requesting agency the background of neither the specialist nor any member of his family recommended for entry contains features rendering his entrance and presence in the United States objectionable.

D. L. Putt
D. L. PUTT
Colonel, Air Corps
Deputy Commanding General
Intelligence (T-2)

Classification Changed to
RESTRICTED
By Authority Of
The Joint Chiefs Of Staff

SECRET

- 2 -

V-20878

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Authority 013039

Figure D.693: Edse, Rudolf. Foreign Scientist Case File. [NARA RG 330, Entry A1-1B, Box 35, Folder Edse, Rudolf]

Figure D.694: Luigi Romersa reported observing an apparent atomic bomb test near the Baltic coast in October 1944.

[Luigi Romersa (1917–2007), shown in Fig. D.694, was an Italian military and aerospace journalist who had a long and distinguished career both during and after the war. According to him (and supported by documents such as those below and others [Karlsch 2005]), Benito Mussolini sent him to Germany in October 1944 as his special representative to observe the latest German secret weapons tests and to report back to Mussolini to strengthen his flagging confidence that Germany could win the war. Along with a long list of now well known advanced German rockets, missiles, and jets, Romersa said he was also briefed about V-3 and V-4 rockets and an atomic bomb.

The calendar of Mussolini's appointments has been published, and it shows that Mussolini met with Romersa on 1 October 1944 (before Romersa's trip to Germany) and 30 October 1944 (after his trip), and that Mussolini had met with Romersa on several earlier occasions as well [Guerrazzi 2020, pp. 219, 241, 250, 257–258, 279–280]. This independent information supports Romersa's account.]

29 October 1944 memo for Mussolini to meet with Luigi Romersa [Archivo Centrale dello Stato, Rome, SPD CO RSI B 65, File 5680]

Telefona il Tenente Romersa per informare che è rientrato dal suo viaggio in Germania e per chiedere di essere ricevuto dal DUCE, possibilmente in giornata.

29 ott. XXIII

Lieutenant Romersa called to report that he has returned from his trip to Germany and to ask to be received by the DUCE, possibly within the day.

29 Oct. 1944
[beginning of year XXIII of the Fascist Era]

[See document photo on p. 4467.]

Ubaldo Alberto Mellini Ponce De Leon. 1950. *Guerra diplomatica a Salò.* Cappelli. pp. 44–45.

Qualche speranza fu riaccesa da nuove notizie ottimistiche da parte tedesca circa le armi segrete confermate dalla relazione che fece a Mussolini il giornalista Romersa su quanto aveva visto in proposito con i suoi occhi in una recente visita.

Some hopes were rekindled by new optimistic news from the German side about the secret weapons confirmed by the report that the journalist Romersa made to Mussolini on what he had seen in this regard with his own eyes in a recent visit.

[Ubaldo Alberto Mellini Ponce De Leon (1896–1969) served under Mussolini as a diplomat from the 1920s onward and also as Undersecretary of Foreign Affairs during February–March 1945.]

Luigi Romersa. Entrano in campo i soldati della Repubblica. [The soldiers of the Republic enter the field.] ***Corriere della Sera*** **[*Evening Mail*], 5 August 1944, p. 1.**

Siamo poi a una svolta decisiva nella tecnica e nella condotta della guerra. Siamo all'inizio di una nuova epoca di lotta, in cui i vecchi sistemi, quali fino ad oggi conosciuti, si dovranno considerare sorpassati ed inefficaci. Non sarà più l'epoca del cannone e (siamo autorizzati a credere) del velivolo, ma quella di una, di dieci armi X, la cui micidialità sarà talmente decisiva da non consentire all'avversario di escogitare né contromosse né rimedi. La produzione germanica che determinerà il capovolgimento sta per conseguire l'apice del suo sviluppo; e si dimostrerà così che questo lungo periodo difensivo ad altro non è servito se non a preparare i mezzi necessari per la controffensiva generale.

Quando il nemico non potrà fondare le sue previsioni di vittoria sull'azione terroristica dei "liberatori", sulle sue squadriglie che distruggono con sadismo città e villaggi, monumenti e chiese, ospedali e conventi, che cosa avverrà? Lascio la risposta ai fatti. Ricordiamo intanto che in questa nuova fase della guerra, la fase risolutiva, della reazione germanica e della vittoria del Tripartito, accanto ai valorosi soldati del Reich si saranno battute le Forze armate della Repubblica Sociale Italiana.

We are then at a decisive turning point in the technique and conduct of war. We are at the beginning of a new era of struggle, in which the old systems, as they have been known up to now, will have to be considered obsolete and ineffective. It will no longer be the era of the cannon and (we are authorized to believe) of the aircraft, but that of one of ten X weapons, whose lethal nature will be so decisive as not to allow the adversary to devise either countermoves or remedies. The German production that will determine the reversal is about to reach the peak of its development; and it will thus be demonstrated that this long defensive period has served no purpose other than to prepare the means necessary for the general counteroffensive.

When the enemy cannot base his predictions of victory on the terrorist action of the "liberators," on his squads that sadistically destroy cities and villages, monuments and churches, hospitals and convents, what will happen? I will leave the answer to the facts. Let us remember in the meantime that in this new phase of the war, the decisive phase, of the German reaction and the victory of the Tripartite, the Armed Forces of the Italian Social Republic will have fought alongside the brave soldiers of the Reich.

International News Service. Germans Made Atom Bombs, Italian Says. ***Daily Mirror*** **(Sydney), 30 April 1947, p. 18. https://trove.nla.gov.au/newspaper/article/273118095**

ROME.—Italian newsman, Luigi Romersa, once close collaborator of Mussolini, has made the amazing claim that the atom bombs dropped on Hiroshima and Nagasaki were "made in Germany."

Romersa asserted that he personally witnessed Nazi atom-bomb experiments in Rügen Island, in the Baltic, in the first week of October, 1944.

He claims to be in possession of "absolute proof" that the Nazis discovered the atom bomb and were preparing to produce it on a large scale.

Romersa, following Italy's liberation, was arrested and gaoled in Brescia.

While there, on May 29, 1945, he described to a warden the "effects of a disgregatory bomb, and said he had witnessed them at Rügen Island."

The warden, Michele Erra, has issued a sworn statement to this effect.

[According to the Italian warden's statement, Luigi Romersa had been telling his story about the Baltic nuclear test since May 1945. Romersa was quoted telling the same story in numerous newspapers from 1947 onward. Thus Romersa's story was consistent from 1945 until his death.

Romersa claimed to have personally witnessed the German nuclear test in October 1944, but certainly would not have had any way of knowing whether the bombs dropped on Hiroshima and Nagasaki in August 1945 were made in Germany instead of the United States. In contrast to Romersa's first-hand information about wartime German nuclear work, the brief claim about the U.S. nuclear bombs is merely speculation by Romersa in 1947, or perhaps speculation by another newspaper reporter in 1947 based on Romersa's original May 1945 statements that naturally would not have mentioned Hiroshima and Nagasaki.]

James Wellard, North American Newspaper Alliance. Italian Tells of German Weapons Which Might Have Prolonged War. ***Scranton Times*****, 15 December 1947, pp. 1, 14.**
https://www.newspapers.com/image/533794898/
https://www.newspapers.com/image/533795026/

Rome, Dec. 9 (By Air Mail).—A strange and sinister story of Germany's last months during which the Nazis fought for time in which to unleash a whole series of new V weapons—including an atomic bomb—is now being told with the publication of the diary of a Fascist journalist calling himself Luigi Romersa, who visited Germany in October, 1944.

Among the weapons discussed are those which the world already knows about, such as the V-1 and V-2, the so-called buzz bomb and explosive rocket. Other secret weapons which the journalist claims to have seen were perfected or nearly perfected; and, if Romersa's diary is authentic, these new V weapons would certainly have changed the outcome of the war, if the Germans had had just a few more months in which to use them.

There was, for instance, a tiny, motorless plane, thousands of which were to be catapulted vertically from airfields into our bomber formations, where the pilot was to discharge hundreds of small rockets into the attacking planes, then glide back to the ground.

Romersa said he also saw a perfected acoustic torpedo which German marine engineers asserted "could not miss." Fired from long-range submarines, it was capable of finding its target at a distance of fifty miles, traveling completely submerged, and guided by the propeller wash caused by the ship under attack.

On Oct. 18, 1944, Romersa was summoned to the Ministry of Propaganda and told that Goebbels would see him that evening, at the Propaganda Minister's own home. Goebbels began by saying: "We shall win the war. A few more months, and we shall be in a position to give the enemy the decisive blow." And then he spoke of what he called "the disintegrating bomb," which had been developed on the island of Ruegen in the Baltic Sea.

"The bomb is already being mass produced," said Goebbels. "It will overturn the world. By the time the enemy finds a countermeasure, everything will be finished and forgotten."

The Propaganda Minister went on to say that Germany awaited a miracle. The miracle was already beginning. The V-1 and V-2, and new submarines which did not have to surface for weeks at a time, plus rocket-propelled planes, were the first phase. The "disintegrating bomb" would be the next, and final, phase. Twenty-four hours would be enough once Germany was ready.

"Churchill knows all this," continued Goebbels. "Hence his Commandos who are constantly landing in Eastern Germany and Norway. Usually they do no serious harm, but in Norway they got at our heavy-water plants and did some 'relevant' damage. But we have other plants. We have had heavy-water experiments under way since 1942. And we knew how to split the atom two year ago."

Goebbels then made a statement which throws some doubt on Nazi claims to have perfected an atomic bomb, for he admitted to Romersa that "we should not credit too much importance to a scientific discovery." The bomb by itself, he said, could not win the war. But the bomb would prepare the hostile territory for the entry of the armor and infantry of the German armies.

Romersa asserts he saw the effects of the German "disintegrating bomb." He says one was exploded near Ruegen on the Baltic Coast. It wiped out every trace of life, including all plant life, leaving the area like "a valley on the moon," without a single trace of color.

It is certainly a curious story, and some of it is supported by known facts, such as Nazis' experiments with heavy water and uranium fission. It is true also, as I recall from my own experiences in Germany, that the Nazis talked of a "miracle" and a German officer once stated that Hitler had the means of "destroying the whole world except Germany." I disbelieved this at the time, but reported it in a dispatch to the newspapers I was representing, in September, 1944.

One can conclude that the Nazis' "disintegrating bomb" was a new atomic-type explosive, far more lethal than any explosives used in the war, with the exception of the bombs used against Hiroshima and Nagasaki.

[James Howard Wellard (1909-1987) was born and educated in the U.K., obtained a Ph.D. in Library Science from the University of Chicago in 1935, was a journalist embedded with Patton's Third Army during World War II, wrote a biography of Patton, and spent the rest of his life traveling the world and writing books and articles. In addition to reporting Romersa's claims, Wellard had also gathered his own information that supported his conclusion that wartime Germany had developed nuclear weapons. While traveling with Patton's forces during the war, Wellard may have seen considerably more than he was ever able to publicly report, due to secrecy and censorship.]

Luigi Romersa. May-June 1955. Le armi segrete di Hitler [Hitler's Secret Weapons]. *Civiltà delle Macchine.*

Il dottor Schaeffer, referente per la stampa italiana presso il ministero della propaganda tedesco, mi combinò il primo incontro col sottosegretario [Werner] Naumann, braccio destro di Goebbels. Il 6 ottobre 1944, Schaeffer mi comunicò all'albergo che Neumann mi avrebbe ricevuto alle quattordici al Propaganda Ministerium, nel suo ufficio. [...]

Dr. Schaeffer, contact person for the Italian press at the German propaganda ministry, arranged for me to meet first with Undersecretary [Werner] Naumann, Goebbels' right-hand man [p. 4696]. On 6 October 1944, Schaeffer informed me at the hotel that Naumann would receive me at 2:00 p.m. in his office at the Propaganda Ministerium. [...]

Si raccolse per un istante poi scandendo le parole riprese: "Abbiamo raggiunto la disgregazione dell'atomo. Abbiamo la bomba disgregatrice i cui effetti vanno al di là di ogni umana immaginazione..." [...]

He [Naumann] collected himself for a moment, then emphasizing the words resumed: "We have achieved the disintegration of the atom. We have the disintegration bomb whose effects are beyond all human imagination..." [...]

Alla fine del suo lungo monologo, Naumann venne a parlare delle "V 2", "V 3" e "V 4" precisando che gli ultimi due tipi, ai quali ne dovevano seguire altri tre, erano radiocomandati e perciò infallibili. Ottenni anche la promessa di una visita alle fabbriche sotterranee e del suo interessamento, presso Goebbels, per assistere a un esperimento di bomba disgregatrice che doveva aver luogo in quei giorni in un'isola del Baltico. [...]

At the end of his long monologue, Naumann came to talk about the "V-2," "V-3," and "V-4," pointing out that the last two types, to be followed by three more, were radio-controlled and therefore precise. I also obtained the promise of a visit to the underground factories and his support, with Goebbels, that I could witness a test of the disintegration bomb which was to take place within days on an island in the Baltic. [...]

Il 10 ottobre 1944 fui avvertito di tenermi pronto a partire per il nord.

On 10 October 1944, I was warned to be ready to leave for the north.

Lasciai Berlino nella notte dell'11 in automobile; mi accompagnavano due ufficiali, uno mi disse che al ritorno sarei stato ricevuto da Goebbels.

I left Berlin on the night of the 11th by car; two officers accompanied me, one of whom told me that on my return I would be received by Goebbels.

Avevo passato quasi tutta la serata nel rifugio dell'albergo Adlon. Mi era rimasta negli orecchi la voce di un altoparlante che nel corso del bombardamento diceva ai berlinesi dove erano cadute le bombe, il numero degli apparecchi incursori e le località in cui si erano sviluppati incendi. Molti, ancora prima di lasciare il rifugio, sapevano che all'uscita non avrebbero più trovato la casa. Viaggiammo per diverse ore nel buio umido che s'incollava ai vetri come nebbia. Pareva che sui vetri della macchina invece di nebbia colasse buio. Solo alla fine del viaggio seppi che mi trovavo nei pressi di Stralsund, davanti all'isola di Rugen che raggiungemmo con un motoscafo della marina militare.	I had spent most of the evening in the bomb shelter of the Adlon Hotel. In my ears remained the voice of a loudspeaker, telling Berliners during the bombing where the bombs had fallen, the number of bomber formations, and the locations where fires had broken out. Many people, even before they left the shelter, knew that they would never see their homes again. We traveled for several hours in the damp darkness that stuck to the windows like fog. It seemed that instead of fog, darkness was dripping onto the car windows. Only at the end of the trip did I learn that I was near Stralsund, in front of the island of Rügen, which we reached by a navy speedboat.
Rügen era un centro d'esperimenti dove venivano collaudate le nuove armi germaniche. Speciali reparti di truppe d'assalto proteggevano l'isola e ne impedivano l'accesso a chiunque. Per recarsi a Rugen occorreva un salvacondotto a firma del capo dello stato maggiore della Wehrmacht. Ci recammo subito in una zona folta di alberi dove trovammo altri ufficiali e alcuni tecnici. Nel bosco erano stati costruiti rifugi in cemento e piccole case in mattoni. Entrammo in una torretta blindata, semisepolta, attraverso una porticina metallica che venne richiusa con ogni cura. Dentro eravamo in quattro: i due ufficiali che mi avevano accompagnato, un altro uomo vestito di una tuta e io. Aspettavo mezzogiorno col cuore in gola. A mezzogiorno, secondo quanto aveva detto l'uomo in tuta, ci sarebbe stato l'esperimento della "bomba disgregatrice".	Rügen was an experimental center where the new German weapons were tested. Special units of assault troops protected the island and restricted access. To travel to [part of] Rügen required a safe-conduct pass signed by the Wehrmacht's chief of staff. We immediately went to an area thick with trees where we found other officers and some technicians. Concrete shelters and small brick buildings had been built in the woods. We entered an armored, half-buried turret through a small metal door that was closed with every precaution. Inside there were four of us: the two officers who had accompanied me, another man dressed in a suit, and me. I waited for noon with my heart in my throat. At noon, according to what the man in the suit had said, there would be the test of the "disintegration bomb."
La bomba doveva scoppiare a terra, a due chilometri circa dal nostro osservatorio blindato.	The bomb was to explode on the ground, about two kilometers from our armored observatory.

Il tempo non passava mai; i minuti erano ore. Aveva ripreso a piovere e una fumana densa saliva dal sottobosco. La terra, davanti a noi, era marcia e scura, color del saio dei monaci. Squillò un telefono nell'interno del bunker. Avvertirono che l'esperimento era stato anticipato alle 11,45. Mancavano perciò cinque minuti. Feci appena in tempo a consultare l'orologio che sentii un boato tremendo. Il pavimento mi dondolò sotto i piedi e per un istante mi parve che le pareti del rifugio si chiudessero. Davanti non vedevo che fumo, un fumo biancastro, lanoso, che ribolliva come la melma vomitata da una fogna. Si sentirono altri scoppi seguiti da lampi accecanti. Il cielo, tetro e chiuso, era stracciato da lampi bianchissimi. Mi passai una mano sulla faccia, sudavo. Nessuno aprì bocca. Al boato di poc'anzi seguì un silenzio che metteva i brividi. Fu l'uomo in tuta che parlò per primo. Era un colonnello dell'"Heereswaffenamt", l'organo addetto alla preparazione degli armamenti. "Quello che vedremo oggi—disse—è di capitale importanza. Quando potremo lanciare la nostra bomba sulle truppe d'invasione o su una città nemica gli angloamericani saranno costretti a meditare se valga la pena di continuare la guerra o di finirla ragionevolmente. Sono anni che studiamo. Siamo finalmente arrivati in porto". Le sue parole caddero nel silenzio. Lo ascoltavamo tutti con gli occhi.

Time did not pass; the minutes were hours. It had started raining again and a dense fog was rising from the undergrowth. The ground in front of us was rotten and dark, the color of monks' robes. A telephone rang inside the bunker. They warned that the test had been brought forward to 11:45 a.m. It was therefore five minutes away. I barely had time to consult the clock when I heard a tremendous roar. The floor rocked under my feet, and for an instant it seemed to me as if the walls of the shelter were falling in. In front I could see nothing but smoke, a whitish, woolly smoke that bubbled up like slime spewed from a sewer. More bursts were heard followed by blinding flashes. The sky, bleak and closed, was ripped apart by the whitest flashes of lightning. I ran a hand over my face; I was sweating. No one opened their mouth. The roar just then was followed by a chilling silence. It was the man in the suit who spoke first. He was a colonel in the "Heereswaffenamt" [Army Ordnance Office], the body in charge of developing weapons. "What we witness today—he said—is of paramount importance. When we can drop our bomb on invading troops or on an enemy city, the Anglo-Americans will be forced to decide whether it is worth continuing the war or ending it reasonably. We have been working for years. We have finally achieved our objective." His words fell into silence. We all listened to him with our eyes.

Uscimmo dal bunker verso la diciassette, dopo che erano arrivati alcuni uomini vestiti di una tuta mostruosa; in testa portavano uno scafandro del tipo di quello dei palombari, soltanto che era floscio e non aveva viti. Anche noi indossammo uno strano camiciotto di stoffa ruvida, bianchiccia e pantaloni dello stesso tessuto. Camminammo preceduti dai soldati. A mano a mano che avanzavamo la terra ci appariva sconvolta, arata, straziata da paurose voragini. Faceva freddo eppure tutto era arso come se fosse passata sull'isola una ventata di fuoco. Gli alberi non avevano più chioma nè rami; erano ridotti a tronconi abbrustoliti. Col piede urtai qualcosa; mi abbassai e vidi una capra carbonizzata. Si capiva che era una capra perché sulla carne strinata si vedevano ciuffi di peli; aveva la testa schiacciata, come pestata col martello. Le casette di pietra, erano mucchi di calcinacci. Solo le torrette in cemento armato avevano resistito. Qualche capra moribonda belava in maniera disperata; pareva il lamento di un uomo.

In nottata rientrai a Berlino. Alla fine di ottobre vidi Goebbels. Passai una serata nella sua casa e seppi la lui altre cose che Neumann non mi aveva detto. Seppi che esistevano altri due tipi di razzi, l'"A 4" e l'"A 9", uno di dieci tonnellate e l'altro di quindici, muniti di cariche atomiche, dotati di un'autonomia fantastica. Goebbels parlò di alcune migliaia di chilometri e aggiunse che con quei missili la Germania avrebbe bombardato anche l'America. Per il piccolo, claudicante ministro della propaganda che fu l'anima della Germania in guerra, occorrevano sei o sette mesi prima che il suo paese fosse in grado di sferrare un'offensiva che lui stesso, allora, definì infernale.

[...] Nel 1936 gli stessi tecnici, Walter Dornberger, Thiel e Wernher von Braun, inventore della "V 2", ora in America, impiantarono il centro di Peenemünde da cui uscirono tutte le bombe volanti, compreso l'"Aggregat 10", un razzo del peso di 65 tonnellate capace di volare per 5000 chilometri con il quale il Führer si riprometteva di martellare gli Stati Uniti.

We left the bunker around 5:00 p.m., after some men dressed in monstrous suits had arrived; on their heads they wore a helmet like that of a diving suit, only it was floppy and had no screws. We, too, wore a strange smock of rough, off-white cloth and pants of the same fabric. We walked ahead of the soldiers. As we advanced, the land appeared to have been shocked, plowed, torn apart by fearful chasms. It was cold and yet everything was scorched as if a blast of fire had passed over the island. The trees no longer had foliage or branches; they were reduced to burnt trunks. My foot bumped into something; I bent down and saw a charred goat. You could tell it was a goat because tufts of hair could be seen on the streaked flesh; its head was crushed, as if it had been pounded with a hammer. The little stone buildings were piles of rubble. Only the concrete bunkers had been resistant. A few dying goats bleated desperately; it sounded like a man's lament.

During the night I returned to Berlin. In late October I saw Goebbels. I spent an evening at his house and from him learned other things that Naumann had not told me. I learned that there were two types of rockets, the "A-4" and the "A-9," one of ten tons and the other of fifteen, equipped with atomic warheads, with a fantastic range. Goebbels spoke of several thousand kilometers and added that with those missiles Germany would also bomb America. According to the little, limping propaganda minister who was the soul of Germany at war, it would take six or seven months before his country would be able to launch an offensive that he himself then defined as hellish.

[...] In 1936 the same technicians, Walter Dornberger, Thiel, and Wernher von Braun, inventor of the "V-2," now in America, established the Peenemünde center, from which came all the flying bombs, including the "Aggregat 10," a rocket weighing 65 tons capable of flying 5,000 kilometers, with which the Führer vowed to hammer the United States.

[Romersa misspelled the name of Goebbels' undersecretary Werner Naumann as "Neumann." I have corrected the spelling here.

A French translation of Romersa's *Civiltà delle Macchine* article was published as:

> Luigi Romersa. J'ai Vu Exploser La Bombe Atomique de Hitler!
> *Paris-Presse L'Intransigeant*. 19 November 1955 p. 14.

In 1984, Romersa repeated his claims in a Spanish article:

> Luigi Romersa. August-September 1984. Las "Armas Secretas" de Hitler,
> algo más que fantasía. *Defensa* No. 76–77.

He continued to make the same claims for the rest of his life, as shown by:

> Luigi Romersa. 2005. *Le Armi Segrete di Hitler*. Milan: Mursia.

and the following article (p. 4478).

See also pp. 5400–5403 for more information from Romersa.]

Figure D.695: Examples from Luigi Romersa's long and distinguished career as an international journalist: meeting with Egyptian President Gamal Abdel Nasser (1952), Spanish Prince Juan Carlos (1962), U.S. President Lyndon Johnson at the White House (1964), and Israeli General Moshe Dayan (1967).

John Hooper. 30 September 2005. Author fuels row over Hitler's bomb. *The Guardian.* [https://www.theguardian.com/world/2005/sep/30/books.italy]

Mr Romersa [...] lives today in an elegant flat in the Parioli district of Rome. His study walls are covered with photographs from a career during which he interviewed many of the major figures of the 20th century, from Chiang Kai-shek to Lyndon Johnson. Though he suffers from some ill-health these days, he is still lucid and articulate.

He told the *Guardian* how, in September 1944, Italy's wartime dictator, Benito Mussolini, had summoned him to the town of Salo to entrust him with a special mission. Mussolini was then leader of the Nazi-installed government of northern Italy and Mr Romersa was a 27 year-old war correspondent for *Corriere della Sera.*

Mr Romersa said that when Mussolini had met Hitler earlier in the conflict, the Nazi dictator had alluded to Germany's development of weapons capable of reversing the course of the war. "Mussolini said to me: 'I want to know more about these weapons. I asked Hitler but he was unforthcoming'."

Mussolini provided him with letters of introduction to both Josef Goebbels, the Nazi propaganda chief, and Hitler himself. After meeting both men in Germany, he was shown around the Nazis' top-secret weapons plant at Peenemünde and then, on the morning of October 12 1944, taken to what is now the holiday island of Rügen, just off the German coast, where he watched the detonation of what his hosts called a "disintegration bomb".

"They took me to a concrete bunker with an aperture of exceptionally thick glass. At a certain moment, the news came through that detonation was imminent," he said. "There was a slight tremor in the bunker; a sudden, blinding flash, and then a thick cloud of smoke. It took the shape of a column and then that of a big flower.

"The officials there told me we had to remain in the bunker for several hours because of the effects of the bomb. When we eventually left, they made us put on a sort of coat and trousers which seemed to me to be made of asbestos and we went to the scene of the explosion, which was about one and a half kilometres away.

"The effects were tragic. The trees around had been turned to carbon. No leaves. Nothing alive. There were some animals—sheep—in the area and they too had been burnt to cinders."

On his return to Italy, Mr Romersa briefed Mussolini on his visit. In the 1950s, he published a fuller account of his experiences in the magazine *Oggi*. But, he said, "everyone said I was mad".

2004 testimony of Elisabeth Mestlin, as described by Wolfgang Ebsen [Karlsch and Petermann 2007, p. 163]

Sie erinnerte sich aufgrund glaubwürdiger Umstände genau an das außergewöhnliche Ereignis. Frau Mestlin fuhr nach der Bombardierung von Stralsund am 6. Oktober 1944 zu ihren Kindern nach Vitte auf der Insel Hiddensee. Auf der Insel Hiddensee hörte sie am 12. Oktober 1944 eine heftige Explosion und sah eine große Staubwolke an der Südspitze der Halbinsel Bug.

Interview mit Elisabeth Mestlin vom 5.10.2004, aufgezeichnet von Lutz Riemann, ausgestrahlt vom NDR am 13.3.2005.

She remembered the extraordinary event because of credible circumstances. After the bombardment of Stralsund on 6 October 1944, Ms. Mestlin went to see her children in Vitte on the island of Hiddensee. On the island of Hiddensee on 12 October 1944, she heard a violent explosion and saw a large cloud of dust on the southern tip of the Bug peninsula.

Interview with Elisabeth Mestlin from 5 October 2004, recorded by Lutz Riemann, broadcast by NDR on 13 March 2005.

[In some sources, Elisabeth Mestlin's name is given as Ilse Menslin.

Bug is a peninsula on the northwestern side of Rügen island. During the war, it was used as a German naval base. It is geographically rather isolated from the rest of Rügen and from the Baltic coastline of Germany. Because of its relative isolation and its highly secure military status, it would have been a good location for atomic bomb development and/or testing. It is known that new types of bombs were tested in that area [e.g., Stüwe 1999, pp. 451, 461]. Advanced scientific testing was conducted at other locations on the Baltic coast of Germany—virology at Riems island, rockets and jets at Peenemünde, radar on the German-occupied Danish island of Bornholm off the coast, etc.

Vitte is the main village on Hiddensee island. It is approximately 3 km west of the southern tip of the Bug peninsula. It would be reasonable to expect a large explosion on Bug to be audible and visible from the eastern ocean side of Vitte.]

Heinrich Himmler's chief adjutant Werner Grothmann on test explosions [Krotzky 2002]. For a discussion of the background and reliability of this source, see pp. 3414–3415.

[S. 31] Also, es ist so: Mir ist bekannt, dass es vier Atomversuche gab. Der erste noch 1943 im Herbst in der Nordsee, der ist gescheitert. Dann zwei 1944 im Herbst und im Spätherbst. Einer davon am Boden, also auf einem niedrigen Gestell, der spätere in der Atmosphäre am Fallschirm. Der im Winter 1944 in der Luft war brisant und die Ladung war auch größer. Das könnte im November gewesen sein. Der letzte Versuch war dann wieder mit kleiner Ladung im März 1945. Wo die Versuche waren, möchte ich jetzt noch nicht sagen, weil sich sonst die Bevölkerung unnötig aufregen würde.

[p. 31] Well, it is so: It is known to me that there were four atomic tests. The first still in 1943 in the autumn in the North Sea, which failed. Then two in 1944 in the autumn and the late autumn. One of them on the ground, that is on a small stand, the later one in the atmosphere on a parachute. That one in winter 1944 in the air was highly explosive and the charge [fuel] was also larger. That could have been in November. The last test was then again with a small charge in March 1945. Where the tests were I would like to not say now, because otherwise the population would be unnecessarily upset.

[S. 32] Ich kann aber mit Bestimmtheit erklären, dass mir von sechs Atombomben berichtet wurde, die aus drei verschiedenen Forschungsanlagen stammten. Alle waren Prototypen. Darüber hinaus gab es einige Kleinstkörper, die für die Laborversuche vorgesehen waren. Für den Versuch im Winter 1944 ist allerdings eine größere Ladung verwendet worden, wie ich ja schon sagte.

[p. 32] I can definitely declare that I was told of six atomic bombs that came from three different research installations. All were prototypes. In addition, there were some very small devices that were intended for laboratory experiments. For the experiment in the winter of 1944, a larger charge was indeed used, as I already told you.

[S. 13] Als im Oktober 1944 klar war, dass die Theorie zur Atombombe grundsätzlich stimmt, ist in verschiedenen Kreisen natürlich auch darüber nachgedacht worden, was man dann machen sollte, um den Krieg schnellsten zu beenden.

[p. 13] When, in October 1944, it was clear that the theory of the atomic bomb was in principle correct, various circles had, of course, also been thinking about what should be done to end the war as quickly as possible.

[S. 17] Ich möchte aber mal etwas zu dem Hintergrund sagen, warum Himmler nicht zu dem Atombombentest am vierten März nach Thüringen gekommen ist.

[p. 17] But I would like to say something about the background, why Himmler did not come to Thuringia for the atomic bomb test on the fourth of March.

[S. 40] Dieser Versuch sollte den Beweis bringen, dass das Zündsystem stabil arbeitet und der Vorbereitung eines entsprechenden Angriffs dienen, der mit einer Rakete geflogen werden sollte.

[p. 40] This test was to provide proof that the ignition system worked stably and to serve as preparation for a corresponding attack that was supposed to be flown with a rocket.

[S. 40] Das sind aber alles Projekte gewesen, wo die Industrie auf die eine oder andere Weise beteiligt war. Ob die Facharbeiter stellten, oder ihre spezielle technische Kompetenz. Natürlich lieferten die auch Einzelstücke oder Bauteile für Prototypen oder für die Versuche. Das war ja kein Problem, weil man einem Metallstück ja nicht ansieht, für welchen Zweck es gebraucht wird. Sehen Sie, das ging soweit, dass das Gestell für unseren Atomversuch in Thüringen von einer Schlosserei aus Thüringen hergestellt wurde. Ich weiß es deshalb, weil, als man sich dort traf, Diebner auf die Frage von jemandem, ob den unsere Leute gebaut hätten erklärte, der wäre von einer Schlosserei aus der Gegend. Die hätten ja nicht erfahren, wofür der gedacht war.

Der Versuch ist gerade dort durchgeführt worden, obwohl das ja in bewohntem Gebiet liegt, weil wir durch den Kriegsverlauf nicht mehr viel Auswahl hatten und natürlich, weil ja auch die Zeit drängte. Also sind wir gleich dort geblieben, wo auch das erforderliche Material erzeugt und auch gelagert worden war. Außerdem hatten hier unsere Leute und die von Diebners anderer Gruppe ihre Labors und die Entwicklungsabteilung. Und hier in der Nähe war ja auch die Serienproduktion der Uran-Bombe geplant gewesen. Außerdem sollte Anfang Januar die Zünderfertigung oder zumindest die Entwicklung eines für die Uran-Bombe vorgesehenen Zündsystems nach meiner Erinnerung ebenfalls hierher verlagert werden. Das war aber in einem aufgelassenen Bergwerk untergebracht, nicht in einer der Anlagen vor Ort. Diebner hatte angeblich, versichert, die Sprengwirkung wäre bei der geringen Menge, die der Versuch kosten würde, ganz gering. Leider hat sich seine Vorhersage aber nicht bestätigt. Das was da geschehen ist, war scheußlich. Außerdem hat es in der Umgebung noch Folgen gegeben, wobei ich nur hörte, dass Ärzte, die bei uns unter Vertrag standen, dort eingesetzt werden mussten.

[p. 40] But these were all projects where industry was involved in one way or another. Whether the skilled workers were placed, or their special technical competence. Of course, they also supplied individual pieces or components for prototypes or for the tests. That was not a problem, because one cannot tell from a piece of metal for what purpose it is needed. You see, that went so far that the stand for our atom test in Thuringia was manufactured by a metalworking shop in Thuringia. I know it because when meeting there, Diebner explained, in response to someone's question about whether our people had built it, it was from a metalworking shop from the area. They would not have known what it was meant for.

The test was carried out directly there, even though that was in an inhabited area, because due to the course of the war we did not have a lot of choice and, of course, because time was also critical. So we just stayed where the necessary material was produced and stored. In addition, our people and those of Diebner's other group had their laboratories and the development department. And here close by, too, the mass production of uranium bombs had been planned. In addition, at the beginning of January, the ignition [system] production or at least the development of an ignition system intended for the uranium bomb was likewise supposed to be relocated here, according to my memory. But this was placed in an abandoned mine, not in one of the facilities on site. Diebner allegedly assured that the explosive effect would be quite small for the small amount [of fuel] that the test would require. Unfortunately his prediction was not confirmed. What happened there was horrible. In addition, there were other consequences in the surrounding area, of which I only heard, that doctors, who were under contract with us, had to be deployed there.

[S. 13] Nach dem dritten Versuch, also das war dann der vom März in Thüringen, ist Hitler informiert worden. [...] Es war doch so, als der Versuch in Thüringen gelang, sind nach meiner Kenntnis unbeabsichtigt Arbeitskräfte aus einem Lager ums Leben gekommen. Die Leute, die bei dem Versuch dabei waren, hatten zum Teil größte Bedenken, ob man die Waffe einsetzen sollte, also ich meine, es war ja klar, dass im Einsatz nicht mit einem Testkörper operiert werden würde.

[p. 13] After the third attempt, which was the one from March in Thuringia, Hitler was informed. [...] It was like this: when the test in Thuringia succeeded, according to my understanding, workers from a camp died accidentally. The people involved in the test had some of the biggest concerns about using the weapon, I mean, it was clear that deployment would not involve an experimental device.

[S. 43] Was bleibt, sind die drei gelungenen Atomwaffenversuche, darunter ein größerer, ein Fehlschlag und ein Unfall.

[p. 43] What remains are the three successful atomic weapons tests, including a big one, a failure, and an accident.

[According to Grothmann, at least six prototype atomic bombs were produced at at least three different facilities. Of those, at least four were detonated in test explosions:

1. A test in autumn 1943 in the North Sea that failed. Grothmann provided no other details, and little information is available from other public sources. (For some possibly related sources, see pp. 4444, 5057, 5080.) Elsewhere, Grothmann stated that fission fuel was very scarce even in 1944–1945 and that the implosion system was not perfected until 1944. Although it is very surprising that a test would even be attempted in 1943, either or both of those problems could have easily caused the failure.

2. A test in the first half of October 1944 at a location that Grothmann refused to name for fear of public reaction. The bomb was on a low stand or holder, and its explosion successfully demonstrated the principles of the device. This information is consistent with statements from Rudolf Zinsser (p. 4448), Luigi Romersa (pp. 4468–4478), Elisabeth Mestlin (p. 4479), and other sources, who described a test explosion on the Baltic coast, possibly on Rügen island, on approximately 12 October 1944. That area of the Baltic coast has long been a popular tourist destination for people from all of Germany and beyond, which may explain Grothmann's reluctance to name the location.

3. A test during or around November 1944 at another location that Grothmann refused to name for fear of public reaction. That bomb was suspended from a parachute (presumably after having been dropped by a large aircraft), contained more fission fuel, and had a larger explosive yield. This information is consistent with statements from Robert Jackson (p. 4502), Felix Kersten (p. 4514), Wilhelm Wulff (p. 4515), and other sources, who described a test explosion near Auschwitz, which was said to have occurred over a specially constructed concentration camp and its inmates. If that is true, both that specific war crime and the larger issue of war crimes at Auschwitz and elsewhere in Poland could explain why Grothmann would not name the location.

4. A test on 4 March 1945 in Thuringia. Although Grothmann did not name the specific location, he said the test occurred very close to the research installation, and he separately said the research installation was located at or adjacent to the Ohrdruf Truppenübungsplatz military base. According to Grothmann, the bomb was mounted on a test stand, used a smaller amount of fission fuel, and had a smaller explosive yield, but was intended to test an improved implosion system that would be light enough to be carried on a rocket. Nonetheless, the explosive yield was still larger than had been expected, killed a number of workers, contaminated the area, and necessitated the use of special doctors to treat local people who were affected by the "horrible" event. This description closely matches those given by Ivan Ilyichev (pp. 4525–4529), Oscar Koch (p. 4612), Cläre Werner (p. 4597), Heinz Wachsmut (p. 4603), and other sources.

Assuming that Grothmann did not overlook any tests or failures and that there were at least six bombs as he stated, at least two bombs remained at the end of the war. Grothmann reported that the United States captured at least one bomb (p. 5088).]

D.11 Possible ∼November 1944 Test Explosion in Poland

[There may have been a test explosion in Poland in approximately November 1944, as reported by multiple sources:

- As already mentioned, a Top Secret U.S. cable from March 1946 stated that a "capable young engineer" in Poland knew that atomic bomb casings included a layer of cadmium, which was true for the implosion bomb designs described by both Ilyichev and Schumann (p. 4293). The Polish engineer's knowledge suggests that German-run industry in wartime Poland was involved in developing and/or testing an atomic bomb.

- Robert Jackson, chief U.S. prosecutor at the Nuremberg trials, stated on 21 June 1946 that he had received evidence that a new bomb design producing very intense heat had killed 20,000 Jewish prisoners in a specially constructed test village near Auschwitz (p. 4502).

- In August 1946, a FIAT intelligence document mentioned that there had been a number of unconfirmed reports that "about Christmas 1944, successful experiments were conducted in Pomerania with V-1 and atomic warheads, radio directed. The ensuing crater was 2 km in diameter" (p. 4504). There was also an August 1944 report of nuclear weapons development work in Pomerania (p. 4434).

- In December 1946, Otto Hahn said that there had been rumors that "atom bomb tests had been carried out in Poland during the last year of the war which were supposed to have had an effect similar to the first atom bomb dropped on Hiroshima though on a considerably smaller scale" (p. 4504).

- Gezo Mansfeldt, a survivor of Auschwitz, reported in December 1946 that he was frequently interrogated by Soviet officials about high-security wartime production work at Auschwitz and that he "learned of the atomic bomb tests" (p. 4507).

- A 1947 U.S. intelligence report stated that the Germans built a heavy water production plant near Auschwitz and that it was removed by the Soviets (p. 4507). Heavy water would only be useful for nuclear work, and the production of heavy water near Auschwitz suggests the presence of other nuclear work in Poland.

- Another 1947 intelligence report discussed wartime nuclear weapons work at Tucheler Heide in Poland, including the production of ^{235}U and ^{239}Pu and apparently even 1–5 kg fission pits for atomic bombs (p. 4948).

- In 1947, Heinrich Himmler's physical therapist, Felix Kersten, stated that Franz Göring, a senior SS security official, had told him that a new bomb design producing several thousand degrees of heat had killed 20,000 Jewish prisoners in a specially constructed test village near Auschwitz (p. 4514).

- Heinrich Himmler's personal astrologer, Wilhelm Wulff, confirmed that Franz Göring had stated that a new bomb design producing several thousand degrees of heat had killed 20,000 Jewish prisoners in a specially constructed test village near Auschwitz (p. 4515).

- Werner Grothmann stated that there was a successful atomic bomb test in or around November 1944 (p. 4480).

Some of the major sources and details are summarized in Table D.5.]

Details	Polish engineer March 1946	Jackson June 1946	Rumor cited by Hahn Dec. 1946	Mansfeldt Dec. 1946	Edmund Tilley August 1947	Kersten 1947	Wulff 1973	Grothmann 2000-2002
Test date	Prior to end of war (implied)	Late 1944?	~November 1944	Prior to January 1945	Prior to January 1945 (implied)	1944	1944	~November 1944
Test location		Near Auschwitz	Somewhere in Poland	Associated with Auschwitz	Somewhere in Poland (implied)	Near Auschwitz	Near Auschwitz	Location would provoke negative public reaction [war crimes]
People who were involved	German-run industry in Poland	SS	SS (implied)	SS	SS, I.G. Farben, German-run industry in Poland	SS	SS	SS, Himmler, Kammler, Gerlach, Post Office, Diebner, Flügge
Blast		Immediately vaporized entire test village with 400-500°C [4000-5000°C?]	Like Hiroshima but smaller			Single burst of 6000°C incinerated entire test village	Explosion, heat of 6000°C incinerated entire test village in a flash	Highly explosive, ~3 kilotons?, detonated in air over test site
Radio-activity	Atomic	Atomic	Like Hiroshima but smaller	Atomic	Nuclear fission	Atomic	Atomic	Nuclear fission
Casu-alties		20,000 Jewish prisoners in specially constructed test village	Like Hiroshima but smaller			20,000 Jewish prisoners in specially constructed test village	20,000 Jewish prisoners in specially constructed test village	
Device design	Atomic bomb with a layer of cadmium in the case	Newly invented atomic weapon of mass destruction	Atomic bomb	Atomic bomb	Atomic bomb with a 1-5 kg pit of U-235 or Pu-239	Atomic bomb detonated above the test site	Atomic bomb detonated above the test site	> 1 m dia. sphere Very heavy Aluminum case Larger amount of U-235 than other tests Ignition by special system Dropped over the test site on a parachute

Table D.5: Details about possible ~November 1944 test explosion from primary sources.

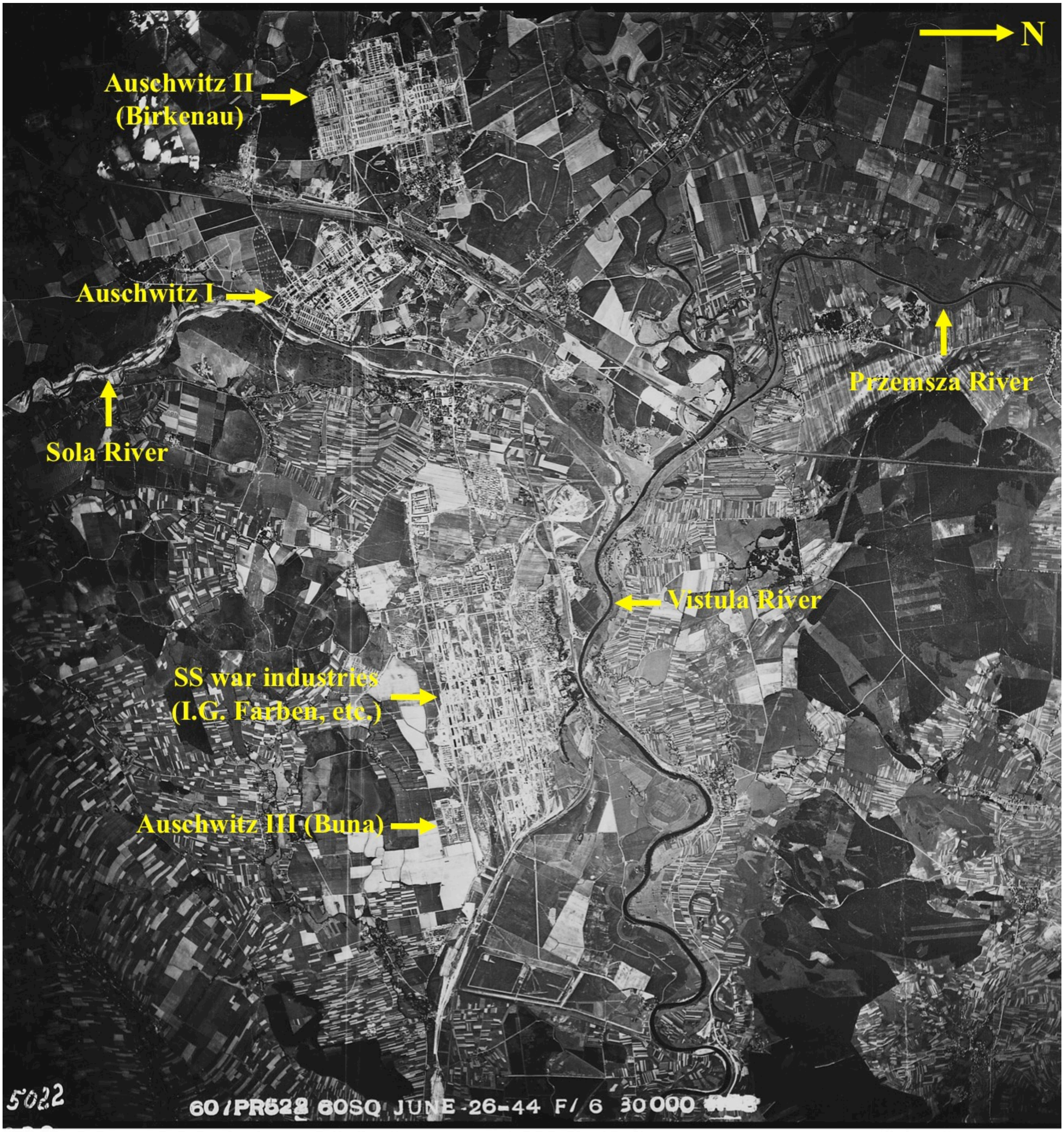

Figure D.696: U.S. aerial surveillance photo of Auschwitz on 26 June 1944, showing very large industrial installations built next to three rivers.

PW Intelligence Bulletin No. 2/25. 9 January 1945. [AFHRA folder 506.61952 Nos. 2/25–2/31 9–25 Jan 1945, IRIS 207531; AFHRA A5186 frames 0023–0027]

[See document photos on pp. 4489–4493.]

[...]

PW INTELLIGENCE BULLETIN No. 2/25

21. Bunawerke MONOWITZ nr AUSCHWITZ

See ANNEXES I and II.

Preamble. PW, a Slovak, was drafted into the Slovakian labor service 15 April 43 and sent to a guard coy in AUSCHWITZ. After three days black SS uniforms were issued the coy. PW remained there until July 44.

Location. The factory, commonly known as Bunawerke MONOWITZ, houses the two firms BUNA and IG FARBEN. Completely underground, it can nevertheless be located easily by six large wooden barracks, used as quarters for foremen and head mechanics, and situated atop a hill.

Personnel. Employed in the factory are appr 30,000 workers, all political prisoners whose work is supervised by SS guards. The workers—Poles, Russians, Czechs, and Jews—march to and from the factory from the nearby concentration camp at AUSCHWITZ, where a total of 680,000 prisoners are detained. There are two shifts, 0600 to 1800 and 1800 to 0600.

Products. Synthetic rubber products and Flak guns are turned out in the BUNA section. Although never inside the factory, PW has seen tanks (believed to be Tiger IIs) being taken from the factory grounds by rail.

PW does not know what is manufactured by the IG FARBEN section of the factory, but he saw the name on some of the barracks and on papers.

Guards. A total of 37 guard towers are situated at irregular intervals around the area. Every second tower has one machine gun. Encircling the area is electrically-charged wire fencing four meters high, run in 2 rows three meters apart. The area is flood-lighted at night.

Rubber Plants. There are appr 35 sq km of fields covered with rubber plants brought from RUSSIA. The fields and plants are maintained entirely by Russian civilians. The plants are used in the manufacture of rubber product.

LEGEND FOR ANNEX I (ITEM 21)

1. DAW uniform factory.
2. AUSCHWITZ concentration camp, containing 30,000 prisoners.
3. GUSTLO shell factory (connected with BUNA), employing 1,500.
4. BUNA underground factory (See ANNEX II).
5. Supply and ordnance depot.

6. "REISKO" Jail for women, with 275 prisoners.
7. BUNA synthetic rubber laboratory.
8. Same as 7.
9. Shed for storage of plants used for rubber production.
10. Concentration Camp BIRKENAU I. 150,000 prisoners, Jews of all nationalities.
11. Salvage dump for planes. [...]
12. Barracks for RR police.
13. Power distribution plant.
14. Flour mill.

    [...] 15. PW believes a new plant was under construction here. Circles indicate reservoir-like concrete pits 8 m in diameter.

    16. Incomplete concrete foundations 6-7 m in diameter.

LEGEND FOR ANNEX II

1. Main entrance to area, with iron gate.
2. Second entrance.
3. Section of guard towers (37 encircle the factory area. Every other one contains LMG. Dimension: 2 m x 2 m x 10 m).
4. Air-raid shelters.
5. Entrance guard booth.
6. Cistern. (PW is not sure of contents, probably liquid rubber (?)).
7. Three ventillation towers, appr. 10 m high and 1 m in diameter.
8. Tower appr 7 m high and 4 m in diameter. Has been observed emitting steam.
9. Tower appr 8 m high and 1 m wide. Has been observed emitting smoke.
10. Coal shed, 20 m x 30 m x 1 m.
11. Wooden barracks appr 30 m x 20 m x 5 m. Roofs camouflaged with paint and walls painted green. Windows in the roofs only. Barracks rest on cement foundations. Under each of these barracks is a subterranean hall housing the factory proper.
12. Electrified fence.

[...] Note: The factory grounds are completely grassed. There are heavy Flak installations throughout the area. Over the whole area are barrage balloons. PW does not know where the entrances to the actual underground factory are located.

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Rubber Plants. There are appr 35 sq km of fields covered with rubber plants brought from RUSSIA. The fields and plants are maintained entirely by Russian civilians. The plants are used in the manufacture of rubber products.

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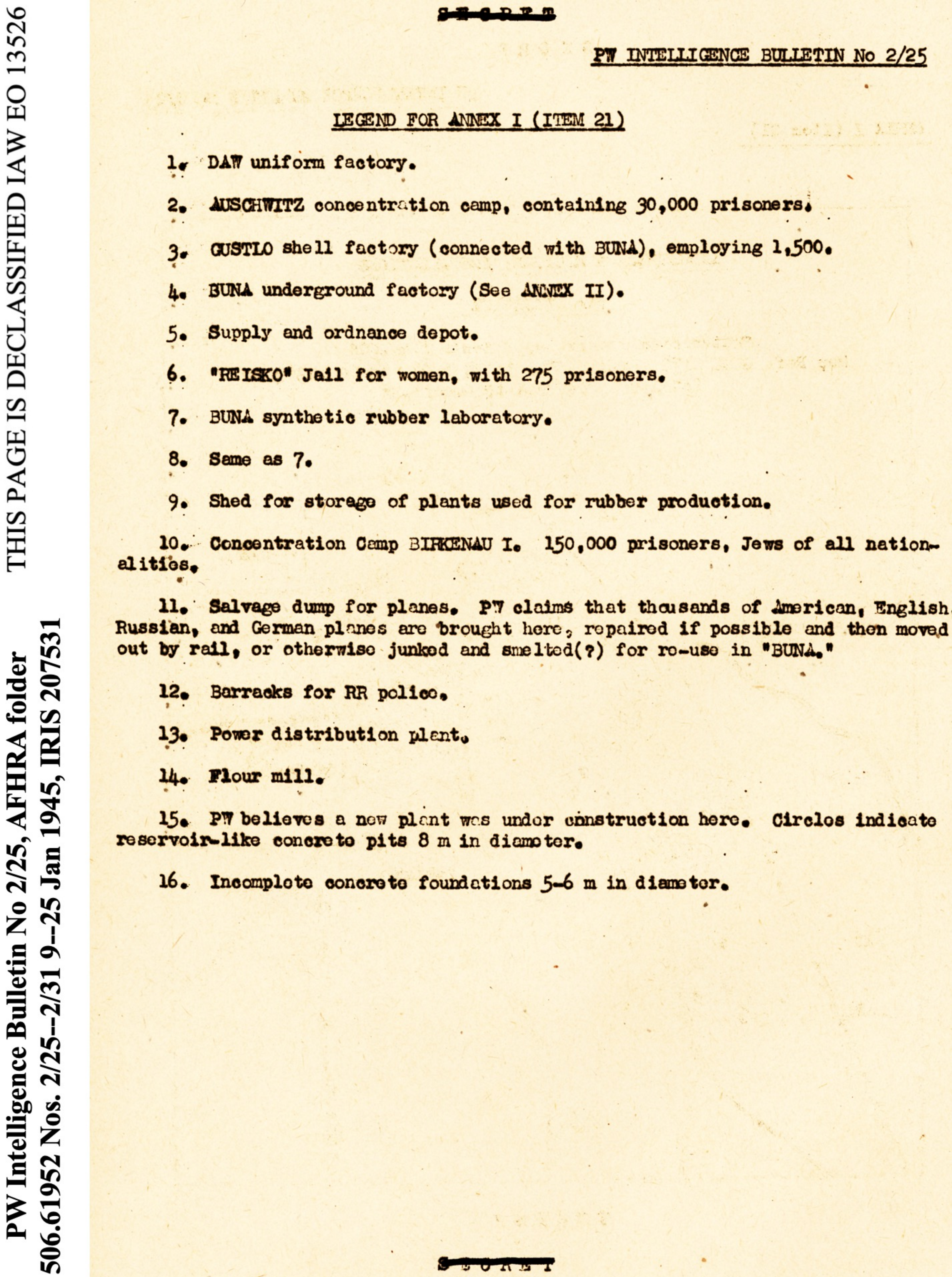
Figure D.697: There was a very large and very secretive underground I.G. Farben factory near Auschwitz. PW Intelligence Bulletin No. 2/25. 9 January 1945 [AFHRA folder 506.61952 Nos. 2/25–2/31 9–25 Jan 1945, IRIS 207531; AFHRA A5186 frames 0023–0027].



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PW Intelligence Bulletin No 2/25, AFHRA folder 506.61952 Nos. 2/25--2/31 9--25 Jan 1945, IRIS 207531

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PW INTELLIGENCE BULLETIN No 2/25

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10. Concentration Camp BIRKENAU I. 150,000 prisoners, Jews of all nationalities.

11. Salvage dump for planes. PW claims that thousands of American, English, Russian, and German planes are brought here, repaired if possible and then moved out by rail, or otherwise junked and smelted(?) for re-use in "BUNA."

12. Barracks for RR police.

13. Power distribution plant.

14. Flour mill.

15. PW believes a new plant was under construction here. Circles indicate reservoir-like concrete pits 8 m in diameter.

16. Incomplete concrete foundations 5-6 m in diameter.

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Figure D.698: There was a very large and very secretive underground I.G. Farben factory near Auschwitz. PW Intelligence Bulletin No. 2/25. 9 January 1945 [AFHRA folder 506.61952 Nos. 2/25–2/31 9–25 Jan 1945, IRIS 207531; AFHRA A5186 frames 0023–0027].

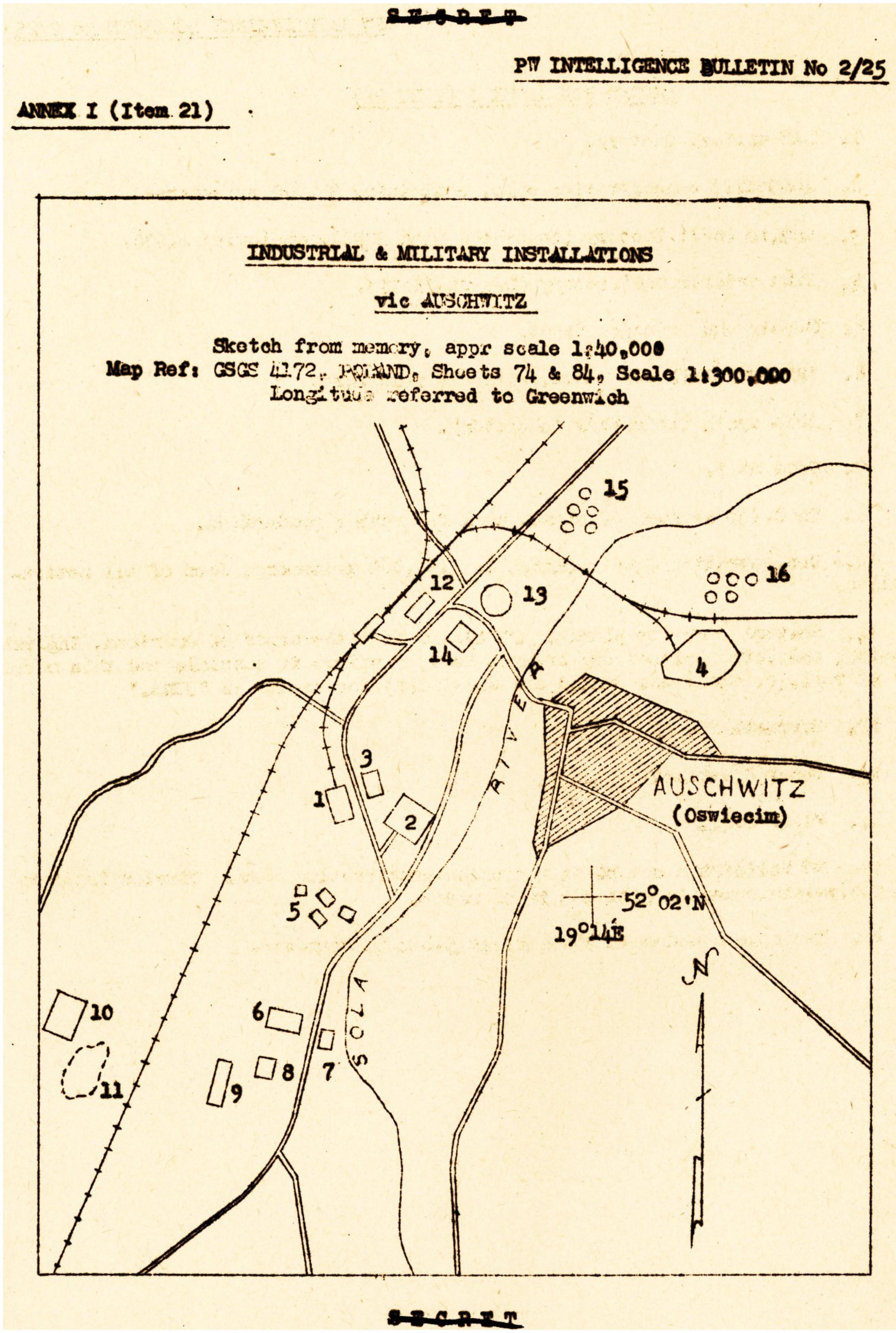

Figure D.699: There was a very large and very secretive underground I.G. Farben factory near Auschwitz. PW Intelligence Bulletin No. 2/25. 9 January 1945 [AFHRA folder 506.61952 Nos. 2/25–2/31 9–25 Jan 1945, IRIS 207531; AFHRA A5186 frames 0023–0027].

PW Intelligence Bulletin No 2/25, AFHRA folder 506.61952 Nos. 2/25--2/31 9--25 Jan 1945, IRIS 207531

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PW INTELLIGENCE BULLETIN No 2/25

LEGEND FOR ANNEX II

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2. Second entrance.

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5. Entrance guard booth.

6. Cistern. (PW is not sure of contents, probably liquid rubber(?)).

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12. Electrified fence.

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Figure D.700: There was a very large and very secretive underground I.G. Farben factory near Auschwitz. PW Intelligence Bulletin No. 2/25. 9 January 1945 [AFHRA folder 506.61952 Nos. 2/25–2/31 9–25 Jan 1945, IRIS 207531; AFHRA A5186 frames 0023–0027].

PW Intelligence Bulletin No 2/25, AFHRA folder 506.61952 Nos. 2/25--2/31 9--25 Jan 1945, IRIS 207531

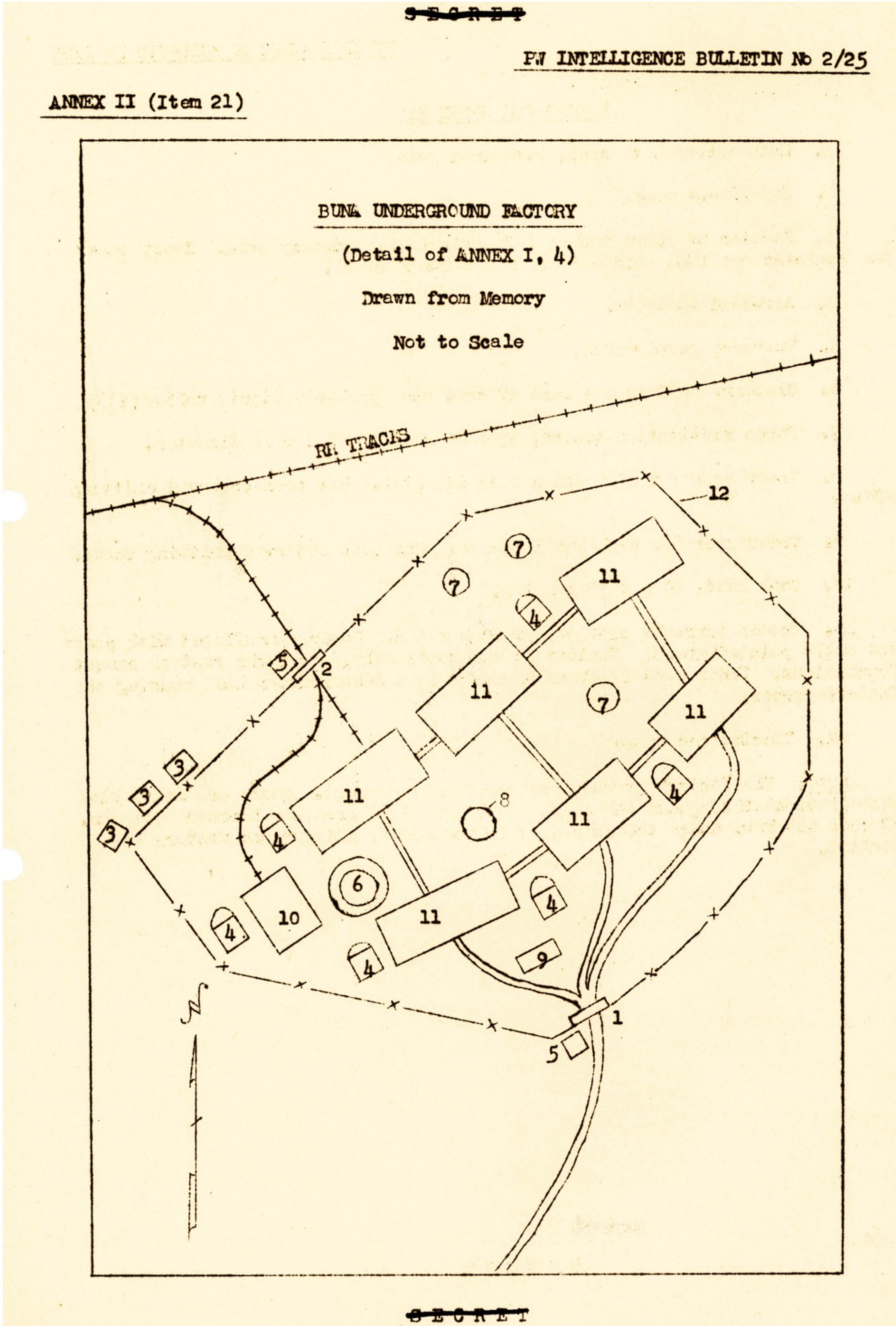
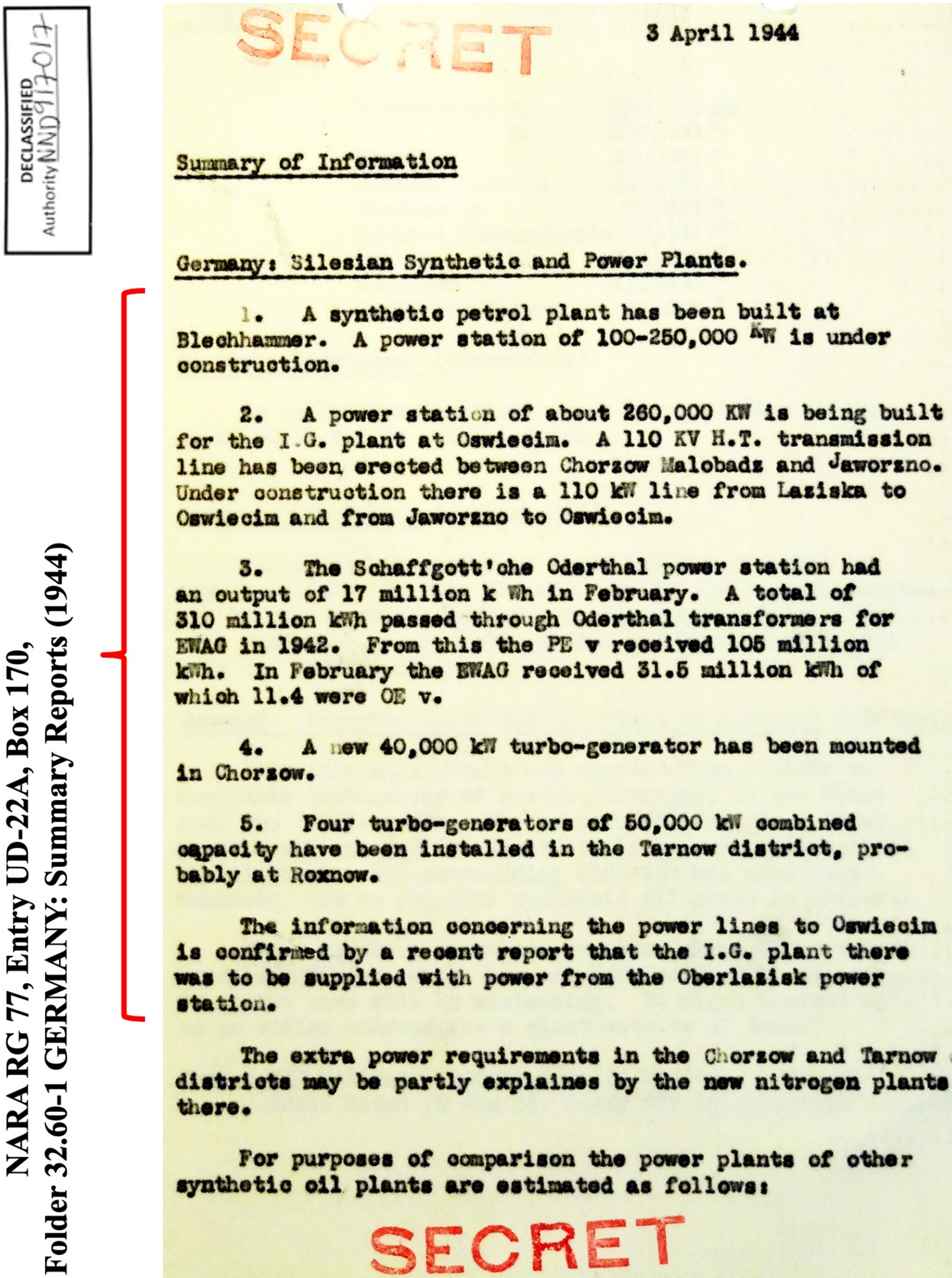


Figure D.701: There was a very large and very secretive underground I.G. Farben factory near Auschwitz. PW Intelligence Bulletin No. 2/25. 9 January 1945 [AFHRA folder 506.61952 Nos. 2/25–2/31 9–25 Jan 1945, IRIS 207531; AFHRA A5186 frames 0023–0027].



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3 April 1944

Summary of Information

Germany: Silesian Synthetic and Power Plants.

1. A synthetic petrol plant has been built at Blechhammer. A power station of 100-250,000 KW is under construction.

2. A power station of about 260,000 KW is being built for the I.G. plant at Oswiecim. A 110 KV H.T. transmission line has been erected between Chorzow Malobadz and Jaworzno. Under construction there is a 110 kW line from Laziska to Oswiecim and from Jaworzno to Oswiecim.

3. The Schaffgott'che Oderthal power station had an output of 17 million k Wh in February. A total of 310 million kWh passed through Oderthal transformers for EWAG in 1942. From this the PE v received 105 million kWh. In February the EWAG received 31.5 million kWh of which 11.4 were OE v.

4. A new 40,000 kW turbo-generator has been mounted in Chorzow.

5. Four turbo-generators of 50,000 kW combined capacity have been installed in the Tarnow district, probably at Roxnow.

The information concerning the power lines to Oswiecim is confirmed by a recent report that the I.G. plant there was to be supplied with power from the Oberlazisk power station.

The extra power requirements in the Chorzow and Tarnow districts may be partly explaines by the new nitrogen plants there.

For purposes of comparison the power plants of other synthetic oil plants are estimated as follows:

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NARA RG 77, Entry UD-22A, Box 170,
Folder 32.60-1 GERMANY: Summary Reports (1944)

Figure D.702: Examples of numerous power plants near Auschwitz. Summary of Information. 3 April 1944 [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)].

NARA RG 77, Entry UD-22A, Box 170,
Folder 32.60-1 GERMANY: Summary Reports (1944)

SECRET

Blechhammer N.	250,000 kw
S.	300,000 "
Böhlen	390,000 "
Bottrop Welheim	100,000 "
Deschowitz	75,000 "
Ruhland Schwarzheide	60,000 "
Pölitz	300,000 "
Scholven	110,000 "
Syerkrade Holten	80,000 "

Germany: Blechammer (Censorship)

In early November there was a big explosion in the works which killed several people.

Germany: Blechammer (British P/W)

Informant had worked at I. G. Heydebreck until November 1942. He only did odd jobs in the Siemens section of the factory which made gas producer generators. The main factory made synthetic petrol and 15-20 tank wagons left the factory daily.

Germany: Reported Synthetic Oil Plant at Urdinger (Air Rec)

"The only significant new construction visible on available photographs of Krefelt/Urdingen, is the Plant near the I.G.F. works. The purpose of this plant is at present unknown and the plant itself appears quite unlike an oil plant. The surrounding district has also been examined, but no possible synthetic oil plant is present.

There may be a plant two or three miles distant from Krefeld/Urdingen, which has not been covered by photographs. If so the name will be misleading. It might however refer to an office address for a plant outside of town."

From : MID Military Attache Report, London - 1 Feb 44.
Incl. dated 10 Jan 44. Enemy Oil Intelligence Committee

SECRET

Figure D.703: Examples of numerous power plants near Auschwitz. Summary of Information. 3 April 1944 [NARA RG 77, Entry UD-22A, Box 170, Folder 32.60-1 GERMANY: Summary Reports (1944)].

H. W. Dix to Francis Smith. Subject: Heavy Water. 26 December 1944. [NARA RG 77, Entry UD-22A, Box 171, Folder 32.7003-3 GERMANY: US Wartime Positive Int. (Nov. 44–June 45)]

This office has received the following comments from our Swedish people and it is dated 22 November 1944 and has a B-2 rating.

> Heavy water is manufactured primarily in Norway by I. G. at Norsk Hydro. However, manufacture in Germany at the Bayrische Stickstoffwerke in Piesteritz or Auschwitz is certainly a possibility.
>
> I have heard nothing about experiments with heavy water as an explosive. After all, that would be a case of splitting the atom!

Monthly Intelligence Summary. II Information on Possible TA Sites. January 1945. [NARA RG 77, Entry UD-22A, Box 168, Folder 202.3-1 LONDON OFFICE: Combined Intell Rpts.]

Report received from OSS Stockholm mentions the possibility that heavy water is being made in Germany at Piesteritz or Auschwitz at The Bayrische Stickstoffwerke, but the same source said he has heard nothing about heavy water in connection with an explosive. While coverage of these two towns has been requested, Auschwitz is in that part of Germany which is now in Russian hands.

Monthly Intelligence Summary. II Information on Possible TA Sites. February 1945. [NARA RG 77, Entry UD-22A, Box 168, Folder 202.3-1 LONDON OFFICE: Combined Intell Rpts.]

Reference Monthly Intelligence Summary, January 1945, II 5, page three. All available air coverage and Interpretation Reports of Auschwitz and Piesteritz have been obtained and forwarded to General Groves' office for further study.

U.S. Embassy, Warsaw. 12 August 1947. Report No. R-107-47, MIS-390731. Subject: Plants producing heavy water. [NARA RG 319, Entry 85A, Box 2534, Folder 390731–390740] [See document photo on p. 4498.]

1. It is believed that no plants designed specially for the production of heavy water exist in Poland. It is reliably reported that the Germans built one such plant near OSWIECIM (Auschwitz) but that it was destroyed or moved out by the SOVIETS in 1945.

2. A definite potentiality exists for the production of heavy hydrogen as a by-product of coal hydrogenation. There is believed to be small likelihood of the realization of this potential, since the Polish government insists on the complete orientation of industry toward the physical reconstruction of the country. [...]

[Heavy water would be of little use for anything other than nuclear work, specifically as a moderator for fission reactors. Because it was "reliably reported" that the Germans had built a heavy water production plant near Auschwitz and that the Soviets had removed, and that heavy water manufacturing was given such a high priority amid all the other war-related materials that urgently needed to be produced, these documents appear to confirm that the I.G. Farben and/or other installations at Auschwitz were (at least in part) manufacturing materials for a nuclear weapons program.]

BIOS 562. *The German Phosphorus Industry at Bitterfeld & Piesteritz.* p. 41.

[Piesteritz]

The plant was well laid out and in excellent condition but at the time of inspection was partially dismantled. The whole of the dearsenicating equipment had been removed.

BIOS 889. *Manufacture of Nitric Acid, Ammonium Nitrate and Fertilizers at Bitterfeld, Wolfen and Piesteritz.* p. 1.

Little information however was obtained from Piesteritz. The plant for making nitric acid and ammonium phosphate had already been completely dismantled, for transfer to Russia. It is believed that information on these plants had been obtained earlier by American investigators.

[If there was any nuclear-related work (such as heavy water production) at Piesteritz, the Russians would have removed all evidence of that before other countries ever had a chance to see it.]

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Report No. R-107-47 | CLASSIFICATION | Copy No. 2

INTELLIGENCE REPORT

FOR GENERAL USE BY ANY U.S. INTELLIGENCE AGENCY

From Military Attache (AGENCY OR OFFICER) Warsaw, Poland (STATION) Date 12 August 1947

Source Officers, U.S. Embassy, Warsaw Eval. B-2

Area Reported On POLAND Subject Plants producing heavy water

Reference Control S-781 (DIRECTIVE, CORRESPONDENCE, PREVIOUS REPORT, ETC., IF APPLICABLE.)

SUMMARY: ENTER CAREFUL SUMMARY OF REPORT, CONTAINING SUBSTANCE SUCCINCTLY STATED. ANSWER QUESTIONS WHERE, WHEN, WHAT, HOW, HOW MANY, AND GIVE DATE OF EVENT. IN A FINAL ONE SENTENCE PARAGRAPH GIVE SIGNIFICANCE. BEGIN TEXT ON PAGE 2.

1. It is believed that no plants designed specially for the production of heavy water exist in Poland. It is reliably reported that the Germans built one such plant near OSWIECIM (Auschwitz) but that it was destroyed or moved out by the SOVIETS in 1945.

2. A definite potentiality exists for the production of heavy hydrogen as a by-product of coal hydrogenation. There is believed to be small likelihood of the realization of this potential, since the Polish government insists on the complete orientation of industry toward the physical reconstruction of the country.

3. Absolutely no intimations have been received of Polish activity in the fields of research or development of atomic energy on Soviet account.

4. This subject will be kept under observation.

T. J. BETTS
Colonel GSC
Military Attache

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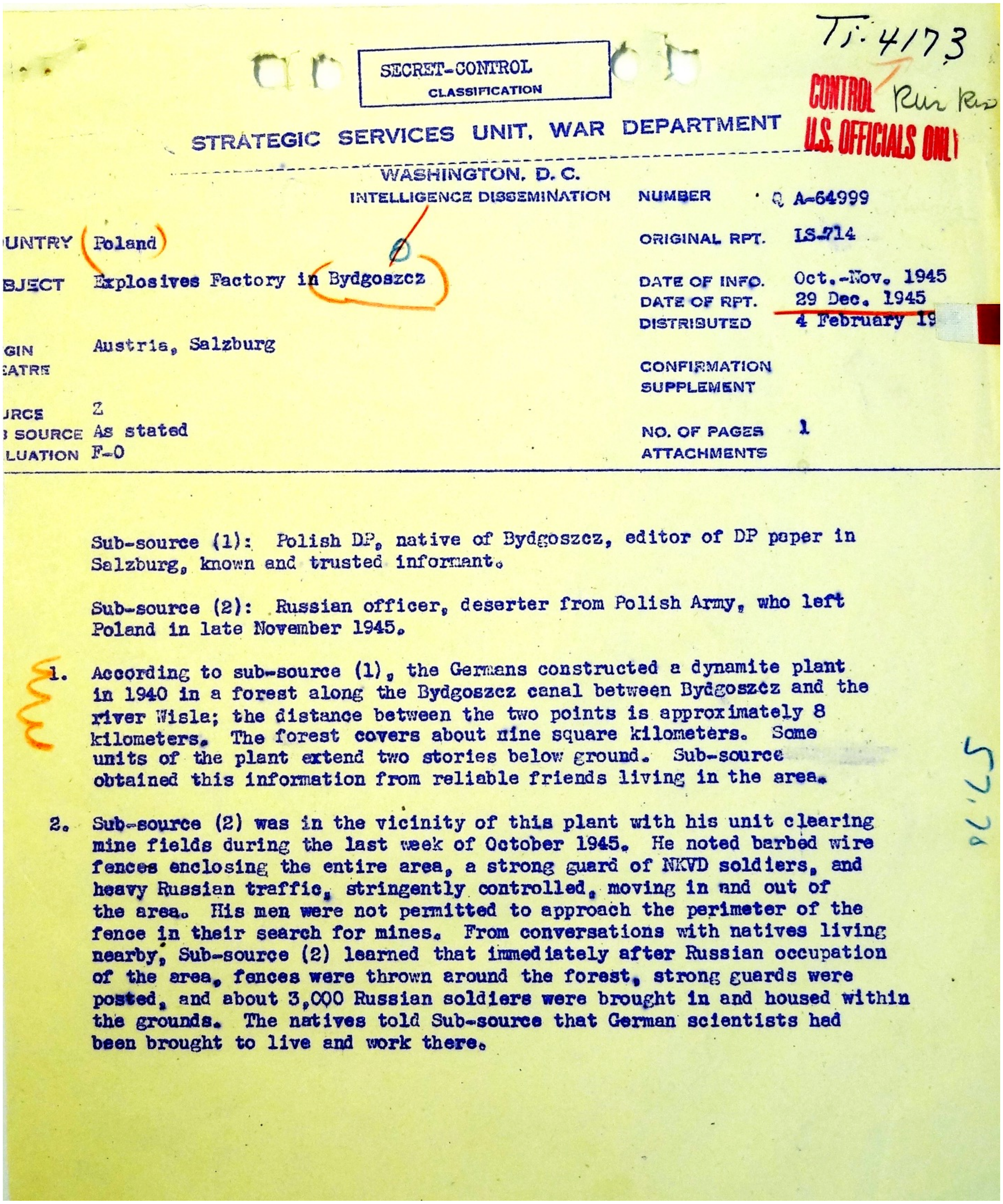
Figure D.704: U.S. Embassy, Warsaw. 12 August 1947. Report No. R-107-47, MIS-390731. Subject: Plants producing heavy water. [NARA RG 319, Entry 85A, Box 2534, Folder 390731–390740]

DECLASSIFIED
Authority NND 917017

NARA RG 77, Entry UD-22A,
Box 163, Folder 57.70 Poland Misc



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STRATEGIC SERVICES UNIT, WAR DEPARTMENT
WASHINGTON, D. C.
INTELLIGENCE DISSEMINATION

UNTRY	Poland	NUMBER	A-64999
BJECT	Explosives Factory in Bydgoszcz	ORIGINAL RPT.	IS-714
		DATE OF INFO.	Oct.-Nov. 1945
		DATE OF RPT.	29 Dec. 1945
		DISTRIBUTED	4 February 19
GIN EATRE	Austria, Salzburg	CONFIRMATION SUPPLEMENT	
JRCE	Z		
3 SOURCE	As stated	NO. OF PAGES	1
LUATION	F-0	ATTACHMENTS	

Sub-source (1): Polish DP, native of Bydgoszcz, editor of DP paper in Salzburg, known and trusted informant.

Sub-source (2): Russian officer, deserter from Polish Army, who left Poland in late November 1945.

1. According to sub-source (1), the Germans constructed a dynamite plant in 1940 in a forest along the Bydgoszcz canal between Bydgoszcz and the river Wisla; the distance between the two points is approximately 8 kilometers. The forest covers about nine square kilometers. Some units of the plant extend two stories below ground. Sub-source obtained this information from reliable friends living in the area.

2. Sub-source (2) was in the vicinity of this plant with his unit clearing mine fields during the last week of October 1945. He noted barbed wire fences enclosing the entire area, a strong guard of NKVD soldiers, and heavy Russian traffic, stringently controlled, moving in and out of the area. His men were not permitted to approach the perimeter of the fence in their search for mines. From conversations with natives living nearby, Sub-source (2) learned that immediately after Russian occupation of the area, fences were thrown around the forest, strong guards were posted, and about 3,000 Russian soldiers were brought in and housed within the grounds. The natives told Sub-source that German scientists had been brought to live and work there.

Figure D.705: Strategic Services Unit, War Department. Explosives Factory in Bydgoszcz. 4 February 1946. [NARA RG 77, Entry UD-22A, Box 173, Folder 57.70 Poland Misc]

Strategic Services Unit, War Department. Explosives Factory in Bydgoszcz. 4 February 1946. [NARA RG 77, Entry UD-22A, Box 173, Folder 57.70 Poland Misc]

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[See document photo on p. 4499.

From the details provided, it sounds as if this plant was manufacturing something far more secret, more complex, and more valuable than dynamite. It could have been enriching uranium-235, or breeding and/or purifying plutonium-239 or uranium-233. Apparently General Leslie Groves and intelligence officers of the U.S. Manhattan Project thought so too, which is why they included this report in their foreign intelligence files.

With intelligence reports of apparent nuclear-related work at Auschwitz, Bydgoszcz, and possibly Posen (see p. 3263), there are indications that the wartime German nuclear program may have involved extensive production work at a number of sites in Poland. All of those sites were taken over by the Russians, while the western Allies only received fragmentary reports about them.]