UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON

July 7, 1949

Dear Dr. Szilard:

I have your note of June 29, 1949 concerning our recent talk.

I appreciated very much going over this rather broad problem with you and I am happy to hear that you had an opportunity to talk with Mr. Hafstad concerning the reactor development program. I have found Dr. Hafstad imbued with a goodly share of healthy caution and yet quite capable of bold planning in this field.

I hope that when you are next in Washington you will stop by the Commission and give me the benefits of your further thinking.

Sincerely yours,

Gordon Dean

Gordon Dean

Dr. Leo Szilard
1155 East 57th Street
Chicago 37, Illinois

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

IN REPLY REFER TO:
GCP:RAA

May 23, 1955

Dr. Leo Szilard
Brandeis University
Waltham, Massachusetts

Dear Dr. Szilard:

There is enclosed herewith for your files a copy of Patent No. 2,708,656, "Neutronic Reactor", which recently issued on Application S. N. 568,904 after declassification of the subject matter by the Declassification Branch of the Commission.

We wish to express our appreciation to you for reporting the subject invention.

Very truly yours,

Roland A. Anderson.

Roland A. Anderson
Chief, Patent Branch

Enclosure:
Patent No. 2,708,656

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

JAN 18 1956

Dr. Leo Szilard
1155 East 57th Street
Chicago 37, Illinois

Dear Mr. Szilard:

Mr. Strauss in his acknowledgment of November 18th noted a referral to me of your letter of November 16th.

The circumstances surrounding the 1943 negotiations with the War Department which resulted in a settlement agreement for $15,417.60 for the assignment of certain inventions made prior to November 1, 1940, in which you were either the sole or joint inventor, have been reviewed. The records indicate that the negotiations were conducted over an extended period, during which time you received the advice of your own counsel.

We are well aware of the interest you stimulated in the early days of the atomic project, and of your contributions, along with those of many others, which are reflected in the Smyth Report and other early historical accounts of the inception of the atomic energy program. However, in view of the settlement made by you and the War Department, further action by the Commission in this matter does not appear to be warranted.

Sincerely yours,

K. E. Fields

K. E. Fields
General Manager

John von Neum

Willard F. Libby

Thomas Murray

Harold Vance

Strauss

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON

OFFICE OF THE CHAIRMAN

April 4, 1956

AEC

Dear Dr. Szilard:

Mr. Strauss has just returned from California and finds that his duties require him to leave shortly for Europe. So as not to waste any time in examining the potentialities of your suggested research concerning cancer of the prostate, he has briefed Dr. Libby on your correspondence with us and, also, on the conversations which I have held with you and our Division of Biology and Medicine. Dr. Libby will pursue this matter and will be your point of contact here in the Commission during the time while Mr. Strauss is in Europe.

With every good wish, I remain

Sincerely yours,

M. Dupkin, II
Special Assistant to
the Chairman

Dr. Leo Szilard
1155 East 57th Street
Chicago 37, Illinois

Mary Lasker
Fund for Adv
of Med

Kettering
Alfred P Sloan

1172 80/100 per Month

Social Security
Tel 17 8 6200

U.S. Atomic Energy Com

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

August 24, 1956

Mr. Leo Szilard
c/o Mr. A. N. Spanel
International Latex Co.
350 Fifth Avenue
New York, New York

Subject: CASE S-10,565; SERIAL NO. 323,452

Dear Mr. Szilard:

A Notice of Allowability was received from the U. S. Patent Office for your patent application identified above, entitled "Chain Reactions" and executed by you on November 26, 1952. This normally means that whenever the application is declassified, the application will issue as a patent, at which time you will be notified and sent a copy of the issued patent.

Your courtesy and assistance to the members of the staff of the Patent Branch in connection with the prosecution of this application are appreciated.

Very truly yours,

Foster York, Chief
Chicago Patent Group
John A. Horan

MARSHALL

Reg
Return Receipt
Special delivery

file

The Quadrangle Club
The University of Chicago
Chicago 37, Illinois
September 7, 1956

Mr. Charles L. Marshall
1901 Constitution Avenue, N.W.
Washington 25, D. C.

Dear Mr. Marshall:

Going through my files which I have at home, in contradistinction to those which I had at the Argonne National Laboratory, I found the attached sheets which are stamped either "Confidential" or "Secret". I would much appreciate your having them declassified and returned to me at my above address.

I was very grateful for your kind cooperation in going through the documents which had been kept for me at the Argonne National Laboratory, and which have now been returned to me.

With best wishes,

Very sincerely yours,

Leo Szilard

m
Encl.

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

IN REPLY REFER TO:
C:CLM

September 13, 1956

Dr. Leo Szilard
The Quadrangle Club
The University of Chicago
Chicago 37, Illinois

Dear Dr. Szilard:

I have reviewed the items you forwarded to me with your letter of September 7, 1956 and found that they do not contain any Restricted Data as defined by the Atomic Energy Act of 1954.

I hope to send you soon a report on the items I sent from Chicago.

Sincerely yours,

C. L. Marshall, Director
Division of Classification

Enclosures:
1. Ltr dtd 2/7/44 frm Greenstein,
   EIDM A-42-b MS
2. Contract No. W-7401 eng-156, 12/1/43
3. Ltr dtd 2/2/44 frm Greenstein
   EIDM A-42-c MS
4. Memo dtd June 1944 frm Stearns
   to Monthly-rated employees
5. Contract of Employment, Supplement No. 1
   dtd 5/30/44 (Johnson to Szilard)
6. Contract of Employment, dtd 5/1/43
   frm Johnson to Szilard (2 pages)

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

IN REPLY REFER TO:

C:CLM

September 24, 1956

Dr. Leo Szilard
The Quadrangle Club
The University of Chicago
Chicago 37, Illinois

Dear Dr. Szilard:

I am returning herewith the following documents which I sent from Chicago following my meeting with you and Dr. Johnson. We have reviewed the documents and have determined that they do not contain any Restricted Data as defined by the Atomic Energy Act of 1954:

1. Rough draft of "Proposed Conversation with Dr. Bush" dated February 1944. (2 copies).

2. 3 pages of rough draft of a proposed letter.

3. Pages 6, 13 and 14 of draft paper entitled "Proposed Conversation with Bush. Part II. The Exclusion Principle".

The following documents have been declassified and all holders of copies should be notified as to their declassification:

1. MUC-LS-28, letter dated July 7, 1944 from Szilard to W. W. Watson, Montreal (10 pages, Secret, Defense Information).

   7 page rough draft of above dated 7-3-44 (Secret, Defense Information, undocumented).

2. Letter dated March 13, 1942 from E. C. Creutz to Dr. E. V. Murphree, Standard Oil Company, New York. (3 pages - carbon copy). (Confidential).

3. Cy 3A of letter dated August 28, 1945 from Szilard to Capt. R. A. Lavender, Washington, D. C. (Secret).

   Cy 4A of above letter.

4. Letter dated January 18, 1944 from V. Bush, Director, Office of Scientific Research & Development, Washington, D. C., to Szilard. (4 pages, Secret, undocumented).

5. Copies 2A and 3A of letter dated January 14, 1944 from Szilard to Dr. Bush, MUC-LS-11. (3 pages, Secret, Defense Information).

6. Copy 2 of 7, N.R.C. Report No. C1462-40S, dated 4-1-41, entitled "The Preparation of Uranium" by D. F. Stedman and A. G. Brown. (13 pages, Confidential).

7. MUC-LS-22, letter dated May 20, 1944 from Szilard to Dr. Wigner, Cy 3A, Subject: "Peristaltic Method for Purifying Plutonium". (2 pages with 1 figure, Secret, Defense Information).

8. Paper entitled "What is Wrong With Us?" by L. Szilard dated September 21, 1942. (11 pages, Secret, Defense Information). (Undocumented).

   Draft of above paper dated September 19, 1942 (no classification indicated on draft - 12 pages - captioned "Memorandum").

The remainder of the papers I sent from Chicago are being returned to the Argonne National Laboratory to be placed in their classified files.

Sincerely yours,

C. L. Marshall, Director
Division of Classification

Enclosures:
15 as above

cc: Dr. W. C. Johnson

U. S. Atomic Energy Commission
CLASSIFIED MATERIAL RECEIPT

Date Mailed: September 26, 1956

To:
Dr. Warren C. Johnson, Dean
Division of the Physical Sciences
111 Eckhart Hall
University of Chicago
Chicago 37, Illinois

FROM:
C. L. Marshall, Director
Division of Classification
U. S. Atomic Energy Commission
1901 Constitution Avenue
Washington 25, D. C.

9/25/56 From: C. L. Marshall To: Dr. W. C. Johnson

1. MUC-LS-63, 2 page memo dated 3-15-45 from Szilard to W. Bartky, copy 7A, Secret, Defense Information.
2. Carbon cpy of lttr dated 9-1-42 fr Szilard to R. Oppenheimer, 2 pages, Secret, Defense Information, undocumented.
3. MUC-LS-38, lttr dated 8-18-44 fr Szilard to V. Bush, 2 pgs Cy 3A, with following attachments:
   a. cc cpy of lttr dtd 8-18-44 fr Szilard to Lord Cherwell-unclass
   b. cc of memo dtd 8-22-44 fr Szilard to Dr. Bush-unclassified
   c. cc of lttr dtd 8-25-44 fr Szilard to Brig. Gen. Lindeman, British Embassy - unclassified.
   d. cpy of telegram dtd 8-24-44 fr Bush to Szilard - unclass.
   e. Cpy of class. receipt & registered return receipt for above material.
4. MUC-LS-27, 2 pgs., memo dtd 7-7-44 fr Szilard to E.P. Wigner, cy 1A, with 2 figures
5. cc copy of paper dtd 10-21-41 entitled "Memorandum Raising the Question Whether the Action of Explosive Chain-Reacting Bodies Can Be Based on an 'Explosion' Method" CRD

6. 2 copies of paper dtd 2-28-44 by Szilard "Proposed Conversation with Bush-Part IV-Physhological Situation of the Scientists". Classified Secret, Restricted Data. No documented.
7. 2 copies of paper dated 2-28-44 by Szilard "Proposed Conversation with Bush-Part III-Rule by Directives". Classified Secret, Restricted Data. Not documented.
8. 2 copies of paper dated 2-28-44 by Szilard "Proposed Conversation with Bush - Part II-The Exclusion Principle," Classified Secret, Restricted Data. Not documented.

U. S. Atomic Energy Commission
CLASSIFIED MATERIAL RECEIPT

Date Mailed: September 26, 1956

To:
Dr. Warren C. Johnson, Dean
Division of the Physical Sciences
111 Eckhart Hall
University of Chicago
Chicago 37, Illinois

FROM:
C. L. Marshall, Director
Division of Classification
U. S. Atomic Energy Commission
1901 Constitution Avenue
Washington 25, D. C.

9/25/56 From: C. L. Marshall To: Dr. W. C. Johnson

1. MUC-LS-63, 2 page memo dated 3-15-45 from Szilard to W. Bartky, copy 7A, Secret, Defense Information.
2. Carbon cpy of lttr dated 9-1-42 fr Szilard to R. Oppenheimer, 2 pages, Secret, Defense Information, undocumented.
3. MUC-LS-38, lttr dated 8-18-44 fr Szilard to V. Bush, 2 pgs Cy 3A, with following attachments:
   a. cc cpy of lttr dtd 8-18-44 fr Szilard to Lord Cherwell-unclass
   b. cc of memo dtd 8-22-44 fr Szilard to Dr. Bush-unclassified
   c. cc of lttr dtd 8-25-44 fr Szilard to Brig. Gen. Lindeman, British Embassy - unclassified.
   d. cpy of telegram dtd 8-24-44 fr Bush to Szilard - unclass.
   e. Cpy of class. receipt & registered return receipt for above material.
4. MUC-LS-27, 2 pgs., memo dtd 7-7-44 fr Szilard to E.P. Wigner, cy 1A, with 2 figures
5. cc copy of paper dtd 10-21-41 entitled "Memorandum Raising the Question Whether the Action of Explosive Chain-Reacting Bodies Can Be Based on an 'Explosion' Method" CRD
6. 2 copies of paper dtd 2-28-44 by Szilard "Proposed Conversation with Bush-Part IV-Physhological Situation of the Scientists". Classified Secret, Restricted Data. No documented.
7. 2 copies of paper dated 2-28-44 by Szilard "Proposed Conversation with Bush-Part III-Rule by Directives". Classified Secret, Restricted Data. Not documented.
8. 2 copies of paper dated 2-28-44 by Szilard "Proposed Conversation with Bush - Part II-The Exclusion Principle," Classified Secret, Restricted Data. Not documented.

THE UNIVERSITY OF CHICAGO
CHICAGO 37 · ILLINOIS
THE ENRICO FERMI INSTITUTE
FOR NUCLEAR STUDIES

The Quadrangle Club
The University of Chicago
Chicago 37, Illinois
September 27, 1956

Mr. C. L. Marshall, Director
Division of Classification
United States Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Marshall:

I have your kind letter of September 24th, and I wish to take this opportunity to thank you for the kind cooperation which you have shown in this matter.

Your letter indicates that you are sending some of the papers, which were held for me at the Argonne National Laboratory, back to the Argonne National Laboratory to be placed in their classified files. I have now the following request:

(1) I would like to have a list which will identify these documents by their date, title, and author so that I might ask for their declassification at a later time. If you have already sent these documents to Miss Hoylande Young in the Argonne, I can arrange with her to send me such a list.

(2) I suspect that most of these documents contain no classified information under the Atomic Energy Act, and that the reason you did not declassify them is that you did not wish to take the responsibility of saying that they did not contain information which relates to the national defense in some way that does not come under the Atomic Energy Act. If these documents are still in your office, I would therefore very much appreciate it if, before returning them to Miss Hoylande Young in the Argonne, your office would note on each of them either

"Kept classified under the Atomic Energy Act" or else "No Classified Information under the Atomic Energy Act".

If you have already returned the documents to the Argonne, I would like to arrange for them to be returned to your office so that your office can put such a notation on them. This, of course, would not be necessary if you could inform me that none of these documents which remain for the present classified contains information classified under the Atomic Energy Act.

My reason for this request is that I may wish to submit for declassification some of those documents which contain no classified information under the Atomic Energy Act to the Secretary of Defense for declassification.

(3) Please note that I am interested in this regard only in documents which originated with me or documents which represent a communication addressed to me.

(4) Some time ago Miss Hoylande Young forwarded to the Atomic Energy Commission three documents that were marked "Secret" and which did not contain any information that is classifiable under the Atomic Energy Act. I understand that General Nichols did not wish to declassify these documents even though they do not contain information classified under the Atomic Energy Act, and I am now herewith asking that these documents be returned to Miss Hoylande Young for safekeeping so that, if necessary, I might myself ask the Secretary of Defense to declassify them.

(5) Please note that among the three documents mentioned above there was a copy of a petition which was stamped "Secret". This stamp should have been removed by me in 1945 when I declassified this document with the approval of the Manhattan District. Some time afterwards I was asked by the Manhattan District to reclassify this document "Secret". I was, however, not able to comply with this request because in the meantime I had distributed a number of declassified copies to friends, acquaintances, and others who were interested without keeping a record of the distribution of the document. Therefore, this document remained declassified, notwithstanding the "Secret" stamp which remained on the one copy which Miss Hoylande Young sent to Washington.

I regret that I must encroach upon your time in this manner. The disposition of these matters in the manner suggested above has, it seems to me, the merit that it would settle them once and for all as far as the Atomic Energy Commission is concerned.

I wish to thank you once more for the help which you have extended to me, and remain

Very sincerely yours,

Leo Szilard

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UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

October 4, 1956

Mr. Leo Szilard
The Quadrangle Club
The University of Chicago
Chicago 37, Illinois

Dear Mr. Szilard:

In reply to your letter request of September 6, 1956, and your later telephone request to myself, we are enclosing a list of all cases filed in your name, together with the names of co-inventors, and the present status of the case. The formal title for each case is given, and in cases where this is not very descriptive certain other information has been added.

Very truly yours,

John A. Horan

John A. Horan, Acting Chief
Chicago Patent Group

Enc.

Leo Szilard cases: -

S-98 - "Production of Radioactive Substances by Neutrons Lost from a Neutronic Reactor"

Coinventors - E.P.Wigner, R.F.Christy and E.L.Friedman.

Case still under prosecution.

- -

S-386 - "Improvement in Method of Preparing Uranium Oxide of Sufficient Purity to Make Possible a Chain Reacting System with Graphite (Ether Extraction of Nitrate)"

Coinventors - H.L.Anderson, Enrico Fermi, Samuel K. Allison, and C. J. Rodden.

Abandoned during prosecution due to adverse findings in Patent Office.

- -

S-1/501- "Carbon Pile Method for Determining the Suitability of Samples of Graphite for Use in a Nuclear Chain Reacting System"

Coinventor - Enrico Fermi .

Abandoned; published in Official Gazette of the U.S. Patent Office Feb. 17, 1953; British and Canadian applications filed.

- -

S-1/506- "Air Cooled Neutronic Reactor" (Site X)

Coinventor - Enrico Fermi.

Under prosecution. British and Canadian applications filed.

- -

S-521 - "Water Cooled Pile (Basic Case, U-C) Vertical Pile with Internal Cooling"

To dominate all H_2O Cooled Pile Cases. Specifically shows U-C Vertical with Internal Cooling.

Coinventors - R.Christy, G. Plass, A.M.Weinberg, R.R. Williamson, and E. P. Wigner.

Under prosecution.

- -

S-532 - "Improved End Closure for Bonded Slugs"

Coinventors - Gale J. Young and Leo A. Ohlinger.

Notice of Allowability - June 22, 1953.
(Secrecy not yet removed.)

- -

S-1035 - "Controlled Fast Neutronic Reactor - Bismuth Cooled"

Under prosecution.

- -

S-1036 - "Neutronic Reactor for the Production of Product"

Under prosecution.

- -

S-1/1051- "Bismuth Cooled Power Unit"

Under prosecution.

- -

S-1578- " Slug End Caps of High Thermal Conductivity"

Coinventor - Gale J. Young.

Application allowable, secrecy order in process of removal.

- -

S-1738- "Intermittent Heating of Mercury in a Reactor"

Prosecution terminated; some claims will be allowed.

- -

S-2247- "Method of Protecting Uranium from Corrosion"

Coinventors - Edward C Creutz and E.P.Wigner.

Notice of Allowability May 17, 1954. Still under secrecy order.

- -

S-2321- "Neutronic Reactor " (Clumping and Diameter-U/Moderator Ratio Graphs)

Coinventor - Enrico Fermi.

Patent 2,708,656.

- -

S-3004- "Slab, Plate or Layer Reactors" (Continuation-in-part of S-2321)

Coinventor - Enrico Fermi.

Under prosecution.

- -

S-10,564- "Chain Reactions" (Divisional application of basic Pile Case S-2321. Operation and Control on Delayed Neutrons)

Coinventor - Enrico Fermi.

Under prosecution.

- -

S-10,565- "Chain Reactions" (Divisional application of basic Pile Case S-2321. Use of shim rods.

Coinventor - Enrico Fermi.

Allowable July 30, 1956. Under process of declassification.

- -

S-10,566- "Chain Reactions"(Divisional application of basic Pile Case S-2321 - Openings in the Side of a Reactor for the Escape of Fast Neutrons _

Coinventor - Enrico Fermi.

Prosecution abandoned due to difficulties with Patent Office.

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

IN REPLY REFER TO:

C:CLM

October 4, 1956

Dr. Leo Szilard
The Quadrangle Club
University of Chicago
Chicago 37, Illinois

Dear Dr. Szilard:

Attached herewith is an additional group of documents which were discovered and forwarded for clearance. We have reviewed them, declassified them, and are returning same for your files.

1. Letter dated 12/12/44 from C. Vanden Bulck to Szilard, EIDMV-a MD-7401-eng-156. (Secret, Defense Information, undocumented).

2. MUC-PA-7084, letter dated 11/15/44 from H. E. Metcalf to Szilard. (Secret, Defense Information, Copy 1A).

3. Memorandum from A. H. Compton to Szilard dated 10-7-42. (Secret, undocumented).

4. MUC-LS-#1 - "Memorandum on Metallurgical Problems Connected with the Power Unit Which is Cooled by Liquid Metal" dated June 12, 1943. (Secret, Defense Information, 2 pages).

5. Draft "Proposed Conversation with Bush" dated February 28, 1944, Part I. (Unclassified, 9 pages).

Sincerely yours,

C. L. Marshall, Director
Division of Classification

cc: Dr. W. C. Johnson
Dr. H. D. Young

October 4, 1956

Mr. C. L. Marshall
Director, Division of Classification
United States Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Marshall:

Many thanks for your very kind letter of September 24th, in which you return to me a number of declassified documents. I take this opportunity to say how much I appreciate your kind cooperation in this matter.

I understand that you have returned to Warren C. Johnson a number of documents listed on the attached sheet.

Items 6, 7, and 8 on the sheet were not classified previously, but you have now classified these items under the Atomic Energy Act. Your office has put paper-clips marking the spot at which classified information is contained. There is one possible error in item 7 (Part III) on page 2, where there is no classified information although there is a paper-clip. The corresponding passage is now marked on the copy in red pencil with a question mark. In the other spots where there is a paper-clip the passage is now indicated in red pencil which should be omitted. I take it that if these passages are omitted, the material listed under 6, 7, and 8 can then be declassified. I would much appreciate your looking at these documents and instructing Dr. Warren C. Johnson to return these documents to me declassified, after eliminating the passages marked in red pencil.

Under item 3 in your list, there is a letter MUC-LS-38 which is classified but which contains no information relating to the national defense at the present time. I would appreciate your taking another look at this letter to see whether you can or cannot declassify it.

Stapled to this document are a number of unclassified documents which were not originally attached to it. I would much appreciate your authorizing Dr. Johnson to return to me these unclassified documents whether or not you are able to declassify the classified letter. This unclassified material is referred to in the attached list under 3 - a,b,c, and d.

I regret that I must once more trouble you with such matters of declassification.

Sincerely yours,

Leo Szilard

m
cc: Dr. Warren C. Johnson

THE UNIVERSITY OF CHICAGO
CHICAGO 37 • ILLINOIS

THE ENRICO FERMI INSTITUTE
FOR NUCLEAR STUDIES

October 5, 1956

To: Mr. C. L. Marshall

From: Leo Szilard

I just took over a copy of the attached letter to Dr. Johnson's office and was told that he left for Washington where he will see you within a few days. I have thereupon asked Dr. Johnson's office to send on the documents which are marked by red pencil on the sheet attached to my letter to Dr. Johnson, in care of your office. I hope that Dr. Johnson and you may find time to settle this matter on the spot and that Dr. Johnson can bring the documents back with him to Chicago.

U.S. Atomic Energy Com.

The Quadrangle Club
The University of Chicago
Chicago 37, Illinois
October 11, 1956

Mr. John A. Horan, Acting Chief
Chicago Patent Group
United States Atomic Energy Commission
Chicago Operations Office
P. O. Box 59
Lemont, Illinois

Dear Mr. Horan:

I am writing to acknowledge your letter of October 4th. I greatly appreciate your letting me have this material.

Very truly yours,

Leo Szilard

m

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

IN REPLY REFER TO:
C:CLM

October 23, 1956

Dr. Leo Szilard
The Quadrangle Club
The University of Chicago
Chicago 37, Illinois

Dear Dr. Szilard:

We have reviewed the following papers and have deleted all portions which might reveal Restricted Data as defined by the Atomic Energy Act of 1954. Consequently, the copies of the papers which are attached have been declassified effective this date. The deleted material has been destroyed.

1. MUC-LS-63, 2 page memo dtd 3-15-45 frm Szilard to Bartky.
2. Carbon copy of letter dtd 9-1-42 frm Szilard to Oppenheimer.
3. Carbon of letter dtd 8-18-44 frm Szilard to Cherwell.
4. Carbon of memo dtd 8-22-44 from Szilard to Dr. Bush.
5. Carbon of letter dtd 8-25-44 frm Szilard to Brig. Gen. Lindemann, British Embassy.
6. Copy of telegram dtd 8-24-44 frm Bush to Szilard.
7. Copy of classified receipt and registered return receipt.
8. MUC-LS-27, memo dtd 7-7-44 frm Szilard to Wigner with 2 figures.
9. Paper dtd 2-28-44 by Szilard "Proposed Conversation with Bush-Part IV-Psychological Situation of the Scientists," 2 copies.
10. Paper dtd 2-28-44 by Szilard "Proposed Conversation with Bush-Part III-Rule by Directives," 2 copies.
11. Paper dtd 2-28-44 by Szilard "Proposed Conversation with Bush-Part II-The Exclusion Principle," 2 copies.

See IIIa, C-1

Sincerely yours,

C. L. Marshall, Director
Division of Classification

Enclosures:
As above.

cc: Dr. W. C. Johnson
Dr. H. D. Young

14 3 cc

file A.E.C.

October 25, 1956

Mr. C. L. Marshall, Director
Division of Classification
United States Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Marshall:

I am writing you today about a matter which is not directly connected with the documents recently returned to me by the Argonne National Laboratory.

Sometime ago, at the time when General Nichols was still General Manager of the A.E.C., Miss Hoylande Young sent three documents which are my property to the A.E.C. for declassification. These three documents were as follows:

a). The text of the petition to the President which I had written in 1945,

b). A letter from the Manhattan District dated after the bomb was dropped on Hiroshima, asking me to reclassify this petition "Secret" after I had declassified it with the approval of the Manhattan District,

c). A letter by Edward Teller relating to this petition.

None of this material contains any information that may be kept Secret under the Atomic Energy Act of 1954. I understand that General Nichols informed the Argonne National Laboratory that he is not going to ask the Department of Defense that these documents be declassified, and I also understand from Miss Hoylande Young that these documents were not returned to her.

I am writing you today for two purposes:

(1) After the text of the petition was declassified by me with the permission of the Manhattan District, I have declassified and distributed copies which were not stamped "Secret" to a number of people who wanted to have them. I have not kept any list of distribution, and when later, after Hiroshima, I was asked by the Manhattan District to reclassify this petition, I was neither willing nor able to comply. Not knowing who had copies of this petition, it was impossible for me to gather in these copies and stamp them "Secret" or even to inform the recipients that the document will be reclassified.

Consequently, this document remains declassified. The copy sent to the A.E.C. by Miss Hoylande Young which happens to have a "Secret" stamp on it ought to have its "Secret" stamp removed.

(2) I need the letter of the Manhattan District, referred to above, for my protection in order to be able to prove that the petition was in fact declassified by me with the approval of the Manhattan District.

I would appreciate your informing me what steps I can take in order to have the letter from the Manhattan District and also Dr. Teller's letter, neither of which contains information classifiable under the Atomic Energy Act, removed from the "Secret" category. I would, therefore, appreciate it if you were to review the earlier decision of the A.E.C. concerning this material. If you come to the conclusion that it is not within the power of your office to declassify this material, please return these documents to Miss Hoylande Young for safekeeping so that I may be able to take proper steps for their

declassification through an agency, other than the Atomic Energy Commission.

I might add for your information that, in view of the appearance of Dr. Compton's book (which is factually not entirely correct in its references to the two petitions that I have written in 1945), I might publish an article, including the text of these petitions, in the near future. The names of the signatories to these petitions might also be made public on this occasion in those cases where permission can be obtained from the individuals concerned.

Thanking you for your help in this matter in advance, I am

Sincerely yours,

Leo Szilard

m

cc: Dr. Warren C. Johnson
Miss Hoylande Young

file A.E.C.

October 25, 1956

Mr. C. L. Marshall, Director
Division of Classification
United States Atomic Energy Commission
Washington 25, D. C.

Re: Your letter, October 23rd, 1955 - C:CLM

Dear Mr. Marshall:

Many thanks for your very kind letter of October 23rd. I once more wish to express my appreciation of your help in this matter.

Looking through the documents attached, I find that items 1 and 2 listed in your covering letter are missing. They must have been left behind in your office, and if they should turn up later on, I would appreciate receiving them.

Sincerely yours,

Leo Szilard

m

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

IN REPLY REFER TO:

C:CLM

November 2, 1956

Dr. Leo Szilard
The Quadrangle Club
The University of Chicago
Chicago 37, Illinois

Dear Dr. Szilard:

Reference is made to your letter dated October 25, 1956 concerning items 1 and 2 listed in our letter to you of October 23, 1956.

I am very sorry that these two items were listed inasmuch as they have not been declassified and were returned to Dr. Warren C. Johnson for retention in the Argonne National Laboratory classified files.

I am attaching herewith document MUC-LS-38, letter dated August 18, 1944 from you to Dr. V. Bush, which has been declassified.

Sincerely yours,

C. L. Marshall, Director
Division of Classification

Enclosure:
Ltr MUC-LS-38

cc: Dr. W. C. Johnson
Dr. H. D. Young

REGISTERED MAIL: RETURN RECEIPT REQUESTED

January 24, 1957

Mr. C. L. Marshall, Director
Division of Classification
United States Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Marshall:

I have so far not received acknowledgment from your office of the receipt of the letter which I sent you on October 25, 1956, and of which you will find attached a copy.

I should greatly appreciate your office acknowledging the receipt of this letter.

I should also greatly appreciate a response on the part of your office to the substance of the letter.

Sincerely yours,

Leo Szilard

m
Encl.

cc: ~~Dr. Warren C. Johnson~~
Miss Hoylande Young

REGISTERED NO. 106258
Value $ n.v. Spec. del'y fee $
Fee $ 40 Ret. receipt fee $ 7
Surcharge $ Rest. del'y fee $
Postage $ 15 ☐ Airmail
POSTMARK CHICAGO, ILL. JAN 25 '57 No. 106
Postmaster, By
From L. Szilard
Enrico Fermi Inst. Nuclear Studies
Univ of Chic - Chic 37 Ills
To Mr. C. L. Marshall Dir
Div of Classification
U.S. Atomic Energy Comm
Wash. 25 D. C.
POD Form 3806
May 1954

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

IN REPLY REFER TO:

C:CLM

February 1, 1957

Dr. Leo Szilard
The University of Chicago
The Enrico Fermi Institute
for Nuclear Studies
Chicago 37, Illinois

Dear Dr. Szilard:

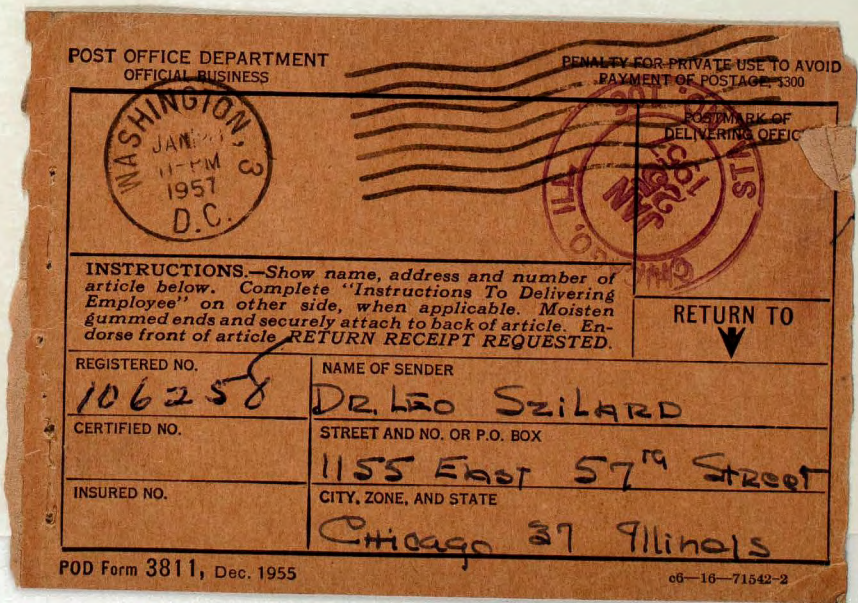
I regret that you did not receive an acknowledgement of the receipt of your letter of October 25, 1956. I had discussed your letter with Dr. Warren C. Johnson at the time it was received by us and Dr. Johnson said that he would discuss the matter with you upon his return to Chicago. Apparently, in the press of other business, he was unable to do so.

I have called Dr. Johnson concerning your letter of January 24, 1957 and he has again assured me that he will discuss this matter with you in the very near future.

Best regards.

C. L. Marshall, Director
Division of Classification

cc: Dr. W. C. Johnson



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

IN REPLY REFER TO:

C:CLM

February 13, 1957

Dr. Leo Szilard
The University of Chicago
The Enrico Fermi Institute
for Nuclear Studies
Chicago 37, Illinois

Dear Dr. Szilard:

Since writing to you on February 1, 1957, I have learned that Dr. Johnson did speak to you concerning the request you made in your letter of October 25, 1956. It is my understanding that you now know that the situation which was described in the letter to you from Dr. Beckerley during the time when General Nichols was still the General Manager still holds true.

This matter, as all other matters involving classification, is under continuous review and as soon as any change takes place, I will be very happy to inform you.

Best personal regards,

C. L. Marshall, Director
Division of Classification

cc: Dr. W. C. Johnson
H. F. Carroll, ORE.

February 15, 1957

Mr. C. L. Marshall, Director
Division of Classification
United States Atomic Energy Commission
Washington 25, D. C.

Reference: C:CLM

Dear Mr. Marshall:

Many thanks for your letter of February 13th which I received today.

Dr. Johnson did mention to me some time ago that you had talked to him over the telephone about this matter, but at that time I did not understand from him that the matter is out of your hands. Yesterday, however, when I happened to speak to him, he explained to me this point, and said that he planned to take up the matter with the General Manager of the Commission on his next visit to Washington.

Accordingly, I am not going to trouble you any more with this matter except as follows:

I am further mystified about your reference to a letter which Dr. Beckerley wrote me in this matter. I have received no communication from Dr. Beckerley whatsoever and would, therefore, greatly appreciate it if you could send me a copy of Dr. Beckerley's letter.

With best personal regards,

Sincerely yours,

Leo Szilard

m
cc: Dr. W. C. Johnson

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

IN REPLY REFER TO:

C:CLM

February 20, 1957

Dr. Leo Szilard
The University of Chicago
The Enrico Fermi Institute
for Nuclear Studies
Chicago 37, Illinois

Dear Dr. Szilard:

Apparently there was a misunderstanding on my part. I thought Dr. Beckerley had written to you concerning this matter. A close check of our records indicate that he did not. However, I think that by now you know that the document which is the subject of all of this correspondence is presently held as classified and that we will certainly advise you of any change in its classification status as soon as it occurs.

Please accept my thanks for your patience in this matter. I have enjoyed this opportunity to exchange letters with you and I hope that I shall see you again very soon.

Best regards.

C. L. Marshall, Director
Division of Classification

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

CPD: lo

March 13, 1957

Mr. Leo Szilard
The Quadrangle Club
The University of Chicago
Chicago 37, Illinois

Subject: PATENT NO. 2,778,792

Dear Mr. Szilard:

This office takes pleasure in forwarding a copy of the above-identified patent which, as you will note, issued on January 22, 1957 based on application Serial No. 663,452.

Your courtesy and assistance to the members of the staff of the Patent Branch in connection with the prosecution of this application are appreciated.

Very truly yours,

Edgar Verlich Acting

George H. Lee, Acting Chief

~~Foster York, Chief,~~
Chicago Patent Group

Enc.(1)

A.E.C.

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS June 12, 1957

Dr. Leo Szilard
c/o Mr. A. N. Spanel
International Latex Co.
350 Fifth Avenue
New York, N.Y.

Subject: CASE S-1578 - SER.NO.664,732

Dear Dr. Szilard:

We send herewith for your execution an Affidavit that is to be used in the patent application for antedating a patent cited against the patent application.

The Affidavit establishes through the attached exhibit that the inventive subject matter claimed in the application was invented by you and the other applicant prior to December 19, 1944. The Affidavit of Mr. Edwin A. Smith is intended to prove reduction to practice of the invention by operation of the Hanford reactors prior to December 19, 1944. The patent relied on by the Patent Office does not disclose the exact invention but the Patent Office holds that the invention is not inventive thereover.

Please sign the Affidavit, have it notarized, and return it to us at your earliest convenience. We ask you to give this matter your prompt attention because the Affidavit must be filed in the Patent Office in the near future.

Very truly yours,

George H. Lee

George H. Lee, Chief
Chicago Patent Group

Enc.

June 21, 1957

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
P.O. Box 59
Lemont, Illinois

Subject: CASE S-1578 -Ser.No.664,732

Dear Mr. Lee:

In response to your letter, I am sending you enclosed affidavit which I have executived.

Please note that my correct address is:

The Research Institutes
The University of Chicago
Chicago 37, Illinois

rather than the address which you used in your letter.

Very truly yours,

Leo Szilard

m
Encl.

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

A. E. C.

JUL 23 1957

Dr. Leo Szilard
University of Chicago
The Enrico Fermi Institute for
Nuclear Studies
Chicago 37, Illinois

Dear Dr. Szilard:

As you requested, we have had under consideration the declassification of the petition to the President of the United States, which you prepared at the Metallurgical Laboratory in Chicago in July of 1945. I am happy to be able to report to you that this petition has been declassified.

Please accept my thanks for your understanding and cooperation during the past several months. I have enjoyed meeting with you, and I hope that I may look forward to seeing you again in the not too distant future.

Sincerely yours,

C. L. Marshall, Director
Division of Classification

Encl.
~~16~~ 29 Pages of Petition dated 7/15/45

Copy furnished:--(letter only)
Mrs. Alice Kimball Smith, Bulletin of the Atomic Scientists

August 5, 1957

Dr. C. L. Marshall, Director
Division of Classification
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Dr. Marshall:

Many thanks for your very kind letter of July 23rd. I greatly appreciate the successful efforts which you made in connection with the declassification of the petitions, and I wish to thank you for your help in this matter.

At the time when these petitions were sent to your office for declassification, there were two other documents, which carried the secret stamp, sent along for declassification also. One was a personal letter from Dr. Edward Teller to me, and the other was a letter from the Manhattan District, asking me to reclassify one of the petitions "secret." I wonder whether you are in a position to declassify this material also and have it returned to me. The letter which I wrote you on October 25th, 1956 makes reference to these documents, and I assume therefore that they have been located in your files in the meantime.

Sincerely yours,

Leo Szilard

m

SECRET

A.E.C.

UNIVERSITY OF CALIFORNIA

RADIATION LABORATORY
BERKELEY 4, CALIFORNIA

October 15, 1957

C. L. Marshall, Director
Division of Classification
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Charlie:

I do not object in the slightest to declassification of my letter of July 2, 1945 to Leo Szilard, and I hope the letter will be declassified.

I also wonder whether in doing so a misprint can be corrected. In the last line of my letter the word "battle" should be replaced by "bottle".

As you requested, the copy of the letter is returned herewith.

Sincerely yours,

Edward Teller

ET:gg

cc: Leo Szilard

Enc.: Cy 1CLM of ltr dated 7/2/45

P.S. After declassification, I would appreciate receiving a copy of the letter if that is convenient.

SECRET

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

IN REPLY REFER TO:
C:CLM

October 30, 1957

Dr. Leo Szilard
University of Chicago
The Enrico Fermi Institute
for Nuclear Studies
Chicago 37, Illinois

Dear Dr. Szilard:

In your letter of August 5, 1957 you requested the declassification of two documents which you identified as a letter from Dr. Teller and a letter from the Manhattan District, asking to reclassify the petition.

We have reviewed the Teller letter and have determined that it need no longer bear any classification. The letter has been declassified and is attached for your files.

The letter from Captain Murray, Manhattan District, is still under study. We will advise you as soon as a final determination has been made.

Sincerely yours,

C. L. Marshall, Director
Division of Classification

Enclosure:
1. Ltr dtd 7/2/45 frm
Dr. Teller to Dr. Szilard

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

April 15, 1958

CPD: lo

Dr. Leo Szilard
c/o Mr. A. N. Spanel
International Latex Company
350 Fifth Avenue
New York, N. Y.

Subject: PATENT NO. 2,796,396

Dear Dr. Szilard:

This office takes pleasure in forwarding a copy of the above-identified patent which, as you will note, issued on June 18, 1957 based on application Serial No. 662,512.

Your courtesy and assistance to the members of the staff of the Patent Branch in connection with the prosecution of this application are appreciated.

Very truly yours,

George H. Lee
Foster York, Chief,
Chicago Patent Group

Enc.(1)

United States Patent Office 2,796,396
Patented June 18, 1957

2,796,396

METHOD OF INTERMITTENTLY OPERATING A NEUTRONIC REACTOR

Leo Szilard, Chicago, Ill., assignor to the United States of America as represented by the United States Atomic Energy Commission

Application April 16, 1946, Serial No. 662,512

2 Claims. (Cl. 204—154)

This invention relates to neutronic reactors and more particularly to a method and apparatus for removing heat from a neutronic reactor in a form to convert a fluid into a vapor to produce power in a useful form.

In neutronic reactors, a neutron fissionable isotope such as U^{233}, U^{235}, or 94^{239} or mixtures thereof is subjected to fission by absorption of neutrons and a self-sustaining chain reaction is established by the neutrons evolved by the fission. In general, such reactors comprise bodies of compositions containing such fissionable material, for example, natural uranium, disposed in a neutron slowing material which slows the neutrons to thermal energies. Such a slowing material is termed a neutron moderator. Carbon, beryllium, and D_2O (heavy water) are typical moderators suitable for such use. Heat is evolved during the reaction which is removed by passage of a coolant through the reactor in heat exchange relationship therewith. Specific details of the theory and essential characteristics of such reactors are set forth in U. S. Patent No. 2,708,656 of Enrico Fermi and Leo Szilard, dated May 17, 1955.

In a fluid cooled reactor only certain coolants in certain amounts can be present at any one time because the neutron absorption of the coolant cannot exceed a predetermined maximum or the chain reaction will not take place. For this reason heat abstraction is limited. However, if the reactor is operated without coolant therein to store heat in the reactor, a coolant of high capture cross section can be passed through the reactor to remove the stored heat. While this is being done, the reaction will cease. If the coolant is then drained from the reactor the reaction can again start. By thus intermittently operating the device, any desired coolant can be used to remove the heat. The present invention is directed toward using a coolant of high neutron cross section passed through the reactor while inoperative to remove heat generated by a previous operation of a self sustaining chain reaction in the device.

Therefore, a principal object of this invention is to utilize in a novel manner reactors similar to those disclosed in the above-mentioned Fermi and Szilard patent by intermittently operating such a reactor and flowing a fluid coolant of high neutron absorption therethrough in heat absorbing relationship, and then passing the coolant in heat exchange relationship with another fluid to vaporize the second fluid to produce power or heat energy in a useful form.

Another object of the invention is to control a neutronic reactor in a novel manner by intermittently flowing a coolant fluid having a high capture cross-section through the reactor in a predetermined cycle.

In the invention herein contemplated to accomplish the above objects, a reactor is used with tubes having large coolant capacity. Preferably, mercury is circulated through the reactor until the uranium temperatures fall to 400° C. The hot mercury is passed to a heat exchanger or steam boiler through which the hot mercury passes slower than through the reactor. The boiler thus

operates continuously during intermittent action of the reactor. Steam is produced at a desired temperature-pressure ratio consistent with the mercury heat loss.

Control of the mercury is either by a timer or by a thermostat in the mercury outlet from the reactor. The neutronic reaction starts as the mercury coolant is drained from the reactor. When the uranium rods or other fissionable material within the reactor reach a desired temperature, such as 600° C., a pump starts flooding the reactor with mercury, stopping the neutronic reaction. For further safety, the control rod can be timed for the shut-down operation.

It is thus possible to operate a neutronic reactor on a 50–50 time schedule so that one-half the power of the pile should be available in the form of steam from a heat exchanger in combination therewith, at a usable temperature and pressure. By adjusting the hot mercury flow in the boiler to give hot mercury storage, it is possible to have the steam boiler operate continuously.

Other objects and advantages of the present invention will be more readily understood by reference to the following specification and attached drawing wherein the single figure in the drawing is a schematic view illustrating a neutronic reactor in combination with a heat exchange device wherein the neutronic reactor and heat exchange device are actuated in a predetermined cycle for the heat transfer embodying the teachings of the present invention.

A neutronic reactor **10**, preferably of the type in which a coolant is passed therethrough, such as those that are disclosed and claimed in the above-mentioned patent of Enrico Fermi and Leo Szilard, may be used in carrying out the objects of this invention with the exception, however, that it is preferred to modify the usual coolant passages to provide enlarged coolant passages **11** about sheathed uranium rods **12** so that an annular passage approximately .635 cm. across will separate the sheathed uranium rods **12** from the interiors of the tubes forming passages **11**. It is preferred to use a graphite moderator although other forms of moderator may be used, such as deuterium oxide or beryllium oxide, depending upon the type of reactor used and the conditions under which it is desired to operate the reactor. The neutronic reaction is controlled by a suitable control rod **14**. For the particular structure of the control rod as well as the construction of the safety rods for use with a neutronic reactor of this type, reference is made to the above-mentioned Fermi and Szilard patent.

The neutronic reactor **10** includes a mercury distributing inlet header **15** and a mercury outlet header **16**. The mercury inlet header **15** is connected to a cool mercury storage sump **17** through piping **18** connected to a suitable pump **19** which in turn is connected to the mercury distributing inlet headed **15** through piping **20**.

The mercury pump **19** is preferably actuated by an electric motor **21** controlled through a timer mechanism **22** operating from a suitable source of electric power **23**. Any type of timing mechanism **22** may be used as is well known in the art, and no particular mechanism will be described since this is not necessary for the understanding of this invention. However, the timing mechanism **22** must be such that it may control the motor **21** for the mercury pump **19** in a predetermined cycle or cycles in synchronism with a motor **24** actuating the control rod **14** through suitable control rod mechanism **25**. The motors **21** and **24** are connected to the timer through suitable wiring **26** and **27**, respectively. Hence, the operation cycle of the reactor **10** broadly includes the steps of permitting the reaction to come to a desired power level and operating thereat until the temperature reaches a predetermined level, as 600° C., stopping the neutronic reaction by substantially simultaneously driv-

ing the control rod **14** into the reactor **19** and pumping mercury from the sump **17** into the inlet header **15** and into the reactor **10**, absorbing in the mercury the heat of the neutronic reaction until the temperature of the reactor drops to a predetermined level, as 400° C., then discharging the mercury from the neutronic reactor **10** and withdrawing the rod **14** to permit the reaction to again come to operating level.

The heated mercury flows into a heat exchange device in the form of a mercury boiler **28**, where the heat is removed, and the cooled mercury is returned to the sump **17**.

The mercury boiler **28** preferably comprises a mercury header **29** connected through piping **30** to the mercury outlet header **16** of the neutronic reactor **10**. The mercury inlet header **29** is connected to a mercury outlet header **31** through tubing **32**. A water inlet header **33** and a steam header **34** are separated from each other by the above-described construction, the water inlet header **33** and the steam header **34** being connected together by tubing **35** extending through the tubing **32** and through the mercury headers **29** and **31**, respectively. It is thus obvious that, if water or other vaporizable fluid is discharged through suitable piping **36** into the inlet header **33**, the water is vaporized into steam as it passes through the tubing **35** in heat conducting relationship with respect to the mercury in the tubing **32**, emerging as substantially saturated steam or super-heated steam depending upon the inlet and outlet temperatures of the mercury. The steam collected in the steam header **34** is then discharged through the steam manifold piping **37**, whereupon the steam may be discharged for use in a battery of turbines, reciprocating steam engines or for heating, and/or other uses for steam, as is well understood in the art.

Although a mercury boiler of the type as disclosed may be used, it is within the scope of this invention that other forms of mercury boilers and/or heat exchange devices may be used, as is well understood in the art.

The mercury after passing through the mercury boiler **28** is returned to the cool mercury storage sump **17** through suitable piping **38** whereupon the cycle for the pumping of the mercury may be repeated.

Preferably, the ratio of the capacity of the reactor coolant tubes to the capacity of the mercury boiler tubes is such that continuous generation of steam, or the like, results from the described intermittent operation of the reactor **10**. If desired, a storage tank may be provided between the reactor **10** and the mercury boiler **28** for the heated mercury to facilitate continuous steam generation.

The amount of mercury utilized and the temperature range within which the mercury boiler **28** and the neutronic reactor **10** operate is predetermined by the amount of power developed within the reactor and the period of time within which it is desired to control the reactor after the reactor has come up to the predetermined operating temperature. As an example, however, of the conditions of operation, the reactor may be operated to have a maximum temperature of 600° C. within the rods. While passing the mercury in heat conducting relationship with respect to the rods until the temperature within the rods falls to 400° C. With the mercury system, as herein described, it is obvious that mercury may be vaporized in the reactor, if necessary, at temperatures much higher than those set forth above or the mercury may be kept in a liquid state. With a vaporization temperature of the mercury within the neutronic reactor of about 800° F., the pressure of the mercury within the reactor would be 45 pounds per square inch absolute; and, if it is desired to operate at a still higher temperature, for example, of 1000° F., the pressure of the mercury at this vaporization temperature would be 180 pounds per square inch absolute. When mercury is used as a coolant for the reactor within this temperature range, it is quite obvious that as the mercury is discharged into the mercury boiler, the water supplied to and within the mercury boiler and/or heat exchange device is vaporized into steam at fairly high pressures for the operation of steam turbines, and the like.

Although the neutronic reactor has been described as using the control rod as part of the means for stopping the reaction as well as for the control of the reactor, it is also within the scope of this invention that the reaction within the reactor be stopped by the sole use of the mercury and/or fluid which is used as a coolant. This may be accomplished by pumping the mercury into the reactor to stop the reaction in a predetermined cycle, letting the mercury remain within the reactor to absorb the heat of the neutronic reaction, and then discharging the mercury from the reactor whereupon the neutronic reaction will start.

In a neutronic reactor of the type preferred, it is particularly desirable to use a coolant tube construction for the mercury to provide the annular passage surrounding the uranium rods formed from a suitable metal, such as is used and is well known in the construction of mercury boilers, and in addition, the tubes for the mercury should also have the further characteristic of having a low capture cross-action for thermal neutrons as is well understood in the art and explained in the above-mentioned co-pending application. Furthermore, it is desirable to use a metal for the tubes which is not wet by the mercury and with which the metal of the tube does not amalgam.

Although this invention is disclosed primarily as a source of power of large power outputs of from 100,000 to 500,000 kilowatts, when the system is operated for an extended period of time there is a high production output of element 94^{239}. Therefore, it is within the scope of the invention that the mercury distributing headers, particularly the inlet header shall be constructed in such a manner as to permit the insertion and removal of the uranium rods **12** into and from the moderator of the reactor and at the same time to provide a suitable support for these rods within the reactor.

With a neutronic reactor of the type shown, which may have substantially 2,000 coolant passages in which are placed the uranium rods having a radius of substantially 1.7 centimeters and a thickness of aluminum sheath 0.5 millimeter and a length of 7 meters, it is necessary with a .635 cm. annulus of mercury surrounding each rod to supply substantially 56 tons of mercury to fill the reactor. The passages in the moderator through which the mercury flows have an inside radius of 2.385 cm. Thus, these passages are small enough that, when they are free of liquid mercury, the reactor reactivity may be made substantially greater than unity, and these passages are large enough that, when they are filled with liquid mercury, the reactor reactivity is less than unity. However, it is within the scope of this invention to operate with a lesser amount of mercury and to vaporize the mercury, if necessary, to abstract the heat of the neutronic reaction. The other dimensions of the reactor with regard to the amount of graphite in the moderator and the amount of active uranium in the reactor may follow the dimensions as disclosed in the above-mentioned co-pending application, the critical and operating sizes for the reactor being calculated in accordance with the disclosure in the above-mentioned co-pending application. It is necessary that the reproduction ratio within the reactor shall be such that the exponential rise in density when the control rods are removed from the reactor shall not take place so rapidly that this rise cannot be readily controlled by the control rods. However, if the reactor should get out of control, the mercury can be pumped into the reactor, thus stopping the reaction.

Within the scope of the present invention is the use of a plurality of neutronic reactors **10** connected to the mercury boiler **28** and so operated intermittently that the

flow of the coolant through each of the reactors is such as to produce a continuous output of steam from the boiler.

Although this invention has been disclosed utilizing mercury as the preferred coolant, it is within the scope of the invention to use other coolants such as bismuth, and like fluids having high specific heats and which do not vaporize except under conditions wherein the fluids are used at high temperatures. It is preferred to operate the reactor with the coolant as a liquid, and for low temperatures water can be used. However, it is within the scope of this invention that, if desirable, the coolant within the reactor may be vaporized before being discharged into the heat exchange device provided the reaction is shut down during the cooling portion of the cycle.

While this invention has been described as applied to a neutronic reactor structure in which the active portion is cooled by circulating a liquid coolant in heat exchange relationship therewith, it is to be understood that in certain neutronic reactor structures the moderator only may be cooled and also that there may be direct cooling of the uranium alone or of both the uranium and the moderator. Also, it is not desired to limit this invention to a chain reacting system wherein only the active portion of the reactor is directly cooled but it is desired to apply the invention as described and claimed herein to any chain reaction system whether or not otherwise cooled.

It is also to be understood that this invention is equally applicable to other types of reactors including those having liquid moderators, such as deuterium oxide or other reactors constructed in accordance with the general principles described in the above-mentioned copending application, for example, uranium containing greater than usual concentrations of U^{235} may be used. Alternately, the invention may be applied to other fissionable compositions such as U^{233}, 94^{239}, etc., or to combinations of these fissionable isotopes with U^{238} or Th^{232} or similar isotope which yields a fissionable isotope by neutron absorption.

While the theory of the nuclear chain fission mechanism in uranium set forth herein is based on the best presently known experimental evidence, it is not desired to be bound thereby, as additional experimental data later discovered may modify the theory disclosed.

What is claimed is:

1. A method of intermittently operating a neutronic reactor having a plurality of spaced uranium fuel rods, a graphite moderator, passages between the rods and the moderator adapted to the flow of mercury therethrough, the passages being small enough that when free of liquid mercury the reactor reactivity may be made substantially greater than unity and large enough that when the passages are filled with liquid mercury the reactor reactivity is less than unity, said method comprising the steps of instituting a nuclear chain reaction within the reactor, permitting a period of time to elapse until the fuel rods and moderator are heated to substantially above the ambient temperature, then circulating mercury through the passages of the hot reactor thereby heating the mercury and stopping the nuclear chain reaction, then draining the mercury from the reactor whereby the nuclear chain reaction is reinstituted, removing heat from the mercury, and then recirculating the mercury through the said passages to again stop the reaction and transfer heat from the reactor to the mercury.

2. The method of claim 1 for intermittently operating a neutronic reactor having uranium fuel rods of 1.7 cm. radius wherein the passages are annular, coaxial with the fuel rods, and 2.385 cm. inside radius.

References Cited in the file of this patent

UNITED STATES PATENTS

2,708,656	Fermi et al.	May 17, 1955

FOREIGN PATENTS

114,150	Australia	May 2, 1940
114,151	Australia	May 3, 1940
233,011	Switzerland	Oct. 2, 1944
861,390	France	Oct. 28, 1940

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Atomic Energy, A Survey, edited by J. Rotblat, published for Atomic Scientists Associated by Taylor and Francis, Ltd., London, 1954. Pages 26, 27.

U. S. Atomic Energy Commission MDDC 893. Factors involved in the production of Atomic Power. Farrington Daniels, April 1, 1947, pages 10, 11.

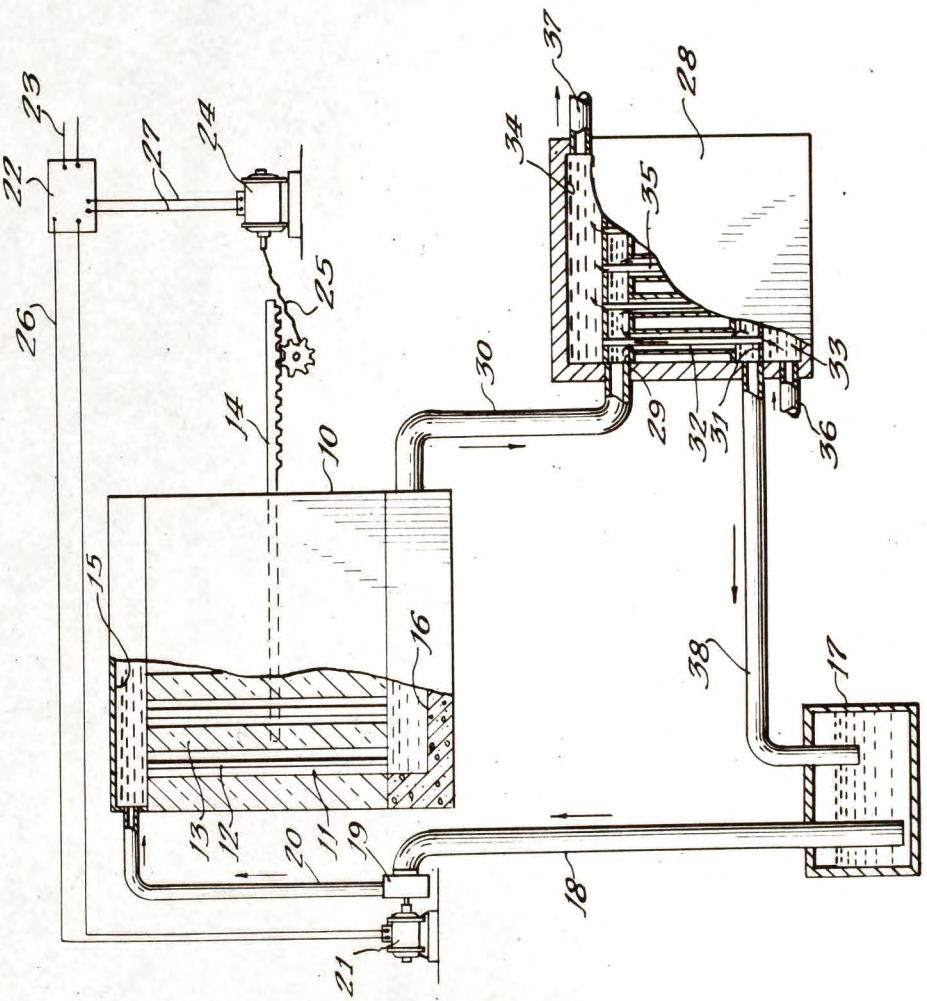
A Forum Report, Nuclear Reactor Development, from a meeting held under the auspices of "Atomic Industrial Forum, Inc." (edited by Townsend et al.). Pages 16–20. (Meeting held May 24, 1954.)

De Ment et al.: Uranium and Atomic Power, pages 20 and 21 (1941), Chemical Publishing Co., Inc., Brooklyn, N. Y.

June 18, 1957 L. SZILARD 2,796,396

METHOD OF INTERMITTENTLY OPERATING A NEUTRONIC REACTOR

Filed April 16, 1946



Witnesses:
Henry H. Johnson
Estill E. Ezell

Inventor:
Leo Szilard
By: Robert A. Sarnoff
Attorney

A.E.C. (Mrs H)

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

April 15, 1958

CPD: lo

Dr. Leo Szilard
c/o Mr. A. N. Spanel
International Latex Company
350 Fifth Avenue
New York, N. Y.

Subject: PATENT NO. 2,796,396

Dear Dr. Szilard:

This office takes pleasure in forwarding a copy of the above-identified patent which, as you will note, issued on June 18, 1957 based on application Serial No. 662,512.

Your courtesy and assistance to the members of the staff of the Patent Branch in connection with the prosecution of this application are appreciated.

Very truly yours,

George H. Lee

George H. Lee
~~Foster~~ York, Chief,
Chicago Patent Group

Enc.(1)

Pen note

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

December 12, 1958

Dr. Leo Szilard
Quadrangle Club
1155 East 57th Street
Chicago, Illinois

Subject: ASSIGNMENTS IN BRITISH APPLICATIONS BASED ON S-501X, S-506 AND S-2321

Dear Dr. Szilard:

We send herewith patent forms for certain United Kingdom patent applications covering inventions made by you and the late Dr. Fermi. In each instance a corresponding U. S. patent application was executed by you and Dr. Fermi.

Each of Patents Forms No. 18 we ask you to sign on the reverse side at the place tabbed. You will note that Mrs. Fermi has already signed each of these forms.

Each of the Acknowledgments we ask you to sign and date at the place tabbed. Mrs. Fermi has already signed separate Acknowledgments for the same United Kingdom patent applications.

Please sign the forms as indicated and return them to us.

Very truly yours,

George H. Lee

George H. Lee, Chief
Chicago Patent Group

Enclosures:
1. Acknowledgments (3)
2. Patents Form No. 18 (3)

signed documents sent Feb 19/59

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

Per file

February 16, 1959

Dr. Leo Szilard
6101 East 11th Avenue
Denver 20, Colorado

Subject: ASSIGNMENTS IN BRITISH APPLICATIONS BASED ON S-501X, S-506 aND S-2321

Dear Dr. Szilard:

Patent forms for the above British patent applications and our covering letter of December 12, 1958 were sent to you at the Quadrangle Club. Your secretary, Mrs. Norene Mann, has informed us that she promptly forwarded the letter and forms to you, at the present address.

The British patent applications cover inventions made by you and the late Dr. Fermi. Corresponding U. S. patent applications were executed by you and Dr. Fermi.

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Please sign the forms as indicated and return them to us.

Very truly yours,

George H. Lee, Chief
Chicago Patent Group

Returned and sent Feb 24/59

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

February 16, 1959

Dr. Leo Szilard
6101 East 11th Avenue
Denver 20, Colorado

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George H. Lee, Chief
Chicago Patent Group

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

December 12, 1958

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

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Please sign the forms as indicated and return them to us.

Very truly yours,

George H. Lee, Chief
Chicago Patent Group

Enclosures:
1. Acknowledgments (3)
2. Patents Form No. 18 (3)

V-89

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

April 8, 1959

Dr. Leo Szilard
Quadrangle Club
1155 East 57th Street
Chicago, Illinois

Subject: U. S. PATENT NO. 2,836,554, ISSUED: MAY 27, 1958; AEC CASE NO. S-506

Dear Dr. Szilard:

I am pleased to enclose for your files a corrected copy of the above patent.

I want to thank you for the courtesy and assistance which you extended to members of my staff in connection with the preparation and prosecution of the patent application.

Very truly yours,

George H. Lee

George H. Lee, Chief
Chicago Patent Group

Enclosure:
Patent No. 2,836,554

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

July 15, 1959

Dr. Leo Szilard
University of Chicago
Chicago 37, Illinois

Dear Dr. Szilard:

As you may know, the Atomic Energy Commission last year established in its Washington headquarters a small staff of professional historians and assigned them the responsibility of preparing an official history of the Commission. During the past year intensive research in the records of the AEC and other agencies has produced most of the specific information needed for Volume I, which will include the wartime backgrounds and the establishment of the Atomic Energy Commission in 1946.

In our study of the records of the Manhattan District and in our interviews with General Groves and Drs. Conant, Compton, Urey, and Allison, we have become very much interested in your part in the development of the production reactors. It would be of great help to us if we could discuss with you some of the events in which you were involved in order to assure ourselves that we fully understand your position.

I wonder if it would be possible for Dr. O. E. Anderson, the Assistand Historian, and me to see you for an hour or so sometime this summer. We will probably be free to come to Chicago any time except the first week in August. If it would be more convenient for you to see us sometime when you are in Washington, we would be glad to arrange a meeting here.

Sincerely yours,

Richard G. Hewlett

Richard G. Hewlett
AEC Historian

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
P. O. Box 59
LEMONT, ILLINOIS

July 22, 1959

Dr. Leo Szilard
Quadrangle Club
1155 East 57th Street
Chicago 37, Illinois

Subject: U. S. PATENT NO. 2,807,581, ISSUED: SEPTEMBER 24, 1957; AEC CASE NO. S-3004

Dear Dr. Szilard:

I am pleased to enclose for your files a corrected copy of the above patent.

I want to thank you for the courtesy and assistance which you extended to members of my staff in connection with the preparation and prosecution of the patent application.

Very truly yours,

George H. Lee

George H. Lee, Chief
Chicago Patent Group

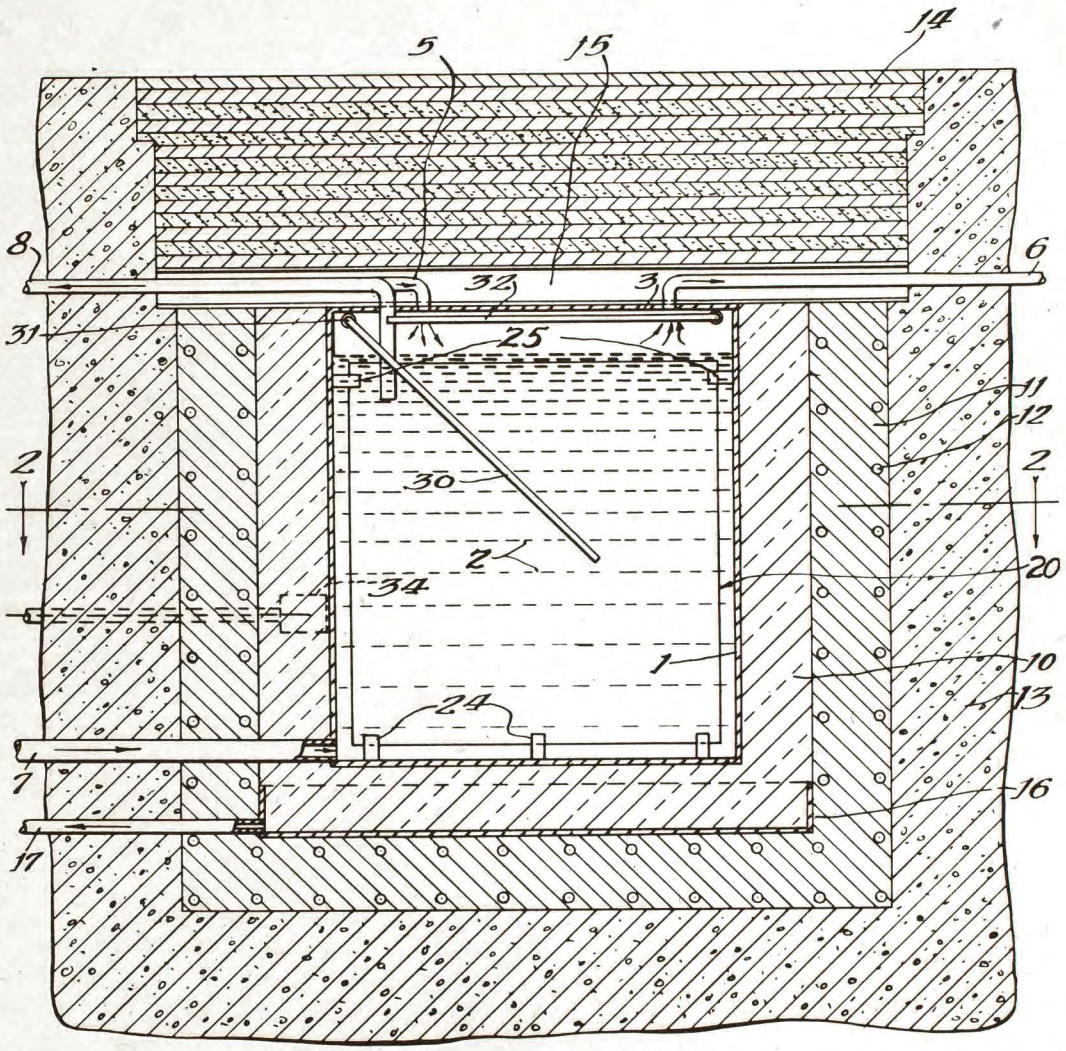
Enclosure:
Patent No. 2,807,581

Sept. 24, 1957 E. FERMI ET AL 2,807,581

NEUTRONIC REACTOR

Filed Oct. 11, 1945 6 Sheets-Sheet 1

FIG. 1.



Witnesses:
Herbert E. Metcalf
Henry E. Stanton

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By: Robert A. Saunders
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Sept. 24, 1957 E. FERMI ET AL 2,807,581

NEUTRONIC REACTOR

Filed Oct. 11, 1945 6 Sheets-Sheet 2

FIG. 2.

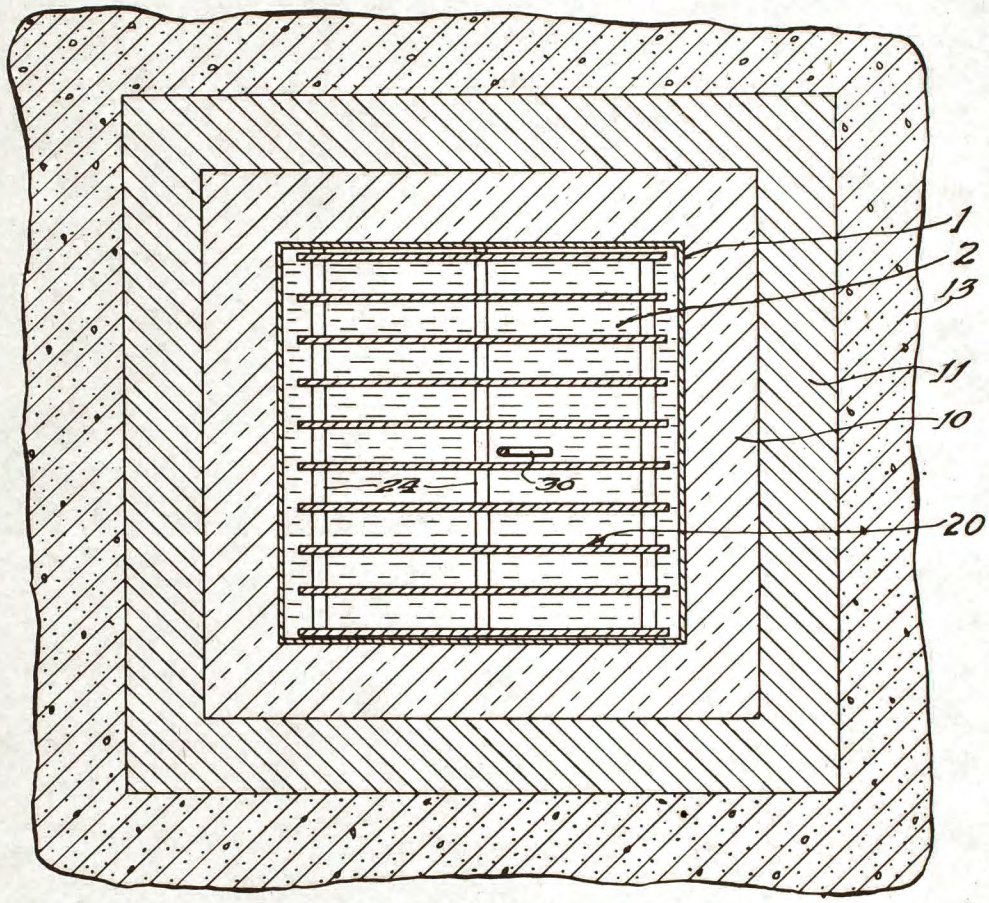

FIG. 3.

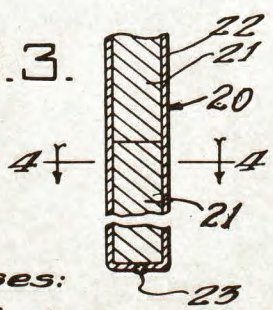

FIG. 4.

Witnesses:
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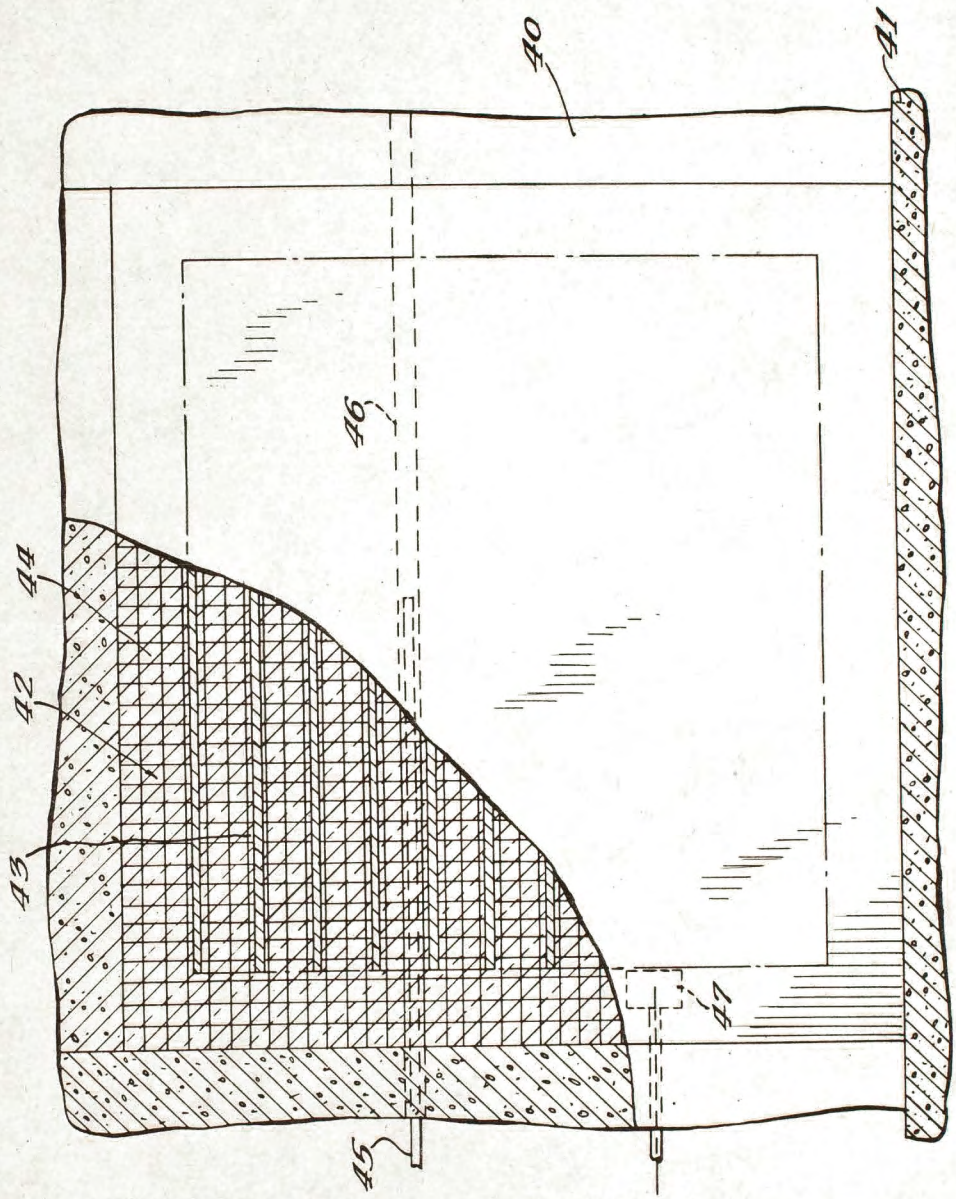
Leo Szilard
By:
Robert A. Saunders
Attorney

Sept. 24, 1957 E. FERMI ET AL 2,807,581

NEUTRONIC REACTOR

Filed Oct. 11, 1945 6 Sheets-Sheet 3

FIG. 5.



Witnesses:
Herbert E. Metcalf
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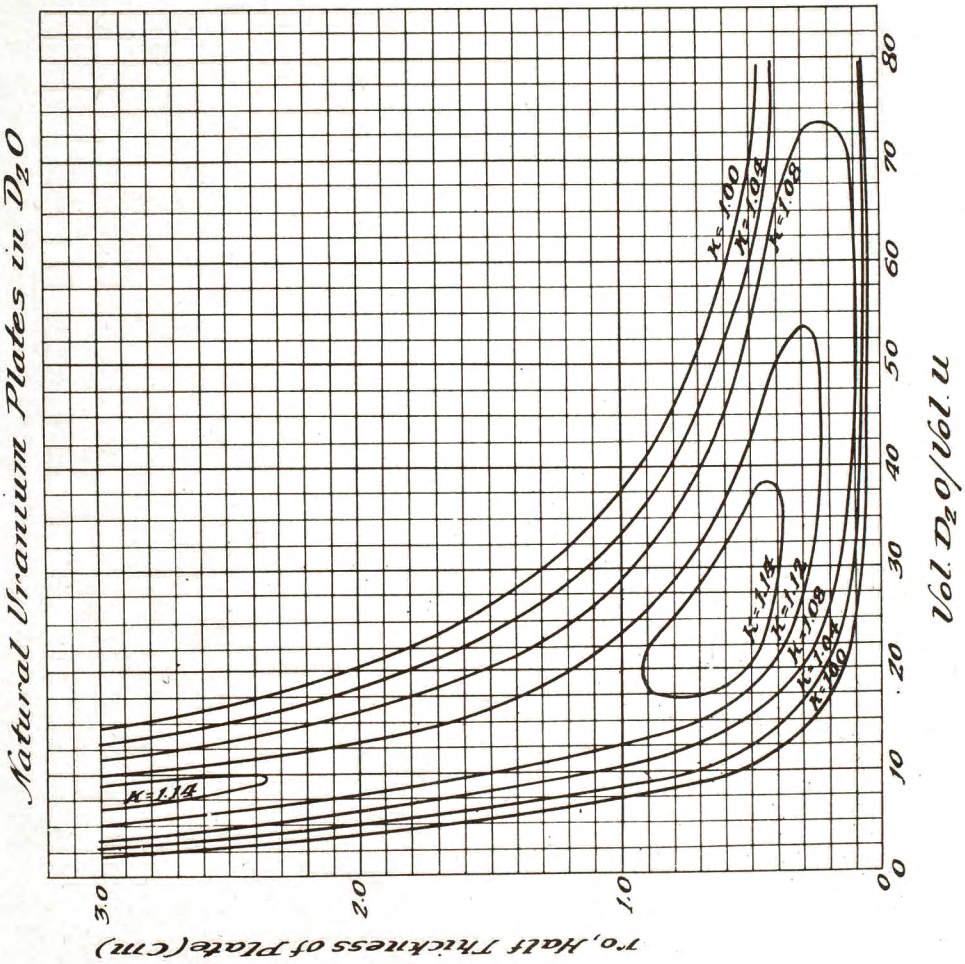
Sept. 24, 1957 E. FERMI ET AL 2,807,581

NEUTRONIC REACTOR

Filed Oct. 11, 1945 6 Sheets-Sheet 4

FIG. 6.



Witnesses:
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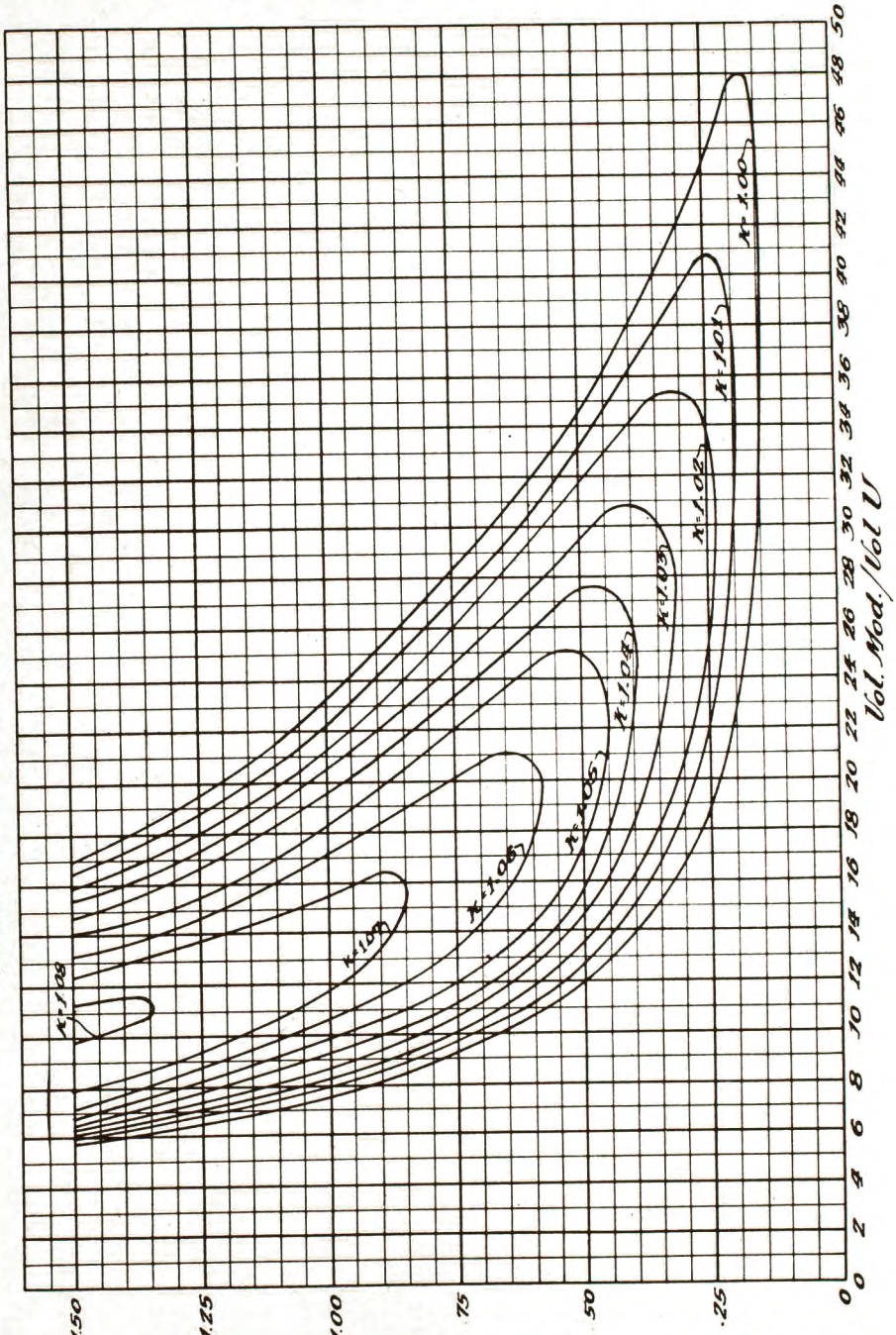
Sept. 24, 1957 E. FERMI ET AL 2,807,581

NEUTRONIC REACTOR

Filed Oct. 11, 1945 6 Sheets-Sheet 5

FIG. 7.



Witnesses:
Herbert E. Metcalf
Henry E. Stanton

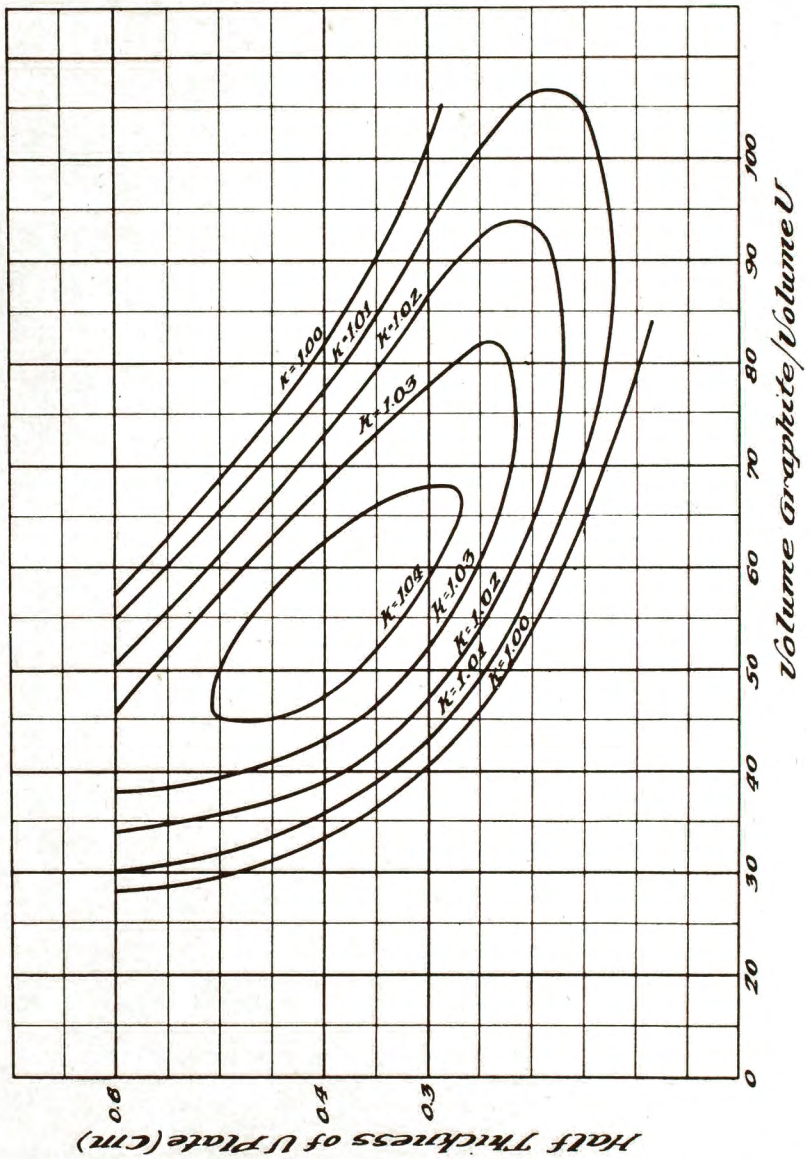
Inventors:
Enrico Fermi
Leo Szilard
By Robert A. Spencer
Attorney

Sept. 24, 1957 E. FERMI ET AL 2,807,581

NEUTRONIC REACTOR

Filed Oct. 11, 1945 6 Sheets-Sheet 6

FIG. 8.



Witnesses:
Herbert E. Metcalf
Henry E. Stanton

Inventors:
Enrico Fermi
Leo Szilard
By Robert A. Emmons
Attorney

United States Patent Office 2,807,581
Patented Sept. 24, 1957

2,807,581

NEUTRONIC REACTOR

Enrico Fermi, Santa Fe, N. Mex., and Leo Szilard, Chicago, Ill., assignors to the United States of America as represented by the United States Atomic Energy Commission

Application October 11, 1945, Serial No. 621,838

2 Claims. (Cl. 204—193.2)

The present invention relates to the general subject of nuclear fission and particularly to the establishment of self-sustaining neutron chain fission reactions in systems embodying uranium having a natural isotopic content.

This application is a continuation in part of our co-pending application Serial Number 568,904 filed December 19, 1944, now matured into U. S. Patent 2,708,656, issued on May 17, 1955.

When it became known that the isotope U^{235} in natural uranium could be split or fissioned by bombardment with thermal neutrons, i. e., neutrons at or near thermal equilibrium with the surrounding medium, many predictions were made as to the possibility of obtaining a self-sustaining chain reacting system operating at high neutron densities. In such a system, the fission neutrons produced give rise to new fission neutrons in sufficiently large numbers to overcome the neutron losses in the system. Since the result of the fission of the uranium nucleus is the production of two lighter elements with great kinetic energy, plus approximately 2 fast neutrons on the average for each fission along with beta and gamma radiation, a large amount of power could be made available if a self-sustaining system could be built.

In order to attain such a self-sustaining chain reaction in a system of practical size, the ratio of the number of neutrons produced in one generation by the fissions, to the original number of neutrons initiating the fissions, must be known to be greater than unity after all neutron losses are deducted, and this ratio is, of course, dependent upon the values of the pertinent constants.

In the co-pending application of Enrico Fermi, Serial Number 534,129, filed May 4, 1944, and entitled "Nuclear Chain Reacting Systems," now Patent No. 2,780,595, dated February 5, 1957, there is described and claimed a means and method of determining the neutron reproduction ratio for any type of uranium containing structure, directly as a result of a simple measurement which can be performed with precision. Accurate values for all of the pertinent nuclear constants need not be known.

In a self-sustaining chain reaction of uranium with slow neutrons, as presently understood, 92^{238} is converted by neutron capture to the isotope 92^{239}. The latter is converted by beta decay to 93^{239} and then to 94^{239}, also by beta decay. Other isotopes of 93 and 94 may be formed in small quantities. By slow or thermal neutron capture, 92^{235} on the other hand, can undergo nuclear fission to release energy appearing as heat, gamma and beta radiation together with the formation of fission fragments appearing as radioactive isotopes of elements of lower mass numbers, and with the release of secondary neutrons.

The secondary neutrons thus produced by the fissioning of the 92^{235} nuclei have a high average energy, and must be slowed down to thermal energies in order to be in condition to cause slow neutron fission in other 92^{235} nuclei. This slowing down, or moderation of the neutron energy, is accomplished by passing the neutrons through a material where the neutrons are slowed by collision.

Such a material is known as a moderator. While some of the secondary neutrons are absorbed by the uranium isotope 92^{238} leading to the production of element 94, and by other materials such as the moderator, enough neutrons can remain to sustain the chain reaction, when proper conditions are maintained.

Under these proper conditions, the chain reaction will supply not only the neutrons necessary for maintaining the neutronic reaction, but also will supply the neutrons for capture by the isotope 92^{238} leading to the production of 94, and excess neutrons for use as desired.

As 94 is a transuranic element, it can be separated from the unconverted uranium by chemical methods, and as it is fissionable by slow neutrons in a manner similar to the isotope 92^{235}, it is valuable, for example, for enriching natural uranium for use in other chain reacting systems of smaller overall size. The fission fragments are also valuable as sources of radioactivity.

An initial number of fast neutrons in the system by going through the process of absorption and fission produce in the next generation a number of neutrons generally different from the initial number. The ratio of the number produced after one generation to the initial number for a system of infinite size is called the reproduction or multiplication factor of the system and is denoted by the symbol K. For any finite system, some neutrons will escape from the periphery of the system. Consequently a system of finite size may be said to have a K constant, even though the value thereof would only exist if the system as built were extended to infinity without change of geometry or materials. Thus, when K is referred to herein as a constant of a system of practical size, it always refers to what would exist in the same type of system of infinite size. If K can be made sufficiently greater than unity to indicate a net gain in neutrons in the theoretical system of infinite size, and an actual system is built to be sufficiently large so that this gain is not entirely lost by leakage from the exterior surface of the system, then a self-sustaining chain reacting system of finite and practical size can be built to produce power and related by-products by nuclear fission of natural uranium. The neutron reproduction ratio in a system of finite size, therefore, differs from K by the external leakage factor, and by a factor due to the neutron absorption by localized neutron absorbers, and the reproduction ratio must still be sufficiently greater than unity to permit the neutron density to rise exponentially with time in the system as built.

Progressive empirical enlargement of any proposed system for which the factor K is not accurately known in an attempt to attain the overall size of a structure of finite size above which the rate of loss of neutrons by diffusion through the periphery of the structure is less than the rate of production of neutrons in the system leads only to an expensive gamble with no assurance of success. The fact that K is greater than unity and the fact that the critical size is within practical limits must be known rather accurately in advance, as otherwise a proposed structure having a K factor less than unity, or even a K factor greater than but close to unity, might not sustain a chain reaction even if all of the uranium in the world were included.

The earliest attempts to predict a structure capable of sustaining a chain reaction, using natural uranium, involved the use of fine uranium particles such as uranium oxide powder, dispersed in hydrogen in combined form as the slowing agent. However, these attempts were not successful, and analysis of experiments made has indicated that the neutron losses in such a system when natural uranium is used, will prevent a chain reaction from being sustained, irrespective of the size of the system, due

to neutron absorption at resonance, in the U^{238} content of the uranium.

However, as we have pointed out in our above cited application, it is possible by proper physical arrangement of the materials to reduce substantially uranium resonance absorption. By the use of light elements for moderators, fewer collisions are required to slow the neutrons to thermal energies with large increments of energy loss per collision, thus decreasing the probability of a neutron being at a resonance energy as it encounters a uranium atom. During the moderation, however, neutrons are moving through the slowing medium over random paths and distances so that the uranium is not only exposed to thermal neutrons but also to neutrons of energies varying between the energy of fission and thermal energy. Neutrons at uranium resonance energies will, if they enter uranium at these energies, be absorbed on the surface of a uranium body whatever its size, giving rise to surface absorption. Any substantial reduction of overall surface of the same amount of uranium will reduce surface absorption, and any such reduction in surface absorption will release neutrons to enter directly into the chain reaction.

For a given ratio of moderator to uranium, surface resonance absorption losses of neutrons in the uranium can be substantially reduced by a large factor when the uranium is aggregated into spaced substantial masses in the molerator. The uranium may be placed in the system in the form of geometrically spaced uranium masses or bodies of substantial size, preferably either of metal, oxide, carbide, or combinations thereof. The term geometric is used to mean any pattern or arrangement wherein the uranium bodies are distributed in the moderator with at least a roughly uniform spacing and are roughly uniform in size and shape, or are systematic in variations of size, shape or spacing to produce a volume pattern conforming to a generally symmetrical system. If the pattern is a repeating or rather exactly regular one, the structure may be conveniently described as a lattice.

The resonance losses in uranium constitute one of the critical factors in the total losses permissible in a neutronic reactor. Proper sizes and shapes of the uranium bodies and volume ratios of uranium to moderator must be fairly accurately known in order that optimum geometry be approached, or if the used of near-optimum geometry is not desirable, then the permissible ranges of departure from the optimum should be determined, so that a reproduction ratio greater than unity can be maintained in a reactor of practical size.

Neutrons are also subject to capture by the moderator. While carbon and beryllium have very small capture cross sections for thermal neutrons, and deuterium still smaller, a fraction of the thermal neutrons present in the system under best conditions is lost by capture in the moderator during diffusion therethrough. It is therefore desirable to have the neutrons reaching thermal energy enter uranium as promptly as possible. This may be taken car of by using optimum or near optimum geometry where the resonance absorption is substantially equal to absorption in the moderator.

Moderators differ in their ability to slow down neutrons and in their capacity to absorb neutrons. An important criterion of the ability to slow down neutrons is what is known as the scattering cross section of the nucleus. The ability to absorb or capture neutrons is expressed by what is known as the capture cross section of the nucleus. The ratios of absorption cross section to scattering cross section for various moderators are approximately as follows:

Light water (H_2O)	.00478
Diphenyl	.00453
Beryllium	.00127
Graphite	.000726
Heavy water (D_2O)	.00017

The choice of moderators, therefore, will depend on many considerations, as will be apparent from further discussions herein.

The parent application cited above has set forth that K factors greater than unity can be obtained by aggregating the uranium in the form of spheres, rods and layers, and has shown the structure, K factor and volume ratio ranges for uranium spheres and rods in various moderators. The present application deals solely with aggregation of the uranium into layers, sometimes called plates or slabs, in various moderators, and K factors and volume ratios for operative neutronic reactors embodying such construction.

While plate or slab geometry is not as efficient in reducing resonance absorption as sphere or rod geometry, due to the fact that the aggregation of the uranium into plates does not reduce the exposed surface as much as the other geometries mentioned, reactors embodying plate geometry have several advantages, especially when the plates are used in liquid moderators. The plates are thin in section for practical K factors, and in consequence can be easily cooled by circulation of the moderator. Furthermore, less jacketing material need be used for protection from the effects of moderator corrosion or to prevent fission product contamination of the moderator or coolant than in the other forms, and in consequence K reduction due to neutron absorption in jacket material is less. Fewer units need be used and handling problems are thus reduced. Therefore, in spite of a somewhat reduced efficiency, plate geometry has a definite place in reactor design.

It is, therefore, an object of the present invention to provide plate geometry neutronic reactors operative to sustain a chain fission reaction with natural uranium disposed in a moderator.

It is a further object of the present invention to set forth the ranges within which operative reactors can be constructed of alternate layers of natural uranium and a neutron moderator.

The objects and advantages of the present invention will be more readily understood from the following description read by reference to the drawings, which show two illustrative forms the present invention may take, as follows:

Fig. 1 is a diagrammatic vertical sectional view of the basic structure of a neutronic reactor incorporating spaced uranium plates immersed in a heavy water moderator;

Fig. 2 is a cross-sectional view taken as indicated by the line 2—2 in Fig. 1;

Fig. 3 is a cross-sectional view of a fragment of a uranium plate in a protective jacket;

Fig. 4 is a longitudinal sectional view taken as indicated by line 4—4, of Fig. 3;

Fig. 5 is a diagrammatic side view, partly in central section, of the basic structure of a neutronic reactor embodying uranium plates disposed in a solid moderator;

Fig. 6 is a graph or diagram showing K factors for uranium plates in terms of volume ratios of D_2O moderator to uranium and half thickness of uranium plate;

Fig. 7 is a graph or diagram for uranium plates in terms of volume ratios of Be metal moderator to uranium and half thickness of uranium plate; and

Fig. 8 is a graph or diagram for uranium plates in terms of volume ratios of graphite moderator to uranium and half thickness of uranium plate.

Referring first to Figs. 1 to 4 inclusive, in Fig. 1 a substantially cubical reactor tank 1 is shown preferably of aluminum or thin stainless steel containing a quantity of heavy water as indicated by liquid lines 2. The top of the tank 1 is closed by a cover plate 3 forming a space above the heavy water. A helium inlet pipe 5 and a helium outlet pipe 6 enter this space through the cover plate 3 of tank 1. In order that the heavy water may be circulated, a heavy water inlet pipe 7 is provided at the bottom of the tank and a heavy water outlet pipe 8 passes through the

cover plate 3 of the tank and extends downwardly into the heavy water.

The tank 1 is surrounded on five sides by a graphite reflecting layer 10 preferably built up from machined graphite blocks. This graphite layer is in turn surrounded on five sides by a shielding layer 11 formed from bricks of a cadmium lead alloy and cooled by water pipes 12. This shield is in turn surrounded by thick concrete walls 13, and at the top of the reactor is a stepped back opening to be filled during operation with shielding material 14, supported on beams 15, preferably removable, to complete the shielding around the sixth side of the reactor. In order to conserve heavy water in case of a leak in tank 1, a bottom cup-shaped lining 16 is provided between the graphite reflecting layer 10 and the cadmium shield 11, the lining 16 being drained through drainage pipe 17. Before shield 14 closes the top of the reacting system, fissionable material is inserted in the heavy water consisting in this case of spaced plates or slabs 20 formed from natural uranium. As shown particularly in Figures 1 and 2, the plates or slabs 20, formed of natural uranium, separate and isolate the heavy water or other moderator mass into distinct and individual layers, the width and length of each plate being substantially equal to the width and length of the adjoining moderator layers, each plate 20 having an uninterrupted surface area substantially equal to the cross-sectional area of the active portion of the reactor. A plurality of plates 20 is used to provide definite volume ratios of uranium to heavy water, as will be brought out later. Only a few plates are shown in Fig. 2 for clarity of illustration.

As it is at present impractical to roll or otherwise form complete sheets of uranium metal several centimeters thick, it is preferred to form each plate from a plurality of strips of uranium 10 to 20 centimeters wide and the full height of the plate, such strips being readily fabricated by rolling extruded uranium rods, for example, into flat strips. These strips 21 are shown in Figs. 3 and 4, and are positioned in edge to edge relationship to form a plate of the width desired and the composite plate thus made is enclosed in a thin aluminum jacket 22 comprising aluminum plates rolled in firm contact with the uranium and secured by turning the edges thereof and welding the aluminum sheets around the entire edge of the plate as indicated by weld 23.

To properly space the uranium plates 20 inside the reactor, spacer bars 24 are provided on the bottom of the reactor notched to receive the plates, and similar spacer bars 25 are positioned near the top of the uranium plates, so that the plates 20 are tied together with the assembly standing erect with the plates in parallel relationship inside the reactor. When the proper volume ratio of uranium to moderator is used with the plates of definite thicknesses and extent, a chain reaction will take place at elevated neutron densities. To remove the heat of the reaction from the reactor, it is preferred that the heavy water be circulated outside the reactor, cooled in heat exchangers not shown, and returned to the reactor.

The reactor is controlled first by the use of a control rod 30 (Fig. 1) which is movable from an upper corner bearing 31 by a shaft extending outwardly through the shields so that a greater or less extent of the rod will enter the heavy water between plates in the reactor. For safety reasons, a second rod 32, which may be termed a safety rod, is normally held horizontally above the level of the heavy water to be released at will to swing into the heavy water between the plates in case a predetermined neutron density is exceeded. The neutron density in the reactor can be monitored in several ways, such as, for example, monitoring the temperature of the outgoing heavy water, or more directly by measuring the neutron density just outside the tank 1 by means of an ionization chamber 34 connected to an indicating device in view of the operator of the reactor. Such ionization chamber will also permit the operator to start and stop the reactor and to reach a desired neutron density level by varying the amount of absorbing material in control rod 30 within the reactor. The size of the reactor is preferably such as to provide a neutron reproduction ratio of unity with the control rod material approximately half-way inserted into the reactor. Under these conditions, insertion of more of the rod into the reactor will stop the reaction while the removal of some of the rod material will permit a reproduction ratio over unity to be obtained so that the neutron density can rise to a desired level and then be held there by moving the control rod back to its position where the reproduction ratio is again unity. Thereafter, small movements of the control rod will permit the chosen neutron density value to be maintained.

Slab or plate geometry for the disposition of uranium in a moderator can also be used with solid moderators, such as, for example, graphite, or graphite and beryllium metal of high purity. In this case, a simple nuclear reactor can be made, for example, as shown diagrammatically in Fig. 5, in which construction the uranium plates need not be jacketed. In Fig. 5, the reactor comprises a heavy concrete shield wall 40 mounted on a concrete base 41 enclosing a cube 42 of solid moderating material preferably formed from machined bricks of graphite or beryllium metal to form a closely packed shield of moderating material. In this moderator cube 42 layers of uranium 43 are horizontally positioned by the bricks and spaced vertically to provide the desired geometry. The uranium layers, however, do not extend entirely to the surface of the moderator cube but terminate on all sides and above and below short of these surfaces to provide a reflecting layer 44 completely enclosing the uranium-bearing portion. In this case, control is by a horizontally movable control rod extendable into and out of the reactor through a slot 46 in the bricks, and the neutron density is monitored by an ionization chamber 47 positioned in the reflector. Control of the reaction in this case is as before by inserting more or less of rod 45 into the reactor. Safety rods, not shown, are also arranged to be pulled into the reactor by gravity upon an excessive rise in neutron density as indicated by the ionization chamber. Full details of the reactor control are given in our co-pending application cited above.

Having discussed several forms for the present invention, what will hereafter be called plate slab geometry as used in these reactors will next be discussed.

In reactors operating continuously at high powers (high neutron densities), radioactive elements of extremely high neutron capture cross section are formed inside the reactor within a few hours, notably the gaseous fission product $xenon^{135}$. The production of $xenon^{135}$ and its destruction by neutron absorption and by decay creates an equilibrium poisoning effect in the reactor determined as to value by the power at which the reactor is to be continuously operated. It can thus be seen that a neutronic reactor can have a satisfactory operating size when operated intermittently and at low power which is entirely too small to support a chain reaction when operated at some elevated power where a noticeable equilibrium amount of $xenon^{135}$ is formed. It is, therefore, necessary, to obtain a continuously operating reactor when a high power is required, to determine the operating sizes required to maintain the desired high power output. Thus, it will be seen there is actually a minimum critical (and operating) size for a neutronic reactor based on operating power, that is larger than the critical size for the reactor if zero power level is not to be substantially exceeded.

However, the reduction in the reproduction ratio due to the $xenon^{135}$ equilibrium amount present when the neutron density is theoretically infinity in the reactor, has been found to be about .03, which means that to obtain a rise in neutron density to any desired density up to infinity, the control rod would have to be eventually removed by an amount corresponding to an increase in

the reproduction ratio of about .03, and somewhat less than .03 when finite densities are to be obtained. In accordance with the density desired, the size of the reactor has to be initially big enough to provide the increase. For example, in a continuously operated water cooled uranium graphite reactor, the poisoning effect due to xenon^{135} at equilibrium in terms of the reproduction ratio is about .0012 at 10,000 kilowatts, .009 at 100,000 kilowatts, and about .013 and .020 at 200,000 kilowatts and 500,000 kilowatts, respectively. As before stated, operating sizes ordinarily are not sufficiently large to provide maximum reproduction ratios of over 1.01 with all controls removed. However, if power outputs over 100,000 kilowatts are desired, the reactor must have its critical and operating sizes defined as set forth herein, using final constants decreased by the xenon^{135} factor for the power desired, even though the amount of reduction is over .01. In other words a significant impurity is added during operation at high powers, and must be compensated for by enlargement of the reactor.

This may lead to the requirement for a reactor of such size that, if it did not acquire xenon^{135} during operation, could attain a maximum reproduction ratio of over 1.01 with all control rods removed, and which, before a substantial amount of xenon^{135} is formed, could in consequence attain a dangerous neutron density if controls were entirely removed.

Such a reactor can be adequately safeguarded by the use of "shim" or limiting rods of neutron absorbing material inserted in the reactor preferably to depths that will not permit a reproduction ratio of about 1.01 to be attained at any time during the operation of the reactor, even when the control rod is completely removed. Then, if a reproduction ratio of more than unity cannot be attained by outward movement of the control rod alone, due to the build-up of the xenon^{135} effect, the shim rod can be withdrawn to compensate for the xenon^{135} effect, but still be left in a position where the reproduction ratio cannot exceed 1.01, when the control rod is completely removed.

It can thus be seen that compensation for the xenon^{135} effect is obtained, first by considering the xenon^{135} impurity factor for the power desired, as a reduction in reproduction ratio to determine a proper operating size for a desired power; and second, by initially providing in the reactors, impurities that can be removed by amounts compensating for the xenon^{135} equilibrium amount acquired at a given power output. Clearly then, there are two operating sizes; one, that is able to sustain a chain reaction at low power in absence of any substantial amount of xenon^{135}; and two, a larger size able to sustain chain reaction with xenon^{135} present. Both must be known prior to building the reactor.

As D_2O is the best moderator so far known, the range of plate thicknesses and volume ratios for uranium in heavy water will first be discussed with reference to Fig. 6. In this figure, a family of K factor curves is shown as graphs on coordinates where the ordinates represent half thicknesses of the uranium slabs, and the abscissae the ratio of volume of the moderator to uranium volume.

Curves showing the K factors from unity to the optimum are shown, and it will be seen that the maximum K factor of somewhat more than 1.14 is found with a high volume ratio of about 25–1 and a half thickness of about .6 cm. and also at a lower volume ratio of about 7½–1 with a half thickness of about 3.0 cm.

As an example of the use of the curves of Fig. 6, when uranium slabs or plates are to be used as a reactive composition spaced 17 cm. in a D_2O moderator, the volume ratio will be about 43 to 1 with the uranium plates .4 cm. thick. The K factor will be about 1.1 from the curves in Fig. 6. If spaced 33 cm., the plates will be about .76 cm. thick and the K factor will be about 1.13.

The reduction of resonance absorption due to the use of slabs is sufficient to permit a chain reaction to be sustained in a reactor of practical size when beryllium metal is used as a moderator, with K factors obtainable for the reactive composition up to slightly over 1.08, as indicated in Fig. 7. In Fig. 7, K curves are plotted as graphs in the same manner as Fig. 6. It will be noted that in this case the K=1 curve is closed at the high volume ratio end, thus clearly indicating uranium units smaller than .15 cm. half thickness will not sustain a chain reaction with any volume ratio or in any size. Thus, a mixture of fine particles of natural uranium and beryllium will not be a reactive composition able to sustain a chain reaction. The reduction in resonance absorption by the use of alternate layers of uranium and beryllium does, however, permit the creation of the desired chain reaction.

Uranium plates can also be used with a graphite moderator, and K curves for uranium plates in graphite similar to those shown in Figs. 6 and 7, are shown in Fig. 8. Here it will be seen that optimum geometry occurs with a volume ratio of about 55–1 and a half thickness of the uranium plates of about 0.4 cm.

When the K factor is known, operating sizes for various reactive compositions can be found by the use of critical size formulae, modified to include size increase due to absorption in a cooling system, absorption caused by xenon^{135}, and excess reproduction ratio desired while operating as follows:

$$K-C-X-r=\frac{M}{R^2}$$

for spherical reactors where R is the radius in cm.

$$K-C-X-r=M\left(\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}\right)$$

for a parallelepiped where a, b, and c are the sides thereof in cm. and

$$K-C-X-r=M\left(\frac{1}{H^2}+\frac{0.59}{R^2}\right)$$

for cylinders where H is the height and R is the radius in cm.

In the above formulae:

K=Reproduction factor for a reactive compositon of infinite size

C=Reduction in K due to absorption in coolant tubes, coolant and in jackets to protect uranium from corrosion by the coolant, when any of these items are used inside the reactor

X=Reduction in reproduction ratio due to xenon^{135} poisoning at desired operating power

r=Excess of reproduction ratio desired while reactor is operating with xenon^{135} equilibrium established. This amount is usually not greater than 0.005 and may be 0.0005

M=a constant embodying the effect of the moderator and slab geometry, as follows:

M for $D_2O\cong 2500$
M for Be metal$\cong 3000$
M for graphite$\cong 6500$

However, reactive compositions by themselves are seldom used in a neutronic reactor because of the cost of materials and because of the fact that operating sizes can be very considerably reduced in size by surrounding the reactive mass with a layer of neutron scattering material to form what is known as a neutron reflector, as shown in Figs. 1–3. All good moderators are good reflectors.

The reduction in size due to the use of a reflecting layer surrounding the reactive mass is given for reflecting layers, which are thin with respect to the extent of the reactive mass, by the formula

$$\Delta r^1 \approx L \tanh \frac{\Delta r}{L}$$

where r^1 is the reduction in radius of the reactor due to surrounding the reactive mass by a reflecting layer Δr

thick and where L is the diffusion length for thermal neutrons in the reflecting material.

Using data given above, the reactor shown in Fig. 1, when surrounded on five sides with a 1 ft. reflector of graphite, and when using uranium plates having a thickness of 1.2 cm., a volume ratio of 15 total volume to 1 uranium and 1 mm. aluminum jackets will have an operating size for continuous operation up to 5000 kilowatts, for example, of 12.0 cu. meters for the active portion and will use 12.4 metric tons of D_2O and 15.2 metric tons of uranium. Similarly, a uranium slab-Be metal reactor such as shown and described herein having a 1 ft. Be reflector on all sides, and using uranium slabs 3 cm. thick with a volume ratio of about 10 to 1 will have a volume of 33.7 cu. meters in the active portion and will contain 59.0 metric tons of uranium and 56.6 metric tons of beryllium exclusive of 42.2 metric tons of beryllium in the reflector. This latter reactor, being uncooled, cannot be operated continuously at high power outputs, but reactors of this type can dissipate a few watts continuously, and up to 10,000 kilowatts intermittently for short periods.

When graphite is used as a moderator, in the form of bricks, for example, a neutronic reactor similar to that shown in Fig. 5 can be built. In this case, using optimum geometry as shown in Fig. 7, the K factor will be about 1.05, when uranium layers 0.8 cm. thick are used with a volume ratio of 55–1. The reactor, with a 1 foot graphite reflector, will have a volume of about 258 cu. meters, in the active portion and will contain 87.4 metric tons of uranium and 390 metric tons of graphite inclusive of 115 metric tons of graphite in the reflector.

What is claimed is:

1. A neutronic reactor consisting essentially of plates of natural uranium separating a moderator mass into distinct and individual layers, the width and the length of each plate being substantially equal to the width and length of adjoining moderator layers, and each plate having an uninterrupted surface area substantially equal to the cross-sectional area of the active portion of the reactor, said moderator mass selected from the group consisting of heavy water, beryllium and graphite, the thickness of the uranium plate and the volume ratio of moderator to uranium being within the area encompassed by the branches of the $K=1.00$ curves of Figures 6–8, and the purity of the moderator and the uranium and the total mass thereof being sufficient to sustain a chain reaction.

2. A neutronic reactor in the shape of a rectangular parallelepiped comprising a plurality of plates of natural uranium uniformly disposed in parallel relationship to each other in a moderator of heavy water, said plates separating the moderator into distinct and individual layers, and each plate having an uninterrupted surface area substantially equal to the cross-sectional area of the active portion of the reactor, the width and the length of each plate being substantially equal to the width and length of adjoining moderator layers, tubes communicating with the moderator to provide an inlet and an outlet for movement of the heavy water through the reactor, jackets on said uranium plates to isolate the uranium from the moderator, the volume ratio of moderator to uranium and the thickness of the uranium plate being within the area encompassed by the branches of the $K=1.00$ curve of Figure 6, the excess reproduction ratio, r being between 0.0005 and 0.005, the neutron absorption of the jackets, and the tubes diminishing the K factor by an amount C, the Xenon–135 concentration at the desired operating power diminishing the K factor by the amount X, and the dimensions a, b and c of the reactor active portion being given by the equation

$$K-C-X-r=M\left(\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}\right)$$

where M is a constant embodying the effect of the moderator and slab geometry, and having a value of 2500.

References Cited in the file of this patent

UNITED STATES PATENTS

2,708,656	Fermi et al.	May 17, 1955

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114,150	Australia	May 2, 1940
861,390	France	Oct. 28, 1940
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OTHER REFERENCES

Physical Review, Aug. 1, 1939, vol. 56 (1939), pp. 284–286. An article by Anderson, Fermi & Szilard.

Journal de Physique Series 7, 10, pp. 428–429 (1939), by Von Halban, Joliot, Kowarski, Perrin.

H. D. Smyth: "A General Account of the Development of Methods of Using Atomic Energy for Military Purposes," 1940–1945. Supt. of Doc., Washington, D. C., August 1945, pp. 22, 177.

Swain: "Power," July 1940, article titled "Uranium 235—Power Fuel of the Future?" pp. 56–59.

Kelly et al.: Phy. Rev., vol. 73 pp. 1135–9 (1948).

UNITED STATES PATENT OFFICE

Certificate of Correction

Patent No. 2,807,581 September 24, 1957

Enrico Fermi et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 74, for "r^{11}" read Δr^{1};.

Signed and sealed this 27th day of January 1959.

[SEAL]

Attest:
KARL H. AXLINE,
Attesting Officer.

ROBERT C. WATSON,
Commissioner of Patents.

Engagements

Dr.Richard G. Hewlett,
AEC Historian
United States
Atomic Energy Commission,
WASHINGTON 25, D.C.

Vienna, 3rd August, 1959.

Dear Dr. Hewlett:

Your letter of July 15 was forwarded to me to Europe. Since it is very difficult to get hold of me at Chicago, it would probably be better for us to meet when I am in Washington. I expect to be there some time in November and I shall contact you at the AEC when I am there.

In Washington the office of Dr. Robert B. Livingston, The National Institutes of Health, Bethesda 14, Md. Telefone: Oliver 64000, ext. 3501, usually knows my whereabouts.

Yours sincerely,

LEO SZILARD

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

IN REPLY REFER TO: ADBS

March 7, 1961

Dr. Leo Szilard
DuPont Plaza Hotel
DuPont Circle
Washington, D. C.

Dear Dr. Szilard:

As I promised, I am enclosing a copy of the tentative program for the Gatlinburg meeting. I think you will be interested in a number of the sessions, for example, Evelyn Witkin and Doudney have produced much of the data showing the influence of postirradiation events on the observed mutation rate in bacteria and the evening round-table discussion seems particularly germane to some of the questions we were discussing.

I would suggest that if you are interested in going that you write Hollaender very promptly since they may already have a full house.

I wish to thank you for your interest in these problems.

Sincerely yours,

M. R. Zelle
Assistant Director for
Biological Sciences
Division of Biology and Medicine

Enclosure

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UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
9800 SOUTH CASS AVENUE
ARGONNE, ILLINOIS

May 23, 1961

Dr. Leo Szilard
Quadrangle Club
1155 East 57th Street
Chicago 37, Illinois

Subject: U. S. PATENT NO. 2,798,847
AEC CASE NO. S-10,565

Dear Dr. Szilard:

I am pleased to enclose for your files a copy of the above patent.

I want to thank you for the courtesy and assistance which you extended to members of my staff in connection with the preparation and prosecution of the patent application.

Very truly yours,

George H. Lee, Chief
Chicago Patent Group

Enclosure:
Patent No. 2,798,847

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
9800 SOUTH CASS AVENUE
ARGONNE, ILLINOIS

August 31, 1961

Dr. Leo Szilard
Quadrangle Club
1155 East 57th Street
Chicago 37, Illinois

Subject: U. S. PATENT NO. 2,986,510; AEC CASE NO. S-98

Dear Dr. Szilard:

I am pleased to enclose for your files a copy of the above patent.

I want to thank you for the courtesy and assistance which you extended to members of my staff in connection with the preparation and prosecution of the patent application.

Very truly yours,

George H. Lee

George H. Lee, Chief
Chicago Patent Group

Enclosure:
Patent No. 2,986,510

GENERAL ADVISORY COMMITTEE
TO THE
U.S. ATOMIC ENERGY COMMISSION
P.O. BOX 3528
WASHINGTON 7, D.C.

January 4, 1963

ENRICO FERMI AWARD

Dear Sir:

The General Advisory Committee invites you as an individual to submit a nomination for the next Enrico Fermi Award. This Award is made under the provision of Section 157b(3) of the Atomic Energy Act of 1954 which states that, "..... The Commission may also, upon the recommendation of the General Advisory Committee, and with the approval of the President, grant an award for any especially meritorious contribution to the development, use, or control of atomic energy."

The first award under this Act was made on November 16, 1954, to Enrico Fermi. In December of 1955 the General Advisory Committee recommended to the Atomic Energy Commission that an Enrico Fermi Award be established on a permanent basis, and that it be international in scope, available to scientists of all nations. The recommendations, together with others pertaining to the Award, were approved by the Commission early in 1956.

The Commission determined that the Award should be made not more often than annually, and not necessarily annually. The recipients of the Award have been Dr. John von Neumann, Dr. Ernest O. Lawrence, Dr. Eugene P. Wigner, Dr. Glenn T. Seaborg, Dr. Hans A. Bethe, and Dr. Edward Teller.

The General Advisory Committee now has the duty of soliciting nominations for the next Award and of recommending a candidate or candidates to the Commission. The Committee and the Commission wish no worthy candidate to be overlooked. In making a nomination, please place principal emphasis on the statement of scientific and technical achievements upon which the nomination is based. Please minimize such data as can be found in standard reference works.

You may wish to know that nominees who fail of selection are retained on the Committee's list for further consideration for two additional years. If the candidate has not been selected in three consecutive years, his or her name will be removed from the list unless the candidate has been renominated in that time or until renominated.

Nominations for the next Award should be received by the Chairman, General Advisory Committee, U. S. Atomic Energy Commission, P. O. Box 3528, Washington 7, D. C., not later than March 1, 1963. Your assistance in making nominations will be greatly appreciated.

Sincerely yours,

Manson Benedict

Manson Benedict
Chairman

Dr. Leo Szilard
Dupont Plaza Hotel
Washington, D. C.

UNITED STATES
ATOMIC ENERGY COMMISSION
CHICAGO OPERATIONS OFFICE
9800 SOUTH CASS AVENUE
ARGONNE, ILLINOIS 60439

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September 20, 1963

Dr. Leo Szilard
Quadrangle Club
1155 East 57th Street
Chicago 37, Illinois

Subject: U. S. PATENT NO. 3,103,475
AEC CASE NO. S-1035

Dear Dr. Szilard:

I am pleased to enclose for your files a copy of the above patent of which you are the inventor.

I want to thank you for the courtesy and assistance which you extended to members of my staff in connection with the preparation and prosecution of the patent application.

Very truly yours,

George H. Lee

George H. Lee, Chief
Chicago Patent Group

Enclosure:
Patent No. 3,103,475

September 27, 1963

George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
9800 South Cass Avenue
Argonne, Illinois

Subject: U.S. Patent No. 3,103,475
AEC Case No. S-1035

Dear Mr. Lee:

Your letter of September 20th, with enclosures, has arrived while Dr. Leo Szilard is still abroad. Though I do not have a definite date for his return, I expect it will be in the early part of October. If Dr. Szilard finds it necessary to correspond with you further regarding your letter of September 20th, then you may expect to hear from him later in October.

With best wishes,

Very truly yours,

Kay M. Shannon
Secretary to Dr. Szilard

file

October 2, 1963

George H. Lee, Chief
Chicago Patent Group
United States Atomic Energy Commission
9800 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Lee:

On September 20th you were kind enough to send Dr. Leo Szilard a file copy of his patent, No. 3,103,475. I see that this is a 13 sheet document. The copy you sent Dr. Szilard did not include sheet 12 and, therefore, this is to request a copy of sheet 12 of the patent.

Thank you very much for your assistance in this matter.

Very truly yours,

Kay M. Shannon
Secretary to Dr. Szilard